Is Growth in Automotives Beneficial for Slovakia?
An Applied CGE Model Study

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Abstract

A static computable general equilibrium model of an open economy applied to the economy of Slovak Republic is presented in this paper. The data base of the model is a social accounting matrix created and adapted for purposes of this model and based on 2004 data. A methodology of a social accounting matrix disaggregation as an optimization problem of goal programming is proposed. The model applies to the automotive sector and shows how to analyze the impacts of changes in policy making such as increase of export, increase of export price and drop in production.

Keywords: *applied computable general equilibrium model, disaggregation, automotives*

JEL Classification: C68, C82

Preliminary

The aim of this paper is to shortly summarize knowledge about the principles and methodology of the computable general equilibrium (CGE) models and extend the current state of these models in Slovakia (see Benčík, 2001; Kotov, 2002; Páleník a Kotov, 2002; Páleník et al., 2004) by applied model of Slovakia with special emphasis to the sector of automotives. This paper presents the applied computable general equilibrium model and introduces a disaggregation method of social accounting matrix which was developed because of imperfect data availability or even unavailable data to construct the social accounting matrix.

Computable general equilibrium models are a class of economy-wide models used in policy analysis because they explicitly recognize that an exogenous change that affects any one part of the economy can produce repercussions

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throughout the system. CGE models describe by a system of equations the main idea that in economy resources equal to their uses. They are based on the micro-economic assumptions according to producers maximize profits subject to production functions, with primary factors as arguments, while households maximize utility subject to budget constraints. The model presented in this work is based on the model of Löfgren (2003) and is adapted to Slovak conditions. Changes were made in order to apply the model to the data base of System of national account according to ESA95 (Miťková, 2006).

Benčík (2001) elaborated the CGE problems in his work in which he constructs an experimental computable general equilibrium model of Slovakia based on Branch-and-Commodity Tables for the Supplies and Usage for year 1996. The model is used for import price increase simulation in primary industry by 8%, for import price increase of agricultural commodities, raw materials and products of primary industry. Benčík concludes that the model is able to provide rational results in spite of its considerable instability. Páleník and Kotov (2002) quantify the positives and the negatives of Slovakia's joining the European Union by the CGE model based on social accounting matrix for year 1998. The domestic production is aggregated to eight sectors of production represented by eight commodity sets. The sector of households is aggregated by the principle of the representative household, the same holds true for the sector of government which is understood as the whole area of public finance. All tax and non-tax revenues of government are expressed endogenously. The foreign is divided into the three groups: European Union countries, candidate countries approximated by CEFTA (Central European Free Trade Agreement) and the rest of the world. The model quantifies the changes in economy induced by the changes of VAT (*value added tax*) rate, changes of excise tax rate, changes of import rates of Slovakia in compliance with EU rates, changes of custom tariffs for exports of Slovakia in the countries of extended EU, changes of income for legal entities and for natural persons, by net incomes from the EU funds and by environmental investment costs. The overall conclusion of this work is that the entry of Slovakia to the European Union does not tend to the significant increase of the standard of living but that the total benefit prevail the total cost. Šikula (2003) and Páleník, Kotov and Kotulič Bunta (2004) extend the results of this work.

1. The Data Base of the Model

Models are usually based on social accounting matrix (SAM) which synthesizes two basic principles of economics: input-output idea according to which a purchase of one sector is a sale of another sector in the same time and principle

of national accounts according to which revenues equal expenditures. The model presentation is followed by a social accounting matrix that includes the data needed to solve the model using calibration. The functional forms of the various relationships embodied in the model have been selected so as to assure that all parameters can be directly derived from the underlying SAM. The calibration consists of finding numerical values for the model parameters so that for existing policy regime the model reproduces the benchmark data as a model solution (Dawkins at al., 1998). The first task in general equilibrium analysis is not finding the equilibrium state but use the current equilibrium for finding parameter values.

Social accounting matrices for Slovakia were constructed by Hajnovičová (1998) for the period of transformation of the economy in 1989 – 1990. The problem of the social accounting matrix is broadly discussed in Hajnovičová (2004) where a methodological framework was developed for SAM construction from data of National Accounts and Branch-and-Commodity Tables for the Supplies and Usage. In this work was presented the SAM for Slovakia, year 2000 and suggestions for SAM construction with emphasis to the labor market.

The social accounting matrix used in the construction of the presented model contains accounts of activities and corresponding commodities. The explicit distinction between activities and commodities facilitates model calibration, but it is not necessary. The distinction is needed for cases where at least one activity produces more than one commodity and/or at least one commodity is produced by more than one activity. Besides that SAM contains the accounts of households, the factors accounts, the government account, the savings – investments account, the tax account and finally the account of the rest of the world. The following aggregates from the system of national accounts are needed to fill in the SAM presented here:

P.1	Output	D.5	Current taxes on income, wealth, etc.
P.2	Intermediate consumption		
P.4	Real consumption	S.1	– domestic
P.4:S.13	– government	S.1	– foreign
P.4:S.14	– households	B.1g	Gross domestic product
P.6	Export	B.2g	Gross operating surplus
P.7	Import	B.3g	Gross mixed income
D.1	Compensation of employees	B.6g	Gross disposable income
D.1:S.1	– domestic	B.8g	Gross savings
D.1:S.2	– foreign	S.14	– households
D.2-D.3	Net taxes on production and import	S.13	– government
		S.2	– foreign
D.21-D.31	Net taxes on products	B.8n	Net savings
D.29-D.39	Net other taxes on products	B.12	Foreign trade balance
		K.1	Consumption of fixed capital

T a b l e 1

The Structure of Aggregated SAM for the CGE Model

	Activities	**Commodities**	**Factors**	**Households**	**Government**	**Investments**	**Income tax**	**Commodity tax**	**ROW**
Activities		*P.1*							
Commodities	*P.2*			*P.4(S.14) + B.12*	*P.4(S.13)*	*K.1 + B.8n*			*P.6*
Factors	*B.1g – (D.21 – D.31)*								
Households			*D.1(S.1) + B.2g + B.3g + (D.29 – D.39)*		calculation				*D.1 (S.2)*
Government							*D.5 (S.1)*	*D.21 – D.31*	calculation
Savings				*B.8g(S.14)*	*B.8g(S.13)*				*B.8g (S.2)*
Income tax				*D.5 (S.1)*					
Commodity tax		*D.21 – D.31*							
ROW		*P.7*							

Source: By author.

T a b l e 2

Aggregated SAM for Slovakia, 2004

	Activities	**Commodities**	**Factors**	**Households**	**Government**	**Investments**	**Income Tax**	**Commodity Tax**	**ROW**	**Total**
Activities		3 090 651								3 090 651
Commodities	1 879 977			907 934	168 509	315 712			1 018 835	4 290 967
Factors	1 210 674									1 210 674
Households			1 210 674		57 165				32 203	1 300 042
Government							81 240	144 588	4 690	230 518
Savings				310 868	4 844				0	315 712
Income tax				81 240						81 240
Commodity tax		144 588								144 588
ROW		1 055 728								1 055 728
Total	3 090 651	4 290 967	1 210 674	1 300 042	230 518	315 712	81 240	144 588	1 055 728	

Source: System of National Accounts (2004).

The structure of aggregated social accounting matrix corresponding to the model presented in this work is given in the Table 1. Particular cells show the national accounts assigned to the accounts of the matrix.

The System of national accounts for Slovakia, 2004 was used to fill in a SAM (Table 2). Some flows, as that for household-government account, have been calculated.

The goal of the CGE models is to analyze an impact of policy changes, so called external shocks, to the various parts of the economy. To enable the studies such effects the disaggregation of the social accounting matrix is needed. The most economic and natural way is to divide the sectors into the analyzed sector and the aggregate of the rest of sectors which allows us to study the changes in the analyzed sector in relation to the others. The sector of activities and the sector of commodities are divided according to this rule to the sector of automotives and the sector of remaining sectors, industries. The sector of households is divided to urban households and to rural households, the sector of factors to labor and capital factors. The tax account includes the income tax and the commodity tax.

Since sometimes there is no possibility to obtain the disaggregated data needed to fill in the SAM, we propose a disaggregation method employing all available information about sectors from National Accounts, Statistical Yearbooks, Branch-and-Commodity Tables for the Supplies and Usage, Trade Balance and others. Not always there are available up-to-date information, for example in year 2008 there were available National Accounts for 2004 latest and Branch-and-Commodity Tables for the Supplies and Usage for 2004 latest.

Data from various available sources are mostly a result of procedure of aggregation according to particular methodology; the precise back-disaggregation is not always possible. For this reason the optimization model of goal programming is constructed according to available information which allows us to find the values of coefficients for initial social accounting matrix disaggregation. This method allows disaggregation of SAM according to latest information available anywhere. Moreover, it allows disaggregation to many subsectors, to the arbitrary depth. The main advantage of this method comparing to RAS method (Stone at al., 1963) and Maximum Entropy method (Jaynes, 1957) is that does not require any information from previous period, including previous SAM.

Non-financial corporations' account (*S.11*) according to International Standard Industrial Classification of all Economic Activities (ISIC), (SNA 2004, Table III.4 – 1) provides information needed to set up the division of payments within the account of production (*P.1* Output), account of intermediate consumption (*P.2* Intermediate consumption), value added account (*D.1* Compensation of

employees). In this analysis the activities and commodities are disaggregated to the automotives and the rest of activities/commodities. The former include categories 34 – Manufacture of motor vehicles, trailers and semi-trailers, 35 – Manufacture of other transport equipment. Households' consumption account is disaggregated according to Gross money income and expenditure of private households by social groups (household budget surveys) (Statistical Yearbook, 2005, Table 5.2, yearly per capita averages) taking into account the Transport item. Households' income can be divided according to assumption about production factors use in specific proportions. For households savings is assumed that rural households save more than urban ones while the ratio of urban and rural households is given by number of inhabitants living in cities and in countryside according to the statistical yearbook.

Table 3 gives reference shares k_i^{pq} for all sectors of SAM for Slovakia in 2004.

T a b l e 3

Data for Disaggregation

Aggregate	***Reference Share*** k_i^{pq}		***Aggregate***
production in automobile industry	0.113	0.887	production in the rest of the industries
intermediate consumption on automotives	0.141	0.859	intermediate consumption in the rest industries
household consumption on automotives	0.067	0.933	household consumption on the rest commodities
government consumption on automotives	0.223	0.777	government consumption on the rest of commodities
investments in automotive sector	0.018	0.982	investments in the rest of industries
value added in automotive sector	0.039	0.961	value added in the rest of industries
household income from labor	0.300	0.180	consumption tax on the automotives
household income from capital	0.700	0.820	consumption tax on the rest of commodities
government transfers to urban households	0.550	0.550	foreign transfers to urban households
government transfers to rural households	0.450	0.450	foreign transfers to rural households
savings of urban households	0.500	0.500	savings of rural households
export of automotive commodities	0.247	0.753	export of the rest of the commodities
import of automotive commodities	0.143	0.857	import of the rest of the commodities

Source: System of National Accounts (2004); Statistical Yearbook (2004) and own calculations.

The equality of revenues and expenditures is formally expressed as the sum of row equals the sum of corresponding column:

$$\sum_{q=1}^{s} A^{pq} = \sum_{q=1}^{s} A^{qp} \text{ for } p = 1,\ldots,s \tag{1}$$

T a b l e 4a

Disaggregated SAM for Slovakia, 2004

		Activities		**Commodities**		**Factors**		**Institutions**		
		auto	rest	auto	rest	labor	capital	urban	rural	gov.
Activities	auto			329 136						
	rest				2 761 516					
Commodities	auto	3 457	147 250					31 065	30 866	38 747
	rest	277 913	1 451 357					425 650	420 353	129 762
Factors	labor	11 405	364 913							
	capital	36 361	797 995							
Institutions	urban					187 540	416 355			31 295
	rural					188 778	418 001			25 870
	gov.									
Savings	savings							155 463	155 405	4 844
Taxes	income							40 702	40 537	
	com.			16 949	127 639					
ROW	ROW			157 021	898 707					
Total		329 136	2 761 516	503 106	3 787 862	376 318	834 356	652 881	647 161	230 518

Source: System of National Accounts (2004); own calculations.

T a b l e 4b

Disaggregated SAM for Slovakia, 2004 (cont.)

		Investments	**Taxes**		**ROW**	**Total**
		inv.	income	com.	ROW	
Activities	auto					329 136
	rest					2 761 516
Commodities	auto	5 522			246 199	503 106
	rest	310 190			772 636	3 787 862
Factors	labor					376 318
	capital					834 356
Institutions	urban				17 690	652 881
	rural				14 513	647 161
	gov.		81 240	144 588	4 690	230 518
Savings	savings				–	315 712
Taxes	income					81 240
	com.					144 588
ROW	ROW					1 055 728
Total		315 712	81 240	144 588	1 055 728	

Source: System of National Accounts (2004); own calculations.

The problem of disaggregation is formulated as follows:

$$\begin{aligned}
&\min\left(d^{+}+d^{-}\right) \\
&\sum_{j=1}^{n} k_{ij}^{pq} + d^{-} \geq k_{i}^{pq} \quad i,=1,\ldots,n,\ p,\ q=1,\ldots,s \\
&\sum_{j=1}^{n} k_{ij}^{pq} - d^{+} \leq k_{i}^{pq} \quad i,=1,\ldots,n,\ p,\ q=1,\ldots,s \\
&\sum_{i=1}^{n}\sum_{j=1}^{n} k_{ij}^{pq} = 1 \quad p,\ q=1,\ldots,s \qquad (2) \\
&\sum_{q=1}^{s}\sum_{i=1}^{n}\sum_{j=1}^{n} k_{ij}^{pq}\cdot A^{pq} = \sum_{q=1}^{s}\sum_{i=1}^{n}\sum_{j=1}^{n} k_{ij}^{qp}\cdot A^{qp} \quad p=1,\ldots,s \\
&0 \leq k_{ij}^{pq} \leq 1 \quad i,j=1,\ldots,n,\ p,\ q=1,\ldots,s \\
&d^{+}, d^{-} \geq 0
\end{aligned}$$

where

A^{pq} – element of aggregated SAM,
a_{ij}^{pq} – element of disaggregated SAM,
k_{ij}^{pq} – split coefficient of SAM aggregate,
k_{i}^{pq} – reference split coefficient of SAM aggregate,
i, j – number of disaggregated accounts,
s – number of accounts,
d^{+}, d^{-} – deviation variables.

The values of disaggregated flows are obtained solving this optimization problem:

$$a_{ij}^{pq} = k_{ij}^{pq}\cdot A^{pq} \quad i,j=1,\ldots,n,\ p,\ q=1,\ldots,s$$

and are presented in Table 4.

2. The CGE Model of Open Economy

Notations sets:

activities α, $\alpha \in A = \{S-A, O-A\}$,
commodities c, $c \in C = \{S-C, O-C\}$,
factors f, $f \in F = \{LAB, CAP\}$,
institutions i, $i \in I = \{U-HHD, R-HHD, GOV, ROV\}$,
households h, $h \in H\,(\subset I) = \{U-HHD, R-HHD\}$,

where

$S-A$	– analyzed activity,
$O-A$	– aggregated other activities,
$S-C$	– analyzed commodity,
$O-C$	– aggregated other commodities,
LAB	– labor,
CAP	– capital,
GOV	– government,
ROW	– rest of the world,
$U-HHD$	– urban household,
$R-HHD$	– rural household.

The model is based on two basic microeconomic foundations: consumer utility maximization problem and firm's cost minimization problem. The problem of consumer utility maximization subject to household's income from ownership of production factors and household's expenditures less income tax and savings equality is formulated as follows:

$$\begin{aligned} &\max_{QH_{ch}} U\left(QH_{ch}\right) = \prod_{c\in C}\prod_{h\in H} QH_{ch}^{\beta_{ch}} \\ &s.t. \quad \left(1-mps_h\right)\cdot\left(1-ty_h\right)\cdot YH_h - \sum_{c\in C} PQ_c \cdot QH_{ch} = 0 \end{aligned} \tag{3}$$

and the household's demand function derived from this problem is

$$QH_{ch} = \frac{\beta_{ch}\cdot\left(1-mps_h\right)\cdot\left(1-ty_h\right)\cdot YH_h}{PQ_c}, \qquad c\in C,\ h\in H \tag{4}$$

where

mps_h	– ratio of disposable income of household h to savings,
ty_h	– rate of household h income tax,
β_{ch}	– share of commodity c in the consumption of household h,
PQ_c	– composite commodity c price,
QH_{ch}	– quantity of consumption of commodity c by household h,
YH_h	– household h income.

The production side is described by production function:

$$QA_\alpha = \alpha d_\alpha \cdot \prod_{f\in F} QF_{f\alpha}^{\alpha_{f\alpha}} \qquad \alpha\in A \tag{5}$$

and demand on production factors is derived from the production function such that the wage of factor equals the value of marginal product of that factor:

$$WF_f \cdot WFDIST_{f\alpha} = \frac{\alpha_{f\alpha} \cdot PVA_\alpha \cdot QA_\alpha}{QF_{f\alpha}} \qquad f \in F,\ \alpha \in A \tag{6}$$

where

αd_α – production function efficiency parameter in activity α,

$\alpha_{f\alpha}$ – value-added share for factor *f* in activity α,

PVA_α – value-added price of activity α,

QA_α – level of activity α,

$QF_{f\alpha}$ – quantity demanded of factor *f* by activity α,

WF_f – average wage of factor *f*,

$WFDIST_{f\alpha}$ – wage distortion factor for factor *f* in activity α.

The model embodies of two types of representative households which own two types of factors: labor and capital which are used in production of commodities. Two types of commodities are demanded by domestic consumers – households and foreign consumers – export. Besides that domestic consumers demand foreign commodity – import which are, with domestic commodity, also used as intermediate goods in production. Households receive income from the ownership of factors and the government and foreign transfers and they have to pay to the government sales tax and income tax.

The equations of the model are grouped in four blocks: price block, production and commodity block, institution block and system constraint block. In the price block, the exogeneity of import and export prices indicates that the country is small relative to the rest of the world. The export and import prices in domestic currency are simply expressed as multiples of export/import price in foreign currency and the exchange rate. The absorption, total domestic expenditures on commodities in domestic prices, is expressed as sum of the spending on domestic output and import. The domestic price together with the import price enters the composite commodity price. All domestic agents as households, government, producers and investors pay a composite price. The value of domestic output is set in producers prices as sum of domestic output sold in domestic country and the value of export for each commodity. It is distinguished among commodity prices, activity prices and value-added prices. The activity price is derived from suppliers' price and it depends on yield of commodity used per unit of particular activity. Value added per activity is given as the difference between the price of the activity and the price of the commodity used as intermediate good. Prices of factors tend to be distorted in the real world in the broad sense that they differ across activities.

In the production and commodity block it is assumed that all domestic consumers use composite commodities. Constant elasticity of substitution (CES) aggregation function captures the imperfect substitutability of domestic output

sold in domestic country and import. Composite commodity is "produced" by domestic commodities and imported commodities and enters the production function as input. It means that demander preferences over import and domestic outputs are expressed as CES function which is called Armington function. Constant elasticity of transformation (CET) function is identical to the CES function, expect to negative elasticities of substitution. The difference between CES and CET functions is that arguments of CES function are inputs and arguments of CET function are outputs. In this sector equations defining optimal mix between imports and domestic output and export and domestic sales, respectively, are also included. The difference between import demand equation and export supply equation is that demanded quantity of import is in an inverse relationship to the price of import and supplied quantity of export is directly related to the price of export.

The institution block states that factors are mobile across activities, available in fixed supplies and demanded by producers at market-clearing prices. On the basis of fixed shares, factor incomes are passed on to the households, providing them with their only income besides the transfers from the sector of government. The composite commodity is therefore demanded by the households at market-clearing prices. Thus it is assumed for the factor market that each activity pays a wage expressed as the product of a wage variable and a distortion factor. In each factor market, adjustments in the average wage clear the market. The investment demand is simply given as base-year investment adjusted by investment adjustments factor. Two types of taxes are implemented to the model: income tax and commodity tax, which make up the revenue of the sector of the government. On the other side the expenditures of the government consist of government demand on commodities and transfers to the households.

The system constraints block contains the set of equilibrium conditions that is functionally dependent for the economic system without being considered by its individual agents. The "micro constraints" consider individual factor markets and commodity markets and it is assumed (with few exceptions for labor, export and import) that flexible prices clear the markets. The "macro constraints" apply to the government, savings-investments balance and the rest of the world. The equilibrium for the government (government closure) is satisfied by its savings and the investment value adjusts to changes in the value of total savings. The model enables two types of closures for the rest of the world sector: the flexible exchange rate or flexible rest of the world savings. In this model the flexible exchange rate ensures the rest of the world closure. The equilibrium condition for factors market assumes that unemployment is fixed with activity specific real wage for labor and fixed use of capital for each activity. The equilibrium condition on the composite commodity market imposes equality of the demand side represented by all

types of domestic commodity use with the supply coming from the Armington function that aggregates import and domestic output sold domestically.

3. Analyzed Policy Changes in the Automotive Sector

We are concerned to the analysis of automotive industry in Slovakia since it is a frequently discussed topic nowadays. For first let's suppose the 5% increase in the price of the export of automotive commodity. This change results in the following macroeconomic aggregates as it is shown in the Table 5. Production in the automobile industry increases by approximately 2.75% while production in the rest of the sectors slightly decreases by 0.15%. The total GDP increases by more than 0.2 percent. The domestic market price of the automotive commodity decreases by 0.25% while its export price increases by 3.72%. It is less than the initial change and this result may be explained by multiplicative effect. On the other hand, the domestic market price of the rest commodities rose by 0.26%, while its export price dropped by 1.22%. These changes resulted in the decrease in the consumer price index by 0.32%. The exchange rate decreased by more than 1.3%.

For second suppose the 10% increase of export in the automotive sector. Changes are recorded in the Table 5 again. The production value decreased in the automotive sector (–0.66%) as well as in the rest of the industries (–0.1%). These changes may be explained by drop in prices which influence the value of the production: domestic market price of the automotive commodity decreased by 0.16%, while its export price decreased by 0.78%. The domestic market price of the rest of commodities rose by 0.17% and its export price dropped. The consumer price index decreased by 0.16%. Export of the rest of the commodities decreased by 1.88%. From the view of economic policy the expansion in the automotive sector represented by the export price increase or the export increase, ceteris paribus, leads to drop in investments. The primary feature of automotive sector expansion is the investment demand increase. This negative effect is eliminated in real economy. This may be also explained by the static character of the model which is appropriate for short run prognosis and deals with investment demand only with difficulties.

Since households are the owners of the firms and receive their profits we can focus on the welfare analysis of households. The Hicksian equivalent variation (EV) was used for evaluation of policy changes from the view of the urban and rural households' welfare comparison. The equivalent variation takes the old equilibrium incomes and prices and computes the change needed to achieve new equilibrium utilities. For a welfare improving change the value of EV is positive. For the economy as a whole, the welfare improvements are measured by aggregating the EVs across each type of household (Hicks, 1939).

T a b l e 5

Experiments Results

Macroeconomic aggregate	Initial Value	5% Increase of the Export Price		10% Increase of Export	
		value after shock	% change	value after shock	% change
Production, consumption, investment and income					
Production in automobile industry	334 429	343 614	2.75	332 209	–0.66
Production in the rest of the industries	2 759 693	2 755 603	–0.15	2 757 058	–0.10
Intermediate consumption	1 879 978	1 884 148	0.22	1 882 641	0.14
GDP	1 210 674	1 218 455	0.64	1 215 639	0.41
Household consumption on automotives	61 931	61 777	–0.25	61 833	–0.16
Household consumption on the rest of commodities	846 003	848 226	0.26	847 423	0.17
Urban household income	652 882	656 548	0.561	655 221	0.358
Rural household income	647 162	650 884	0.575	649 537	0.367
Investments in the sector of automotives	5 158	5 156	–0.03	5 157	–0.02
Investments in the sector of the rest of commodities	297 059	296 966	–0.03	297 003	–0.02
Government					
Government consumption on automotives	38 747	38 651	–0.25	38 686	–0.16
Government consumption on the rest of commodities	129 762	130 103	0.26	129 980	0.17
Government income	230 671	231 159	0.21	230 983	0.14
Government expenditure	225 678	225 074	–0.27	225 293	–0.17
Consumption tax on the automotives	17 323	17 359	0.21	17 195	–0.74
Foreign trade					
Export of the automotive commodity	246 199	266 161	8.11	267 460	8.64
Export of the rest of commodities	772 636	750 914	–2.81	759 090	–1.88
Import of the automotive commodity	157 021	158 078	0.67	157 683	0.44
Import of the rest of commodities	898 707	909 199	1.17	905 760	0.67
Exchange rate	1.000	0.988	–1.22	0.992	–0.78
Prices					
Costumer price index	1.046	1.043	–0.25	1.044	–0.16
Domestic market price of the automotive commodity	1.000	0.998	–0.25	0.998	–0.16
Domestic market price of the rest of commodities	1.000	1.003	0.26	1.002	0.17
Export price of the automotive commodity	1.000	1.037	3.72	0.992	–0.78
Export price of the rest of commodities	1.000	0.988	–1.22	0.992	–0.78

Source: Own calculations.

$$EV_h = \frac{U_h^N - U_h^0}{U_h^0} \cdot YH_h^0 \qquad h \in H \tag{7}$$

where

U_h^0 – pre-change utility level of household h,

U_h^N – changed utility level of household h,

YH_h^0 – pre-change income of household h.

For the increase of the export price the utility level has increased for both types of households and the income consisting from the factors income, government transfers and foreign transfers increased as well, as shows the Table 6. The equivalent variation, positive in both cases, indicates that urban and rural households are better off after this shock. This can be explained by increased domestic output value which is passed on to the households in form of factor income. It increases household's consumption demand for the rest of commodities which results in the higher utility level for both types of households. To achieve a pre-change utility level for the urban household, it must be taken away 25 183 monetary units and for the rural household, it must be taken away 14 648 m. u. The welfare comparison states that the households as aggregate representatives of individuals in the economy are better off after the change.

T a b l e 6

Welfare Analysis for 5% Increase in the Export Price of Automotive Commodity

	Urban Household	**Rural Household**	**Economy**
Pre-change utility level	$1.1835 \cdot e^{10}$	$1.1605 \cdot e^{10}$	
Changed utility level	$1.2291 \cdot e^{10}$	$1.1868 \cdot e^{10}$	
Pre-change income	652 882	647 162	
Changed income	656 548	650 884	
EV	25 183	14 648	39 831

Source: Own calculations.

For the increase in export, the utility level of urban and rural household increases indicating that individuals in the economy are better off after the modeled change. The income of the households increased and the welfare analysis indicates that it must be taken off 25 266 monetary units from the households to achieve their pre-change utility level, see Table 7.

Finally the model was used to evaluate the impact of current economic crisis in Slovakia. As it was stated before Slovakia is highly dependent on production in automotives nowadays. Let's suppose a 20% fall in production in the sector of

automotives and 15% fall in other sectors. This initial shock results in more than 28% decrease in the value production of automotives and more than 23% fall in the production of other sectors. This massive dropdown was caused partly by the initial shock, partly by multiplicative effect, and partly fall of the domestic price of automotives by 11.55% and other commodities by 9.9%. All prices in economy (domestic, export, import) fall resulting in CPI drop by more than 10%. The GDP falls by 6.3%. The welfare analysis states that the economic situation of households measured by changes in their utility level and income is better. The impact of the crisis represented by dropdown in production is hence ambiguous.

T a b l e 7

Welfare Analysis for 10% Increase in Export of the Automotive Commodity

	Urban Household	Rural Household	Economy
Pre-change utility level	$1.1835 \cdot e^{10}$	$1.1605 \cdot e^{10}$	
Changed utility level	$1.2124 \cdot e^{10}$	$1.1772 \cdot e^{10}$	
Pre-change income	652 882	647 162	
Changed income	655 221	649 537	
EV	15 962	9 304	25 266

Source: Own calculations.

Conclusion

The computable general equilibrium model of an open economy that uses the social accounting matrix for Slovakia, 2004 as a database was introduced in this paper. The optimization goal programming problem formulated as a system of linear equations was introduced for purposes of disaggregation the matrix and the resulting SAM disaggregated according to this procedure was presented. The static CGE model was discussed and used to analyze policy changes in the automotive sector.

Three scenarios were analyzed: the first for increase of the export price of the automotive commodity. While the export price of automotives increased as a direct repercussion of initial shock, the domestic price decreased; these changes together led to a higher value of production in automobile sector and higher value of exported automotives. The situation in the sector of aggregated rest of the commodities in contrary led to lower export price, higher domestic price, slightly decreased value of production and value of export. These changes resulted in higher GDP and lower CPI values. The households' welfare analysis concludes that both types of households are better off after this shock.

The second scenario simulated the increase of export in the automotive sector. The effect of such external shock was lower export and domestic price of automotives, which resulted in lower value of production in this sector. In aggregated rest of the sectors the value of export decreased because the export price lowered. The domestic price in this sector grew leading to higher value of the domestic consumption. The GDP increased in this case and CPI decreased. Similarly as in previous simulation, households' economics situation improves.

The third scenario simulated the economic crisis as fall in production in both sectors. Resulting changes led to huge fall in production, prices, and GDP; which are in congruence with international trade theories. According to the welfare analysis the households gain in this situation because the prices they face lowered and their income rose.

The strong orientation of Slovakia toward automotive industry may have either positive or negative effect because any external shock results in multiplicative effect throughout the economy as was illustrated in this paper. The overall effect of any change during the recession is ambiguous, resulting in one side in change of the GDP and in the other side in welfare of domestic households measured by their utility and income from the ownership of production factors. Based on the simulations made in this work we can conclude that growth in the automotive industry is definitely beneficial for the country's inhabitants.

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