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Poland's Membership in the European Union: An Analysis with a Dynamic Computable General Equilibrium (CGE) Model

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Poland's Membership in the European Union: An Analysis with a Dynamic Computable General Equilibrium (CGE) Model

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Abstract

This paper presents a dynamic Computable General Equilibrium (CGE) model for Poland's integration into the European Union (EU) that allows for quantification of income and welfare effects stemming from tariff reduction, border-cost reduction, reduction of technical barriers to trade and increased EU-transfers. For all channels, long-run income increases substantially compared with the reference scenario. The welfare effects are also positive, but much smaller because the welfare measure takes into account the time path of consumption throughout the adjustment period. Typical welfare effects are estimated at less than 1 percent of total consumption over time discounted to the beginning of the adjustment period. This low figure reflects the compression of consumption early in the adjustment period that finances the investment needed to build up the capital stock to support higher output and consumption farther into the future. The paper presents also sensitivity analyses for the CGE model concerning different specifications of the adjustment cost parameters, the intertemporal elasticity of substitution, the Armington substitution elasticity and the rate of time preference. The overall result of the examination of Poland's membership in the EU with the dynamic CGE model draws attention to the fact, that income growth effects as such are not necessarily welfare gains, since growth requires investment and therefore foregone consumption.

1 The Issue¹

At the 15th of February 2000 negotiations about membership in the European Union have started between the EU on the one side and Bulgaria, Latvia, Lithuania, Romania and Slovakia plus Malta on the other side. These countries thereby follow the Czech Republic, Cyprus, Estonia, Hungary, Poland and Slovenia who have opened negotiations about EU-accession in March 1998.² Poland is the largest transition country set to join the EU in the near future. The quantitative analysis about the effects of EU-membership presented in the following will concentrate on Poland as the most important candidate. However, the results will be qualitatively transferable to the other joining transition countries.

The objective of this paper is to derive an assessment of the potential consequences of Poland's accession to the EU. The analysis is based on a dynamic Computable General Equilibrium Model of a small open-economy Ramsey-type with intra-industry trade. The intertemporal feature of the Ramsey model allows to examine the development of the economy. Moreover, it shows clearly that consumption has to be foregone today in order to enable investment which will lead to higher output in the future and higher overall welfare. The paper discusses and illustrates the importance of the distinction between the income and welfare effects of regional integration.

The effects of Polish accession to the EU run two ways: EU economies will be affected too; however, since the present EU is already a large single market, the effects for the

¹ For helpful advice I thank Claudia Buch, Roberto De Santis, Glenn Harrison, Josef Konings, Rolf J. Langhammer, Matthias Lücke, Brian Parmenter, Carlo Perroni, Katrin Springer, David Tarr, Rainer Thiele, Bas Van Aarle, Erinc Yeldan and the participants of the LICOS research seminar, the Second GTAP conference and a CGE conference in Genoa. I am also grateful to Shantayanan Devarajan and Delfin Go from the World Bank for considerable help and the provision of the GAMS code that was extended for the present purpose. Financial support from the Volkswagen Foundation is gratefully acknowledged.

² At the EU-summit in Helsinki in December 1999, it was also decided to give Turkey a special candidate status.

European Union will be much smaller in relation to GDP than for Poland.³ Therefore, the following analysis will not attempt to assess the effects of an enlargement on the present member states, but will look at the effects for the joining country. Table 1 displays the regional trade structure of Poland for the year 1996 and 1997 and shows that 65 percent of Poland's foreign trade is with the present EU, 5 percent with the first echelon of countries that opened up negotiations about EU-membership in March 1998 (i.e. Cyprus, Czech Republic, Estonia, Hungary, Slovenia) and about 3 percent with the second echelon of EU-accession countries (i.e. Bulgaria, Latvia, Lithuania, Malta, Romania and Slovakia). Consequently, Poland will find itself in a single market with 26 partner countries that account for more than 70 percent of its foreign trade, which will deeply affect its export and import opportunities. Since EU membership also implies free trade in industrial goods with the other members of the European Economic Space (i.e. Iceland, Liechtenstein, Norway and with a special status Switzerland) and also Turkey, about three quarters of all Polish trade will be fully liberalized after accession (cf. Table 1).⁴

The paper is structured in the following way: Section 2 presents very briefly the concept of the dynamic effects of regional integration and the idea behind the dynamic modeling of these effects. Section 3 of the paper presents the dynamic model for the analysis of the integration of Poland into the European Union. Section 4 summarizes the potential channels of EU membership effects and section 5 offers five simulations of such effects. Section 6 concludes and describes some further avenues for research. The last section presents as an appendix sensitivity analyses for the specification of the adjustment

³ This assessment reflects also the findings of multi-country CGE models which simulate the effects of policy changes due to NAFTA (cf. Kehoe and Kehoe, 1994b). The income gain relative to GDP from NAFTA for Mexico is far higher than for the other two economies. The US and Canada as large and fairly open economies have limited scope for realizing further gains from regional integration by exploiting the opportunities of a slightly larger market size. Similar findings are supplied by a static multi-country CGE model for the Eastern enlargement of the EU (Baldwin et al., 1997), which shows that in relative terms the gains for the Eastern European countries are far higher than for the present EU members. Kohler (2000) surveys the expected effects of enlargement for the present members, based on the theory of economic integration.

⁴ Estimates of the expected trade pattern of the Central and Eastern European countries (CEECs) with a gravity model predict even a slightly higher share of the present EU in the CEECs' total foreign trade (Piazolo, 1997).

Table 1 — Poland's Trade with Partner Countries in 1996 and 1997

PRODUCT: Total Trade	FLOW: Imports				FLOW: Exports			
	1996		1997		1996		1997	
	Value in 1000 US\$	Percentage of Total Imports	Value in 1000 US\$	Percentage of Total Imports	Value in 1000 US\$	Percentage of Total Exports	Value in 1000 US\$	Percentage of Total Exports
World	37107424	100	42277231	100	24425663	100	25747222	100
EU	23383040	63.01	26632449	62.99	16004801	65.52	16322642	63.40
Austria	786791	2.12	831777	1.97	468694	1.92	465567	1.81
Belgium-Luxembourg	921381	2.48	1137709	2.69	593119	2.43	547016	2.12
Denmark	784050	2.11	797593	1.89	727401	2.98	740289	2.88
Finland	597690	1.61	715258	1.69	307520	1.26	323516	1.26
France	1988172	5.36	2461040	5.82	1058704	4.33	1115076	4.33
Germany	9123907	24.59	10143391	23.99	8381125	34.31	8444682	32.80
Greece	71835	0.19	78270	0.19	177608	0.73	94117	0.37
Ireland	183159	0.49	210536	0.50	62080	0.25	67798	0.26
Italy	3650713	9.84	4145513	9.81	1288497	5.28	1494801	5.81
Netherlands	1374503	3.70	1493213	3.53	1150723	4.71	1182496	4.59
Portugal	41747	0.11	64351	0.15	36142	0.15	25152	0.10
Spain	736195	1.98	1020625	2.41	243460	1.00	280311	1.09
Sweden	970159	2.61	1247812	2.95	565465	2.32	592579	2.30
United Kingdom	2152738	5.80	2285361	5.41	944263	3.87	949242	3.69
First Echelon of EU Accession	1699422	4.58	2037603	4.82	1265222	5.18	1367336	5.31
Czech Republic	1119859	3.02	1288754	3.05	817730	3.35	882696	3.43
Estonia	20952	0.06	24061	0.06	50363	0.21	47700	0.19
Hungary	411874	1.11	556631	1.32	295838	1.21	367897	1.43
Slovenia	145123	0.39	166999	0.40	38893	0.16	44747	0.17
Cyprus	1614	0.00	1158	0.00	62398	0.26	24296	0.09
Second Echelon of EU Accession	633377	1.71	725726	1.72	647505	2.65	834597	3.24
Bulgaria	28050	0.08	32283	0.08	42637	0.17	58083	0.23
Latvia	14717	0.04	17928	0.04	69263	0.28	99526	0.39
Lithuania	104747	0.28	106737	0.25	205977	0.84	308860	1.20
Romania	67247	0.18	63378	0.15	68483	0.28	72756	0.28
Slovakia	418616	1.13	505400	1.20	261145	1.07	295372	1.15
European Economic Space (apart from EU members)	902808	2.43	1004798	2.38	498697	2.04	359158	1.39
Iceland	7088	0.02	8245	0.02	9527	0.04	3807	0.01
Norway	363860	0.98	403745	0.95	291284	1.19	207952	0.81
Switzerland	531860	1.43	592808	1.40	197886	0.81	147399	0.57
Others	6015990	16.21	6937754	16.41	3523002	14.42	4380422	17.01
Belarus	250868	0.68	214666	0.51	246695	1.01	294681	1.14
Ukraine	409647	1.10	407709	0.96	942807	3.86	1170120	4.54
Russian Federation	2513529	6.77	2673868	6.32	1616729	6.62	2118369	8.23
Japan	586712	1.58	715939	1.69	50049	0.20	56095	0.22
Korea	651596	1.76	1059909	2.51	119463	0.49	92779	0.36
United States	1603638	4.32	1865663	4.41	547259	2.24	648378	2.52
Rest of the World	4472787	12.05	4938901	11.68	2486436	10.18	2483067	9.64

Source: OECD (1999), International Trade by Commodities Statistics (ITCS) CD-ROM; own calculations.

cost parameters, the intertemporal elasticity of substitution, the Armington substitution elasticity and the rate of time preference.

2 Dynamic Effects of Regional Integration and Dynamic CGE Models

Membership in the Single European Market implies not only preferential trade liberalization but also the freedom of movement for goods, capital, labor and firms. The resulting effects can be classified into allocation and accumulation or, alternatively, static and dynamic effects. The static effects relate to the reallocation of resources and expenditures in response to changing relative prices. The dynamic effects relate to changes in the amount of resources available, i.e. through increases (or decreases) in the capital stock due to changes in the profitability of investments.⁵

This paper attempts to model the dynamic effects of Poland's integration into the EU and uses a Computable General Equilibrium (CGE) model for this purpose. The CGE approach for the analysis of regional integration has attracted the Rodrik (1997) critique, stating that the gains from trade liberalization will be overestimated unless the model accounts for the foregone consumption necessary to build up the capital stock. Rodrik's critique is directed at the wide-spread use of comparative statistics analyses before and after trade liberalization. Also dynamic models have attracted this critique. Baldwin (1999) emphasizes that by focusing on income effects, CGE models based on a Solow type growth model (i.e. one-good economy, neoclassical production function and constant savings rate) might substantially overestimate the actual welfare effects when consumers optimize over time. Also, Harrison, Rutherford and Tarr (1996 and 1997) note that their calculations based on steady state comparisons ignore the foregone consumption necessary to obtain an increase in the capital stock. Furthermore, Rutherford and Tarr (1998 and 1999) propose that a CGE model analyzing dynamic effects of trade liberalization should account for endogenous growth. However, the link between endogenous growth theory and CGE modeling is still a young and fragile one.

The present Ramsey-type model accounts for the foregone consumption necessary to build up the capital stock as well as consumer optimization and includes a welfare measure

⁵ For a general discussion of the dynamic effects of regional integration the reader is referred to the relevant surveys by USITC (1997), Walz (1997) and Baldwin and Forslid (1999).

depending on the present value of all future consumption. Furthermore, the dynamic model is able to show the time path of most important economic variables.

Several static CGE models try to assess the consequences of the accession of the transition countries to the EU. However, only few CGE models examine the consequences of EU membership for a specific transition country.⁶ This paper is to my knowledge the first fully dynamic CGE study for Poland analyzing the effects of EU accession.⁷

3 The Dynamic Computable General Equilibrium Model for Poland

A dynamic single-country CGE model reflecting the economic conditions of Poland for 1996 is employed to assess the key effects of Poland's membership in the European Union. The Poland's Regional INtegration Computable Equilibrium (PRINCE) Model is of a small open-economy Ramsey type with intertemporal consumer as well as producer optimization and with intra-industry trade. The PRINCE Model is a perfect-foresight dynamic model: the decisions of the economic agents are intra- as well as intertemporally consistent. The theoretical framework for the Ramsey model is set out in greater detail in Blanchard and Fischer (1989) as well as Barro and Sala-i-Martin (1995).⁸ This model is an extension of the work by Devarajan and Go (1998) for the Philippines which is, in turn, a dynamic and expanded version of Devarajan et al. (1997) and Go (1994). The subsequent presentation follows the notation used by Devarajan and Go.

In the base structure of the model, which will be extended in future work, the economy is divided into two produced goods (exports and domestic goods) and two consumed goods (imports and domestic goods). Consequently, there is only one endogenous price per period (i.e. the price of the domestic good) to be solved for. There are three types of imports, each with a separate import duty: Capital imports, which are a fixed share requirement in investment, intermediate imports, and final imports, which compete with the domestic good. Imperfect substitution characterizes the competition between foreign and domestic

⁶ See Piazzolo (1998) for a selective survey of CGE models for transition countries and a discussion concerning the steady state assumption for transition countries.

⁷ Banse (1999) and Banse et al. (1999) offer a recursive dynamic CGE model for Hungary and Poland. Lensink (1999) examines the effects of interest rate deregulation and changes in reserve requirements for Poland with a CGE model containing a commercial banking sector and a central bank.

⁸ Implementations of the Ramsey Model as CGE models for the General Algebraic Modeling System (GAMS) are offered by Manne (1986), Go (1994), Lau et al. (1997) and Devarajan and Go (1998).

goods as reflected by the so-called Armington substitution elasticity between the domestic goods and final imports and by a constant elasticity of transformation (CET) between sales to the domestic market and sales to the export markets. The Armington specification assumes that the domestic products in consumer preferences differ from foreign goods. This allows the prices of domestic products to vary at given world market prices, exchange rates and import duties (cf. Kehoe and Kehoe, 1994a as well as Blonigen and Wilson, 1999). Consequently, it is possible to model two-way flows of goods, i.e. intra-industry trade.

3.1 Consumption of the Representative Household

The representative household maximizes overall utility, U , as given by:

$$(1) \quad U_o = \sum_{t=0}^{\infty} \left(\frac{1}{1+\rho} \right)^{t+1} u(C_t)$$

with

$$u(C_t) = \frac{1}{1-\nu} (C_t)^{1-\nu}$$

and

$$u'(C_t) = C_t^{-\nu}$$

U and C represent aggregate utility and aggregate consumption, whereas the parameters ρ and ν represent the rate of time preference and the constant elasticity of intertemporal substitution, respectively. See also Tables 2 to 4 for the notation. This formulation assumes that the household's utility at time 0 is the sum of all future discounted aggregate consumption. The rate of time preference ρ is positive and indicates that the consumption is valued the less the later it occurs.

The household faces a budget constraint and cannot spend more in present value terms on consumption than the overall household's wealth:

$$(2) \quad \sum_{t=0}^{\infty} \mu_t^c PC_t C_t \leq W_o$$

W denotes wealth, PC_t reflects the price of consumption at time t and μ_t^c represents a discount factor defined by:

$$(3) \quad \mu_t^c = \prod_{s=0}^t (1+r_s^c)^{-1}$$

Table 2 – Parameters and Parameter Values for the PRINCE Model

e_t^c	Real Exchange Rate for Demand	
e_t^p	Real Exchange Rate for Production	
i_t^*	World Interest Rate (= Debt Service /Debt)	(0.062 /0.072)
r_t^c	Interest Rate faced by the Consumer	
r_t^p	Interest Rate faced by the Producer	
μ_t^c	Discount Factor for Consumption; $\mu_t^c = \prod_{s=0}^t (1 + r_s^c)^{-1}$	
μ_t^p	Discount Factor for Production; $\mu_t^p = \prod_{s=0}^t (1 + r_s^p)^{-1}$	
α	Adjustment Cost Parameter for the Investment Function	0
β	Adjustment Cost Parameter for the Investment Function	2/4/8
α_c	Shift Parameter in the CES Function for Aggregate Supply	calibrated
α_e	Shift Parameter in the CET Function for Gross Output	calibrated
ρ_c	Exponent Parameter in the CES Function for Aggregate Supply	-0.875/-0.500/ 1.000
ρ_e	Exponent Parameter in the CET Function for Gross Output	2.666
δ_c	Share Parameter in the CES Function for Aggregate Supply	calibrated
δ_e	Share Parameter in the CET Function for Gross Output	calibrated
δ	Depreciation Rate	calibrated (0.067)
ρ	Rate of Time Preference = World Interest Rate	(0.052/ 0.062 /0.072)
ν	Constant Intertemporal Elasticity of Substitution	0.50/ 0.90 /0.95

Note: If several values for a parameter are given, than the **bold value** represents the one used in the main analysis of Part E. The other values are applied in the sensitivity analyses.

Table 3 – Quantities for the PRINCE Model

C_t	Aggregate Consumption
D_t	Domestic Goods
E_t	Exports
I_t	Net Investment
J_t	Gross Investment
K_t	Capital Stock
M_t	Final Imports
Q_t	Gross Output
$R(t)$	Net Revenue of the Firm
U_t	Utility
V_o	Value Added of the Firm
W_t	Wealth
X_t	Aggregate Supply
Y_t	Current Income

Table 4 – Prices for the PRINCE Model

PC_t	=	Price Aggregate Consumption at time t
PD_t	=	Price of Domestic Good
PE_t	=	Domestic Price of Exports
PM_t	=	Domestic Price of Imports
PK_t	=	Price of Capital
PQ_t	=	Price of Gross Output
PX_t	=	Price of Aggregate Supply

r_s^c is the interest rate faced by consumers, represents the opportunity cost of savings and equals therefore the cost of foreign borrowing. The cost of foreign borrowing depends on the world interest rate i^* and on the forward percentage change in the real exchange rate, e_t^c . The household has perfect foresight and the savings versus consumption decisions are "forward-looking":

$$(4) \quad r_t^c = i^* + \frac{e_{t+1}^c - e_t^c}{e_t^c}$$

The relevant real exchange rate for the consumer, e_t^c , is the price ratio of the goods bought by the consumer from abroad (PM_t – final imports denominated in domestic currency) relative to the ones purchased from the domestic market (PD_t – domestic goods):

$$(5) \quad e_t^c = \frac{PM_t}{PD_t}$$

The household's wealth, W_0 , consists of the discounted flow of income Y_t :

$$(6) \quad W_0 = \sum_{t=0}^{\infty} \mu_t^c Y_t$$

It is assumed that all transactions take place at the end of the period. This means that at the beginning of the first period income earned in that period has to be discounted by r_0^c . Similarly, the stock of wealth W_t in period t earns an interest income $r_t W_t$ at the beginning of the next period $t+1$.

The household's intertemporal optimization problem depicted in equation (1) can be represented, given the budget constraint, equation (2), as a Lagrangian:

$$(7) \quad L = \sum_{t=0}^{\infty} \left(\frac{1}{1+\rho} \right)^{t+1} u(C_t) + \lambda \left[\sum_{t=0}^{\infty} \mu_t^c PC_t C_t - W_0 \right]$$

With the first order conditions of equation (7), the following ratio must hold for the marginal utility of consumption for two periods, s and t :

$$(8) \quad \frac{u'(C_s)}{u'(C_t)} = \frac{PC_s}{PC_t} \frac{(1+\rho)^{s-t}}{\prod_{u=t+1}^s (1+r_u^c)}$$

The consumption pattern is determined by the relative prices of consumption in the respective periods, the time preference and the interest rate faced by the household. This ratio gives the marginal rate of substitution between the consumption of two periods.

For two adjacent periods, the following holds (cf. equation (1)):

$$(9) \quad \frac{C_{t+1}}{C_t} = \left(\frac{PC_{t+1}(1+\rho)}{PC_t(1+r_{t+1}^c)} \right)^{-\frac{1}{\nu}}$$

3.2 Investment Structure

The representative firm maximizes the present value of the income flows from its investment:

$$(10) \quad V_o = \sum_{t=0}^{\infty} \mu_t^p R(t)$$

$R(t)$ represents the net revenue of the firm. Here, the discount factor, μ_t^p , depends on the interest rate affecting the producer, r_t^p , which depends on the world interest rate and the forward percentage change in the real exchange rate. The relevant real exchange rate for the producer, e_t^p , reflects the price ratio of the goods sold by the producer, i.e. exports and domestic goods:

$$(11) \quad e_t^p = \frac{PE_t}{PD_t}$$

Consequently,

$$(12) \quad r_t^p = i^* + \frac{e_{t+1}^p - e_t^p}{e_t^p}$$

The capital stock K_t in each period is the sum of the capital stock of the previous period plus investment I_{t-1} and minus depreciation δ :

$$(13) \quad K_t = (1 - \delta)K_{t-1} + I_{t-1}$$

Investment is non-negative in each period. Due to adjustment cost, the necessary investment outlays, J_t , to achieve a certain level of net investment, I_t , has the following form:

$$(14) \quad J_t = PK_t \cdot I_t \left[1 + \frac{\beta}{2} \frac{\left(\frac{I_t}{K_t} - \alpha \right)^2}{\frac{I_t}{K_t}} \right]$$

PK_t stands for the price of capital, α and β are adjustment cost parameters. This is a standard formulation for the adjustment cost of investment. The capital installation costs are determined by the ratio of investment relative to the existing capital stock (cf. Uzawa, 1969). Fast increases in the capital stock are expensive and the establishment of the desired capital stock requires the more time the higher the adjustment costs.⁹

3.3 Trade and Capital Flows

The model economy is integrated into the world economy through trade and capital flows. It is assumed that capital is perfectly mobile and that the world interest rate is fixed from the point of view of the small open economy. As mentioned before, imports are used as intermediates, investment goods and consumption goods. Substitution between foreign and domestic goods is imperfect as reflected by the Armington constant elasticity of substitution (CES) between domestic goods and final imports for the household:

$$(15) \quad x_t = \alpha_c \left[\delta_c M_t^{-\rho_c} + (1 - \delta_c) D_t^{-\rho_c} \right]^{-1/\rho_c}$$

X_t , M_t and D_t represent aggregate (or composite) supply, imports and the domestic goods. α_c , δ_c and ρ_c stand for the shift parameter, the share parameter and the exponent parameter in the CES function for aggregate supply.

The price of the aggregate supply is determined by:

$$(16) \quad P_t X_t = P M_t M_t + P D_t D_t$$

⁹ Alternative specifications of the adjustment costs for the representation of transition countries within CGE models are discussed in Piazzolo (1998).

P_t, M_t and PD_t stand for price of aggregate supply, the price for imports and the price for domestic goods. The household minimizes the costs of the consumption of the aggregate supply by choosing the amount of consumption of imports and domestic goods by the following first order condition:

$$(17) \quad \frac{M_t}{D_t} = \left[\frac{\delta_c}{1 - \delta_c} \frac{PD_t}{PM_t} \right]^{1/(1+\rho_c)}$$

In a similar way, the firm allocates overall output with a constant elasticity of transformation (CET) to exports and the home market.

$$(18) \quad Q_t = \alpha_e \left[\delta_e E_t^{\rho_e} + (1 - \delta_e) D_t^{\rho_e} \right]^{1/\rho_e}$$

Q_t, E_t and D_t represent gross output, exports and the domestic goods. α_e, δ_e and ρ_e stand for the shift parameter, the share parameter and the exponent parameter in the CET function for gross output.

The price of the gross output is determined by

$$(19) \quad PQ_t Q_t = PE_t E_t + PD_t D_t$$

with PQ_t as the price of gross output. The firm maximizes the revenues of gross output by determining the amount of exports according to the following first order condition:

$$(20) \quad \frac{E_t}{D_t} = \left[\frac{(1 - \delta_e) PE_t}{\delta_e PD_t} \right]^{1/(\rho_e - 1)}$$

3.4 Equilibrium Conditions

Intratemporal and intertemporal equilibrium conditions have to be fulfilled for the model to be solved. The intratemporal general-equilibrium conditions are: demand equals supply for all goods and for labor, the current account balance is matched by the capital account balance, government savings plus government current expenditure (consisting of public consumption, transfers and subsidies) equals government revenue (derived from tariffs, domestic indirect taxes, income taxes and external borrowing).

Concerning the intertemporal equilibrium, it is important to note that the decisions about investment and domestic savings are made independently and that foreign savings fill the gap. Changes in future debt repayments due to the consequent increase in debt are fully anticipated in the household's decision between consumption and savings. A further intertemporal aspects of the model is that future prices and future quantities are fully

incorporated into the decisions concerning savings and investment. Consequently, in the steady state, prices and exchange rates are stable and convergence after a shock to the new steady state is unique. During the adjustment after a shock, savings and investment decisions may diverge due to the existence of two discount rates and different adjustment mechanisms for the consumer and the producer.

3.5 Database for the Poland's Regional INtegration Computable Equilibrium (PRINCE) Model

The Poland's Regional INtegration Computable Equilibrium (PRINCE) Model is implemented to approximate the Polish economy. The database reflects mainly the situation in 1996, with data supplied partly by the Gdansk Institute for Market Economics in Poland. Table 5 describes the aggregated social accounting matrix (SAM) for Poland for the year 1996 and shows the financial flows between the various economic agents in the economy. Thus, the SAM just provides a "snap-shot" for a certain year on the development path of the Polish economy. Furthermore, data about the exchange rate, debt and the import structure are needed. As mentioned before, imports are divided up according to the broad categories of consumer, intermediate, and capital imports, each with its own tariff level. On the basis of the tax information, the components of the Gross National Product at factor prices and the various tax ratios and price indices in the model are derived.

Table 5 — Social Accounting Matrix for Poland 1996 in Mill. Zloties

Income	Expenditures								Total
	Production		Factors	Institutions					
	Sectors	Goods		Firms	Households	Government	Capital Account	Abroad	
	1	2	3	4	5	6	7	8	
1 Sectors	685986.0							90091.7	776077.7
2 Goods	424619.6				236326.4	63428.0	73191.7		797565.7
3 Factors	305464.5								305464.5
4 Firms			139441.5						139441.5
5 Households			166023.0	139441.5					305464.5
6 Government	45993.6	11356.1							57349.7
7 Capital Account					69138.1	-6275.1		10328.7	73191.7
8 Abroad		100223.6				196.8			100420.4
9 Total	776077.7	797565.7	305464.5	139441.5	305464.5	57349.7	73191.7	100420.4	2554975.7

Note: For Social Accounting Matrix (SAM) structure cf. Thiele (1996: 101).

Source: Gdansk Institute for Market Economics (1999); GUS (1998); WIIW (1998); own calculations.

3.6 Calibration of the Dynamic General Equilibrium Model for Poland

The economic relationships within a CGE model are calibrated on the benchmark dataset. In the calibration process, exogenous variables (like tax rates) and exogenous parameters (like substitution elasticities) are combined with endogenous variables (like output) to determine the endogenous parameters (like the share parameters of the Armington elasticities). This calibration process computes parameters in such a way that the equilibrium solution of the model reproduces the observed data.

For simplicity, the paper assumes that the balanced growth rate equals zero. This allows a better interpretation of the results of the policy simulations in comparison to the reference run, since one escapes the otherwise necessary detrending of the exogenous growth rate. Consequently, the reference run steady state is in this case actually a stationary state. However, this model and the dynamic calibration procedure could incorporate an exogenously determined balanced growth rate which is larger than zero. For further simplification, all relevant data are scaled to per-capita terms (i.e. divided by the population). In the present form, a stationary population (i.e. no population growth) is assumed. Again, this restriction could be relaxed in an extension of this model.

For dynamic models, it is not feasible to calibrate the model exactly to the database of a particular year (as one would do in the case of a static model). This approach may violate the intertemporal consistency requirements, because the database may be inconsistent with the assumptions of the stationary or steady state. Therefore the dynamic model is calibrated to a base-year, but adjusted to reproduce a reference run with a base-year according to what a hypothetical stationary state for this year would have looked like. (cf. Knudsen et al., 1997: 83).¹⁰ The parameters are calibrated for such a reference run, which ensures that the model will generate an equilibrium solution with values that approximate the benchmark data of the economy in question. A change in policy or the advent of an

¹⁰ Alternatively, it has been suggested (Knudsen et al., 1998) to account explicitly for the fact that the base year is a temporary equilibrium on the path of temporary equilibria converging to the final stationary state (or steady state). Further development in CGE modeling might make it feasible to specify a whole range of temporary equilibria in the base-run. However, the present state of the art allows only to fix some of the endogenous variables at their values in the base year set in the first period, whereas from period 2 onwards such a model is identical to the standard dynamic model approach (Knudsen et al., 1998: 10). The temporary equilibrium of the first period is only achieved through additional restrictions valid for one period.

external shock will lead to an alternative path which will reflect the deviation from the steady state reference run.

In the dynamic calibration for the PRINCE model, the depreciation rate is determined endogenously to achieve consistency between the observed investment and the capital stock and consequently the required replenishment of the capital stock due to depreciation. In the steady state of an economy the investment ratio has to equal the depreciation rate if one abstracts from technological progress and population growth (see Table 2 for the derived depreciation rate).

4 Channels of EU Membership Effects

4.1 Tariff Reduction and Adoption of the Common External Tariffs of the EU

The Europe Agreements between the present EU members and 10 Central and Eastern European Countries have already led to a substantial reduction in bilateral tariffs and have in fact already created a kind of regional trading area. By the end of 1999, only few industrial goods from the EU to Europe Agreements partner countries or vice versa face any tariff. However, Poland charges an average tariff of 12 percent on industrial imports from third countries on a most favored nation basis, whereas the EU has a most-favored-nation (MFN) average tariff of only 2 percent. Via full EU membership, Poland will adopt the common external tariff of the EU. Furthermore, Poland will have to align its fiscal and agricultural policies with EU regulations, especially the Common Agricultural Policies (CAP). However, this alignment of agricultural policies involves a complex set of policy issues including various subsidy flows and price support schemes. For the present analysis, the detailed mechanisms of the CAP are neglected. Different scenarios for the development and the application of the CAP for the joining Eastern European countries are discussed in Herok and Lotze (1998). For the present study, the relevant issue is that full EU membership will lead to further overall tariff reduction in Poland, especially vis-à-vis third countries. In the following simulations, tariff reductions between Poland and the EU as well as between Poland and non-EU countries are included.

4.2 Reduction in Trade Costs Resulting from Borders

Before the implementation of the Single Market, the border cost for trade between the member states of the European Community was estimated to sum up to 1.7 percent of the

value of trade (Cawley and Davenport, 1988).¹¹ This border cost before 1992 was due to customs and fiscal controls between the members states. With the Single Market in force, no customs clearance is required at the borders and the remaining necessary forms documenting the flows of trade (e.g. for statistical purposes) can be completed in the European headquarters. The 1.7 percent border cost of the total amount traded has been recently used to derive the gains for the present EU member states from the Single Market with CGE analysis (Hoffmann, 1998) and can be employed to assess the benefits for acceding countries.

The importance of borders and of border costs has also been highlighted by studies examining trade between very similar advanced industrialized countries. McCallum (1995) finds in his analysis of trade among Canadian provinces and US American states that, other things equal, trade between two Canadian provinces is more than 20 times larger than trade between a Canadian province and a US state and concludes that even "relatively innocuous" borders with an average tariff rate of less than 5 percent may have a decisive effect on trade patterns. McCallum's research is based on data for 1988, i.e. the year in which the Canada-US Free Trade Agreement was signed. Consequently, McCallum's finding reflect the trade barriers between the two countries before the establishment of a free-trade area (CUSTA and subsequently NAFTA). Furthermore, a recent study (Dietz, 1999) about the price structure in Eastern Europe also reveals an extremely large East-West price gap.

4.3 Reduction of Technical Barriers to Trade

Exporters have to modify their products in order to achieve compliance with the technical standards and regulations of the importing country. In certain cases, the product has to be examined again by certifying institutions to obtain the permit to be sold abroad. These procedures incur substantial costs for the exporting company. The European Single Market attempts to reduce and eventually to abolish these technical barriers to trade between member countries in most cases by the European harmonization of standards and in fewer cases by enforcing the mutual recognition principle. The extra costs due to the technical barriers of trade arise at the production for the export market.

¹¹ In a recent study, the European Commission (1997) report a lower estimate of 1.0 percent of the value of trade. However, for Poland the participation in the Single Market is likely to lead to a greater reduction in the border costs.

This approach has been used for CGE modeling of the completion of the Single Market and its effect on the present members. Harrison et al. (1996) estimate that the reduction in the real trade costs from decreases in border costs and standardization costs sum up to 2.5 percent of the value traded. Based on this estimate Hoffmann (1998) uses a value of 0.8 percent of the value of trade as the additional trading costs due to technical barriers before the implementation of the European Single Market (i.e. the difference between the 2.5 percent estimated by Harrison et al. and the 1.7 percent used for the border costs – see above). Similarly, other CGE modelers like Kohler and Keuschnigg (1998) or Baldwin et al. (1997) include in their analysis of the Eastern Enlargement of the EU a reduction in trade cost due to membership in the Single Market summing up the reduction of border costs and of technical barriers to trade. Baldwin et al. assume in their study that EU membership of the Eastern European countries will lower east-west trading cost by up to 10 percent of the value of trade and experiment even with a 15 percent reduction in the trading costs. Consequently, the cut in trade costs resulting from borders in the magnitude of 1.7 percent of the value of trade and the decrease in trade costs due to technical barriers in the magnitude of 0.8 percent represent the lower bound of the estimates.

4.4 Transfers from Brussels

EU members contribute to the common EU budget according to an algorithm based on each country's VAT revenues. More important, however, for the joining countries are the transfers from the common EU budget. Most of these transfers are either connected to the structural funds or to the Common Agricultural Policy. Due to the uncertainties related to the development of the EU common agricultural policy and its compliance with the forthcoming millennium WTO round, the focus here is on the structural funds. A share of 5 percent of GNP probably represent an upper bound for the amount of structural funds flows to a present EU member country (cf. Baldwin et al., 1997). However, Baldwin et al. argue that due to the political economy of the EU and the reduced bargaining power of the new entrants, the gross flows from Brussels will be about 4 percent of GNP in the case of Poland and that the net flows will amount to about 1.5 percent GNP. The net transfer from the common EU–budget to Poland is modeled in the following simulations.

4.5 Other Effects

Three more channels through which EU membership might affect Poland will be mentioned, but not included in the simulations at the present stage. The exclusion is mainly

motivated by the difficulty of finding plausible magnitudes of the necessary parameter changes in the CGE analysis. Therefore, the gains derived in the simulation analysis (Section 5) are likely to represent the lower bound of the EU accession effects for Poland.¹²

4.5.1 Reduction in the Risk Premia

Regional integration will make the transition process irreversible, thus increases the credibility of government policies, and reduces the necessary risk premia of investment projects. The issue of investment under uncertainty has been laid out by Dixit and Pindyck (1994) as well as Brunetti and Weder (1998), whereas the credibility effects of regional integration for Eastern European countries are examined by Piazzolo (1999). Baldwin et al. (1997) discuss in detail the plausibility of the assumption that EU membership will reduce the risk premium on investment in Central Europe (by residents or foreigners), and work with values of up to 15 percent reduction in their CGE analysis.¹³

4.5.2 Migration Effects

Full EU membership also implies the free movement of labor. Migration can be one important channel to close the gap in wages levels between countries. However, since free circulation of labor migration is heavily debated (and objected) among present EU members, it is likely that the joining Eastern European countries will have to accept a further transition period after EU accession until labor is allowed to be as mobile as in the present EU. Consequently, in the present analysis, no migration flows are modeled. However, migration effects can be modeled with CGE models as it has been done for the NAFTA-case (cf. Hinojosa-Ojeda et al., 1995).

4.5.3 Demand Side Effects

A possible extension of the model for the analysis of the consequences of Poland's integration into the EU includes the question of substitution between domestically produced goods and imported goods. Through Polish accession to the EU, Polish and EU goods will become closer substitutes, which might affect the modeled effect, depending on

¹² Furthermore, it could be argued that EU accession will increase total factor productivity in the Eastern European countries. The implementation of the *acquis communautaire* (i.e. the entirety of EU legislation) requires a considerable rise in the technical standards. Outdated machinery has to be replaced by new, advanced capital stock, thereby introducing the latest technology.

the chosen demand function. This feature has not been implemented in this model, but this could be done following similar approaches by Harrison et al. (1996) and Hoffmann (1998) for the question of the completion of the Single Market, or Van Nieuwkoop and Müller (1999) for the question of Swiss Membership in the EU.

5 Simulations with the PRINCE Model

5.1 Integration Scenarios

Five simulations of EU membership effects are carried out examining four different channels of membership effects and the overall consequences if all changes are implemented simultaneously.

Scenario 1: Tariff reduction for products from the EU, EU-associated countries and European Economic Space countries. Poland's trade with these countries amount to 75 percent. However, many product categories in bilateral trade with these countries benefit already from duty free treatment due to the Europe Agreements. The implementation of the common external tariff of the EU will also lead to a tariff reduction for trade with other countries except that the CAP will establish high barriers for agricultural goods toward non-EU members. For total trade, a reduction of tariffs by 50 percent is simulated.

Scenario 2: Reduction in border costs: As mentioned before, the border costs before the implementation of the Single Market were assessed to amount to 1.7 percent of the total trade. Since more than 75 percent of trade will be affected, the reduction of trade costs for exports and imports are modeled through a decrease of $\frac{3}{4}$ of 1.7 percent, i.e. about 1.3 percent. In the single-country PRINCE Model, a reduction in trade costs is represented through a decrease in the import prices and an increase in the export prices.

Scenario 3: Reduction of technical barriers to trade: It is assumed, that technical barriers to trade incur additional trading costs of 1 percent of the amount traded. Again, since more than $\frac{3}{4}$ of trade will benefit from this reduction of trade costs, export and import trade costs are reduced by $\frac{3}{4}$ of 1 percent, i.e. by about 0.8 percent of the amount traded.

¹³ A related issue is the expected inflows in portfolio capital due to EU accession. EU membership requires further harmonization of financial market regulation and better access of foreign financial institutions. Until now the Eastern European countries have received far less portfolio capital than the southern members of the EU (cf. Buch et al., 1999). This is likely to change with full EU membership.

Scenario 4: Based on the arguments and calculations of Baldwin et al. (1997) a net transfer of 1.5 percent of the Polish GNP from the EU–budget is assumed. This is modeled as a permanent flow of resources similar to the remittances of Polish workers living abroad.

Scenario 5: All 4 simulations are implemented simultaneously.

5.2 Results

Table 6 shows the effects of these five simulations on welfare and on the most important macro-economic variables (consumption, investment, exports, imports, domestic good production, borrowing, debt and capital stock) relative to the reference run (i.e. without any changes). For the variables, values for the periods 1, 10, 20, 30 and 40 are presented allowing an examination of the intertemporal aspect of the simulated changes for all five scenarios. Additionally, one column (column five) is included representing the multiplicative aggregate (i.e. the product) of the four sub-scenarios for comparison with the overall effects stemming from the simultaneous simulation of these 4 scenarios. This comparison shows that the membership effects according to the multiplicative aggregate (column five) are far greater than in the case of the simultaneous implementation of the same four scenarios (column six). This is partly due to the adjustment costs for capital formation preventing a more rapid rise for investment. Furthermore, Figure 1 and 2 plot the development of the macro-economic variables for all time periods from 1 to 40 for the overall effects (i.e. the four scenarios simultaneously).

In all simulations, investment goes up in period 1, whereas consumption drops. The increased capital stock is then employed to produce more goods for domestic use and for exports in later periods with consumption rising above the reference–run level approximately from period 5 onwards.

It might be considered counter-intuitive how much consumption renouncement the utility maximizing household is willing to undertake, especially since borrowing from abroad is always possible at a fixed interest rate at the world market. However, consumption and investment decisions are fully decentralized and separate. Given a trade policy shock and the resulting relative price changes, the representative firm will react and optimize its

Table 6 — Simulations of Full EU Membership Effects for Poland – Relative to the Reference Run

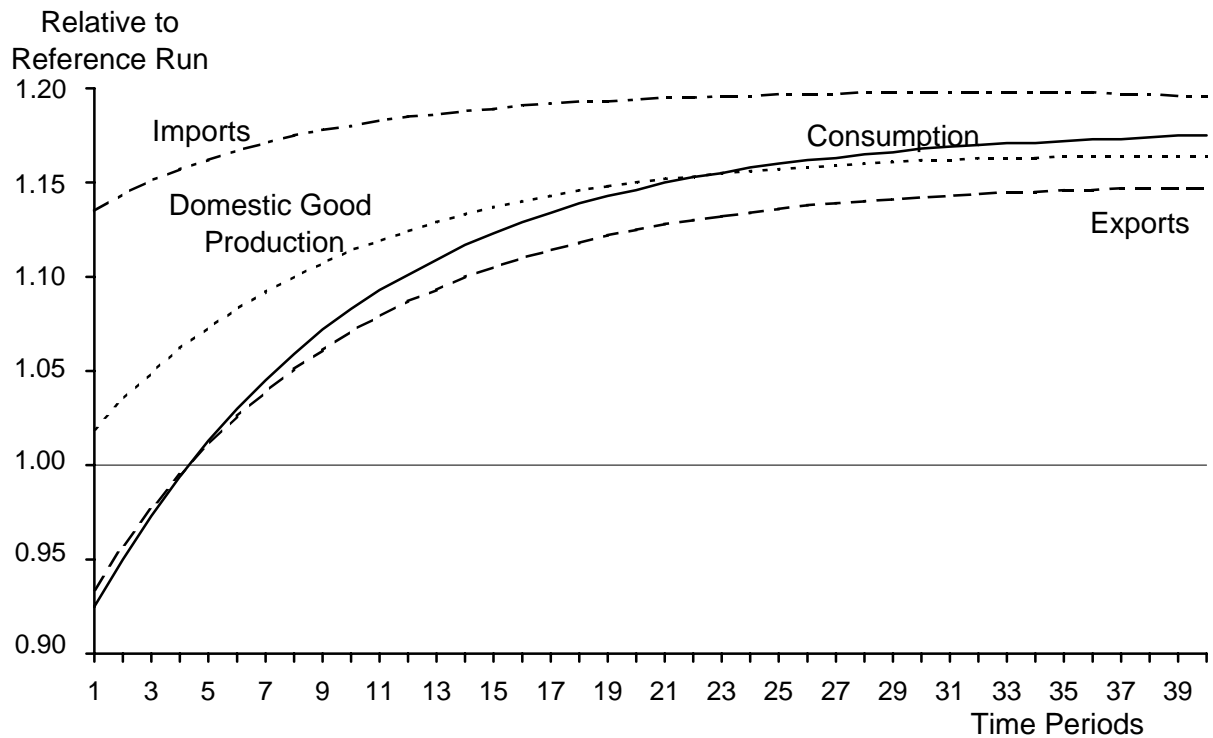
	Tariff Reduction	Border Cost Reduction	Reduction of Technical	Net-EU- Transfers to	Overall Effects	
					Aggregate of	New Simulation

			Barriers to Trade	Poland	the 4 Simulations	with 4 Effects Simultaneously	
Consumption							
Period	1	0.958	0.954	0.972	0.938	0.833	0.925
	10	1.015	1.033	1.021	1.055	1.129	1.083
	20	1.037	1.063	1.039	1.101	1.261	1.146
	30	1.044	1.073	1.045	1.116	1.306	1.168
	40	1.047	1.076	1.047	1.121	1.322	1.175
Investment							
Period	1	1.204	1.279	1.170	1.414	2.548	1.555
	10	1.160	1.221	1.132	1.335	2.140	1.468
	20	1.141	1.195	1.116	1.295	1.971	1.416
	30	1.134	1.185	1.111	1.280	1.911	1.395
	40	1.129	1.178	1.107	1.269	1.868	1.379
Exports							
Period	1	1.009	0.984	0.990	0.959	0.943	0.934
	10	1.061	1.054	1.033	1.062	1.227	1.071
	20	1.081	1.081	1.049	1.101	1.350	1.125
	30	1.088	1.090	1.055	1.114	1.394	1.142
	40	1.089	1.092	1.056	1.117	1.403	1.147
Imports							
Period	1	1.054	1.060	1.036	1.111	1.286	1.135
	10	1.068	1.079	1.048	1.141	1.378	1.180
	20	1.073	1.086	1.052	1.151	1.411	1.194
	30	1.075	1.088	1.053	1.153	1.420	1.198
	40	1.074	1.087	1.053	1.152	1.416	1.196
Domestic Good Prod.							
Period	1	0.997	1.005	1.003	1.012	1.017	1.019
	10	1.031	1.051	1.031	1.081	1.208	1.114
	20	1.043	1.068	1.042	1.107	1.285	1.150
	30	1.047	1.074	1.045	1.115	1.310	1.162
	40	1.048	1.075	1.046	1.117	1.316	1.164
Borrowing							
Period	1	1.534	1.729	1.443	2.032	7.784	2.378
	10	1.318	1.438	1.262	1.633	3.906	1.881
	20	1.177	1.243	1.145	1.353	2.265	1.500
	30	1.081	1.112	1.067	1.163	1.492	1.233
	40	1.000	1.000	1.000	1.000	1.000	1.000
Debt							
Period	1	1.000	1.000	1.000	1.000	1.000	1.000
	10	1.203	1.278	1.167	1.400	2.512	1.549
	20	1.216	1.296	1.177	1.428	2.648	1.596
	30	1.160	1.220	1.131	1.319	2.113	1.448
	40	1.089	1.122	1.073	1.177	1.543	1.250
Capital Stock							
Period	1	1.000	1.000	1.000	1.000	1.000	1.000
	10	1.083	1.114	1.069	1.172	1.512	1.236
	20	1.116	1.160	1.096	1.242	1.761	1.337
	30	1.126	1.174	1.104	1.264	1.846	1.370
	40	1.129	1.178	1.107	1.269	1.868	1.379
Overall Welfare Effects (in %)							
		0.1397	0.3085	0.1957	0.5154	1.1639	0.7676

Note: The table presents the effects of the various simulations on the most important macro-economic variables and on welfare relative to the reference run (i.e. without any changes). The column "Overall Effects - Aggregate of the 4 Simulations" represents the multiplicative aggregate for the macro-economic variables and the sum for the welfare measure of the four sub-scenarios.

Source: Calculations with the Poland's Regional INtegration Computable Equilibrium (PRINCE) Model.

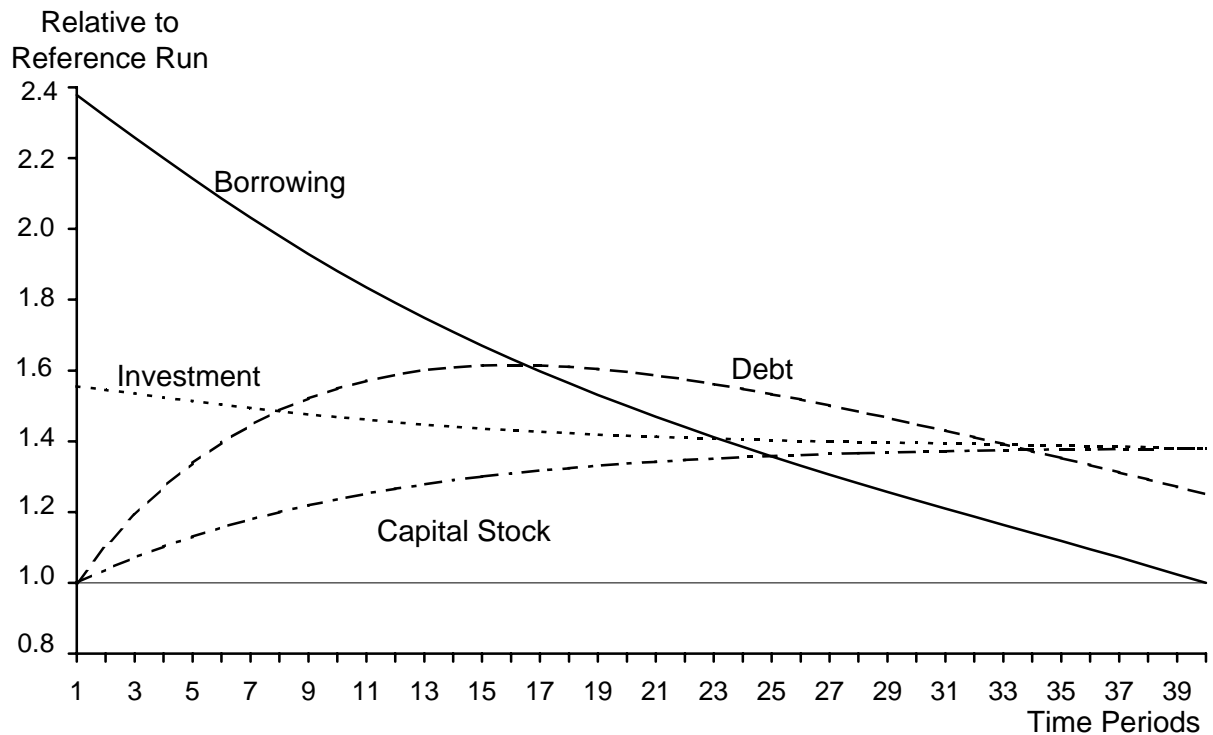
Figure 1 — Overall Effects of EU Membership on Consumption, Exports, Imports and Domestic Good Production – Relative to the Reference Run



Note: The modeled „Overall Effects of EU membership“ consist of the simultaneous implementation of the four scenarios tariff reduction, border cost reduction, reduction of technical barriers to trade and net-EU transfers.

Source: Calculations with the Poland's Regional INtegration Computable General Equilibrium (PRINCE) Model.

Figure 2 — Overall Effects of EU Membership on Investment, Capital Stock, Borrowing and Debt – Relative to the Reference Run



Note: The modeled „Overall Effects of EU membership“ consist of the simultaneous implementation of the four scenarios tariff reduction, border cost reduction, reduction of technical barriers to trade and net-EU transfers.

Source: Calculations with the Poland's Regional INtegration Computable General Equilibrium (PRINCE) Model.

investment decision as determined by the investment function and the intertemporal supply problem. As set out in equation (12), the relevant interest rate for the producer depends on the real exchange rate given by the price ratio of exports and domestic goods. If this price ratio changes due to a trade policy shock, the firm will adapt its investment to maintain asset equilibrium.

The increase in investment as a result of the trade policy change leads to an increase in the use of inputs for investment goods. The increased demand drives up the costs of inputs and, consequently, the initial price for consumption, which is not under the control of the household. Furthermore, the path of consumption is affected by the discount rate for consumption which includes the forward percentage change in the relevant exchange rate, the relative price between imports (PM) and domestic goods (PD) (cf. equations (4) and (5)). After the initial appreciation (PM/PD declines), the real exchange rate for consumption depreciates slowly year after year. As equation (9) determines, a slowly depreciating exchange rate leads to a slowly rising consumption path. To achieve intertemporal consistency, the consumption path has to shift downwards as a result of the trade policy change so that consumption is at the beginning indeed lower than in the reference-run. However, consumption is higher than in the reference-run for the fifth and all following periods. Borrowing increases considerably relative to the reference run, but a further increase in borrowing (to facilitate higher consumption at the beginning) would not be optimal since the capital inflow changes the exchange rate (away from the optimal level) and since the level of borrowing has to return at the terminal period to the original level (a requirement exogenously specified).

5.3 The Overall Effects of Poland's Accession to the EU

Welfare (as defined by the utility measure introduced earlier) increases in all five simulations.¹⁴ The simultaneous implementation of all four effects leads to an increase in welfare by 7.7 per mill. (0.7676 percent in the last row of the last column in the Table 6). Maybe, the size of the increase of welfare is judged to be surprisingly low. However, it has to be remembered that, in the reference run, the representative household maximizes utility

and is at the optimal level of investment. Consequently, the household is neutral toward having a marginal additional unit of capital since it requires a reduction in consumption. The discounted value of potential future additional income due to a marginal increase in the capital stock equals the value of the forgone consumption today. The changes due to EU membership might have considerable effects in the substitution between investment and consumption, yet the welfare effects are much smaller, since the welfare measure accounts for the foregone consumption.

The values for period 40 approximate the new steady state. For e.g. the scenario of the tariff reduction, consumption and domestic good production in the new steady state are 4.7 percent higher relative to the base scenario. The increase in consumption can act as a proxy for the income effect of the trade policy changes. The comparison of the different EU membership effects shows that the modeled net transfer from the EU budget to Poland has the most profound effect on the welfare measure (with an increase by 5.1 per mill). This is due to the substantial increase in investment that is made possible through the funds of the EU partner countries: The simulation shows that investment increases by more than 40 percent in the first period whereas consumption has to be reduced by only 6 percent. This sharp rise in investment points to necessary amendments concerning the modeling of adjustment costs for investments. Some sensitivity analyses for the adjustment cost parameter, are represented in the Appendix (Section 8) and also for the intertemporal elasticity of substitution.

5.4 Issues for Further Research

EU membership is represented in these CGE models as a sudden and unexpected shock, which is not entirely realistic. Consequently, it is also not reasonable to believe that the year of EU accession will bring a dramatic increase in investment. Due to the anticipation of full EU membership and the gradualism practiced in accession, economic agents will adapt (and have already adapted in the cases of the advanced Central and Eastern European countries) their behavior beforehand. Actually, dynamic CGE modeling also allows the

¹⁴ Given that the utility function represents the rational preferences of a representative household with perfect foresight, the utility function can act as a proxy for a welfare measure (cf. Ng, 1983: 7-12). The utility function embedded within a CGE model is frequently used as an exact and convenient evaluation of welfare changes (Martin, 1997: 77). It should be noted that the used welfare measure here is given in "utils".

possibility of phasing in trade policy changes over a longer time periods.¹⁵ If, however, the rational economic agent expects changes in the future, he or she will change the behavior accordingly to maximize utility.

Several research opportunities follow from this paper. First, the other three mentioned channels of EU membership effects (reduction in the risk premia, migration and demand side effects; Section 4.5) could be modeled. Second, the robustness of the findings could be checked with further sensitivity analyses, i.e. by comparing the results when parameters like the Armington substitution elasticities are changed. Third, the announcement effects of regional integration could be investigated with this CGE model along the lines of Willenbockel (1998). Lastly, the model could be extended either to a further disaggregation of sectors or to a multi-country level.

6 Conclusion

The simulations of Poland's membership in the European Union with the Poland's Regional Integration Computable Equilibrium (PRINCE) Model reveal positive effects stemming from regional integration. EU membership effects were modeled through tariff reduction, border cost reduction, reduction of technical barriers to trade, and net EU-transfers from Brussels to Poland. For the simultaneous implementation of all four effects of EU membership, consumption in the new steady state is 17.5 percent higher than in the starting point. The simulations show that the higher future consumption stemming from the increased capital stock requires considerable investment today i.e. foregone consumption. This "disutility" of consumption renouncement is reflected in the welfare measure, which discounts the consumption of all periods. The findings underline that income growth effects do not necessarily constitute welfare gains, since growth requires the building-up of the capital stock. Nevertheless, the positive welfare gain found in the analysis with the PRINCE Model documents that Poland will benefit from membership in the European Union.

¹⁵ As done for the analysis of a new WTO Round of trade liberalization by McKibbin (1999).

7 Appendix

The results of the CGE analysis presented in the main body of this paper depend on the magnitude of the included parameters and elasticities. The values for the exogenously determined behavioral parameters and elasticities were taken from Devarajan and Go (1998) in order to increase the comparability with other CGE studies for the analysis of trade policies. As an extension, this appendix discusses alternatives for the specification of the adjustment cost parameters, the intertemporal elasticity of substitution, the Armington substitution elasticity and the rate of time preference.

7.1 Modification for the Adjustment Costs of Investment

One striking feature of the simulation results is the considerable increase in investment. As Table 6 shows, the simulation with the 4 effects simultaneously implemented induces a surge in investment activities by 56 percent. To assess the importance of the installation costs for capital, the adjustment cost parameter β , introduced earlier at equation (14) is increased.

$$(14) \quad J_t = PK_t \cdot I_t \left[1 + \frac{\beta}{2} \frac{\left(\frac{I_t}{K_t} - \alpha \right)^2}{\frac{I_t}{K_t}} \right]$$

A "moderate" increase in the adjustment costs is modeled through doubling the value of β from the original 2 to 4. The results for the different scenarios and for the various variables are presented in Table 7. Furthermore, a "drastic" increase in the adjustment costs is simulated with a further doubling of the adjustment cost parameter of β to 8. The corresponding simulation results are given in Table 8.

As expected, the surge in investment for the simulation of the 4 effects is the less pronounced, the bigger the adjustment cost parameter. The investment relative to the reference run drops for period 1 in the overall scenario from 1.56 for the original specification to 1.41 for the "moderate" and to 1.26 for the "drastic" increase in adjustment costs. The welfare measure falls with the increase in adjustment costs. In the original specification, the increase in welfare sums up to 7.7 per mill, with the "moderate" increase of adjustment cost to 6.9 per mill and with the "drastic" increase to 6.1 per mill.

Table 7 — Moderate Increase in the Adjustment Cost (Increase of β from 2 to 4). Simulations of Full EU Membership Effects for Poland – Relative to the Reference Run

		Tariff Reduction	Border Cost Reduction	Reduction of Technical Barriers to Trade	Net-EU- Transfers to Poland	Overall Effects	
						Aggregate of the 4 Simulations	New Simulation with 4 Effects Simultaneously
Consumption							
Period	1	0.962	0.960	0.976	0.946	0.852	0.948
	10	1.010	1.026	1.017	1.046	1.103	1.068
	20	1.033	1.058	1.036	1.093	1.237	1.126
	30	1.042	1.070	1.043	1.111	1.293	1.149
	40	1.046	1.075	1.046	1.119	1.316	1.159
Investment							
Period	1	1.169	1.231	1.141	1.344	2.209	1.409
	10	1.150	1.207	1.124	1.314	2.052	1.384
	20	1.140	1.192	1.115	1.292	1.958	1.360
	30	1.134	1.185	1.110	1.280	1.910	1.346
	40	1.127	1.175	1.105	1.265	1.849	1.326
Exports							
Period	1	1.010	0.986	0.991	0.962	0.950	0.935
	10	1.056	1.047	1.029	1.052	1.197	1.041
	20	1.077	1.076	1.046	1.094	1.327	1.091
	30	1.086	1.087	1.053	1.110	1.380	1.111
	40	1.088	1.091	1.055	1.115	1.397	1.118
Imports							
Period	1	1.047	1.051	1.031	1.098	1.246	1.105
	10	1.064	1.073	1.044	1.133	1.351	1.149
	20	1.071	1.083	1.050	1.147	1.398	1.167
	30	1.074	1.086	1.052	1.152	1.414	1.172
	40	1.073	1.085	1.052	1.150	1.408	1.170
Domestic Good Prod.							
Period	1	0.997	1.004	1.003	1.011	1.015	1.019
	10	1.027	1.046	1.028	1.073	1.184	1.094
	20	1.040	1.064	1.039	1.102	1.268	1.129
	30	1.046	1.072	1.044	1.112	1.301	1.143
	40	1.047	1.074	1.045	1.115	1.311	1.146
Borrowing							
Period	1	1.445	1.609	1.369	1.859	5.922	2.015
	10	1.307	1.422	1.252	1.607	3.738	1.737
	20	1.189	1.260	1.155	1.376	2.379	1.464
	30	1.094	1.129	1.077	1.189	1.581	1.235
	40	1.000	1.000	1.000	1.000	1.000	1.000
Debt							
Period	1	1.000	1.000	1.000	1.000	1.000	1.000
	10	1.185	1.254	1.152	1.362	2.331	1.436
	20	1.211	1.290	1.173	1.417	2.595	1.507
	30	1.166	1.228	1.136	1.329	2.160	1.404
	40	1.095	1.130	1.077	1.189	1.584	1.232
Capital Stock							
Period	1	1.000	1.000	1.000	1.000	1.000	1.000
	10	1.074	1.101	1.061	1.153	1.446	1.184
	20	1.109	1.150	1.090	1.227	1.706	1.277
	30	1.123	1.169	1.101	1.257	1.816	1.315
	40	1.127	1.175	1.105	1.265	1.849	1.326
Overall Welfare Effects (in %)		0.1175	0.2785	0.1770	0.4735	1.0502	0.6938

Source: Calculations with the Poland's Regional INtegration Computable Equilibrium (PRINCE) Model.

Table 8 — Drastic Increase in the Adjustment Cost (Increase of β from 2 to 8). Simulations of Full EU Membership Effects for Poland – Relative to the Reference Run

		Tariff Reduction	Border Cost Reduction	Reduction of Technical Barriers to Trade	Net-EU-Transfers to Poland	Overall Effects	
						Aggregate of the 4 Simulations	New Simulation with 4 Effects Simultaneously
Consumption							
Period	1	0.967	0.979	0.979	0.953	0.882	0.975
	10	1.005	1.018	1.012	1.036	1.074	1.055
	20	1.027	1.040	1.031	1.083	1.192	1.101
	30	1.037	1.050	1.040	1.105	1.252	1.123
	40	1.042	1.055	1.044	1.116	1.281	1.134
Investment							
Period	1	1.132	1.132	1.112	1.282	1.827	1.264
	10	1.132	1.131	1.111	1.288	1.833	1.273
	20	1.130	1.129	1.110	1.286	1.820	1.272
	30	1.127	1.126	1.107	1.279	1.796	1.266
	40	1.118	1.117	1.099	1.258	1.726	1.246
Exports							
Period	1	1.011	0.985	0.992	0.964	0.953	0.934
	10	1.049	1.022	1.024	1.042	1.143	1.005
	20	1.070	1.042	1.041	1.085	1.259	1.045
	30	1.080	1.051	1.049	1.105	1.316	1.064
	40	1.083	1.055	1.052	1.113	1.338	1.071
Imports							
Period	1	1.041	1.028	1.026	1.088	1.195	1.074
	10	1.057	1.044	1.040	1.124	1.290	1.108
	20	1.066	1.053	1.047	1.142	1.342	1.126
	30	1.069	1.056	1.050	1.149	1.362	1.133
	40	1.068	1.055	1.049	1.146	1.354	1.130
Domestic Good Prod.							
Period	1	0.996	1.005	1.002	1.011	1.014	1.019
	10	1.022	1.030	1.024	1.065	1.148	1.072
	20	1.035	1.044	1.036	1.095	1.226	1.101
	30	1.042	1.050	1.041	1.108	1.263	1.114
	40	1.044	1.052	1.043	1.113	1.274	1.118
Borrowing							
Period	1	1.356	1.353	1.301	1.719	4.099	1.663
	10	1.281	1.279	1.237	1.582	3.206	1.544
	20	1.194	1.192	1.163	1.407	2.328	1.384
	30	1.106	1.105	1.089	1.226	1.632	1.215
	40	1.000	1.000	1.000	1.000	1.000	1.000
Debt							
Period	1	1.000	1.000	1.000	1.000	1.000	1.000
	10	1.161	1.159	1.135	1.330	2.030	1.306
	20	1.198	1.196	1.166	1.410	2.354	1.384
	30	1.166	1.164	1.139	1.347	2.083	1.327
	40	1.098	1.097	1.082	1.207	1.574	1.195
Capital Stock							
Period	1	1.000	1.000	1.000	1.000	1.000	1.000
	10	1.061	1.061	1.052	1.133	1.342	1.125
	20	1.096	1.095	1.081	1.210	1.570	1.199
	30	1.112	1.112	1.095	1.246	1.687	1.234
	40	1.118	1.117	1.099	1.258	1.726	1.246
Overall Welfare Effects (in %)		0.0871	0.2115	0.1525	0.4211	0.8746	0.6066

Source: Calculations with the Poland's Regional INtegration Computable Equilibrium (PRINCE) Model.

It is remarkable that the investment for period 1 in the scenario "Increase in Net-EU-Transfers to Poland" is even a bit higher than for the overall effects in the case of the "drastic" increase of the adjustment costs (Table 8). Connected to this is the more pronounced decrease in consumption for period 1 in the scenario "Increase in Net-EU-Transfers to Poland" relative to the one of the overall effects. This is again linked to the development of relative prices (as described in more detail in the main body of the text). The more interesting issue is, however, that even in the case of very high adjustment costs, it is necessary for the small open economy to increase considerably the investment to achieve higher overall welfare. Such an enormous surge is unrealistic to expect for the real world. This points to the necessity of a better representation of investment behavior in CGE models. Such a modified representation is suggested in Piazzolo (1998), where adjustment costs depend on the difference between the investment levels of two periods (rather than only on the gross investment ratio). This adjustment cost formulation avoids the sharp rise in investment due to the high marginal productivity of each unit of capital after a trade policy change, but leads to a gradual rise in investment. This modification will be implemented for the PRINCE Model in future extensions.

7.2 Modifications for the Intertemporal Elasticity of Substitution

As stated in Equation (1), the representative household wishes to maximize overall utility, U , as given by

$$(1) \quad U_o = \sum_{t=0}^{\infty} \left(\frac{1}{1+\rho} \right)^{t+1} \frac{1}{1-\nu} (C_t)^{1-\nu}$$

The constant elasticity of substitution, represented by the parameter ν , determines the change in $u'(C_t)$ in response to a change in C_t . The higher ν , the less willing are households to accept deviations from a uniform pattern of C_t over time (cf. Barro and Sala-i-Martin, 1995: 65).

Following Devarajan and Go (1998), for ν a value of 0.90 was used in the main text. However, Rutherford and Tarr (1999) work for their intertemporal utility function of the infinitely lived representative consumer with an intertemporal elasticity of substitution of 0.50. To assess the consequences of the intertemporal elasticity of substitution on the simulation results, two new blocks of simulations are run, one with the value of 0.50 from Rutherford and Tarr (1999) and one with 0.95.

The simulation results for the lower elasticity of substitution are given in Table 9 and the ones of the higher elasticity of substitution are represented in Table 10. Changing the elasticity from 0.90 to 0.50 signifies, that the utility maximizing household is willing to accept deviations from a uniform pattern of consumption and compensates decreased consumption in the present with higher consumption in the future. This is reflected in Table 9. While in the original scenario consumption fell by a bit more than 7 percent in the first period for the simulation with all 4 effects, the decreased intertemporal elasticity leads to a fall in consumption by more than 10 percent. Consumption renouncement sets the resources free for investment and quick capital stock building. Investment in the first period is with a surge by 66 percent for the decreased intertemporal elasticity significantly higher than the 56 percent increase in the original scenario. The remuneration for this flexibility is a considerable increase in the welfare measure. The overall welfare increase through regional integration amounted in the original setting to 7.7 per mill, whereas the acceptance of deviations in the consumption pattern enables an overall welfare increase by 39.4 per mill.

As expected, the increase of the elasticity of substitution from 0.90 to 0.95 leads to the opposite results, as the household tries to smooth consumption over time. Table 10 shows that the consumption in the first period is higher for the setting with the increased elasticity than for the original setting, whereby the difference in consumption is actually quite small. However, the effect on welfare is remarkable. The welfare measure falls from 7.7 per mill in the original setting to only 3.8 per mill.

7.3 Modifications for the Armington Substitution Elasticity

The Armington elasticity is the elasticity of substitution between the domestic goods and final imports. Thus it is assumed that consumer preferences differ between domestic and foreign products (Armington 1969).¹⁶ As set out in equation (15), aggregate supply X_t purchased by the household consists of imports M_t and domestic goods D_t according to:

$$x_t = \alpha_c \left[\delta_c M_t^{-\rho_c} + (1 - \delta_c) D_t^{-\rho_c} \right]^{-1/\rho_c}$$

¹⁶ A corresponding behavioral characteristic is also introduced on the production side through the elasticity of transformation between sales to the domestic market and sales to the export markets.

Table 9 — Reduction in the Intertemporal Elasticity of Substitution (decrease of ν from 0.90 to 0.50).
Simulations of Full EU Membership Effects for Poland – Relative to the Reference Run

		Tariff Reduction	Border Cost Reduction	Reduction of technical Barriers to Trade	Net-EU- Transfers to Poland	Overall Effects	
						Aggregate of the 4 Simulations	Overall Effects
Consumption							
Period	1	0.945	0.937	0.962	0.914	0.779	0.894
	10	1.018	1.037	1.023	1.061	1.147	1.090
	20	1.041	1.069	1.043	1.109	1.287	1.156
	30	1.047	1.077	1.048	1.121	1.325	1.173
	40	1.049	1.080	1.049	1.124	1.336	1.178
Investment							
Period	1	1.247	1.337	1.206	1.497	3.009	1.662
	10	1.171	1.237	1.141	1.357	2.243	1.494
	20	1.145	1.200	1.119	1.301	2.002	1.419
	30	1.138	1.190	1.114	1.286	1.938	1.397
	40	1.134	1.185	1.111	1.279	1.909	1.386
Exports							
Period	1	1.016	0.994	0.996	0.973	0.979	0.952
	10	1.070	1.065	1.040	1.078	1.277	1.090
	20	1.086	1.088	1.054	1.111	1.383	1.135
	30	1.091	1.094	1.057	1.119	1.411	1.146
	40	1.092	1.095	1.058	1.121	1.418	1.149
Imports							
Period	1	1.063	1.073	1.044	1.130	1.345	1.159
	10	1.074	1.087	1.053	1.152	1.416	1.193
	20	1.077	1.091	1.055	1.157	1.434	1.200
	30	1.077	1.091	1.056	1.158	1.437	1.201
	40	1.077	1.091	1.055	1.157	1.435	1.200
Domestic Good Prod.							
Period	1	0.995	1.002	1.001	1.008	1.006	1.014
	10	1.034	1.056	1.034	1.088	1.230	1.123
	20	1.047	1.073	1.045	1.113	1.306	1.157
	30	1.050	1.077	1.047	1.120	1.326	1.166
	40	1.050	1.078	1.048	1.121	1.330	1.168
Borrowing							
Period	1	1.572	1.780	1.472	2.107	8.680	2.466
	10	1.294	1.405	1.241	1.588	3.583	1.810
	20	1.150	1.206	1.122	1.300	2.025	1.418
	30	1.066	1.091	1.054	1.132	1.387	1.185
	40	1.000	1.000	1.000	1.000	1.000	1.000
Debt							
Period	1	1.000	1.000	1.000	1.000	1.000	1.000
	10	1.199	1.272	1.163	1.393	2.471	1.535
	20	1.198	1.272	1.162	1.395	2.471	1.543
	30	1.141	1.194	1.116	1.282	1.950	1.390
	40	1.077	1.106	1.063	1.154	1.460	1.213
Capital Stock							
Period	1	1.000	1.000	1.000	1.000	1.000	1.000
	10	1.094	1.129	1.078	1.194	1.590	1.264
	20	1.125	1.172	1.103	1.258	1.829	1.356
	30	1.133	1.183	1.109	1.275	1.895	1.381
	40	1.134	1.185	1.111	1.279	1.909	1.386
Overall Welfare Effects (in %)		0.7230	1.5866	1.0055	2.6411	6.0795	3.9472

Source: Calculations with the Poland's Regional INtegration Computable Equilibrium (PRINCE) Model.

Table 10 — Increase in the Intertemporal Elasticity of Substitution (increase of ν from 0.90 to 0.95).
Simulations of Full EU Membership Effects for Poland – Relative to the Reference Run

		Tariff Reduction	Border Cost Reduction	Reduction of technical Barriers to Trade	Net-EU- Transfers to Poland	Overall Effects	
						Aggregate of the 4 Simulations	Overall Effects
Consumption							
Period	1	0.959	0.956	0.973	0.940	0.838	0.928
	10	1.015	1.032	1.020	1.055	1.128	1.082
	20	1.037	1.063	1.039	1.100	1.260	1.145
	30	1.044	1.073	1.045	1.115	1.305	1.167
	40	1.047	1.076	1.047	1.120	1.321	1.174
Investment							
Period	1	1.200	1.273	1.167	1.406	2.506	1.545
	10	1.159	1.219	1.131	1.332	2.129	1.465
	20	1.141	1.194	1.116	1.294	1.966	1.415
	30	1.134	1.184	1.110	1.279	1.907	1.395
	40	1.129	1.177	1.106	1.268	1.863	1.378
Exports							
Period	1	1.008	0.983	0.990	0.958	0.939	0.932
	10	1.060	1.053	1.032	1.060	1.222	1.068
	20	1.081	1.080	1.049	1.100	1.347	1.124
	30	1.087	1.089	1.054	1.113	1.390	1.142
	40	1.089	1.092	1.056	1.117	1.402	1.147
Imports							
Period	1	1.053	1.058	1.036	1.109	1.280	1.133
	10	1.068	1.078	1.047	1.140	1.375	1.179
	20	1.073	1.085	1.052	1.150	1.409	1.193
	30	1.074	1.087	1.053	1.153	1.418	1.197
	40	1.074	1.087	1.053	1.152	1.415	1.196
Domestic Good Prod.							
Period	1	0.997	1.005	1.003	1.013	1.018	1.020
	10	1.030	1.050	1.031	1.080	1.205	1.113
	20	1.043	1.068	1.041	1.106	1.283	1.149
	30	1.047	1.073	1.045	1.115	1.309	1.161
	40	1.048	1.075	1.046	1.117	1.315	1.164
Borrowing							
Period	1	1.532	1.727	1.442	2.028	7.737	2.374
	10	1.321	1.442	1.264	1.639	3.947	1.891
	20	1.180	1.247	1.147	1.359	2.294	1.509
	30	1.083	1.114	1.068	1.167	1.505	1.239
	40	1.000	1.000	1.000	1.000	1.000	1.000
Debt							
Period	1	1.000	1.000	1.000	1.000	1.000	1.000
	10	1.204	1.279	1.168	1.401	2.520	1.552
	20	1.218	1.299	1.179	1.432	2.671	1.603
	30	1.163	1.223	1.133	1.324	2.134	1.456
	40	1.090	1.124	1.074	1.180	1.554	1.255
Capital Stock							
Period	1	1.000	1.000	1.000	1.000	1.000	1.000
	10	1.082	1.113	1.068	1.170	1.504	1.234
	20	1.115	1.158	1.095	1.240	1.753	1.335
	30	1.126	1.173	1.104	1.263	1.841	1.369
	40	1.129	1.177	1.106	1.268	1.863	1.378
Overall Welfare Effects (in %)		0.0697	0.1539	0.0976	0.2571	0.5794	0.3828

Source: Calculations with the Poland's Regional Integration Computable Equilibrium (PRINCE) Model.

with α_c , δ_c and ρ_c as the shift parameter, the share parameter and the exponent parameter in this CES function. Whereas the efficiency parameter α_c and the distribution parameter δ_c are determined within the model during the calibration process, the decisive constant behavioral elasticity of substitution σ is set exogenously and introduced through the substitution parameter ρ_c into the model according to the relationship:

$$\sigma = \frac{1}{1 + \rho_c}$$

Several recent studies focusing on trade showed a very strong home bias of consumers. Trefler (1995) examines the "case of missing trade" in trade flows between countries and demonstrates that introducing the Armington assumption about the home bias through an imperfect elasticity of substitution into a trade model is statistically and economically significant in explaining international trade. McCallum (1995) shows on the basis of a gravity model that trade between Canadian provinces is over twenty times larger than trade between Canadian provinces and US American states. Using a similar approach, Wei (1996) finds a considerable home bias in the trade pattern among OECD countries.

Some authors have cautioned against a careless use of the Armington assumption. For example Norman (1990) points out that the Armington approximation functions only as a poor substitute if oligopolistic behavior at the firm level is important for explaining international trade within CGE models. Bhattarai et al. (1999) expose certain "unfortunate properties" of the Armington elasticity concerning the implied offer curves, if an exogenous trade imbalance is specified.¹⁷ Gielen and Van Leeuwen (1998) argue that in a multi-country CGE model the Armington assumption has to be supplemented by a specification accounting for relative factor endowment in order to explain growing market shares of developing countries over time. Overall, however, the importance of the home bias is not disputed and the use of the Armington specification in trade models is very wide spread.

¹⁷ The criticism of Bhattarai et al. (1999) is directed to the negligent combination of the usage of an Armington elasticity with a fixed trade imbalance in a static CGE model. The dynamic setting of the PRINCE model does not impose a fixed trade imbalance, but allows the financing of a changing current account deficit through borrowing from abroad as long as the level of borrowing returns to the original level at the end of the modeled time horizon (in the PRINCE model after 40 years).

The specific value for the elasticity of the Armington assumption depends on the aggregation of the data. In the PRINCE model, the same value for the constant behavioral elasticity of substitution σ of 0.5 (implying a substitution parameter ρ_c of 1.0) was used as by Devarajan and Go (1998). This value for the Armington elasticity was tested and employed by Go (1994). Recent empirical estimates for the Armington elasticity for 30 tradable commodities in the Philippines find values between 0.2 and 4 (Kapuscinski and Warr, 1999). Similar considerable differences in the Armington elasticities across commodities were also detected e.g. by Shiells et al. (1986), Reinert and Roland-Holst (1992) or Shiells and Reinert (1993). Blonigen and Wilson (1999), who estimate an average Armington elasticity of 0.81 for 146 US industrial sectors with a standard deviation of 0.63, examine the role of various industry-specific determinants like union presence, average firm size, entry barriers or the existence of foreign-owned affiliates to explain these differences.

The relatively low elasticity of substitution of the representative household in the PRINCE model is due to the aggregate nature of the domestic good and the alternative foreign good. The bundle representing the domestic good includes goods and services that are difficult or impossible to trade (and hence to replace by imports). To examine the sensitivity of the model results, several other Armington elasticities were substituted for the original one. Two of these sensitivity analyses are represented in the Tables 11 and 12.

In Table 11, the original Armington elasticity of substitution σ of 0.5 is raised to $\sigma = 2.0$ (corresponding to a substitution parameter $\rho_c = -0.50$). This increase signifies a considerable jump in the consumer's willingness to substitute domestic goods with foreign goods. The modeled reaction in the various macroeconomic variables are noticeable, but not outstanding. For the simultaneous simulation of all 4 effects (the last column), consumption renouncement at the beginning (0.94 relative to the reference run) is a bit less pronounced than for the corresponding simulation with the original parameters (0.93). Also, consumption is only below the reference run for the first three periods rather than the first four periods as in the case of the original parameter. In the long run, consumption is about the same for both Armington elasticities. Investment for the modified Armington elasticity is smaller than for the original one (1.53 at the beginning instead of 1.56),

Table 11 — Increase in the Armington Substitution Elasticity (Increase of σ from 0.5 to 2). Simulations of Full EU-Membership Effects for Poland – Relative to the Reference Run

		Tariff Reduction	Border Cost Reduction	Reduction of Technical Barriers to Trade	Net-EU- Transfers to Poland	Overall Effects	
						Aggregate of the 4 Simulations	New Simulation with 4 Effects Simultaneously
Consumption							
Period	1	0.966	0.960	0.976	0.947	0.856	0.944
	10	1.015	1.034	1.021	1.058	1.134	1.088
	20	1.033	1.063	1.039	1.100	1.254	1.144
	30	1.039	1.071	1.044	1.114	1.294	1.162
	40	1.041	1.074	1.046	1.118	1.307	1.168
Investment							
Period	1	1.181	1.276	1.168	1.411	2.484	1.534
	10	1.140	1.216	1.129	1.327	2.077	1.438
	20	1.122	1.189	1.113	1.287	1.912	1.386
	30	1.116	1.180	1.107	1.273	1.856	1.366
	40	1.112	1.173	1.104	1.263	1.818	1.352
Exports							
Period	1	1.012	0.986	0.991	0.962	0.951	0.957
	10	1.058	1.054	1.033	1.062	1.223	1.087
	20	1.075	1.080	1.049	1.100	1.338	1.137
	30	1.080	1.088	1.053	1.111	1.376	1.153
	40	1.082	1.090	1.055	1.114	1.386	1.157
Imports							
Period	1	1.057	1.069	1.042	1.126	1.328	1.176
	10	1.065	1.081	1.049	1.144	1.381	1.199
	20	1.067	1.085	1.051	1.149	1.398	1.205
	30	1.068	1.085	1.052	1.150	1.402	1.206
	40	1.068	1.084	1.051	1.148	1.398	1.204
Domestic Good Prod.							
Period	1	0.996	1.004	1.003	1.011	1.015	1.013
	10	1.026	1.050	1.030	1.080	1.198	1.102
	20	1.037	1.067	1.041	1.105	1.271	1.135
	30	1.040	1.072	1.044	1.113	1.295	1.145
	40	1.041	1.073	1.045	1.114	1.300	1.148
Borrowing							
Period	1	1.544	1.827	1.501	2.191	9.276	2.612
	10	1.316	1.483	1.289	1.706	4.293	1.975
	20	1.173	1.265	1.158	1.388	2.383	1.539
	30	1.079	1.120	1.072	1.177	1.524	1.247
	40	1.000	1.000	1.000	1.000	1.000	1.000
Debt							
Period	1	1.000	1.000	1.000	1.000	1.000	1.000
	10	1.203	1.310	1.186	1.451	2.713	1.619
	20	1.213	1.327	1.196	1.477	2.843	1.658
	30	1.158	1.241	1.144	1.353	2.224	1.489
	40	1.087	1.133	1.080	1.195	1.589	1.271
Capital Stock							
Period	1	1.000	1.000	1.000	1.000	1.000	1.000
	10	1.073	1.112	1.068	1.169	1.490	1.224
	20	1.101	1.156	1.094	1.236	1.721	1.315
	30	1.110	1.170	1.102	1.257	1.799	1.345
	40	1.112	1.173	1.104	1.263	1.818	1.352
Overall Welfare Effects (in %)		0.1364	0.3206	0.2025	0.5356	1.1999	0.8129

Source: Calculations with the Poland's Regional Integration Computable Equilibrium (PRINCE) Model.

Table 12 — Drastic Increase in the Armington Substitution Elasticity (increase of σ from 0.5 to 8). Simulations of Full EU-Membership Effects for Poland – Relative to the Reference Run

		Tariff Reduction	Border Cost Reduction	Reduction of Technical Barriers to Trade	Net-EU-Transfers to Poland	Overall Effects	
						Aggregate of the 4 Simulations	New Simulation with 4 Effects Simultaneously
Consumption							
Period	1	0.990	0.978	0.987	0.976	0.933	0.999
	10	1.010	1.039	1.024	1.065	1.144	1.104
	20	1.017	1.060	1.037	1.097	1.227	1.141
	30	1.019	1.066	1.041	1.107	1.252	1.152
	40	1.020	1.068	1.042	1.110	1.260	1.155
Investment							
Period	1	1.090	1.273	1.165	1.413	2.285	1.540
	10	1.065	1.200	1.120	1.305	1.869	1.394
	20	1.056	1.173	1.104	1.263	1.728	1.339
	30	1.054	1.164	1.099	1.250	1.685	1.322
	40	1.052	1.159	1.096	1.242	1.660	1.312
Exports							
Period	1	1.023	0.991	0.995	0.970	0.978	0.999
	10	1.044	1.054	1.033	1.063	1.208	1.118
	20	1.051	1.076	1.046	1.094	1.295	1.158
	30	1.054	1.082	1.050	1.104	1.322	1.169
	40	1.054	1.084	1.051	1.106	1.328	1.172
Imports							
Period	1	1.054	1.105	1.062	1.187	1.469	1.311
	10	1.048	1.086	1.052	1.152	1.378	1.239
	20	1.046	1.080	1.049	1.142	1.353	1.220
	30	1.045	1.078	1.048	1.140	1.345	1.215
	40	1.045	1.077	1.047	1.137	1.339	1.212
Domestic Good Prod.							
Period	1	0.993	1.003	1.002	1.009	1.006	1.000
	10	1.007	1.047	1.029	1.076	1.167	1.085
	20	1.012	1.062	1.038	1.098	1.225	1.113
	30	1.014	1.066	1.040	1.105	1.242	1.120
	40	1.014	1.067	1.041	1.106	1.246	1.122
Borrowing							
Period	1	1.393	2.184	1.700	2.815	14.561	3.734
	10	1.210	1.620	1.371	1.929	5.183	2.348
	20	1.110	1.326	1.195	1.487	2.615	1.697
	30	1.048	1.144	1.086	1.215	1.583	1.306
	40	1.000	1.000	1.000	1.000	1.000	1.000
Debt							
Period	1	1.000	1.000	1.000	1.000	1.000	1.000
	10	1.139	1.413	1.246	1.623	3.254	1.914
	20	1.141	1.419	1.251	1.630	3.303	1.914
	30	1.102	1.303	1.181	1.454	2.466	1.655
	40	1.056	1.165	1.099	1.247	1.686	1.356
Capital Stock							
Period	1	1.000	1.000	1.000	1.000	1.000	1.000
	10	1.035	1.107	1.064	1.163	1.418	1.211
	20	1.047	1.145	1.087	1.221	1.593	1.286
	30	1.051	1.157	1.094	1.238	1.647	1.307
	40	1.052	1.159	1.096	1.242	1.660	1.312
Overall Welfare Effects (in %)		0.0942	0.3600	0.2243	0.6042	1.2882	0.9577

Source: Calculations with the Poland's Regional INtegration Computable Equilibrium (PRINCE) Model.

whereas exports (0.96 instead of 0.93) and imports (1.18 instead of 1.14) are a bit higher. This small shift is also reflected in the long run and represents the increased willingness to consume foreign goods instead of domestic goods. Consequently, the production of the domestic good drops also a bit (1.01 instead of 1.02 at the beginning and 1.15 instead of 1.16 in the long run). The most dramatic change relates to the increase in borrowing. To finance the (slightly) greater demand for foreign goods at the beginning, the economy raises its borrowing (2.61 instead of 2.38). The welfare measure with the modified Armington elasticity is 8.1 per mill instead of 7.7 per mill in the original specification.

In Table 12, the simulation results are represented for a truly dramatic increase of the Armington elasticity from the original $\sigma = 0.5$ to $\sigma = 8.0$ (corresponding to a substitution parameter $\rho_c = -0.875$). Changes for some variables are considerable, but the overall differences and the effect for the welfare measure are not really outstanding.

Again looking at the simultaneous simulation of all 4 effects (the last column), consumption no longer declines in the beginning (1.00 instead of 0.93 in the original specification), but imports jump considerably (1.31 instead of 1.14), whereas exports (1.00 instead of 0.93) rise less dramatically. The surge in imports is financed with heavy borrowing from abroad (3.73 instead of 2.38). In the long run, the changes in imports (1.21 instead of 1.20) and exports (1.17 instead of 1.15) are much less pronounced. The overall welfare measure for this dramatically higher Armington elasticity is 9.6 per mill instead of 7.7 in the original specification.

These sensitivity analyses reveal that the Armington elasticity is decisive for the exact magnitude of the variables, but even an extremely high Armington elasticity does not alter dramatically the overall welfare results with regard to Poland's membership in the European Union. Hence, the welfare measure depends only to a limited extent on the degree of consumption renouncement at the beginning of the observed time period induced by the Armington assumption.

7.4 Modifications for the Rate of Time Preference

The welfare measure in the PRINCE model corresponds to the overall utility measure for the household, U , as given by (1):

$$(1) \quad U_o = \sum_{t=0}^{\infty} \left(\frac{1}{1+\rho} \right)^{t+1} \frac{1}{1-\nu} (C_t)^{1-\nu}$$

The rate of time preference ρ discounts the future consumption and states that the household values consumption the less the later this consumption takes place. Consumption in the future requires abstaining from consumption today and therefore involves the costs of waiting (cf. Siebert 1999: 54). The rate of time preference indicates how the future consumption is assessed in comparison with present consumption. In the PRINCE model, the rate of time preference ρ of the household corresponds to the world interest rate which equals the ratio of Poland's debt service relative to Poland's debt and amounts to 6.2 percent. Whereas the founding father of this type of growth models, Ramsey (1928), assumed $\rho = 0$ and maintained that the discounting of utility for future generations with $\rho > 0$ was "ethically indefensible", most Ramsey-type growth models contain a positive rate of time preference (cf. Barro and Sala-i-Martin 1995: 61). The various possibilities for choosing a value for the rate of time preference and the range of rates employed are discussed by Pearce et al. (1990: 23-56) as well as Bazelon and Smetters (1999).

In the PRINCE model, the rate of time preference equals the world interest rate, which determines together with the expected changes in the real exchange rate the interest rates faced by the consumer and the producer. To evaluate the sensitivity of the model results relative to the exact value of the rate of time preference ρ , various rates are introduced into the model. These sensitivity analyses differentiate also between the mere changes of the rate of time preference (leaving the world interest rate and therefore the domestic interest rates at the old level – Table 13) and the simultaneous change of the rate of time preference as well as the interest rates (Table 14).

The results for an lower rate of time preference with $\rho = 0.052$ instead of 0.062 (but with the world interest rate at the old level) are given in the Table 13. A lower rate of time preference reflects the assumption that a household does not mind as much as before to wait for the future consumption relative to the present consumption. Future consumption is discounted to a smaller extent in the welfare measure. For the overall effect of Poland's EU membership consumption drops considerably in the first period (0.77 for $\rho = 0.052$)

Table 13 — Decrease in the Rate of Time Preference (decrease of ρ from 0.062 to 0.052).
Simulations of Full EU-Membership Effects for Poland – Relative to the
Reference Run

		Tariff Reduction	Border Cost Reduction	Reduction of Technical Barriers to Trade	Net-EU- Transfers to Poland	Overall Effects	
						Aggregate of the 4 Simulations	New Simulation with 4 Effects Simultaneously
Consumption							
Period	1	0.903	0.896	0.898	0.909	0.661	0.769
	10	0.988	1.006	0.999	1.022	1.015	1.054
	20	1.037	1.066	1.056	1.083	1.265	1.193
	30	1.070	1.103	1.091	1.121	1.444	1.260
	40	1.102	1.137	1.125	1.155	1.627	1.308
Investment							
Period	1	1.276	1.371	1.340	1.378	3.232	2.082
	10	1.258	1.342	1.314	1.349	2.992	2.049
	20	1.267	1.345	1.319	1.353	3.042	1.998
	30	1.285	1.361	1.337	1.370	3.202	1.989
	40	1.259	1.331	1.308	1.339	2.936	1.924
Exports							
Period	1	1.079	1.055	1.063	1.029	1.244	1.021
	10	1.137	1.138	1.137	1.111	1.635	1.293
	20	1.155	1.165	1.162	1.139	1.780	1.396
	30	1.155	1.168	1.164	1.142	1.792	1.421
	40	1.146	1.159	1.155	1.132	1.736	1.416
Imports							
Period	1	1.060	1.071	1.067	1.090	1.320	1.258
	10	1.095	1.114	1.107	1.135	1.533	1.375
	20	1.121	1.143	1.135	1.165	1.695	1.424
	30	1.142	1.165	1.157	1.187	1.826	1.450
	40	1.146	1.169	1.161	1.192	1.854	1.450
Domestic Good Prod.							
Period	1	0.973	0.982	0.979	0.991	0.927	0.993
	10	1.027	1.052	1.044	1.063	1.199	1.176
	20	1.061	1.092	1.082	1.104	1.385	1.263
	30	1.085	1.119	1.108	1.131	1.521	1.305
	40	1.102	1.137	1.126	1.149	1.620	1.328
Borrowing							
Period	1	0.874	1.110	1.031	1.055	1.056	2.885
	10	0.516	0.649	0.605	0.608	0.123	1.838
	20	0.480	0.549	0.527	0.522	0.072	1.196
	30	0.710	0.742	0.734	0.733	0.283	1.046
	40	1.000	1.000	1.000	1.000	1.000	1.000
Debt							
Period	1	1.000	1.000	1.000	1.000	1.000	1.000
	10	0.807	0.894	0.865	0.870	0.543	1.631
	20	0.620	0.708	0.679	0.680	0.203	1.500
	30	0.612	0.676	0.656	0.655	0.178	1.265
	40	0.778	0.814	0.803	0.804	0.409	1.146
Capital Stock							
Period	1	1.000	1.000	1.000	1.000	1.000	1.000
	10	1.123	1.164	1.150	1.167	1.754	1.499
	20	1.192	1.252	1.232	1.258	2.313	1.758
	30	1.234	1.303	1.280	1.310	2.695	1.875
	40	1.259	1.331	1.308	1.339	2.936	1.924
Overall	Welfare	0.0897	0.2867	0.2136	0.4387	1.0324	0.8091
Effects (in %)							

Source: Calculations with the Poland's Regional INtegration Computable Equilibrium (PRINCE) Model.

Table 14 — Increase in the Rate of Time Preference and the Interest Rate (increase of $\rho = i^*$ from 0.062 to 0.072). Simulations of Full EU-Membership Effects for Poland – Relative to the Reference Run

		Tariff Reduction	Border Cost Reduction	Reduction of Technical Barriers to Trade	Net-EU- Transfers to Poland	Overall Effects	
						Aggregate of the 4 Simulations	New Simulation with 4 Effects Simultaneously
Consumption							
Period	1	0.960	0.972	0.974	0.931	0.847	0.960
	10	1.014	1.026	1.019	1.060	1.125	1.077
	20	1.034	1.046	1.036	1.109	1.242	1.122
	30	1.040	1.052	1.041	1.123	1.280	1.137
	40	1.042	1.054	1.043	1.128	1.292	1.141
Investment							
Period	1	1.190	1.189	1.159	1.455	2.386	1.402
	10	1.145	1.144	1.120	1.361	1.996	1.323
	20	1.126	1.125	1.105	1.315	1.840	1.284
	30	1.120	1.119	1.100	1.298	1.789	1.269
	40	1.116	1.115	1.096	1.288	1.757	1.259
Exports							
Period	1	1.009	0.983	0.991	0.956	0.939	0.925
	10	1.057	1.030	1.030	1.067	1.198	1.022
	20	1.075	1.047	1.045	1.109	1.305	1.058
	30	1.081	1.052	1.049	1.121	1.338	1.070
	40	1.082	1.054	1.050	1.125	1.347	1.073
Imports							
Period	1	1.050	1.037	1.034	1.122	1.263	1.099
	10	1.062	1.049	1.043	1.152	1.340	1.128
	20	1.066	1.053	1.047	1.161	1.365	1.137
	30	1.067	1.054	1.048	1.163	1.371	1.139
	40	1.067	1.054	1.047	1.162	1.369	1.138
Domestic Good Prod.							
Period	1	0.997	1.005	1.003	1.013	1.018	1.022
	10	1.028	1.036	1.029	1.088	1.191	1.090
	20	1.039	1.047	1.038	1.115	1.259	1.115
	30	1.042	1.051	1.041	1.123	1.280	1.123
	40	1.043	1.051	1.042	1.125	1.285	1.125
Borrowing							
Period	1	1.488	1.483	1.407	2.114	6.561	1.962
	10	1.296	1.293	1.246	1.702	3.553	1.617
	20	1.172	1.169	1.142	1.408	2.202	1.364
	30	1.082	1.081	1.068	1.196	1.495	1.177
	40	1.000	1.000	1.000	1.000	1.000	1.000
Debt							
Period	1	1.000	1.000	1.000	1.000	1.000	1.000
	10	1.187	1.185	1.155	1.438	2.335	1.382
	20	1.202	1.200	1.168	1.478	2.491	1.421
	30	1.154	1.152	1.127	1.365	2.047	1.324
	40	1.087	1.085	1.071	1.205	1.523	1.183
Capital Stock							
Period	1	1.000	1.000	1.000	1.000	1.000	1.000
	10	1.076	1.076	1.064	1.187	1.461	1.166
	20	1.105	1.104	1.087	1.260	1.671	1.233
	30	1.114	1.113	1.094	1.283	1.740	1.254
	40	1.116	1.115	1.096	1.288	1.757	1.259
Overall	Welfare	0.0958	0.2201	0.1589	0.4840	0.9618	0.6619
Effects (in %)							

Source: Calculations with the Poland's Regional INtegration Computable Equilibrium (PRINCE) Model.

compared to the original setting (0.93 for $\rho = 0.062$), whereas investment surges (2.08 instead of 1.56). Consequently, there is a quick and considerable build up of the capital stock (in the period 40: 1.92 instead of 1.38) and high consumption in the long run (in the period 40: 1.30 instead of 1.18). The welfare measure for the overall membership effects increases from 7.7 per mill to 8.1 per mill: The increase in the welfare measure is due to the substantial higher consumption in the future which is also discounted at a low rate. This compensates the lower consumption level at the beginning.

The results for a simultaneous and corresponding increase in the rate of time preference and in the world interest from $\rho = i^* = 0.062$ to 0.072 are given in the Table 14. The higher rate of time preference induces the household to raise consumption close to the present point of time. The higher interest rate also means that the opportunity costs of non-investing rises accordingly. Furthermore, the higher interest rate makes some investment projects at the margin unprofitable and consequently less investment will occur. For the overall effect of Poland's EU membership consumption goes up in the first period (0.96 for $\rho = i^* = 0.072$) relative to the scenario with the original parameters (0.93 for $\rho = i^* = 0.062$), whereas investment drops significantly (1.40 instead of 1.56). There is now a slow build up of the capital stock (in the period 40: 1.26 instead of 1.38) and a lower consumption in the long run (in the period 40: 1.14 instead of 1.18). Due to the lower consumption in the future and the higher rate of time preference, the welfare measure for the overall membership effects drops from 7.7 per mill to 6.6 per mill – despite the higher consumption at the beginning.

7.5 Conclusions from the Various Sensitivity Analyses

The sensitivity analyses for different specifications of the adjustment cost parameters, the intertemporal elasticity of substitution, the Armington substitution elasticity and the rate of time preference highlight that – as expected – the selection of the parameters has an impact on the results, but also that the main conclusions concerning the importance of distinguishing between income and welfare effects are not affected. Overall, the qualitative results of the simulations are not altered; there is no change in the direction of the response of any macro-economic variable. The sensitivity analyses also show that the Armington elasticity is not so decisive as expected in the main text. Almost complete relaxation of the Armington elasticity assumption does not greatly influence the welfare results.

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