

Poland's EU Accession - Results from a Study utilising the PolGem -Model of the Polish Economy

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***ABSTRACT:** This paper presents a computable general equilibrium model of the Polish economy. The POLGEM model belongs to the well-known ORANI family of CGE-models. The paper gives an overview of the model database and highlights the innovations over the standard ORANI model that have been implemented. In particular, we introduce a distinction between imports from and exports to several sources. The report also presents the results of an application of the model to evaluating the effects of Polish accession to the EU. We analyse the effects of trade liberalisation, tax harmonisation, and the repercussions of introduction of the structural fund transfers. Harmonisation affects relatively few sectors of the Polish economy. The impacts of structural funds dominate. We find the overall effects of accession to be favourable on the Polish economy but inevitably, not all sectors of the economy will benefit from EU membership.*

1 Introduction

Computable general equilibrium (CGE) models have in recent years become one of the most widely used tools for the analysis of policies and shocks that involve structural changes in the economy. They possess a distinct advantage over other types of models for the analysis of structural changes in that only CGE-models contain the necessary data on both the structures and markets of an economy that are necessary for such analyses. More and more, CGE models are also finding applications in the analysis of fiscal policies.

This document describes POLGEM, a CGE model for Poland, developed for the Polish Ministry of Finance. The model focuses on fiscal policies, typical tasks envisaged for the model including assessment of the impacts of

- Elimination of import tariffs for internal EU trade and implementation of EU external tariffs as and effect of EU membership by products and branches
- Adjustment of indirect tax rates (e.g., VAT and excise taxes) to EU levels by products and branches
- Elimination and adjustment of subsidies by products and branches.

The model belongs to the ORANI family, but includes significant extensions to the generic ORANI-G –model, such as accounting for income transfers and income taxes. The model also distinguishes three sources for commodities, namely, domestic firms, EU-countries, and non-EU –countries. Exports have similarly two alternative foreign destinations.

The rest of the paper is organised as follows. Section two gives an overview of the model and the database. Section three presents an EU accession applications of the model with three types of policy shocks, while section four concludes.

2 Overview of POLGEM

The POLGEM model belongs to the ORANI family of computable general equilibrium models, which has been well documented in several sources. Consequently, the model description draws heavily on the recent ORANI documentation in Horridge (2000).

However, POLGEM contains a number of extensions to the generic ORANI-G model that have been introduced to study policy issues peculiar to the Polish economy. In the Development of POLGEM, particular attention has been given to differentiating between Polish imports from EU countries and the rest of the world and to making a similar distinction in the case of Polish exports. Various income transfers not present in ORANI-G have also been introduced, and POLGEM can readily be used to study typical balanced-budget tax policy examples, for example. The aim of these extensions has been to make the model suitable for analysing fiscal policies particularly from the point of view of Polish EU accession.

2.1 The POLGEM Data Base

The core of the POLGEM database consists of input-output data. Polish IO-accounts are fairly complete and with the use of supply and use tables, it is possible to construct a 47-industry database for the model. However, the IO-table identifies only costs related to demand and supply of commodities. National account data have been used to introduce to form a complete SAM, which represents a mapping between institutions and agents in the model. The base year of the model is 1999.

Macro-economic characteristics of Polish economy in 1999

Table 2.1 presents GDP from income and expenditure sides. The value of GDP in 1999 was 612 billion zlotys. Consumption is 64 % of expenditures, while investments are around 26 %. Exports are roughly of same size when imports are more than one third of the GDP. Labour incomes are 45% of GDP when capital incomes take 41 % of GDP and indirect taxes 14%.

TABLE 2.1: GDP from Expenditure and Income side

TABLE 2.2: Sources of indirect tax income

One of the distinguishing features of the POLGEM database is also its very disaggregated tax data, which includes indirect taxes by products and branches. Corporate income taxes are also presented by branch, as Poland has different effective rates on corporate income depending on the source of financing, the legal form of the investor, and the residence status of the lender. Government expenditures are also modelled in a slightly more detailed way than in ORANI-G since they contain transfers in addition to the usual factor payments.

2.2 The theoretical Structure of POLGEM

POLGEM is an adaptation of the ORANI family of generic computable general equilibrium models (Dixon, Parmenter, Sutton and Vincent, 1982). Like ORANI, POLGEM is a Johansen-Euler-type CGE-model written almost exclusively in percentage change form. The model has been implemented by GEMPACK software (Harrison and Pearson, 1996).

Each flow in the model database is the product of a price and a quantity. The model consists of equations explaining each of these. The theory underlying these equations is typical of a CGE model. They describe:

- market-clearing conditions for commodities and primary factors;
- producers' demands for produced inputs and primary factors;
- final demands that are investments, household consumption, exports and government demand;
- the relationship of prices to supply costs and taxes;
- and some macroeconomic variables and price indices.

2.2.1 Industry Behaviour

Industries are assumed to be perfectly competitive profit maximizers. This means that their behaviour is consistent with cost-minimising input choices, as well as revenue-maximising output-choices in the cases where more than one good is produced by a single industry. POLGEM considers multi-production of exports and distinguishes between exports to EU and non-EU-countries. The decision over the output mix and the choice of inputs are described as a multi-stage decision problem. Input demands are derived from cost-minimising behaviour. As shown in Figure 1.2, the industry minimise costs by choosing the input mix, subject to a three-tier constant-returns-to-scale input technology. At the top level, it is assumed that commodity composites, primary-factor composites and 'other cost' are combined using a Leontief function. The assumed production structure is illustrated in Figure 1.2

Figure 1.1: Production Structure of an Industry in POLGEM

At the next level, imperfect substitutability between domestic and imported goods is assumed. The assumption is implemented by assuming inputs form different sources to combine into composite goods using a CES (constant elasticity of substitution) production function (Armington, 1969). For each generic commodity i ($i = 1, \dots, c$), the industry optimise the mix of domestic and imported component so as to minimise its costs subject to the CES technology. The demands for land, labour and capital are also derived by minimising the cost of primary factor composites formed according to CES technology.

The last level of the input technology is only applicable to labour. As in the case of the second level, composite labour is a CES aggregate of skilled and unskilled labour. The demands for labour in the two skill categories are derived by minimising labour costs subject to this technology.

On the output side, each industry may produce both domestic and export goods. The choice on the composition of output is made subject to a CET (constant elasticity of transformation) production frontier. This multi-production decision is shown as the highest decision level in figure 1.2.

2.3 Final Demand

Final demand stems from four main sources: household consumption, investment/capital creation, government consumption and exports. This is also the classification of final demand adopted in input-output tables, the main source of the model database.

2.3.1 Household Consumption

Households are represented by a single representative household, which maximises utility. The household utility structure is illustrated in Figure 1.3. The household maximises utility allocating its budget across composite commodities consisting of domestic and imported goods. Household income stems from both wages and capital rents. Households are endowed with capital and two types of labour. Household demand responds to changes in the relative prices of domestic and foreign commodities by substituting between domestic and imported goods (Armington, 1969). We assume furthermore that imports stem from two sources, the European Union, and the rest of the world. Household demands derived from the utility maximising scenario specified in Figure 1.2 follow the Linear Expenditure System, in which household expenditure on any given Armington composite is a linear function of both prices and incomes.

Figure 1.2 Household Utility in POLGEM

2.3.2 Investment

Figure 1.3 illustrates the nesting structure for capital creation. The allocation of investment between industries is assumed to depend on rates of return. Capital thus tends to get allocated to those sectors where its return is highest. A new unit of fixed capital used in industry j is constructed according to a two-tiered technology. At the top level, industry minimises cost by choosing the composite goods subject to a Leontief production function, implying that all composite goods are used in fixed proportions. At the next level, substitution between domestic and imported goods is possible (Armington, 1969). As is evident from Figure 1.3, primary factors are not used in capital creation.

Figure 1.3 The Structure of Capital Creation in POLGEM

2.3.3 Export and Other Demands

Export demand is specified as a downward-sloping schedule. Export volume for each commodity is a declining function of its price in foreign currency. The sensitivity of export volume to the change in its price is determined by an export demand elasticity parameter.

2.3.4 Demand for Margin Services, government demand

Margin services are used to facilitate the flow of each commodity from its source to agents. These demands are assumed to be in direct proportion to the commodity flows with which each specific margin is associated. Margin services are used to facilitate the flows of both imported and domestically produced goods. The other demands, that is, the public ones, are taken to be exogenous.

2.4 The Price System

The model distinguishes two types of prices: basic values and purchaser's prices. For domestically produced goods, basic value is defined as producer price, excluding taxes and margins used to deliver these goods to users. For imported goods, basic value is the price received by importers, including any tariffs. Sales taxes and margins are excluded from basic import prices but import duties are included; that is, the basic value price of an import is its 'landed duty-paid' price. Purchasers' prices for both imported and domestically produced commodities are the basic prices plus sales taxes and margin costs.

In deriving equations representing the model's pricing system, the following simplifying assumptions are adopted. Pure profit does not prevail in any economic activity: production, capital creation, distribution, exporting or importing. Basic prices are uniform for all users and producing industries. This assumption implies that if a difference in purchasing prices exists across users, this is entirely due to the differences in the sales tax and margin costs. In other words, while the basic price is the same for all users, the purchaser's price paid by each user can differ. Since constant returns to scale are assumed, the industry's per unit cost and per unit revenue are independent of output level, being influenced only by the level of technology and the prices of commodities. With the above assumptions, the basic prices per unit of an industry's output equals the total payment for the inputs needed to produce one unit of output.

For the capital creation activity, the above assumptions imply that per unit price of capital for a certain industry is simply its per unit construction cost. As has been elaborated earlier, capital is constructed by using imported and domestically produced goods. It is important to distinguish between the cost of constructing capital and the cost of using capital. The latter is defined as the gross (before depreciation) rental implied by the going rate of return on a unit of capital used in a certain industry.

2.5 Market Clearing Equations

For domestically produced commodities, the total supply is made up of the demand for (i) intermediate inputs to current production; (ii) capital creation; (iii) households' consumption; (iv) exports (v) government purchases; and for (vi) margin services.

For capital and land, one important assumption is made in short-run closures of the model: neither capital nor land is allowed to move between industries. With this assumption, the market clearing equations are simply set to equate the demands for capital and land to their respective supplies in each industry. Unlike capital and land, labour is assumed to be mobile between industries in virtually all closures of the model.

The supply side of labour market is characterised by an identity defining aggregate labour demand. The choice of model closure can then imply either that the supply of labour is fully exogenous, or alternatively, that labour is in infinitely elastic supply at an exogenous wage rate. Thus, in one closure where the supply for labour is exogenously set at the full-employment level, the wage will adjust to bring labour demand to the full-employment level. In another closure where the real wage is set exogenously, the model will solve for the level of employment corresponding to this given wage level.

3 Evaluating aspects of Poland's EU Accession using POLGEM

This section analyses the economic consequences of some policy changes that are implied by Poland's membership in the EU. The coverage of policy measures is by no means complete. We look at the implications of customs union formation, changes in the VAT taxation and impacts of structural funds transfers. Agricultural policy is not touched upon, except in trade policy regime. Transfers related to Common Agricultural Policy (CAP) tied to production or resource use restrictions. Introduction of CAP is likely to induce changes in commodity specific supply responses, but the model has information only on aggregate agriculture. The main aspect of CAP is large income transfers, but their overall economic repercussions are small outside agricultural industries where commodity specific responses are expected to vary significantly (Frandsen and Jensen, 2000).

3.1 Policy Shocks

Reciprocal tariffs have already been abolished in trade between the EU and Poland except in agricultural trade where liberalization to both directions takes place. The custom union formation implies common trade policy against third parties. In sector specific terms this means reduction of Polish tariffs in most of the manufacturing industries, and increases in the tariffs in agricultural and food products. EU's average industry level tariffs from version 5 of GTAP database has been used to estimate the required tariff rate changes.

General rules of Polish VAT and excise tax system are compliant to the rules binding by community law. There is, however, need to adaptation regarding the VAT rates. In its accession agreements Poland has committed to increase some rates of value added and excise taxes. Most important of these are increases in value added taxes for purchases of new flats and construction and repair services from 7 to 22 %. Similar increase has been agreed on taxing restaurant services. Super-reduced rates on agricultural inputs are increased from 3 to 7%.

The EU has largely attempted to use the structural funds to balance out regional development within countries, but another aim of the structural funds has been to promote social cohesion. Low GDP relative to the EU average has been the main factor in the allocation of structural funds expenditure. Regions whose GDP has been below 75 per cent of the EU average have received the bulk of funding from the structural funds.

Structural subsidies have been modelled in this study in a simple, straight-line way, as investment subsidies. The magnitude of the subsidies is taken directly from Financial framework of Copenhagen package. In this estimate, the provision for structural funds expenditure on annual basis for Poland in 2005 is 1.8 billion euros that is 7.5 billion zlotys. This is about 1.2 % of Poland's GDP in 1999. The way in which the subsidies have been accounted for here is relatively rough. Investment subsidies, for example, have not been targeted by sector. In the model, the structural funds are simply public support for the purchase of commodities, which promotes the accumulation of capital and economic growth. As regards any appraisal of the impact of the structural funds, therefore, the results should be seen as being indicative only.

3.2 Simulation results

Figure 3.1 presents macro economic results of the policy experiment. All variables are presented at fixed prices. The results of policy simulations in this study represents compound effect of several exogenous shocks. The policy impacts are decomposed by different aspects of the shocks that are tax harmonization, trade policy and structural fund transfers using method suggested by Harrison et al. (2000)¹.

The model closure that is used can be characterised as long-run. Labour supply is assumed to be fixed and wages flexible. Rate of return is assumed to be fixed and capital stock endogenous. Unlike in typical ORANI closures (see Horridge, 2000) we do not assume fixed trade balance only public sector balance relative to GDP is kept constant. This is done by adjusting income tax rate. Consumption grows proportionally to disposable income. Consumption and investments are independent decisions and foreign saving adjusts to meet the savings investment balance. In this sense the model behaviour resembles that of standard GTAP -model (Hertel and Tsigas, 1997).

Figure 3.1: Macro Impacts of Poland's EU Accession

The combined impact of policy shocks evaluated in this study implies almost 3% increase in GDP at fixed prices. Investment and imports grow almost 6% , consumption 4% and exports a bit less than 2%. In each of GDP components the impact of structural funds dominate. In imports and consumption the trade policy shock is also fairly significant. One third of import increases are induced by trade policy. It should be noted here that most of this impact is not due to increased bilateral trade with the EU but due to decreased rate of protection w. r. t. the rest of the world because of adaptation to the lower tariff rates applied within the EU. More that two per cent of GDP change is due to the structural funds. The impact is about twice of the size of transfers received. In this kind of setup the transfers are effective to promote convergence.

In tables 3.1 and 3.2 is presented the Fan decomposition of output growth of ten best performing and ten worst performing industries. Fan decomposition (see also Horridge, 2000) breaks down the changes in domestic production into three causes:

- the local market effect: an increase in local usage of commodity, whether domestically-produced or imported,
- the export effect: an increase in exports of locally produced good, or
- the domestic share effect: a shift in local usage of commodity from imported to domestically-produced.

Often these three effects will work in different directions. For example, an increase in foreign demand might pull local producers up the supply curve, so increasing the domestic price and

¹ To evaluate the relative significance of each partial component is a non-trivial problem as Harrison et al. (2000) has demonstrated. For example, if contribution of individual variables is calculated, the magnitude of individual contributions depends on the order of calculation. In the case of a non-linear model even the sign of the impact can alter depending on the order of calculation. Fortunately Harrison et al. (2000) provide a natural method of decomposing the policy impact by its exogenous components. The partial effects are conditional for other parts of the policy to take place simultaneously.

facilitating import penetration. The decomposition aims to show the relative magnitude of these three contributions to output change.

TABLE 3.1: Fan decomposition of output growth in ten best performing industries

TABLE 3.2: Fan decomposition of output growth in ten lowest performing industries

Most of the sectors that are within the ten best performers are activities that are related to domestic markets that is services. It's not in any of the cases of best performing industries that trade related factors has dominating role in their output expansion. Only in the top performer that is office machinery and computers has export expansion somewhat significant effect. Local market effects dominate. In the group of worst performers only in the lowest ranked industry, which is wearing apparel, has the export markets a significant role in its output response. However, in most of the cases increased import competition that is reflected in domestic market share is significant contributor to their output behaviour.

Figure 3.2 Local market effect by policy components

Figure 3.3 Domestic share effect by policy components

Figure 3.4 Export effect by policy components

The Fan -decomposition is further broken down by the impacts of various policy components in the case of three top performing and three low performing industries. Local market effect is in the case of low performers almost invisible contrary to high performing industries, where in this subcomponent the structural fund element dominates the expansion effect.

In domestic share effect only one industry improves its competitiveness and gains markets shares. This is takes place in case of office machinery and computers. In most of the industries both trade policy and structural funds tend to deteriorate relative market share. Since economy is getting more capital intensive as a consequence of reforms under study, the deterioration is due to Rybczynski -effect. More capital intensive industries expand while labour intensive industries release labour and contract to give room for this expansion at the given use of labour force.

In export part of Fan -decomposition, manufacturing of food and beverages is a special case since it's the only industry together with agriculture that benefits of the increased market access within the EU. Export effects are not that pronounced in any of the sectors except in wearing apparel where the decline of export markets has significant impact.

4 Concluding remarks

This document has described POLGEM, a CGE model for Poland. The model has been developed for the Polish Ministry of Finance and it focuses on fiscal policies. The model belongs to the ORANI family, but includes significant extensions, such as accounting for income transfers and income taxes. The model also distinguishes several sources of supplies for commodities as well as several export destinations.

As a first policy experiment, some aspects of Poland's accession into the EU has been analysed with the model. It turns out that introduction of structural funds seems to be overwhelmingly the most significant policy change of those under the study. More that two thirds of the implied increases of GDP change is due to the structural funds. The induced

growth effect is roughly twice of the size of transfers. At least under the policy setup the structural funds are modelled here, they seem to promote convergence within the EU.

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FIGURES AND TABLES:

	Million Zlotys	%-share
Consumption	394549.1	64.4
Investment	158062.6	25.8
Government	101473.1	16.6
Stocks	-6903.5	-1.1
Exports	160786.8	26.3
Imports	-195503	-31.9
GDP	612465.6	

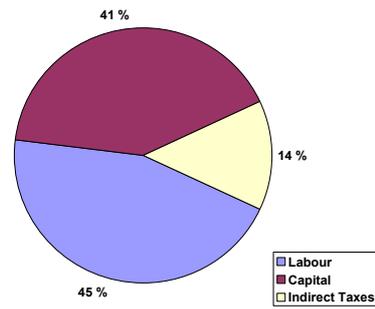


TABLE 2.1: GDP from Expenditure and Income side

	Million Zlotys	%-share
Intermediate taxes	1519373017.8	
Investment taxes	6135025	7.2
Consumption taxes	4872676457.1	
Production taxes	1279868515.0	
Production and product subsidies	-6711230	-7.9
Tariffs	9181045	10.8
Total	85324019	

TABLE 2.2: Sources of indirect tax income

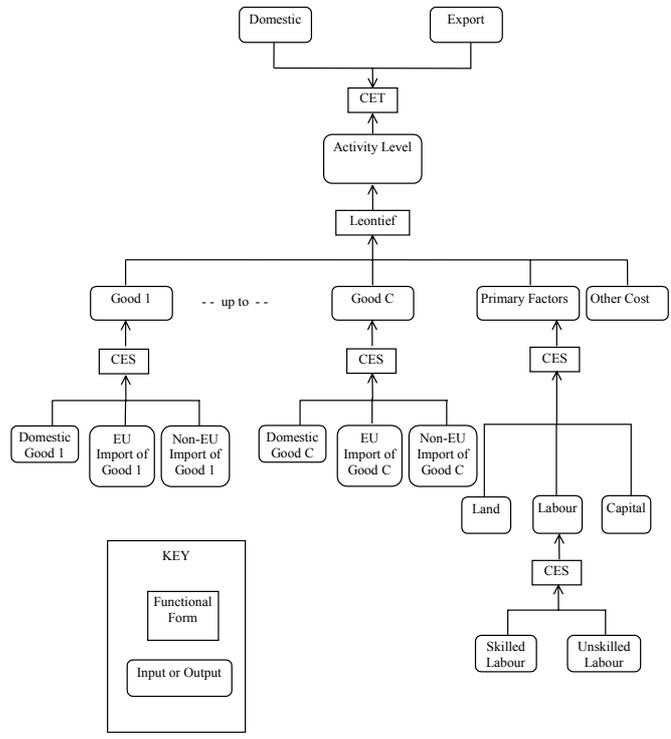


Figure 1.1: Production Structure of an Industry in POLGEM

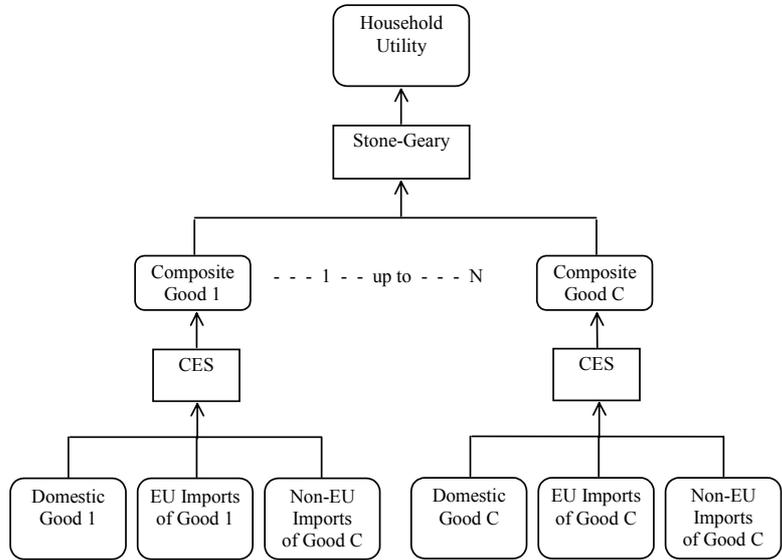


Figure 1.2: Household Utility in POLGEM

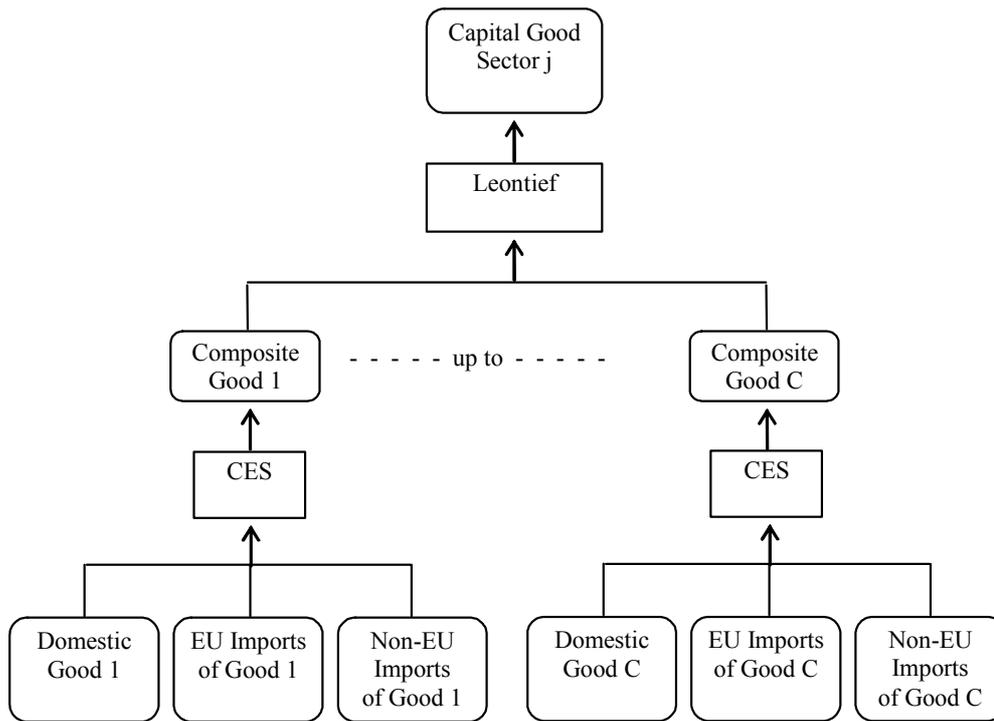


Figure 1.3: *The Structure of Capital Creation in POLGEM*

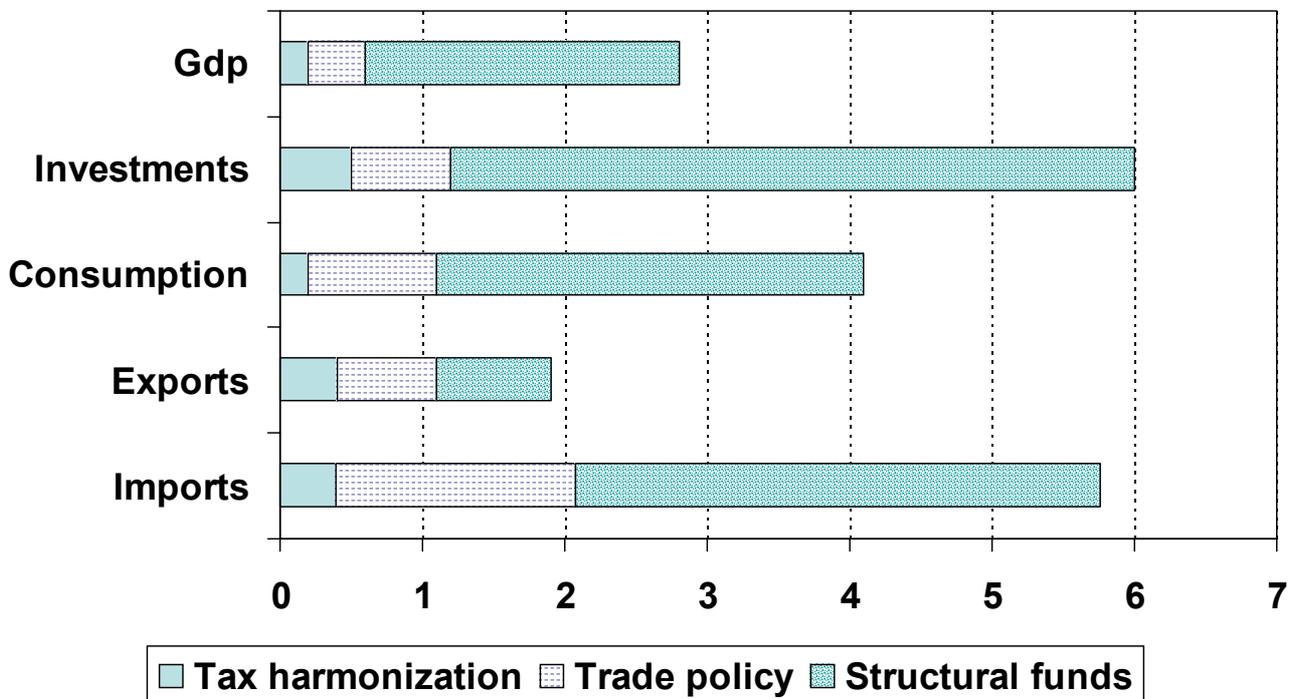


Figure 3.1: **Macro Impacts of Poland's EU Accession**

	LocalMarket	DomShare	Export	Total
Manufacture of office machinery and computers	3.54	0.41	1.54	5.5
Manufacture of food products and beverages	3.41	-0.35	1.8	4.86
Construction	4.44	0.01	0.22	4.67
Other service activities	4.33	0	0.17	4.49
Wholesale and Retail trade	3.94	0.01	0.01	3.95
Manufacture of coke and refined petroleum products	3.14	0.12	0.53	3.79
Publishing, printing	3.61	-0.07	0.08	3.61
Collection, purification and distribution of water	3.22	0	0	3.22
Financial intermediation, Insurance	3.21	-0.16	0.14	3.19
Manufacture of medical and precision instruments	4.37	-1.48	0.23	3.12

TABLE 3.1: Fan decomposition of output growth in ten best performing industries

	LocalMarket	DomShare	Export	Total
Supporting and auxiliary transport activities, activities of travel agency	1.25	-0.41	0.23	1.07
Manufacture of rubber and plastic products	2.02	-1.17	0.21	1.06
Manufacture of machinery and equipment n.E.C.	3.3	-2.3	0	1
Manufacture of chemicals and chemical products	1.92	-1.35	0.12	0.69
Manufacture of fabricated metal products ,except machinery	2.29	-1.74	0.01	0.56
Research and development (R&D)	0.44	-0.03	-0.03	0.38
Manufacture of leather and leather products	1.87	-1.87	0.14	0.14
Manufacture of textiles	0.83	-0.69	-0.07	0.07
Manufacture of basic metals	0.81	-1.38	-0.8	-1.37
Manufacture of wearing apparel; dressing and dyeing of fur	0.46	-1.36	-5.05	-5.95

TABLE 3.2: Fan decomposition of output growth in ten low -performing industries

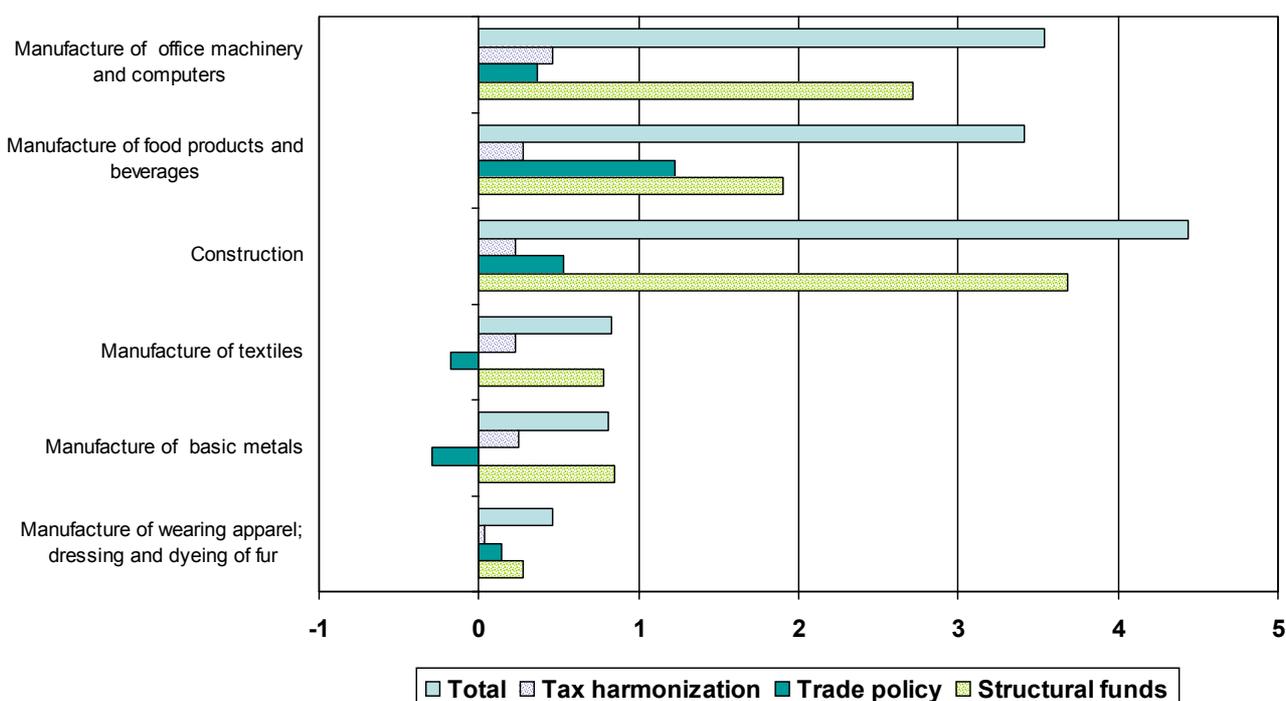


Figure 3.2 Local market effect by policy components

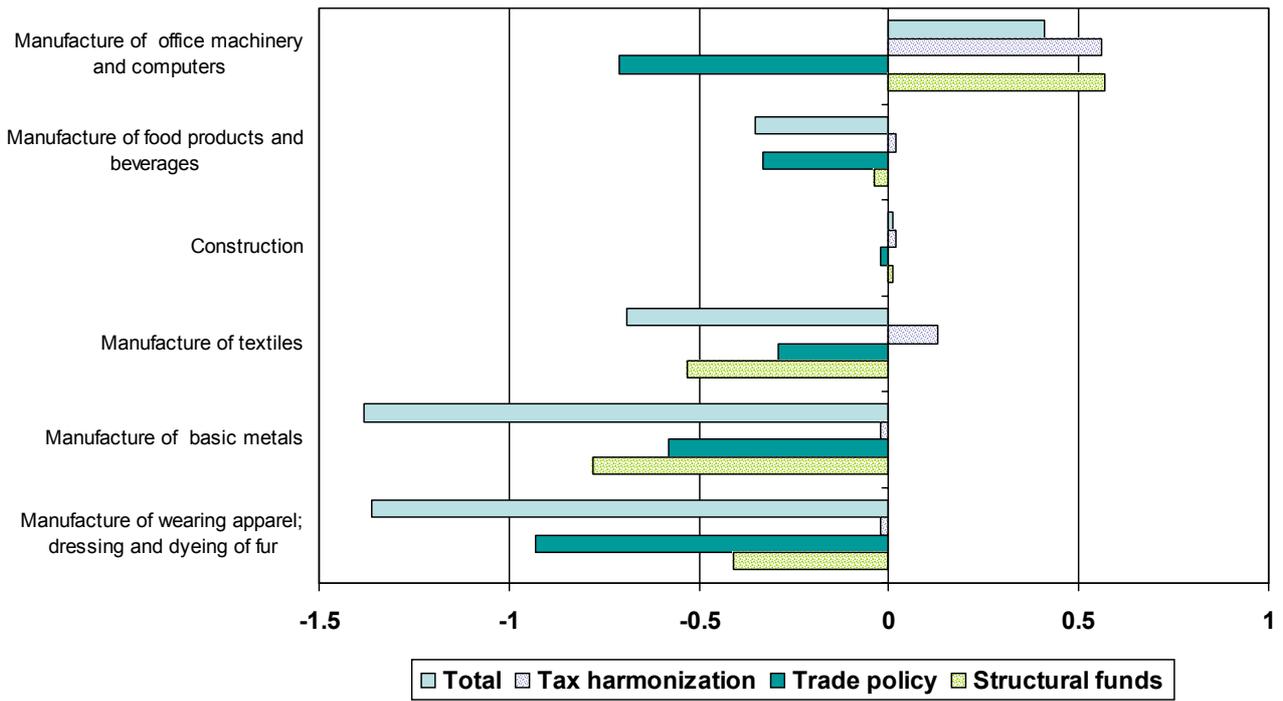


Figure 3.3: Domestic share effect by policy components

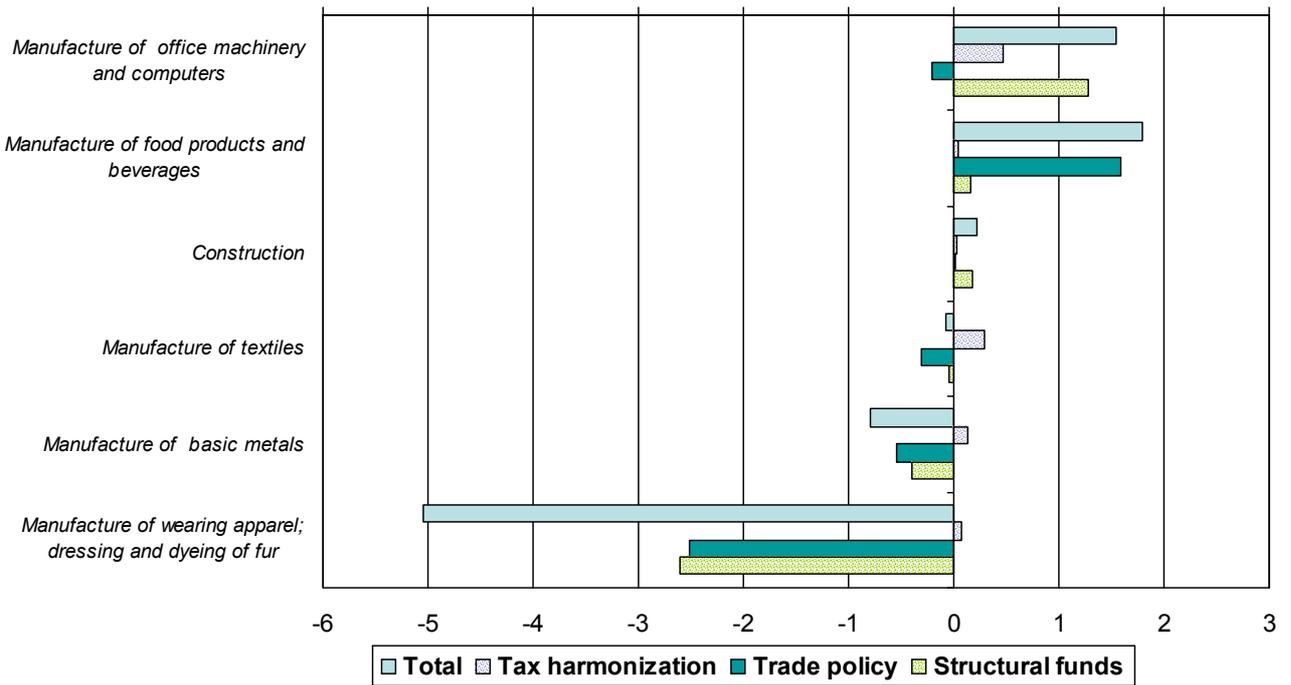


Figure 3.3: Export effect by policy components

POLGEM Industry classification

ISIC Description	Abbr.	ISIC Description	Abbr.
Agriculture, hunting and related service			
-1 activities	Agr	-40 Electricity, gas steam and hot water supply	EGW
Forestry, logging and related service			
-2 activities	ForSrv	-41 Collection, purification and distribution of water	Wdist
Fishing, operation of fish hatcheries and fish			
-5 farms	Fish	-45 Construction	Constr
		Sale, maintenance and repair of motor vehicles	
-10 Mining of coal and lignite, extraction of peat	MiCo	-50 and motorcycles; retail sale of automotive fuel	Trade
(11-		Wholesale and commission trade, except of motor	
12) Mining nec	MiNec	-51 vehicles and motorcycles	Trade
-15 Manufacture of food products and beverages	FoodBev	-52 Retail trade	Trade
-16 Manufacture of tobacco products	Tob	-55 Hotels and restaurants	HoRe
-17 Manufacture of textiles	Tex	-60 Land transport, transport via pipelines	Trans
Manufacture of wearing apparel; dressing			
-18 and dyeing of fur	Wap	-61 Water transport	Trans
-19 Manufacture of leather and leather products	Lea	-62 Air transport	Trans
		Supporting and auxiliary transport activities,	
-20 Manufacture of wood and wood products	Wood	-63 activities of travel agency	TrNec
Manufacture of pulp, paper and paper			
-21 products	PPP	-64 Post and telecommunications	P_T
Publishing, printing and reproduction of			
-22 recorded media	PuP	-65 Financial intermediation	FinBuServ
Manufacture of coke, refined petroleum		Insurance and pension funding, except	
-23 products and nuclear fuel	Fuels	-66 compulsory social security	FinBuServ
Manufacture of chemicals and chemical			
-24 products	ChemPl	-67 Activities auxiliary to financial intermediation	FinBuServ
-25 Manufacture of rubber and plastic products	RPP	-70 Real estate activities	Rstate
Manufacture of other non-metallic mineral			
-26 products	NmM	-71 Renting of machinery and equipment	FinBuServ
-27 Manufacture of basic metals	B_Metal	-72 Computer and related activities	Comp
Manufacture of fabricated metal			
-28 products, except machinery and equipment	MetPrd	-73 Research and development (R&D)	R_D
Manufacture of machinery and equipment			
-29 n.E.C.	MacEq	-74 Other business activities	FinBuServ
Manufacture of office machinery and		Public administration and defence; compulsory	
-30 computers	OfMaCo	-75 social security	PuAdDe
Manufacture of electrical machinery and			
-31 apparatus	EIMac	-80 Education	Edu
Manufacture of radio, television and			
-32 communication equipment and apparatus	RaTVC	-85 Health and social work	Hlth
Manufacture of medical, precision and	MedPrel	Sewage and refuse disposal, sanitation and	
-33 optical instruments, watches and clocks	nst	-90 similar activities	Junk
Manufacture of motor vehicles, trailers and			
-34 semi-trailers	M_Vech	-91 Activities of membership organization	NGO
-35 Manufacture of other transport equipment	TrnsEq	-92 Recreational, cultural and sporting activities	RCSA
Manufacture of furniture, manufacturing			
-36 n.e.c.	Ftre	-93 Other service activities	OS
-37 Recycling	Rec		