2 COMPUTABLE GENERAL EQUILIBRIUM MODELS FOR THE CENTRAL AND EASTERN EUROPEAN EU MEMBER STATES: A SURVEY

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Abstract

The accession of twelve Central and Eastern European countries (CEEC) to the European Union (in 2004 and 2007) has given rise to new challenges in evaluating the effects of integration, for both the old and the new member states. These issues can only be addressed in a consistent, economy-wide framework, given that the institutional and economic changes implied by the membership process produce numerous, dynamic and complex interactions between the economic agents and sectors. Applied general equilibrium offers such a framework.

This paper reviews the existing computable general equilibrium (CGE) models for the Central and Eastern European EU member states.

Keywords: General equilibrium, EU, CEEC, integration.

JEL Classification: C68, D58, F15.

Introduction and brief history

Since the early 1960s, computable general equilibrium (CGE) models have been used to analyze an enormous variety of issues ranging from the effects of agricultural and trade policies to tax policies, environmental policies, regional policies, etc.

A comprehensive survey of the CGE models is practically impossible, due to the rapid expansion of the research in this field. The few survey papers already published consider different subgroups of CGE models, such as those used for analyzing tax and trade policies (Bandara, 1991; Pereira and Shoven, 1988; De Melo, 1988; Shoven

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and Whalley, 1984), environmental policies (Beaumais and Schubert, 1996), agricultural and trade policies (Van Tongeren, Van Meijl and Surry, 2001), energy policies (Bhattacharyya, 1996; Bergman, 1988) and regional policies (Partridge and Rickman, 1998).

In the past, the CGE models have been considered by many not to be appropriate for the former centrally-planed economies on both practical and ideological grounds. For example, in the CGE models, consumers typically maximize their utility and producers maximize their profits, while the demand and supply of products are cleared in markets at flexible equilibrium prices. This makes the CGE models particularly suitable for modeling a market-driven economy. In contrast, input-output models have long been used in many of the centrally-planned economies to solve the "material balance" problem in quantitative planning. These fixed-price models proved to be more suitable to a system where the major policy instrument was direct quantitative control and in which the price system was not given an important role.

Nevertheless, as pointed out by Kis, Robinson and Tyson (1990), two factors enlarged the usefulness of the CGE models for the centrally-planned economies:

- The major reforms undertaken in the late 1960s in some socialist countries, which were meant to improve the economic performance by instituting a new economic system with increased reliance on market mechanisms and price incentives. The leaders in these reforms were Hungary and former Yugoslavia;
- The development of the "structuralist" and the "neoclassical structuralist" CGE models, which incorporate a variety of "structuralist" features and recognize the existence of rigidities and imperfections in the actual economies. Thus, when suitably adapted, a CGE model could be used for policy analysis in the post-reform socialist economies.

The two most important CGE models developed for the Eastern Europe in the 1980s were built under the auspices of the World Bank. Their main purpose was to analyze issues regarding structural adjustment in the medium run, especially the impact of changes in foreign capital inflows and international trade on the structure and performance of the economy. The CGE model for Yugoslavia was developed at the World Bank, while the model for the Hungarian economy was built at the National Planning Office of Hungary and used to support the analysis within the World Bank. The Hungarian economy model is based on the earlier work of Zalai, who built the first CGE model for Hungary (HUMUS) in 1983. In the attempt to adapt the CGE framework so as to incorporate the important institutional features of socialist economies, both models evolved a long way from their neoclassical antecedents. An example could be the Yugoslav model, where the assumption of profit maximization of sectors is replaced by a complex set of relationships that capture the operation of self-managed firms. The effect is that enterprises are less responsive to price signals and the workers' income is no longer equal to the marginal productivity of labor. Nonetheless, these models still reflect their neoclassical roots, as they do not capture macroeconomic interactions among price level, the exchange rate, interest rates and monetary aggregates. Instead, the macro interactions are captured essentially through a special closure where inflation is endogenous and nominal personal income exogenous in the Yugoslav model, while forced savings close the Hungarian model.

Braber, Cohen, Revesz and Zolkiewski (1993) take up again the discussion regarding the use of the CGE models for former centrally-planned economies, from the perspective of the transformation of planning oriented economies to market oriented economies. They consider the Social Accounting Matrix (SAM) as the interface between a central planning model and a free market model and develop two types of models: a fixed price SAM multiplier model and a flexible price CGE model. The SAM model, with fixed prices, is considered to be more suitable within the centrally-planned economy framework, while the flexible price CGE model is considered as the free market economy prototype model. The CGE model developed in this framework is different from the earlier attempts undertaken by the World Bank, in the sense that it is mainly neoclassical and tries to portray an idealized free market economy. Both models are applied to the Polish and Hungarian economy. For each of them, two benchmark years have been introduced, a pre-transition year (1987 for Poland and 1988 for Hungary) and a transition year (1990). There are two policy scenarios for each model and country, respectively: (i) increasing government demand for services, aimed at shifting the production structure towards services, and (ii) increasing government transfers to the first decile household group, aimed at changing the income distribution in favor of the poorest households. For both policy simulations the exogenous shocks seem to lead to smoother adjustments in the centrally-planned economy case. More surprisingly, the second policy simulation suggests that the impact of government transfers on households' income is larger in a flexible price economy than in a fixed price economy. However, Braber, Cohen, Revesz and Zolkiewski (1993) point out that the reliability of the CGE policy simulations results is questionable due to the fact that an economy in transition can hardly be considered to be in equilibrium in the benchmark period, and thus the calibrated parameters may be misspecified. Their exercise is meant to show the functioning of the economy under different policy regimes.

During the 1990s, modelers have more readily applied the CGE framework to the Central and Eastern European countries, as these moved towards market oriented economies.

The paper is structured as follows. The next four sections present the CGE models for the Central and Eastern European EU members according to the purpose they have been built for. The first category focuses on the accession to the European Union. The next two categories analyze common issues in CGE modeling like trade liberalization and environmental policies. Finally, the fourth category comprises other models that attempt to give a "general" description of the CEE economies, analyzing several different types of policy questions ranging from industrial policy and privatization to pension policy reforms and other tax reforms. We conclude in the sixth section. A summary of empirical CGE models for CEEC is provided in Table A.1, Appendix A.

EU enlargement models

One of the most important challenges for the European Union as well as Central and Eastern European countries is the enlargement of the European Union to the East. The economic implications of the Eastern enlargement play an important role in the current debate. A number of CGE models were developed to analyze the effects of

the enlargement from the European Union perspective. Some of them also evaluate the costs and benefits of integration for the CEEC. Two categories of EU enlargement models can be distinguished: world models and country specific models. In this section, we will only summarize the country specific models and the world models which specifically incorporate some of the Central and Eastern European countries. Unfortunately, most of the world models comprise the effects on the Eastern European economies at an aggregate level.

Brown, Deardorff, Djankov and Stern (1995) evaluate the effects of the EU-CEEC integration using a specially constructed version of the University of Michigan CGE world trade model. The model includes 8 countries/regions, where Hungary, Poland and former Czechoslovakia are individually modeled. The European Union is further divided into three groups: EU-North, EU-South and EU-EFTA (Austria, Finland and Sweden). For each region, 29 production sectors are specifically modeled, where manufacturing and services sectors are characterized as being monopolistically competitive with free entry. The model is static and the base year for the calibration is 1992. Brown, Deardorff, Djankov and Stern (1995) analyze the EU-CEEC integration through: the formation of CEFTA, the implementation of the CEEC-EU free trade agreements, the elimination of tariffs and non-tariff barriers. Their results show that both EU and CEEC reap gains although the gains are larger for the Eastern European economies. The effects on the non-European regions are negligible.

Banse and Tangermann (1996) extend the CGE model developed by Adelman and Robinson (1988) for Korea, and applied it to Hungary to analyze the agricultural implications of Hungary's accession to the European Union. The CGE model incorporates 9 production sectors and has a recursive dynamic structure. The base year for the calibration is 1990. Banse and Tangermann (1996) compare the results of the CGE model with those of ESIM (European Simulation Model). ESIM is a static partial equilibrium model used to analyze changes in the Common Agricultural Policy (CAP). ESIM is a world model, including 14 country blocks and 27 commodities. Both models show that the inclusion of Hungary's agriculture in the CAP may result in an increase in agricultural production and exports.

Piazolo (2000) develops a dynamic Ramsey-type open economy CGE model for Poland (PRINCE) to evaluate the effects of its integration into the EU. The model distinguishes one production sector and one type of commodity. PRINCE is calibrated on the Social Accounting Matrix for the year 1996. EU integration membership is captured through tariff reduction, border cost reduction, reduction of technical barriers to trade and net EU-transfers from Brussels to Poland. The welfare gains show that Poland will benefit directly from the EU membership.

Lejour, De Mooij and Nahuis (2001) adopt a CGE model for the world economy, called WorldScan, to explore the implications of EU enlargement in terms of three dimensions: the accession to the internal market, the equalization of external tariffs and the free movement of labor. The economic consequences of accession to the internal market are measured by estimating gravity equations on the industry level[1].

[1] *In the gravity models the trade flow between two countries depends positively on their size and negatively on the distance between them. In economic terms, trade flows between two*

The model is calibrated on the basis of the GTAP database, version 5 (Purdue University, 2001) with 1997 as the base year. WorldScan distinguishes 12 regions: Germany, France, UK, the Netherlands, South EU (comprising Italy, Spain, Portugal and Greece) and the rest of the EU (comprising Austria, Belgium, Luxembourg, Ireland, Denmark, Sweden and Finland), Poland, Hungary, the CEEC5 (comprising Czech Republic, Slovak Republic, Slovenia, Bulgaria and Romania), the former Soviet Union (also comprising the Baltic states), the rest of the OECD and the rest of the world (ROW). For each region the model distinguishes 16 production sectors. WorldScan analyzes the consequence of integration for both the EU and CEEC in a neoclassical framework. The policy simulations suggest that EU enlargement yields large gains for the Central and Eastern European countries and a modest welfare improvement for the EU. The accession to the internal market generates the largest economic effects.

Vanags (2001) uses a comparative static CGE approach to evaluate the economic impact of the EU accession for Latvia. The features of the model are neoclassical structuralist. It incorporates 8 production sectors and the benchmark year for the calibration is 1997. External trade is differentiated according to four main partners: the EU, the CIS, the other Baltic states and the rest of the world. The EU accession is analyzed within two phases. Phase 1 represents the mutual removal of tariffs on manufacturing products. Phase 2 includes the integration of the Latvian agriculture into the CAP, the adoption of the EU common external tariffs and the elimination of the real trade costs on EU trade. Vanags' results (2001) show that the overall trade impact is positive. However, the largest share of trade gains occurs in the first phase.

Bayar, Majcen and Mohora (2003) develop a neoclassical structuralist recursive dynamic CGE model for the Slovenian economy to analyze the effects of trade liberalization and of financial flows from the EU to Slovenia after the accession[1]. The model is calibrated on the Slovenian SAM for 1997 built by the authors. The novelty of the model consists in the modeling of a special institution called the Fund. The aim of the Fund is to collect transfers from both (Slovenian and EU) budgets and redistribute them according to the stated uses: a part of the transfers goes to the EU budget; another part is transferred back to the Slovenian budget (cash flow lump-sums and budgetary compensations); and the rest is used for subsidies or investment[2]. The model distinguishes 15 production sectors and 15 types of goods, and labor demand and unemployment differentiated between skilled and unskilled workers. The recursive dynamic structure incorporates adaptive expectations.

The costs of tax harmonization with the EU requirements and the restructuring of public expenditures, important steps in the preparation for the EU accession, are analyzed by Mohora (2006) using a model developed for Romania (RoMod). RoMod

countries depend on the importer's demand and the exporters supply and on the cost of trade (Lejour, De Mooij and Nahuis, 2001).

[1] *A new version of the model for Slovenia is available, having 2004 as reference year. This version has been used to evaluate the effects of several fiscal reform packages.*

[2] *The distribution of the subsidies or investments between the production sectors is done in line with the Common Agricultural Policy and Rural Development, Structural actions, internal policies and the SPD. The national public co-financing is also taken into account.*

is a recursive dynamic CGE model incorporating neoclassical structuralist features. It comprises 34 branches of activity and 34 types of goods and services. Special attention is given to the representation of taxes and trade and transport margins, which are modeled at a detailed level. RoMod is calibrated on the SAM for Romania for the year 2000, built by the author. Mohora (2006) shows that tax harmonization with the EU requirements results in household's welfare losses and a negative impact on employment and real GDP. However, the magnitude of the effects is small. On the other hand, public expenditures restructuring could lead to positive effects in terms of welfare, employment and GDP.

In summary: EU enlargement models report probable gains for the accession countries. The world models analyzing EU enlargement suggest benefits also for the European Union. However, these positive effects are much smaller than for the Eastern European countries.

Trade liberalization models

Many CGE models have been built to analyze the consequences of trade liberalization for a country's welfare. The main reason for analyzing this issue in connection with the situation in CEEC is the liberalization of the trade regimes with OECD countries and the collapse of the former trade and payments system for East bloc transactions, the Comecon, in 1990. The external liberalization consisted of the removal of non-tariff barriers and, more important, of the abolition of the state monopoly in foreign trade.

Zalai (1993) analyzes the effects of trade liberalization in Hungary with a modified version of the HUMUS model. The latter is a single-period, multisectoral (21 production sectors) model, formulated in the spirit of mathematical programming models of resource allocation, with the objective of maximizing one or more components of final demand, subject to overall resource constraints. The model is essentially built for a centrally-planned economy but also incorporates some market elements, introduced in connection with the reforms started in the late 1980s. The original HUMUS model reflects the institutional structure of Hungary's trade by modeling two separate trade balances, one denominated in USD and taking into account all transactions in hard currencies, the other denominated in roubles and taking into account all Comecom transactions. The new version of the HUMUS model reflects the collapse of Comecom and the liberalization of imports from OECD countries during 1989 and 1990, by incorporating a consolidated balance of trade. Nevertheless, the model still distinguishes between two trading regions following the author's belief that the behavior of representative agents in Eastern and Western markets is expected to be different for a few more years. An interesting feature of the model is that it allows a traditional analysis, based on a sophisticated input-output type solution, as well as a full CGE approach, taking into account the potential effect of a longer run structural adjustment in the economy, by running different policy simulations. The comparison reveals how misleading the standard input-output approach can be. Moreover, Zalai (1993) points out that the CGE solutions seem to capture much better the underlying economic reality.

Another attempt to analyze the effects of trade liberalization by using a CGE approach is the one by Roberts and Round (1999), for the case of Poland. They reconsider the

traditional specification of imports in CGE models and develop an alternative representation which is more consistent with the situation in the transition economies. Their specification of imports reflects a regime shift such that the scope for substitution between domestic and imported goods may change substantially, and differentiates between types of institutional users. In order to capture the importance of the user dimension, an Armington specification for combining imports and domestic supply by user is introduced, while the commodity dimension is suppressed. Another novelty in the model's specification relates to the supplies of domestically produced intermediate and final goods, which are introduced through supply-driven input-output relations. The CGE model is used to examine the different responses of consumers and producers when limited substitution between domestically produced and imported goods is introduced. The direction of many of the effects is predictable. For example, the increase in imports generates a deflationary impact (a typical Keynesian response). Roberts and Round (1999) emphasize the benefit of both the use of CGE approach and the institutional user import specification in capturing sectoral responses, which are less obvious. The main difficulty regarding this approach consists of the availability of data. Generally, imports are classified either by the type of commodity or by the type of purchaser. Relatively few countries produce separate tables for imported and domestic products, distinguishing not only by the type of commodity but also by purchaser group. When the latter classification is not available, the approach becomes infeasible.

Tarhoaca (2000) uses a static CGE framework for Romania, incorporating 2 production sectors and 3 types of goods, to evaluate the effects of external shocks on the economy. The main features of the model are neoclassical structuralist. The model, calibrated for 1997, uses an Armington specification for imports and exports and applies a neoclassical closure with investment adjusting to the level of savings. The policy simulations consider two types of shocks. The positive shock is simulated either as an inflow of foreign savings or as an increase in the international price of exports. The negative shock is simulated either as an outflow of foreign savings or as an increase in the international price of imports. The results of the policy simulations prove to be very sensitive to the choice of the substitution elasticities in the Armington specification, possibly because the real side of the economy is modeled in a very simple manner using highly aggregated variables.

Environmental policy models

The awareness of environmental problems in Central and Eastern European countries has been growing rapidly for the last ten years. However, there are still barriers in implementing drastic policy measures, most of them connected to the fear of potentially negative consequences for the economy. Thus, few models have been built to analyze the impact of different environmental scenarios. These models can be classified in two categories: country specific models and world models. The world CGE environmental models usually treat the Central and Eastern European countries in a rather rudimentary way, at an aggregate level (as one region). Thus, in this section we will only discuss the country specific models.

A prototype model for Poland, for energy and environmental policy analysis, has been developed with the support of the European Commission (Van Leeuwen, 1997). The study is particularly interesting as Poland is one of the main air polluters in Europe. The main features of the model are neoclassical structuralist. A recursive dynamic determination of capital accumulation is included, where the model is solved for a sequence of temporary equilibria by assuming myopic expectations. The environmental issues are emphasized by deriving emissions of SO_2, NO_x and CO_2 and by imposing a maximum level for each pollutant. Environmental policy goals are simulated, by lowering these levels. The model also incorporates tradable emission permits[1]. The same framework is used for evaluating different environmental policies for the Czech Republic and Lithuania (Van Leeuwen, 1997), but these models adopt a static approach. The Polish model incorporates 17 production sectors and the base year for the calibration is 1990. The base year for the Czech model is 1992 and it comprises 13 production sectors. The difference between this model and the Polish one regards the structure of domestic demand. For Lithuania the main difficulty in building the model is that the most recent official input-output table available relates to 1985. Due to the major change in the structure of the economy this table cannot be updated using the usual techniques. Therefore, a new input-output table for 1994 has been prepared, based on the technical coefficients derived from the input-output table for the Netherlands. The model comprises 15 production sectors. The Lithuanian model is further used to analyze the economic and environmental impact of limiting the growth of nuclear fuel-generated electricity (Galinis and Van Leeuwen, 2000).

Kiuila (2003) analyzes the economy-wide effects of SO_2 emissions reduction in Poland, to fulfill the requirements of the Second Sulfur Protocol. The CGE model is neoclassical structuralist, also allowing for unemployment. It distinguishes 17 production sectors, while households are disaggregated into two income groups, "the rich" and "the poor", to investigate the social consequences of an environmental policy. The model has a recursive dynamic structure with myopic expectations and it is solved for the year 2010, based on 1995 as the benchmark year for the calibration. The simulations suggest that future SO_2 emission reduction may have positive effects on the Polish economic indicators. A modified version of the Kiuila's (2003) model is used to evaluate the effects of a comprehensive ecological tax reform for the Polish economy (Kiuila and Sleszynski, 2003). The differences between the two models are given by the inclusion of CO_2 emissions, calculated according to the sources (from fuels and industrial processes) and the fact that the model is solved for 2005, while still keeping 1995 as the benchmark year for the calibration. The policy scenarios analyze the implementation of new tax rates on CO_2 and SO_2 emissions, while the tax revenues are recycled through different mechanisms, e.g. subsidizing the environmental protection facilities for the enterprises, subsidizing capital costs of the firms, etc. Their results also show positive economic effects of the environmental measures.

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[1] *By issuing tradable emission permits, the maximum amount of emissions is set by the government and distributed among the producers by means of these permits. Emission permits can be traded among producers in a free market where the price of permits is determined.*

Other models

A small number of CGE models have been built with the aim of specifically reflecting the structure of present-day Central and Eastern European economies. Even then, their number falls clearly short of the number of CGE models built for developing countries. The policy questions they address cover a wide range of issues, from distributional consequences of a decline in output to industrial policies and financial liberalization. The specification of the models also varies considerably within the gamut from the neoclassical to the structuralist approach. Most models analyze the Polish economy.

De Haan's (1993) approach of modeling the Polish economy is mainly structuralist, following the tradition of Taylor (1990). He analyzes the effects of changes in the nominal wage rates, markup rates and the nominal exchange rate, on prices, the sectoral gross output, the income distribution, the balance of payments and the public budget. The economy is investment-driven, which implies that savings tend to adjust to the level of investment. The adjustment process is driven by changes in income rather than in interest rate. The model closure is Kaleckian, known also as structuralist closure. Under this closure the markets are cleared either through a price adjustment or a quantity adjustment. In some sectors demand adjusts to an inelastic (fixed supply), while in other sectors demand determines supply whereas prices are cost-determined by markups over production costs. De Haan (1995) uses the same approach for modeling the Hungarian economy. The distinction between the two models consists in the level of disaggregation of the production sectors and households. The production sphere identifies 10 sectors in the Hungarian model, compared to 5 in the Polish one. Furthermore, the households are grouped according to 5 income categories in the CGE model for Hungary, as compared to 3 categories in the CGE model for Poland. The policy simulations and the conclusions are similar in both models.

Roberts (1994) develops a neoclassical structuralist CGE model for the Polish economy, based on the conviction that neither a neoclassical approach (Braber, Cohen, Revesz and Zolkiewski, 1993), nor an extremely structuralist approach (De Haan, 1993) is suitable for an economy in transition where many adjustments in response to changes in relative prices take place but where at the same time some rigidities still exist. A one-sector model is used to check to what extent the inferences from the model are robust to the choice of the base year and the assumed elasticities. A Keynesian closure is chosen in order to carry out sensitivity analysis using a multiplier type response to the change in an exogenous variable (the government expenditure). As a consequence, the volume of capital is fixed exogenously, while the level of employment adjusts, allowing for unemployment. Data for 1986-1990 are used for calibrating the model, in order to examine how sensitive the results are to the choice of the base year. The model proves to be quite robust to the choice of benchmark equilibrium year, given that the years under consideration represented a relatively stable period. Instead, the model seems to be more sensitive to the choice of trade substitution elasticities.

Roberts and Zolkiewski (1996)[1] use a modified version of Roberts's (1994) model to analyze the distributional consequences of a decline in output and of privatization. As a novelty, the model identifies 15 production activities and 6 types of commodities. The household sector is disaggregated into 5 socioeconomic groups, distinguished by their source of income. The labor demand is differentiated according to gender and level of education in six types. The model preserves the neoclassical structuralist spirit. The benchmark year for calibration is 1990. Two simulation experiments are conducted with the model: first, a decline in exports of the food, light and electro-engineering sectors, as an example of a negative demand shock, and privatization, as a positive supply shock. The first experiment represents the first stage of transition, when the negative effects on macroeconomic performance tend to be more severe. The privatization scenario is simulated by an exogenous change in factor productivity and in the pattern of primary distribution of income, and reflects the second stage of transition when recovery begins.

Ghatak and Roberts (1997) analyze the effects of adopting a temporary industrial policy for Central and Eastern Europe with a view to reducing the social cost of transition, using a modified version of the Roberts's (1994) model. This CGE model is also applied to Poland and calibrated for 1990. This version includes 24 industrial sectors. The adopted industrial policy is based on unbalanced growth, increasing efficiency in key sectors which, according to the linkage analysis, influence the rest of the economy more than other sectors. Their results show an improved macroeconomic performance when industrial policy concentrates on a key sector.

Roberts (1999) evaluates the consequences of the privatization process in Poland in a CGE framework. The novelty of the model is that it traces the economy-wide effects of a given change generated by the privatization, rather than describing the privatization process in detail and considering the institutional mechanisms behind the various scenarios. Roberts (1999) distinguishes three production sectors: the public sector, the private sector and the sector in transition. The sector in transition emerges as a consequence of initial transfers of assets from the public sector to the newly privatized sector. Once this sector has been established, no other transfer of assets occurs within the analyzed period of time. The model also incorporates rigidities in the functioning of product and labor markets. Neoclassical structuralist features are considered to be more suitable for a transition economy. The model is static and the base year for calibration is 1989. The policy scenarios show that the decline in government revenue from privatized enterprises and the increase in imports of intermediate goods by the private sector (not compensated by an increase in exports), accompanying the privatization process in Poland, may have contributed to the recession and the increase in the budget deficit.

The first attempt to incorporate the financial sector in a model for the Polish economy is by Lensink (1999). His real-financial CGE model is used to analyze the most important financial reforms in the Polish stabilization program, by presenting the effects of interest rate deregulation and changes in reserve requirements. The model

[1] *A new CGE model for Poland is available at the National Bank of Poland (Laursen, Gradzewicz, Griffin and Zolkiewski, 2006).*

is structuralist in the spirit of Rosenweig and Taylor (1990) with a real balance change closure. However, the real side of the economy is modeled in a very simple way. A single Harrod-Domar production function represents the entire production side of the economy and real private consumption and gross real investment are based on econometric estimates, using quarterly data. The rest of the parameters of the model are calibrated, using 1995 as benchmark year.

Jemeljanov (1999) develops another real-financial CGE model with structuralist features, this time for the Latvian economy. The benchmark year used for calibration is 1994. The main purpose of the model is to analyze specific issues regarding the labor market. Two groups of government measures are distinguished, in relation with the labor market. The first group which includes an increase in the working-age population, and a rise in the personal income tax rate and employees' social contributions premiums, inevitably induces a certain amount of unemployment. The other group, which prevents unemployment, comprises the introduction of an investment subsidy, a reduction in the corporate income tax rate and a decrease in the employers' social contributions rate. A shortcoming of the model consists in its loan able funds closure through the interest rate[1].

Funke and Strulik (2003) build a dynamic closed-economy Ramsey-type CGE model for Estonia to analyze the effects of the 2000 income tax act. The model incorporates the behavior of three economic agents: the households, the government and the firms (represented by one production sector) and covers a variety of taxes on retained earnings, dividends and consumption. The model is calibrated on the available data for Estonia for 2000. However, some estimates for Finland are used for non available data, e.g. the capital stock. Funke and Strulik (2003) evaluate the effects of the introduction of a flat tax rate for all distributions of net dividends on investment decisions, output and consumption.

The only overlapping generations CGE model is developed by Jensen and Lassila (2001) for the Lithuanian economy to analyze the effects of different pension policy measures. The open economy model is built in the spirit of Auerbach and Kotlikoff (1987). The pension sector is explicitly modeled. The model is calibrated on the data for 2000. Jensen and Lassila (2001) evaluate the effects of a reform package including: a rise in the retirement age, a decrease in the compulsory social security contributions by raising the VAT, an increase in the basic pension benefits financed on a PAYG basis, and a gradual conversion to a private, funded system. They conclude that the policy measures can result in an efficient pension system in the long-run.

Conclusions

Several CGE models have been built for the Central and Eastern European economies during the last twenty years. These models evolved a long way from their input-output antecedents, after the transition of the Central and Eastern European

[1] *Taylor (1990) emphasized an important problem regarding this adjustment mechanism, the weakness of the interest rate effect in the developing countries. Low elasticities can prevent the adjustment based on the variation of the interest rate.*

economies from centrally-planned to market-oriented economies. The CGE framework proved to be more suitable for modeling the new market driven Central and Eastern European economies.

Most CGE models constructed for the Central and Eastern European EU member states are general purpose models and they attempt to address a wide range of policy questions, from distributional consequences of a decline in output to industrial policies, and financial liberalization. Most of them analyze the Polish economy using a modified version of the Roberts's model (1994). The other CGE models built for Eastern European economies analyze common issues in CGE modeling like trade liberalization and environmental policies or focus on more specific problems that the former socialist countries have been confronted: the accession to the European Union.

There is no agreement among modelers which type of model more adequately describes the Central and Eastern European economies. Even for one country, e.g. Poland, the features of the models vary from a purely neoclassical to structuralist approach. However, most models have neoclassical structuralist features. Also the model closure is a controversial issue, but this may be a consequence of the differences in focus and the time period under investigation. The determination of the parameters of the model also raises problems. Most parameters are calibrated, so their reliability depends directly on the initial estimates of the elasticities, taken from outside sources. The short data series for the Central and Eastern European economies make a reliable econometric estimation of the elasticities impossible. In most cases the elasticity values are fixed according to the modeler's experience regarding the economy.

The majority of CGE models built for the Central and Eastern European EU member states are static or incorporate recursive dynamic features. The only intertemporal dynamic CGE models are built for Poland (Piazolo, 2000), Estonia (Funke and Strulik, 2003) and Lithuania (Jensen and Lassila, 2001). There are two main problems regarding the intertemporal dynamic CGE models. First, they usually represent the economy at a high level of aggregation considering only, e.g. one productive sector, due to the computational effort that they require. Because of this reason, they are not always suitable for analyzing structural policy questions. Secondly, it is doubtful if they are able to describe the dynamic behavior of the economies in transition given very strong assumptions about forward-looking expectations. But it should not be overlooked that the incorporation of financial markets raises another problem, viz. the lack of specific data for the Central and Eastern European economies. Just two financial CGE models have been built so far for the Eastern European economies, one for the Polish economy by Lensink (1999), and another one for the Latvian economy by Jemeljanov (1999).

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Appendix A

Table A.1: CGE models for Eastern European countries

Model	Purpose of the model	Country(ies)	Classification	Modeling time dimension	Base year for data
Braber, Cohen, Revesz and Zolkiewski (1993)	The functioning of the economy under different policy regimes	Poland	Neoclassical	Comparative static	1987, 1990
		Hungary			1988, 1990
Zalai (1993)	Analyzes the effects of trade liberalization	Hungary	Neoclassical structuralist	Comparative static	1990
Brown, Deardorff, Djankov and Stern (1995)	Evaluate the effects of EU-CEEC integration	Global coverage (distinguish Poland, Hungary and former Czechoslovakia)	Neoclassical structuralist	Comparative static	1992
Banse and Tangermann (1996)	Analyze the agricultural implications of Hungary's accession to the European Union	Hungary	Neoclassical structuralist	Recursive dynamics	1990
Piazolo (2000)	Evaluate the effects of Poland's integration into the EU	Poland	Neoclassical (Ramsey-type model)	Dynamic optimization	1996
Lejour, De Mooij and Nahuis (2001)	Analyze the implications of EU enlargement	Global coverage (distinguish Poland and Hungary)	Neoclassical	Recursive dynamics	1997
Vanags (2001)	Evaluate the economic impact of EU accession for Latvia	Latvia	Neoclassical structuralist	Comparative static	1997
Bayar, Majcen and Mohora (2003)	Analyze the effects of trade liberalization and financial flows between Slovenia and EU budgets	Slovenia	Neoclassical structuralist	Recursive dynamics	1997

Model	Purpose of the model	Country(ies)	Classifi-cation	Modeling time dimension	Base year for data
	after the accession				
Mohora (2006)	Evaluate the effects of tax harmonization with the EU requirements and the restructuring of public expenditures	Romania	Neoclassical structuralist	Recursive dynamics	2000
Roberts and Round (1999)	Analyzes the effects of trade liberalization	Poland	Neoclassical structuralist	Comparative static	1987
Tarhoaca (2000)	Evaluate the effects of external shocks on the economy	Romania	Neoclassical structuralist	Comparative static	1997
Van Leeuwen (1997)	Analyze different energy and environmental policies	Poland	Neoclassical structuralist	Recursive dynamics	1990
		Czech Republic		Comparative static	1992
		Lithuania		Comparative static	1994
Galinis and Van Leeuwen (2000), version of Van Leeuwen (1997)	Analyze the economic and environmental impact of limiting the growth of nuclear fuel-generated electricity	Lithuania	Neoclassical structuralist	Comparative static	1994
Kiuila (2003)	Analyzes the effects of SO_2 emissions reduction	Poland	Neoclassical structuralist	Recursive dynamics	1995
Kiuila and Sleszynski, (2003), version of Kiuila (2003)	Evaluate the effects of a comprehensive ecological tax reform	Poland	Neoclassical structuralist	Recursive dynamics	1995
De Haan (1993)	Analyzes the effects of changes	Poland	Structuralist	Comparative static	1990

Model	Purpose of the model	Country(ies)	Classifi-cation	Modeling time dimension	Base year for data
	in the nominal wage rates, markup rates and the nominal exchange rate				
De Haan (1995), version of De Haan (1993)	Analyzes the effects of changes in the nominal wage rates, markup rates and the nominal exchange rate	Hungary	Structuralist	Comparative static	1990
Roberts (1994)	Used to check to what extent the inferences from the model are robust to the choice of the base year and the assumed elasticities	Poland	Neoclassical structuralist	Comparative static	1986-1990
Roberts and Zolkiewski (1996), version of Roberts (1994)	Analyze the distributional consequences of a decline in output and of privatization	Poland	Neoclassical structuralist	Comparative static	1990
Ghatak and Roberts (1997), version of Roberts (1994)	Analyze the effects of adopting a temporary industrial policy for Eastern Europe on reducing the social cost of transition	Poland	Neoclassical structuralist	Comparative static	1990
Roberts (1999)	Analyze the consequences of the privatization process	Poland	Neoclassical structuralist	Comparative static	1989
Lensink (1999)	Analyze the financial reforms	Poland	Structuralist	Comparative static	1995

Model	Purpose of the model	Country(ies)	Classifi-cation	Modeling time dimension	Base year for data
	in the Polish stabilization program				
Jemeljanov (1999)	Analyze specific issues regarding the labor market	Latvia	Structuralist	Comparative static	1994
Funke and Strulik (2003)	Analyze the effects of the 2000 income tax act	Estonia	Neoclassical (Ramsey-type model)	Dynamic optimization	2000
Jensen and Lassila (2001)	Analyze the effects of different pension policy measures	Lithuania	Neoclassical (overlapping generations model)	Dynamic optimization	2000