3 THE COMPUTABLE GENERAL EQUILIBRIUM MODEL

3.1 INTRODUCTION

This section provides a detailed description of the CGE-model which has been used in this study. We will firstly present a general overview and will later describe important details and assumptions of the model.

Our model is based on the so-called GTAP-in-GAMS model which was designed and programmed by Thomas Rutherford, University of Colorado. It is also very similar in its structure to the Uruguay model which was successfully used in a number of studies concerning the impacts of the Uruguay Round, to the GTAP model and the DART model.

We apply a static and a recursive dynamic version of the model to simulate the eastern enlargement of the EU. This incorporates: (i) EU-CEEC trade integration consisting of the complete elimination of tariffs and non-tariff-barriers between both regions, (ii) capital transfers in the context of EU's regional policy flowing from the EU into the CEEC, (iii) mobility of the production factor labour (i.e. migration) on the basis of the parameter values calculated in chapter 4 and (iv) intertemporal investment resulting in capital accumulation within each region.

In successive sections we will present and discuss general issues of the model as well as the assumptions concerning production, demand, international trade, investment and capital, labour migration, the model closure, the data and critical remarks concerning the model's predictive value. Finally, the last section will summarise.

3.2 GENERAL ISSUES

3.2.1 THE THEORETICAL STRUCTURE OF THE MODEL: AN OVERVIEW

The structure of the underlying CGE model is a comparative, recursive dynamic, open economy model with several sectors of production specifying the economic structure of three different, international regions: the European Union (EU), the central and eastern European Countries (CEEC) and the Rest of the World (ROW). For each region the production of nine sectors, private and public demand (consumption) and investment are fully defined. Hence, basically all transactions within an economy are modelled:

---

30 See Rutherford (1998b) for details.
31 See Harrison et al. (1995, 1996b, 1997) for applications of the "Uruguay Model".
32 See Hertel (1997) for a description of the original GTAP-model.
33 The DART model is described in Springer (1998).
34 An algebraic description of the our base model is provided in the Appendix.
35 The term "recursive dynamic" is explained more in detail in section 3.2.3
income flows from producers to consumers, to the state-institution or to investors and from there back to the demand for goods. Figure 5 on p. 73 gives a graphical overview of the assumed transactions within the economy. The continuous arrows show the movements of factors and goods. The broken arrows illustrate all financial transactions. The broken lines, for instance, indicate tax and tariff flows which symbolise an indirect income to the Representative Agent (RA). The dotted lines express all direct income and expenditure of the RA. Goods and factor prices and quantities are assumed to be completely flexible to ensure an equilibrium on each market. All goods are traded between regions, except for the investment good. Producers are assumed to be in perfect competition with each other by assuming constant returns to scale (CRTS). The model contains a predominant static and a smaller dynamic component. Two types of dynamic effects have been included into our CGE-analysis: The first one focuses on the periodical and transregional mobility of the production factor capital from West to East, (section 3.6.2) and labour from East to West (section 3.7). The second effect concentrates on intertemporal, recursive dynamic capital formation within each region (section 3.6.3).

Our model deviates from the standard GTAP-in-GAMS model in that we incorporate a constant government share in total output, a constant marginal propensity to save, non-substitutability between skilled and unskilled labour and the recursive dynamic approach. The model was programmed on GAMS/MPSGE.

3.2.2 The Economic Actors and Prices

The Economic Actors:
Within each region we have one type of representative economic actor. He is responsible for earning income from different sources and spending it according to his utility maximising preferences. The amount of his wealth is a proxy for the economic welfare of a country. He is called Representative Agent and is a combination of private and public economic intermediaries (i.e. households and government). His income is therefore composed of earnings from several sources: firstly, from the provision of production factors, i.e. the supply of labour (households), the supply of capital (firms) and the supply of land. Secondly, it is the RA who is the beneficiary of all tax incomes which are collected within the model by the government, i.e. output, intermediate input, factor and export taxes as well as tariff revenues and taxes on government and private demand. Thirdly, the RA's budget is also determined by foreign borrowing or lending according to the current account balance. The expenditures of the RA consist of the combined value of household and government purchases as well as investment spending. All in all, the RA basically portrays a figure who represents the income and expenditure structure of the whole population of the economy.

Prices:
In equilibrium, the model follows one of the main assumptions of Walras' GE-concept by only determining relative prices. The absolute price level is not important, thus money illusion does not exist. This means that demand functions are assumed to be
homogeneous of degree zero in prices: a doubling of all prices doubles income so that physical quantities demanded remain unchanged. Theoretically, the normalisation of prices in the benchmark scenario would therefore be arbitrary. MPSGE, however, has been programmed in such a way that prices will initially be normalised to 1. When running the counterfactual scenario at a later stage, relative prices may then deviate from the initial value.

A further key assumption of the model is that it satisfies Walras' law, i.e. market demand equals market supply on all markets. A general equilibrium in this system arises when market prices adjust in such a way as to ensure Walras' law.

All goods and factor prices are assumed to be completely flexible. This will probably be particularly criticised in terms of labour prices (i.e. wages) since short-run wage rigidity is a stylised fact. If we abandoned the assumption of complete wage flexibility, the alternative equilibrating variable would be the unemployment rate. It is possible that in this case results would deviate slightly since firms would face a different costs structure.

### 3.2.3 Static and Dynamic Effects

The greater part of the model that will be described in this chapter is of a purely static nature. This means that the model provides two equilibrium situations: initially one *benchmark* and later another *counterfactual* equilibrium. Policy analysis in this context is possible as comparative static analysis between two different states of equilibria.

What the static version of the model leaves completely alone are simulations over various time periods and intertemporal endowment effects. It is precisely these components that characterise the *Recursive Dynamic Approach* which will be applied in some of our simulations. It is necessary to stress that a recursive dynamic model is not the same thing as a fully dynamic model (recall section 2.2.2). The latter is characterised by endogenous intertemporal decision making processes and a higher degree of endogenation of variables.

#### The Recursive Dynamic Approach:

The aim of this study is to analyse CEEC integration into the EU. This integration does not only consist of lower trade barriers but also of reduced impediments to factor mobility. Increased labour migration will be subjected to special examination in this context. Since migration is not a phenomenon which happens once and for all but a gradual and intertemporal occurrence, it seems useful to adopt a model which is capable of incorporating several successive time periods. At the same time it is possible to model repeated investment which will lead to a time-dependent increase in the capital stock of each region. This is done using the recursive dynamic approach, i.e. dynamic sequencing of static equilibria. The approach cannot deal with optimal intertemporal decision making which implies that agents are assumed to have myopic or adaptive expectations. The savings/investment decision, for instance, occurs according to the calibrated marginal propensity to save.

How does a recursive dynamic model work? It is a technique which enables the modeller to run a static model as many times in succession as he wants. In the
programming language each successive run is called a loop. Each loop represents an additional time period after which a new and different state of general equilibrium is reached. Before each new loop, it is necessary to implement the changes which the modeller wants to examine. For instance, we could model a reduction of trade barriers and a change in the endowment of the production factors (i.e. capital transfers and migration) before the very first counterfactual loop. Before the second and each successive loop we would adjust both, the endowment of capital according to our assumptions about investment and capital transfers and the endowment of labour according to assumptions about migration. Additional trade barrier changes to the ones undertaken before the first loop would not be necessary because we believe that a complete integration into the EU suggests that trade barriers are reduced all at once. In other words, the distinctive feature of the recursive dynamic model is that the exogenous endowments of the primary factors are assumed to evolve over time according to an adopted behaviour. How we model labour and capital to develop over time will be explained later.

Eventually, the model presents results for all variables and for each loop. In this way it is possible to illustrate the step-by-step development of the economy. In the progress of the recursive dynamic model, however, preferences and technology are assumed to remain constant. Thus, potential dynamic changes of consumer or producer behaviour (i.e. income effects) due to economic growth are ignored.

### 3.3 PRODUCTION

Firms produce output according to an assumed production function. Its functional form represents the underlying production technology which is assumed to be the same for all sectors and regions. So far, this implies the typical neoclassical technological assumption. Nevertheless, due to differing shares and quantities of inputs in the production process, as provided by the benchmark dataset, each sectoral industry's production structure is slightly different. Hence, shift and share parameters in the production function deviate from sector to sector and from region to region. Producers are assumed to maximise profits by choosing the most cost-saving combination of intermediate production inputs and primary production factors. As primary production factors there are (i) unskilled labour, (ii) skilled labour, (iii) capital and (iv) land and natural resources. Capital includes physical capital such as machines, tools and buildings. Financial capital is not considered. Industries are believed to produce at constant returns to scale.

---

36 Thus, we assume that no transition periods for sensitive sectors take place.
37 It is precisely these shift and share parameters which need to be calibrated before starting with simulations.
3.3.1 THE PRODUCTION FUNCTION

Production is modelled according to a nested CES-production function. "Nested" in this context suggests a functional form which includes various production levels or branches as described in Eq. 2 - Eq. 7 and illustrated in Figure 2.

Eq. 2
\[ Y_{ir} = \min \left\{ FD_{ir}, AD_{ir} \right\} \]
where
\[ FD_{ir} = \psi_{ir} \left( LND_{ir}^{\theta_{LND}} K_{ir}^{\theta_{K}} L_{ir}^{\theta_{L}} \right) \]
\[ I_{ir} = \left[ \delta_{ir}^{L} SKL_{ir}^{\alpha_{SKL}} + \left( 1 - \delta_{ir}^{L} \right) LAB_{ir}^{\alpha_{LAB}} \right]^{1/(1-\sigma_{L})} \]
\[ AD_{ir} = \min \left\{ ID_{ir}, ..., ID_{jr} \right\} \]
\[ ID_{ir} = \left[ \alpha_{ir}^{ID} DI_{ir}^{\sigma_{DM}} + \beta_{ir}^{ID} MI_{ir}^{\sigma_{DM}} \right]^{1/\sigma_{DM}} \]
\[ MI_{ir} = \left[ \sum s \alpha_{irs}^{M} M_{irs}^{\sigma_{DM}} \right]^{1/\sigma_{DM}} \]

where \( Y_{ir} \) is output of good \( i \) in region \( r \), \( FD \) is value-added (factor demand), \( AD \) are aggregate intermediate inputs, \( LND \) is land, \( K \) is capital, \( L \) is labour, \( \theta \) are calibrated Cobb-Douglas share elasticities, \( \psi \) is the calibrated shift parameter. Labour is defined as a CES-function where \( \delta_{L}^{L} \) is the calibrated CES-share elasticity of labour category \( Lc \). \( SKL \) is skilled and \( LAB \) is unskilled labour. \( \sigma_{L} \) is the calibrated CES-substitution elasticity. Initially, we assume \( \sigma_{L} = 0 \) which implies Leontief technology for labour. \( ID \) are intermediate demand of sector \( i \) and \( j \) (Armington intermediates) which is a CES composition of \( DI \), the domestic composite and \( MI \), the import composite. \( \alpha \) and \( \beta \) are the calibrated distribution parameters of intermediates \( ID \), and \( \sigma_{DM} \) is the calibrated Armington CES-substitution elasticity between domestic and imported goods. The import composite is a CES aggregation across imports \( M \) from different regions \( s \) with \( \sigma_{DM} \) being the calibrated import CES-substitution elasticity.\(^{38}\)

At the top level of production we have two kinds of inputs which are Value-Added and aggregate Intermediate Inputs. Both inputs are used in fixed ratios to produce gross output which implies Leontief technologies (Eq. 2) as can be seen in the top-centre part of the graph. However, each of these top-level inputs has its own individual structure:

On the one side there is Value-Added, which uses the factor-inputs Labour, Capital and Land according to a Cobb-Douglas technology (Eq. 3). Labour is further divided into different skill categories defined as Skilled and Unskilled labour. We assume that both skill categories are used in fixed ratios (Eq. 4) implying no substitutability\(^{39}\) between the two types. A graphical illustration of value-added can be seen in the left-hand corner

---

\(^{38}\) All subscripts, superscripts, variables, and parameters are also summarised in tables A1-A3 in the Appendix. We closely follow the notation of Rutherford (1998b), p 3-8.

\(^{39}\) In some of the sensitivity analyses in chapter 6 we test the model assuming other degrees of substitutability between skilled and unskilled labour.
of Figure 2.

On the other side there are aggregate Intermediate Inputs (Eq. 5) which are the composition of several Armington Intermediate Inputs. The amount of Armington Intermediates to produce one aggregate Intermediate Input is fixed. In economics language we call this assumption "fixed input-output coefficients" which is another way of describing a Leontief technology. Each Armington Intermediate is a good which is composed of a domestically produced (Domestic Composite) and an imported unit (Import Composite) and which is described by a CES-function as can be seen in Eq. 6. The substitutability of the domestic against the foreign component of the composite intermediate good is defined by an exogenously given elasticity of substitution, $\sigma_{DM}$. Its value is normally chosen to be fairly high, which implies that both parts can be exchanged relatively well against each other.

**Figure 2:** Model Structure - Production

![Diagram of production structure](image)

Source: Own graph after Weyerbrock (1994), figure II.1.

A further differentiation among the Import Composites is undertaken on an even lower nest. Each Import Composite is put together by the same good from different regions of origin, $s$. Once again a CES-function (Eq. 7) is applied to determine the relationship of the different regions towards each other with an even higher elasticity of substitution, $\sigma_{DM}$, than in Eq. 6. These imperfect yet high substitutabilities modelled in Eq. 6 and Eq. 7 express the so-called Armington assumption which will be explained in greater depth in section 3.5.1.

With respect to domestic production, output can either be sold on the domestic market or exported abroad. All export markets are also regarded as imperfect substitutes from the viewpoint of a producer. This assumption is covered by an approach which is

---

40 So-called Input-Output tables illustrate the demand of intermediate products in the production process. Data on fixed input-output coefficients is derived from these tables.

Hubertus Hille - 9783631751350
Downloaded from PubFactory at 08/06/2019 04:28:46PM via free access
equivalent to the Armington assumption and which will be described and explained in section 3.5.2.

In section 2.3.2 we presented the equilibrium conditions which would have to be met in the context of an MC approach. For all activities, we argued, the zero-profit condition would have to be fulfilled. The zero-profit condition for production activities implies that the value of sales on the domestic and the export market net of tax must equal total costs of production:

\[ (p_r^D, a_r^D + p_r^X, a_r^X)(1 - t_r^D) = \sum f a_{fr}^e p_{fr}^e (1 + t_{fr}^e) + \sum f a_{fr}^d p_{fr}^d (1 + t_{fr}^d), \]

where \( p \) are output prices on the domestic (\( D \)) and export market (\( X \)) of sector \( i \) in region \( r \). \( a \) are the respective unit demand functions on each market, \( t \) are output taxes. The left hand side determines producers' revenue. On the right hand side we find the costs of production with the unit demand functions \( a \), prices \( p \) for primary production factors, and intermediate demand, \( ID \).

### 3.3.2 CONSTANT RETURNS TO SCALE

This model assumes constant returns to scale. The standard theory of perfect competition implies that firms choose the output level where marginal costs equal the market price. Thus, no firm makes any positive profit and all firms are price takers. Models with imperfect competition and increasing returns to scale (IRTS) also exist. They imply that on the supply side, firms "[...] produce with constant marginal costs and a given fixed cost. If the same industry output is produced with fewer firms, there is a rationalisation gain as firms slide down their average cost curve, producing more output with the same fixed costs." Working with IRTS, however, requires estimates of the extent of unrealised economies of scale. Estimates of so-called cost disadvantage ratios by Pratten (1987) and Neven (1990) exist, although values for the CEEC are not yet available.

We know that particularly for the transition economies working with the assumption of perfect competition may be regarded as a daring assumption since the former socialist economic system was based on very large state enterprises. Competition was unknown. Since the start of transition in 1990, however, the CEEC have made tremendous achievements in reforming their economies. Not only has there been ongoing privatisation combined with a breaking up of larger enterprises, there has also been the opening of formerly protected markets to producers from abroad and strong foreign direct investment (FDI) creating additional firms. Perfect competition can then also justify the assumption of CRTS. Besides, the use of IRTS is even more unrealistic for the CEEC. After all, IRTS imply firm rents originating from rationalised production on a large scale. Although the former state owned CEEC enterprises were big, they were anything else but rationalised firms.

---

3.3.3 Taxes in the Production Process

Output which is being sold on the domestic market as well as output which is being exported to other countries can be taxed with an output and an export tax respectively. Value-added inputs are taxed with a factor tax and intermediate inputs with an intermediate input tax. All tax revenues fall to the RA, since he also involves the public agent, i.e. the government which normally executes this "duty".

3.4 Demand

There are three categories of domestic demand in our model. Firstly, there is demand for intermediate production inputs by producers. We have already discussed this kind of demand in the context of the production process and will not consider it in this section again. Secondly, there is private demand for consumption goods by households. And thirdly, there is demand for goods by the public households, i.e. the government. The demand within the household and the government category works in very much the same way as in the case of production inputs. The most important differences between the demand for goods for consumption/government purposes and demand for intermediate goods for production purposes is that it is now determined through utility functions and indifference curves rather than production functions and isoquants.

3.4.1 The Utility Function of Private and Public Consumers

In each region, private and public demand is determined through the utility function of the RA. His total income is allocated to investment, public and private (consumer) demand according to a utility maximising Cobb-Douglas utility function:

\[ U_r = \theta^i_r \log(I_r) \cdot \sum_i \theta^C_r \log(CD_{ir}) \cdot \sum_i \theta^G_r \log(GD_{ir}) \]

where

\[ CD_{ir} = \left[ \alpha^C_{ir} DC_{ir}^{\sigma_{DC}} + \beta^C_{ir} MC_{ir}^{\sigma_{MC}} \right]^{1/\sigma_{DC}} \]

\[ GD_{ir} = \left[ \alpha^G_{ir} DG_{ir}^{\sigma_{DG}} + \beta^G_{ir} MG_{ir}^{\sigma_{MG}} \right]^{1/\sigma_{DG}} \]

\[ MC_{ir} + MG_{ir} = \left[ \sum_s \alpha^M_{irs} M_{irs}^{\sigma_{M}} \right]^{1/\sigma_{M}} \]

where \( U \) is utility, \( I \) is investment, \( CD \) is Armington consumer demand, \( GD \) is Armington government demand, \( \theta \) are the calibrated share parameters of consumers \( C \), and government \( G \) respectively. \( DC \) and \( MC \) are consumer demand for domestic and imported goods, \( DG \) and \( MG \) are government demand for domestic and imported goods and all other variables are defined are before.

Private and public households are assumed to be agents who maximise utility subject to a budget constraint. What is more, consumption of private and public households is modelled as a "production process" in which the zero-profit condition is applied and fulfilled. In this context, private and government consumers are assumed to minimise
expenditure in order to achieve a given utility level. Hence, in equilibrium, utility from the consumption of goods and agents' expenditure for the purchase of these goods must balance so that the following zero-profit conditions are realised.

For private households, the zero-profit function is:

\[
P^C_{ir} = \left( \alpha^C_{ir} P^D_{ir}^{1-\sigma_{DM}} + \beta^C_{ir} P^M_{ir}^{1-\sigma_{DM}} \right)^{\frac{1}{1-\sigma_{DM}}},
\]

where all variables are defined as before. The left hand side of the equation displays the unit expenditure of private demand and the right hand side illustrates the unit cost function defined by the aggregate of domestic \( D \), and imported goods \( M \).

Accordingly the zero-profit function for the government (public household) would appear as follows:

\[
P^G_{ir} = \left( \alpha^G_{ir} P^D_{ir}^{1-\sigma_{DM}} + \beta^G_{ir} P^M_{ir}^{1-\sigma_{DM}} \right)^{\frac{1}{1-\sigma_{DM}}},
\]

### 3.4.2 The Budget Constraint for Government Demand

As we mentioned above, the government is assumed to be an implicit agent who maximises utility subject to a budget constraint. The modelling and definition of the government's budget allow two possible alternatives. In the first form, the government's share in total output is assumed to be constant. Thus, if the RA's overall income rises, government's budget will rise proportionally and vice versa. The second form assumes that the government budget is fixed irrespective of the overall wealth. This implies that government's benchmark budget is believed to be optimal over time. The fact that government demand is included in the Cobb-Douglas utility function in EQ. 9 demonstrates that we apply the first form thereby assuming a constant government share in total output.\(^{42}\)

### 3.4.3 Consumption Taxes

All consumption of private and government demand is taxed with an individual tax rate. The beneficiary of all tax revenues is again the RA. Thus, in a way the RA charges taxes for consumption from himself. This form of "redistribution" is accompanied by a dead-weight loss, characteristic to any form of taxation.

### 3.5 International Trade

In the sections describing the supply and demand characteristics it has already become obvious that the different kinds of demand are met by goods which constitute a composition of domestically produced and imported components. Hence, the

---

\(^{42}\) A sensitivity analysis in chapter 6 will illustrate the welfare implications of both modellings.
assumption of international trade of goods has already been implicitly followed. In our model, trade in goods and services constitutes the most important link between different international regions in this model.

3.5.1 IMPORTS: THE ARMINGTON ASSUMPTION

Each commodity demanded is an aggregate consisting of a mixture of several composite goods as mentioned earlier. These composite goods are a combination of both domestic and foreign products, where the latter can have various sources of origin.

Figure 3 illustrates this particular demand structure. As shown, demand is derived from a system of nested Cobb-Douglas and CES utility or production functions where the Armington assumption is employed. This idea, first developed by Armington (1969), postulates that consumers distinguish goods by their origin and exporters distinguish by region of destination (product heterogeneity). Hence, comparable goods are regarded as being imperfect substitutes. In contrast to the "traditional trade theories" which explain trade by either, differences of efficiency in the production of goods a la David Ricardo or by differences in the factor endowments of countries a la Heckscher/Ohlin/Samuelson (inter-industry trade), the Armington assumption also explains trade in similar products, a phenomenon called intra-industry trade. Although Grubel and Lloyd (1975) confirmed that most European trade occurred in goods within the same industry justifying the use of the Armington assumption, peculiarities of the EU-CEEC trade structure may question it. How far has East-West trade reached normal standards? After all, the CEEC used to form a very closed trading block with the other countries of the Eastern Bloc (i.e. the Council of Mutual Economic Assistance). EBRD (1999: 90) argues that most trade reorientation between the CEEC and the EU had already taken place by 1994, an observation which has also been confirmed by Piazolo (1996) who used a gravity model to estimate the "normal" trade patterns. Thus, our data reflecting the economic situation of 1995 should largely echo regular trade relationships between the CEEC and the EU.

In the model, agents (firms, household, government) decide first on the origin of their imports and based on the resulting composite import price, they then determine the optimal mix of imported and domestic goods. These two decisions are illustrated in Figure 3 in the boxes called Import Composite and Armington Composite 1.... The demand for Import Composites as well as for Armington Composites is characterised by CES-utility/production functions as described in Eq. 6 and Eq. 7 or Eq. 10 and Eq. 11 respectively. The values of the elasticity of substitution are greater than one but are far from being infinite. Hence, a certain tendency towards substitutability of goods is observable without coming close to the assumption of perfect substitutes (because that would contradict the Armington assumption). In fact, the substitution elasticity for import composites has been chosen to be higher than the one for Armington composites.

---

43 Cobb-Douglas functions are a special case of a general CES-function, where the elasticity is equal to 1. For a good introduction to CES-functions see Chiang (1984), pp. 425-30.

44 See also Shoven and Whalley (1992), p. 230, 231.

45 See Samuelson (1948).
Harrison et al. (1997) assume elasticities for the CES-function of import composites of $\sigma_{om} = 8$ and for the Armington function of $\sigma_{om} = 4$.\footnote{See Harrison et al. (1997), p. 1408.} The significance of these values for simulation outcomes will later be tested in detailed sensitivity analyses.

Let us turn back to the demand structure: demand at the very top level in Figure 3, the demand for different Armington goods, is Cobb-Douglas (EQ. 9) in case of the RA or Leontief (EQ. 5) in the case of producer demand for intermediate inputs.

In previous sections we presented the different activities which characterise our model. These were (i) industrial production (ii) private consumption and (iii) public consumption. Each of these activities includes one Armington activity, each of which consists of import and transport activities. Thus, there are three different Armington good markets (one for production, one for private and one for public demand) in each region with three different import value shares. For each Armington activity the zero-profit condition must hold since import demand is characterised by cost minimising producers or expenditure minimising households and governments. Hence, the zero-profit condition for the "production" of one Armington good in general is:

\begin{align*}
\text{Demand for Armington Goods} \\
\text{(Cobb-Douglas) or} \\
\text{(Leontief)} \\
\text{Armitage Composite 1 ...} \\
\text{(CES)} \\
\text{Domestic Composite} \\
\text{Import Composite} \\
\text{(CES) (high elasticity)} \\
\text{Region 1 ...} \\
\text{(Leontief)} \\
\text{Region ... r (Leontief)} \\
\text{Commodity} \\
\text{Transport Services} \\
\text{Commodity} \\
\text{Transport Services} \\
\end{align*}

Source: Own graph
EQ. 14

\[ p_{ir} = \left( \alpha_{ir} p_{ir}^{D1-\sigma_{DM}} + \beta_{ir} p_{ir}^{M1-\sigma_{DM}} \right)^{1/(1-\sigma_{DM})}, \]

where all variables are defined as before. Note that this equation is a generalised form of EQ. 12 and EQ. 13.

The import activity which is included in the Armington activity in EQ. 14 requires an individual nest since its components originate from various regions. This Import Composite also describes a zero-profit condition which consists of various substitution elements (each representing a different international region) and which includes transportation costs. The value of imports at the domestic cif price equals the fob price gross of export tax plus transport margin and tariffs. The zero-profit equation therefore is:

EQ. 15

\[ p_{ir}^M = \sum_s \alpha_{irs}^M \left[ p_{ir}^X \left( 1 + t_{irs}^X \right) + \tau_{irs}^T \right] \left( 1 + t_{irs}^M \right), \]

where the variables are defined as before, superscript \( M \) denotes imports, \( X \) stands for exports, \( T \) means transport services of all trade between regions \( s \) and \( r \). \( \tau \) is the calibrated share parameter of unit transport costs. Note that unit demand for imports in region \( r \), \( \alpha_{irs}^M \), must be multiplied with the good's export price of region \( s \).

**Drawbacks of the Armington Assumption:**

The Armington assumption applied in this model is unfortunately not beyond criticism. In contrast to Armington's theory, other analytic trade models strictly divide goods into tradables and non-tradables. Within the category of tradables, domestic goods and imports are regarded as being perfectly substitutable. Both these assumptions of extreme dichotomy as well as perfect substitutability are, nevertheless, rather unrealistic for trade models so that we tended to follow Armington's hypothesis. Still, the CES (Armington) functional forms also have certain disadvantages. Income effects which should probably have an impact on consumption ratios (between similar imported and domestic goods) are, for instance, neglected completely. It is only the ratio of import and domestic prices (relative prices) which determines our demand ratios. Hence, the demand shares of different sectors remain fixed when increasing income.\(^47\) Weyerbrock (1994)\(^48\) reports additional problems. The assumption of product differentiation in connection with CES import-aggregation functions seems to cause unrealistically strong terms-of-trade effects, as empirical estimations have shown.\(^49\)

One way to avoid such strong assumptions is by applying the Almost Ideal Demand System (AIDS) which defines import demand in a more flexible functional form. It allows for income elasticities of demand which are different from one. However, the AIDS specification becomes difficult in our case since additional elasticities are needed.

\(^{48}\) See Weyerbrock (1994), chapter II.
\(^{49}\) Shoven and Whalley (1984) showed these effects.
which are not available for the CEEC. Also, the policy simulations which we have in mind do not cause strong growth or income effects so that the mentioned drawback of using a CES-function will not be very distinctive. Weyerbrock (1994, 1995) eventually also abstains from using the AIDS import demand form because of the difficulties mentioned of finding the required data. As a matter of fact a CGE-study by Breuss and Tesche (1996) which actually uses the AIDS specification for analysing a very similar formulation finds that the "[...] results mostly support those of Weyerbrock (1995)"\textsuperscript{50}. Thus the functional form of the import demand function is only of minor relevance.

3.5.2 EXPORTS, TRANSPORT SERVICES AND TRADE BARRIERS

Exports:
The export of goods and services is modelled in a corresponding manner to the import. All goods produced in one country can either be sold on the domestic market or exported abroad. This happens according to a Constant Elasticity of Transformation (CET) function. CET functions are basically the counterpart of the CES functions that we have already encountered, with the difference being that they deal with the supply rather than the demand side:

$$Y_{ir} = \left[ \alpha_{ir} D_{ir}^{1+1/\eta} + \beta_{ir} X_{ir}^{1+1/\eta} \right]^{\eta/(1+\eta)},$$

where $Y_{ir}$ is domestic output of good $i$ in region $r$ which is either sold on the domestic market $D_{ir}$ or exported abroad $X_{ir}$. $\alpha$ and $\beta$ are again the distribution parameters which expresses how much of domestic output is used at home or abroad. $\eta$ is the exogenously given elasticity of transformation which decides how strongly the use of domestic output reacts to changes in relative prices. Similar to the substitution of elasticity values, the assumed values for the transformation elasticities are also normally larger than one, implying that different markets (domestic and foreign) are fairly close substitutes to domestically produced goods.

International Transport Services:
All trade in the model is accompanied by additional costs from international transport services, which importers have to bear. These costs have a Leontief type of relationship to actual trade flows, i.e. they are proportional to the trade of each good. This is illustrated at the bottom of FIGURE 3. Thus, real transport costs are:

$$T_{irs} = \pi_{irs} M_{irs},$$

\textsuperscript{50} Breuss and Tesche (1996), p. 22.

\[\]
**Trade Barriers:**
The model also incorporates international tariffs as well as estimations of non-tariff-barriers (NTB) for goods and services which are imported into a region (see section 3.9.3). NTB are interpreted as a supplement to officially charged tariffs with the effect that the resulting tariff rate includes information on both official tariffs as well as NTB. The tariff collector and beneficiary is, as always, the Representative Agent. In the course of different integration scenarios between the EU and the CEEC we adapt tariff rates to the intra-EU levels.

### 3.5.3 Trade and Factor Movements: Substitutes or Complements?
The question may arise as to whether trade and factor movements are substitutes or complements in our model or, putting it differently, if we are in a Heckscher-Ohlin (H-O) or a Ricardian type of world. In fact, the model does not allow such a strict distinction. There are basically two reasons why trade takes place: firstly, there are internationally differing production technologies. Although the nested production function which we displayed in Figure 2 is identical in all regions, different shift and share parameters (originating from the calibration process) account for the distinctiveness of technologies. Secondly, regions have dissimilar factor endowments resulting in divergent relative factor prices. Thus, just as in reality, trade is the consequence of a mixture of both approaches and is additionally complemented by transport costs and the Armington assumption. Which of the two effects (Heckscher-Ohlin or Ricardo) eventually dominates depends on the data. In our model and data the H-O type of effect seems to prevail since the results mostly correspond to the Rybczynski (1955) theorem which, strictly speaking, can only be proved for the 2-commodity, 2-factor, 2-region H-O case. Therefore trade and factor movements are likely to be predominantly substitutive.

### 3.6 Investment and Capital
There are two concepts which involve the term "capital" and which should not be confused. On the one hand side there is capital which is used as a primary factor of production next to labour and land. In a static, one time run of the model this sort of capital is not affected by investment decisions in the sense that its amount does not change. In other words, the initial (benchmark) stock of capital as a production input is given exogenously by the SAM and is assumed to remain unchanged during the whole static run of the model. On the other hand, there exists a separate capital good (cgd) which we will synonymously call Savings and Investment (S&I) Good to prevent any confusion. It reflects the savings and investment decision of economic agents in each period. In the recursive dynamic approach this period's investment accumulates the next period's capital endowments.

---

51 We will discuss this in greater depth in the next chapter.
3.6.1 **Approaches to Modelling Investment**

Under investment we understand real capital formation so that no financial investment is being considered. Investment activity is described as a production process of the composite Savings and Investment Good as illustrated by Figure 4. It is a Leontief aggregation of Armington (intermediate) composites. Primary factors of production (labour, capital and land) are not used in the production process. The investment activity is non-sector specific which means that one investment good is produced for the whole economy. Additionally, the S&I-good is internationally immobile.

Investment behaviour can be modelled in several ways. We will present two possibilities which are relevant for our static and recursive dynamic model.

The benchmark equilibrium is by definition supposed to reflect an optimal state of the economy. According to the first way of modelling investment, an optimal state of the economy must also imply that the amount of investment (as provided by the SAM) is optimal too. The produced quantity of the Savings and Investment Good therefore does not alter between benchmark and counterfactual equilibrium. Merely the price of the S&I-good (i.e. the rental rate of return to capital) alters in order to ensure that the zero-profit condition is fulfilled. We call this form of modelling investment the **Fixed Investment Approach**.

The simple version of the GTAP-in-GAMS model defines investment in this way. Its disadvantage is that in a neoclassical world, investment is unresponsive to the marginal productivity of capital. Thus, in a dynamic scenario net investment keeps accumulating over time and does not reach a steady state.

**Figure 4:** Production Structure of the Savings and Investment Good

![Diagram of production structure](https://via.placeholder.com/150)


The other possibility of modelling investment behaviour works in the opposite way. The quantity of the investment good being produced within a country is not fixed but rather endogenously determined. Logically, we call it the **Endogenous Investment Approach**. This technique following Solow's (1956) neoclassical growth theory assumes that total regional income is either used for consumption or for savings purposes. The share which is used for each of these purposes is determined by the exogenously supplied...
marginal propensity to save, $s_r$. Given the prices of consumption goods, real domestic consumption under consideration of total income can be derived as:

$$\sum_i CD_{ir} + GD_{ir} = \frac{(1-s_r)Exp_r}{p^c_r},$$

where all variables are defined as before, $Exp$ is total expenditure of the RA and $p$ is the price of domestic consumption goods.

The remaining part of total income yields nominal savings, which are entirely spent on domestic investment. Given the price of the investment good, real investment is then:

$$I_r = \frac{s_r \cdot Exp_r}{p^I_r},$$

where $I_r$ is investment in region $r$ and $p^I_r$ is the price of the domestic S&I good.\(^{52}\)

If nominal domestic savings are not equal to investment, the shortfall is compensated for by foreign borrowing or lending, as will be explained in section 3.8.2.

Since investment is actually modelled as a production process, it has to fulfil the same equilibrium conditions as all other sectors of production, i.e. the zero-profit condition needs to be accomplished. Thus, the resulting unit profit function would be:

$$\left(p^D_{ir}, a^D_{ir}\right) \left(1 - t^I_{ir}\right) = \sum_j a^D_{jir} p^D_{jir} \left(1 + t^D_{jir}\right),$$

where all variables are defined as before.

Our simulations will be based on this latter, Endogenous Investment Approach. Nevertheless, in the context of our static simulations in the next chapter we will undertake a sensitivity analysis applying and examining the effects also using the Fixed Investment Approach.

With further extensions Harrison et al. (1997) test this second form of investment in their model. By fixing the rate of return to capital, they assume that a country is on its long-run equilibrium, steady-state path. Short-run increases in the rate of return to capital will lead to an increase in investment (expanding the endogenous stock of capital) until the marginal productivity of capital again reaches its benchmark level. They observe that additional positive welfare effects are the consequence. Although their approach is labelled as being "dynamic", it must be pointed out that it is not a genuinely dynamic technique because the endogenous adjustment of the S&I-good takes place during one simulation run. Hence, no forward looking, intertemporal

\(^{52}\) In the equations we use Rutherford's (1998b) notation for the S&I good. "Cgd" stands for capital good. Thus, S&I and cgd are used synonymously.
investment decisions are reflected in this approach.\footnote{See Piazolo (1998), section 2.2 for a discussion of dynamic investment modelling.} This so-called \textit{Steady State Approach} has been applied in other studies, for example in Francois et al. (1994, 1995) and Harrison et al. (1996a, 1997).

\subsection*{3.6.2 \textbf{Capital Transfers}}

It is very likely that further EU-CEEC integration will boost capital mobility. When we speak of internationally mobile capital, we solely focus on \textit{direct investment} since it constitutes an actual production factor. This includes investment of states or multinational firms who set up factories and infrastructural resources abroad. All forms of \textit{portfolio investment} are ignored.

In this context, the question arises from which region to which region capital is likely to flow? To answer this question it is necessary to differentiate between two different forms of capital flows: (i) private direct investment and (ii) official (state controlled) investment activities.

With respect to \textbf{private direct investment}, economic theories are rather ambiguous as to whether European economic integration will lead to capital flows from the EU into the CEEC or vice versa. When applying the \textit{Heckscher-Ohlin Theory} and particularly the derived Stolper-Samuelson (1941) theorem, capital mobility is basically a question of factor returns. Some theoretical and empirical studies do not, however, confirm the basic results of the Heckscher-Ohlin theory. Lucas (1990 :92), for instance, provides empirical evidence that contrary to the expectations, capital does not flow from rich to poor countries and that there are hardly any income equalising effects. The traditional \textit{Neoclassical Growth Theory} based on Ramsey (1928) and refined by Solow (1956) comes to the same results as the H-O theory. Due to the assumption of its decreasing marginal productivity (i.e. diminishing returns), capital is believed to flow into those countries which are capital scarce, i.e. the CEEC. It is precisely this assumption that is seen differently by the \textit{New Growth Theory}, which assumes a constant or even increasing marginal productivity of capital in highly developed countries. This theory defines "capital" in a much broader sense to include human capital and knowledge (Lucas, 1988), research and development (Romer, 1990) and government investment in material and immaterial infrastructure (Barro and Sala-i-Martin, 1990) in the definition. Additionally it assumes so-called \textit{spillover-effects} which are assumed to lead to a constant or increasing marginal productivity of capital. With respect to capital mobility, this implies that regions which are more developed (such as the EU) are not only more abundant in capital but also that their larger marginal productivity will prevent capital from flowing into lower developed regions (such as the CEEC) or even attract capital from there.
Also the Theories of Customs Union and the Common Market (e.g. Yannopoulos, 1990) as well as the Theory of International Production (e.g. Dunning, 1972) do not offer a clear answer to this question since capital movements are described as the result of complex strategic decisions by multinational firms, which are independent of overall capital endowments or productivities. Thus the flow direction of private direct investment is generally unclear and will therefore not be modelled.

In contrast to this, the direction of capital flows in the context of official investment activities is much more certain. Full membership in the EU will certainly entitle the CEEC to participate in the structural policy of the EU and lead to a considerable amount of official transfer payments. The manifold regional and structural policy ensures that financial aid flows from richer to poorer EU member states. Instruments of this policy are: (i) the different structural funds financed through the EU’s budget, (ii) the cohesion fund also financed through EU’s budget and (iii) a number of other projects which are financed by the European Investment Bank (EIB) and the European Investment Fund (EIF). These resources flow into regions which have gaps in development and living standards compared with the EU average. Currently it is mainly the three southern European member states, Ireland and different structurally weaker regions in other EU countries (e.g. the “neue Länder”) who benefit from this policy. With the admission of the relatively less developed CEEC, however, it is likely that large sums of EU’s structural and cohesion resources will be directed towards them.

We model these forms of capital transfers as shifts of capital endowments from the EU to the CEEC. As will be described in chapter five, we simulate several different scenarios concerning the amount of these transfers.

### 3.6.3 Recursive Dynamic Capital Formation

The successive, loop-by-loop increase in capital endowments through the previous period’s investment is also a very important feature of the recursive dynamic approach. Each period’s amount of investment is determined by the quantity of the Savings and Investment Good produced as we explained above. Thus the intertemporal decision making process of forward-looking, optimising firms and households or the intertemporal allocation of resources is not taken into account. Intertemporal capital accumulation is given by:

\[
K_t = (1 - \mu_{t-1}) \cdot K_{t-1} + I_{t-1}
\]

where \(K_t\) is capital stock in period \(t\), \(\mu\) is the exogenously given depreciation rate and \(I\) is investment which is determined each period by the exogenously supplied constant marginal propensity to save. The depreciation rate has been obtained from the GTAP3

---

54 For further details see Weidenfeld and Wessels (1997), p. 293.
55 For an estimation on nominal transfer payments see Breuss (1998), pp. 5-8.
56 See Keuschnigg and Kohler (1997) and Gaitan and Pavel (2000) for discussion and application.
dataset and is fixed to a value of 0.04 for all international regions.  

Capital accumulation implies a periodical update of factor endowments. As Eq. 21 displays, $K_t$ as well as $I_t$ are both values which are defined in stocks. Remember, however, from section 2.4.1 that the SAM only displays the remuneration of each factor of production and ignores actual stocks of machines etc., i.e. the SAM uses a flow concept. Thus there is an incompatibility between these two concepts which requires a so-called "stock-to-flow conversion", where units of capital stocks are scaled into units of capital services. As Springer (1998:42) explains, this is done by firstly calculating the gross rate of return on capital using benchmark data, $rk_0$. With information on the gross return on capital, Eq. 21 can then be rewritten to obtain the flow concept by:

$$K_t^{\text{flow}} = (1 - \mu_{t-1}) \cdot K_{t-1}^{\text{flow}} + I_{t-1} \cdot rk_0$$

3.7 LABOUR MIGRATION

Analysing the impact of East-West migration flows on both the EU and the CEEC is one major aim of this study. As Golder (1999) describes, free labour migration in an integrated economic area is determined by the supply (push-migration) and the demand for migrants (pull-migration) according to the following theoretical approaches.

The Neoclassical Approach sees migration as an arbitrage phenomenon caused by differing real wage and income levels which is larger, the greater the wage differentials are. The distance between two regions approximates to the transaction costs. Empirically, this approach has not been able to explain why, despite internationally decreasing transport costs and considerable wage differentials, only very little migration has taken place. Straubhaar (1988) as well as Malmberg and Fischer (1997) explain this contradiction with other factors representing extra transaction costs which reduce the willingness to migrate. These are (i) job specific aspects such as pleasant working environments or so-called regionally specific insider advantages, (ii) intertemporal expectations about future wage flows, (iii) imperfect information about future prospects abroad combined with risk aversion and (iv) expectations about possible unemployment abroad because neoclassical theory by definition excludes the possibility of unemployment due to the assumption of perfectly flexible wages.

---

58 The basic neoclassical model has been modified several times. For instance Harris and Todaro (1970) and Todaro (1980) explain rural-urban migration by dropping the assumption of full employment and assuming expected rather than effective wage differentials to be the determining variables. The Harris-Todaro model itself has also been subject to various refinements. Bhagwati and Srinivasan (1974) include wage and production subsidies, Cordon and Findlay (1975) capital mobility, Fields (1975) analyses quantity rather than price adjustments for labour, Stiglitz (1974) includes endogenous wage determination and Calvo (1978) as well as Schmidt, Stilz and Zimmermann (1994) consider the influence of trade unions.
The Human Capital Approach\textsuperscript{59} understands migration as an investment decision of an agent who is assumed to calculate the discounted present value of his expected financial net profits in each region. Migration then takes place if the discounted yield abroad minus the costs of moving surpasses the discounted yield at home. The important contribution of this approach is that it catches individual preferences including a number of pecuniary and non-pecuniary factors, and agents are believed to act according to a dynamic, longer run behaviour. Extensions of this approach include asymmetric and imperfect information (Katz and Stark, 1987; Burda, 1995) or uncertainty (Bauer, 1995) explaining migration networks. Although the inclusion of individual preferences can be seen as an advantage, their empirical testability is made more difficult.

The New Economics of Labour Migration\textsuperscript{60} contains several explanations. The so-called Family Migration Approach, for instance, interprets migration as a collective phenomenon of families or larger households who intend to minimise the risk of losing the family's income by geographically diversifying their resources, i.e. the family members. In that sense, this approach resembles modern portfolio theory. Mincer (1978) provides evidence that the size of a household and the number of gainfully employed family members influences the migration decision considerably. Using the Relative Deprivation Approach\textsuperscript{61}, the migration decision is thus not only dependent on wage differentials between countries but also on wage distributions within a country. Thus, the New Economics of Labour Migration is mostly applicable to situations in less highly developed countries, where the family plays a much more important role than in industrialised countries.

Migration in the context of the Network Migration Approach\textsuperscript{62} is regarded more in a dynamic context. Due to social, ethnic and informational networks, risks and costs of moving for each migrant decrease.\textsuperscript{63} Thus the probability of successful migration for each additional migrant increases, the more information from fellow countrymen exists. This also explains the observed agglomeration effects of immigrants in certain areas. A relatively new trend in this context is cross border migration within multinational companies. As Wolter and Straubhaar (1997 :4) describe, "internal migration" allows the transfer of firm-specific know-how which can be used at other locations.

### 3.7.1 Modelling Migration

As the presented approaches suggest, migration is determined by economic, demographic and political factors. Particularly the economic and political factors are suitable for inclusion into a CGE model. Nevertheless, each of them suggests a different way of designing migration.

\textsuperscript{59} This approach can be traced back to Sjaastad (1962) and Becker (1962).
\textsuperscript{60} See, for instance, Stark and Bloom (1985).
\textsuperscript{63} This approach implies a minor direct correlation between wage differentials, official employment possibilities and migration decisions.
Politically induced migration which is fairly independent of so-called push and pull migration suggests exogenous modelling. Governments decide exogenously about allowing or restricting the inflow and outflow of migrants for a variety of reasons. This sort of migration is more common between countries which do not have treaties on the free movement of labour. Hence this is more the type of migration which still currently describes the situation between the EU and the CEEC. The corresponding way to model exogenous migration would be to assume a certain number of migrants each year, irrespective of wage differentials and other economic factors. Breuss and Tesche (1994, 1996) as well as Weyerbrock (1995) follow the exogenous approach in their CGE models.

Economically induced migration is normally dependent on a variety of economic variables; this means that all migration is modelled endogenously. This is the typical sort of migration we would expect in an integrated area like the EU, where there is free mobility of labour. In this context, most CGE-studies follow the neoclassical approach by solely considering wage differentials between two regions as the main migration-determining variable. For instance Hinojosa-Ojeda and Robinson (1991) and Hinojosa-Ojeda et al. (1995) use wages as the only explanatory variables.

Migration in this Model:
This study is particularly interested in analysing possible migration effects in an integrated economic area. Thus labour mobility will not be considered as an exogenous event which is determined by politicians' disposition on whether to allow immigration or not but rather as an endogenous phenomenon.

Free labour mobility between the CEEC and the EU is determined as:

\[
migrate^{CEEC\rightarrow EU}_{t} = \beta_0 + \beta_1 \log \left( 1 - \frac{y^{CEEC}}{y^{EU}} \right)_{t-1} + \beta_2 \log \left( \frac{UE^{EU}}{UE^{CEEC}} \right)_{t-1} + \beta_3 \log \left( MS^{EU} \right)_{t-1} + \beta_4 \log(D^{EU-CEEC})
\]

Eq. 23

where \(migrate\) is the migration rate in time period \(t\) measured as a percentage of total population in the CEEC, \(y\) is per capita income in each region, \(UE\) is the unemployment rate in each region, \(MS\) is the migrant stock of CEEC citizens living in the EU, \(D\) is the average geographical distance between both regions and \(\beta_0-\beta_4\) are the corresponding coefficients, which we will determine econometrically in the next chapter (see TABLE 12, p.92).

The explanatory variables in Eq. 23 are either determined endogenously by the CGE-model or exogenously "outside" the model. Per capita income (\(y\)) and migrant stock (\(MS\)), for instance, alter endogenously in the course of each simulation run, thereby affecting the migration rate of the next period. In contrast to this, the relative unemployment rate has been fixed at its assumed 1995 value and is treated as an
exogenous dummy variable.\textsuperscript{64} This means that its initial value does not change any more in the course of the simulations since the assumption of perfect wage flexibility prevents any variation. Likewise, the average assumed distance between the CEEC and the EU has been fixed at a value of 1500 km.

The reader may ask himself why unemployment has then been included in the equation in the first place. As we mentioned, the $\beta$-coefficients in EQ. 23 will be estimated quantitatively in Chapter 4 using an econometric model of migration. There, an exclusion of the unemployment rate is not possible since this is likely to lead to an omission bias of the other coefficients. Thus the next chapter's econometric model determines the variables and coefficients which must be contained in EQ. 23. Since our CGE-model, by definition, does not consider unemployment, we treat this variable as an exogenous parameter.

In the recursive dynamic scenarios it is necessary to adjust the values of population and of employment numbers for each loop anew:

\[
\text{employ}_{\text{CEE}}^t = \text{employ}_{\text{CEE}}^{t-1} - \text{Mig}_{t-1} \\
\text{employ}_{\text{EU}}^t = \text{employ}_{\text{EU}}^{t-1} + \text{Mig}_{t-1}
\]

In each loop the recursive dynamic model will influence wage levels in both regions depending on the amount of migration which has taken place in the previous period. In other words, the price of labour (i.e. wages) alters to restore the equilibrium on the labour market. The resulting new wage differentials are then taken as the basis for the endogenous migration flows in the next loop.

The specification of our CGE-model and the construction of the dataset imply several assumptions which should be remembered in the context of discussing the issue of migration: (i) we only consider migration from and into aggregate areas. Thus no particular form of subregional migration patterns can be observed. (ii) Once migrants enter the immigration region they are believed to be perfectly mobile within the region (as domestic workers). (iii) Immigration often permits the exploitation of economies of scale which cannot be considered by our model since we assume constant returns to scale. (iv) Immigration can lead to an increase in the receipts and/or expenditures of governments. Since we assume a constant government share in total output, we neglect this point. (v) We ignore the fact that immigrants can also bring capital into the immigration region and ignore all forms of remittances. (vi) We assume that all migrants leave the labour market at home and enter the labour market in the immigration region.

\textsuperscript{64} For the EU and the CEEC we determined an average unemployment rate of 10.5\% and 15\% respectively.
3.7.2 SKILL CATEGORIES OF LABOUR

One of the purposes of this study is to give special attention to a phenomenon called the "brain drain effect" which has been examined in detail by Straubaar and Wolburg (1998). It stresses the idea that the emigration of highly skilled workers, i.e. of workers with managerial and special technical skills, is damaging the emigration economy since they can hardly be replaced.

To include the idea of this brain drain effect and to study the special interaction and mutual interdependence between skilled and unskilled labour, we assume that there are two types of labour in the economy: skilled and unskilled. The substitutability between skilled and unskilled workers is assumed to be zero (Leontief technology) which means that unskilled people cannot substitute their skilled colleagues and vice versa (skilled workers normally do not want to substitute less skilled workers).

There are obviously a lot more different skill levels in reality. The International Standard Classification of Occupations (ISCO-88) differentiates between 117 occupations with different skills which are structured into 10 broader categories. Depending on the aim of an analysis, these categories are more or less aggregated.

The differentiation into two different skill categories confronts us with a problem in the actual simulations. All coefficients used in Eq. 23 only consider employment in general. Differentiation of the coefficients into skilled and unskilled migrants, incomes, unemployment rates, etc. would, however, be necessary. Unfortunately, such diversified data does not exist so that the estimation of different coefficients is not possible. For this reason we assume that all coefficients are equally valid for both skill categories. This implicitly means that skilled and unskilled workers have similar migration propensities. In sensitivity analyses we will later relax this strict assumption and test the model with differing migration coefficients for each skill level.

3.7.3 INCOME RATIO OF CEEC WORKERS IN THE EU

Eq. 23 suggests that workers from the CEEC move into the EU mainly for economic reasons. The principal variable in their decision to migrate or not is the expected income abroad. Only if income in the EU surpasses income in the CEEC are workers willing to bear the transaction costs of moving. This implies that the economic situation of migrants is assumed to improve after migration. An important question in this context is how strongly migrants' income will increase, because their income level constitutes the overall production costs and the aggregate income of the RA. Will workers originating from the CEEC earn seventy, eighty or hundred percent of the income of their EU-colleagues? On the one hand, experience from the German "Gastarbeiter" phenomenon in the 1960s seems to suggest that the relative wage of foreign employees in the EU rises with their skill level. Thus, whereas blue collar workers are likely to work for much less than their western European counterparts, white collar employees are likely to get closer to the average EU income. On the other hand, we know that contrary to white collar salaries, blue collar wages are often determined by general pay agreements.

---

65 ISCO-88 is one of the main international standards provided by the International Labour Organisation.
which are negotiated between employer organisations and trade unions. Such pay agreements certainly do not take account of a worker’s country of origin.

Unfortunately there is only very little empirical work on this issue. Although Golder and Straubhaar (1999: 25) provide evidence with respect to the income distribution of foreigners and natives in Switzerland, their findings are not applicable to our study since they differentiate between several earnings levels without consideration of skill levels. Therefore we are forced to answer this question hypothetically: we assume that wages and salaries are paid irrespective of the geographical origin of a worker. Hence as soon as a CEEC-migrant moves into the EU and gets a job, we believe that he will earn 100% of his EU colleagues’ remuneration. This assumption will later be checked in a sensitivity analysis.

In our CGE model, migration is simulated as a shift of labour endowments from eastern to western Europe. Hence, for the CEEC the labour endowments including emigration are defined as:

\[ W_{cEEC} = (1 - \text{migrate}_{c,EU}) \cdot W_{c,t-1}, \]

where \( W \) is the endowment of labour category \( c \), involving skilled and unskilled labour and all other variables are defined as previously. The corresponding labour endowments in the EU under the assumption of full wage adaptation of CEEC-workers are then determined by:

\[ W_{c,EU} = W_{EU} + \left( \frac{y_{EU}}{y_{CCEC}} \right) \cdot \text{migrate}_{c,EU} \cdot W_{c,t-1}, \]

where the term in brackets ensures that income of CEEC migrants adapts to the EU level.

### 3.8 Model Closure

Besides the zero-profit condition which has been presented throughout the representation of the model, the MC-format also requires that the market-clearance and the income-balance conditions be met (recall section 2.3.2).

#### 3.8.1 Market Clearance

The market-clearance-condition ensures that all factor and goods markets are cleared, i.e. that demand for a commodity is less or equal to supply. In our case this implies that within each region we have market-clearance conditions for domestic output, imports, exports, Armington aggregate supply and primary factors. Hence there are quite a few market-clearance equations implicitly contained in this model. We shall abstain from illustrating them and refer to their illustration in the Appendix.
3.8.2 INCOME BALANCE

The last equilibrium condition next to zero-profit and market-clearance which needs to be fulfilled is the *income-balance-condition*. It needs to be met for the income and expenditure of the RA. It also plays an important role in the so-called *model closure*, i.e. in making sure that the circular flow of income among the economic actors is completely determined and does not contain any "leakages".

Income balance for the RA is easily followed. Total disposable income (which must equal expenditure, Exp) is composed of income from the supply of production factors (skilled and unskilled labour, capital and land), tax revenue, and the current account balance:

\[
\text{Exp}_r = \sum_f p_{fr}^F F_{fr} \\
+ \sum t_{ir}^I (p_{ir}^D D_{ir} + p_{ir}^X X_{ir}) \\
+ \sum t_{ir}^{JD} p_{ir}^{JD} Y_{ir} \alpha_{ir} \\
+ \sum t_{fr}^F p_{fr} F_{fr} \\
+ \sum t_{ir}^G P_{ir}^{GD} G\text{D}_{ir} \\
+ \sum t_{ir}^C P_{ir}^{CD} C\text{D}_{ir} \\
+ \sum t_{ir}^X P_{ir}^{X} M_{ir} \\
+ \sum t_{ir}^M (p_{ir}^X M_{ir} (1 + t_{ir}^X) p_{ir}^T T_{ir}) \\
\pm p_n^C B_r
\]

where all variables are defined as before, \( F \) is factor supply, and \( B \) is the current account balance.

The last variable may in fact constitute either a source of income or expenditure. It depends on the visible balance of the current account which is a part of the balance of payments of one country vis-à-vis the other regions. This can be explained by looking at the following well-known macroeconomic identity:\(^{66}\)

\[
\text{Eq. 27} \quad Y_r = CD_r + I_r + GD_r + X_r - M_r \quad \text{and} \quad Y_r = CD_r + S_r + TAX_r,
\]

where \( Y \) is national output, \( CD \) is private consumption, \( I \) is private domestic investment, \( GD \) is government spending, \( X \) is exports, \( M \) is imports, \( S \) is private domestic savings

---

\(^{66}\) Compare with Heffernan and Sinclair (1990), p. 207. Interest expenditures (receipts) on foreign debts (credits) are not considered.
gross of depreciation and $TAX$ is taxes, all expressed in aggregate real terms. Under the assumption that $TAX = GD$ (government income balance) it follows that:

$$EQ.28 \quad X_r - M_r = S_r - I_r \quad \text{when} \quad TAX = GD.$$

If a country runs a current account (CA) surplus (exports > imports), its overseas claims will be larger than its liabilities so that according to Eq. 28, domestic savings will surpass domestic investment. Accordingly, a deficit (exports < imports) implies that foreign assets have increased at home because domestic savings are below domestic investment.

For the income of the RA the current account balance therefore represents foreign lending or borrowing. In this setting we ignore all interest claims or liabilities which would normally come about in this context. Thus the income/expenditure balance of the RA is assured by the trade balance and vice versa.

Within the budget constraint of the RA, foreign borrowing constitutes an endowment so that the current account balance in nominal terms must be defined as:

$$EQ.29 \quad B_r = \sum_i p_{ir}^M M_{ir} - \sum_i p_{ir}^X X_{ir}$$

Finally, the world's budget constraint must also be in equilibrium. Since world's exports have to equal world's imports, it is obvious that all regions' current accounts have to sum up to zero:

$$EQ.30 \quad \sum_r B_r = 0$$

### 3.9 The Data

The data used in our CGE application are provided by the Global Trade Analysis Project (GTAP) of Purdue University, USA. This is a consortium which focuses on the application of general equilibrium analyses and on the provision of balanced CGE datasets. For our studies we applied the most recent dataset available: the Version 4 database contains detailed bilateral trade, transport and protection data which characterises economic linkages among regions and is linked together with individual country input-output databases which account for intersectoral linkages among the 50 sectors within each of 45 regions. All monetary values of the data are in $US$ millions and the base year for Version 4 is 1995. The dataset is described in detail in McDougall et al. (1998).
3.9.1 **SECTORAL AND REGIONAL AGGREGATION**

From the very detailed GTAP4 database it is necessary to carry out regional and sectoral aggregations to analyse the questions at hand. It would, for instance, not be useful for us to work with all 45 regions and 50 sectors when studying the interaction between CEEC and the EU.

**TABLE 3** provides information on the sectoral and regional aggregation which has been undertaken in this study. There are eight sectors of production and one Savings and Investment Sector which catches the domestic savings and investment decision of each region. Production sectors were created by clustering the 50 different commodities into eight different groups. This was done with the motivation to obtain a representative but not too detailed reflection of the economic structures in the different regions. In aggregating we tried to minimise the so-called *aggregation bias*. This kind of bias can occur if distortions do affect only a few of all aggregated commodities within one sector.

**TABLE 3: SECTORS AND REGIONS**

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture (Agri)</td>
<td>Rest of the World.</td>
</tr>
<tr>
<td>Food and Clothing (Fo &amp; Cl)</td>
<td>CEEC: Central and Eastern</td>
</tr>
<tr>
<td>Manufacturing (Manu)</td>
<td>European Countries:</td>
</tr>
<tr>
<td>High-tech sector (Htech)</td>
<td>Bulgaria, Czech Republic,</td>
</tr>
<tr>
<td>Private services (Pr.serv)</td>
<td>Hungary, Poland, Romania,</td>
</tr>
<tr>
<td>Transport services (Trans)</td>
<td>Slovakia, Slovenia, Estonia.</td>
</tr>
<tr>
<td>Public services (Pu.serv)</td>
<td></td>
</tr>
<tr>
<td>Savings and Investment Good (S&amp;I)</td>
<td></td>
</tr>
</tbody>
</table>

With respect to the regions, we work with three international blocks as **TABLE 3** describes: the central and eastern European Countries (CEEC), the countries of the European Union (EU) and the rest of the world (ROW). The regional aggregation has partly been deliberately chosen, partly it is pre-determined by the GTAP4 dataset. The aggregation of the CEEC, for instance, is pre-processed and cannot be broken down by the user. The EU could have been disaggregated into the Scandinavian countries, Germany, the United Kingdom and the Rest of the EU. For reasons of clarity and presentability of results and since the usefulness of the permitted degree of disaggregation by the GTAP4 dataset is limited, we abstained from disaggregating the EU.

We are aware of the fact that aggregations on the basis of both sector and region imply a form of simplification which assumes a completely even distribution of potential

---

67 Compare with McDougall et al. (1998), table 8-2.
effects. An aggregated EU block does not, for instance, express anything about how costs and benefits of enlargement are shared out among the various member states. Thus our analysis is completely restricted to the overall effects and ignores all questions of political distribution.

3.9.2 PARTICIPATION RATE AND SKILL LEVELS

The differentiation into skilled and unskilled labour was based on the *International Standard Classification of Occupations* (ISCO) provided by the ILO. The occupational split which has been used is summarised in TABLE 4.

The GTAP4 dataset provides information on aggregate labour payments by skill level. Unfortunately, it does not provide data on the labour force (in absolute numbers) and the amount of people who are actually employed as skilled or unskilled workers in each region. Thus labour payments per worker for each skill category (i.e. aggregate labour payments / employed workers) cannot be calculated from the GTAP4 dataset. This latter variable, however, is an important proxy for the (differing) wage levels in both regions (CEEC and EU) which is required to calculate the migration potential between eastern and western Europe.

**TABLE 4: THE CLASSIFICATION OF WORKERS BY OCCUPATION**

<table>
<thead>
<tr>
<th>Professional workers (Skilled Labour)</th>
<th>Production workers (Unskilled Labour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISCO 1: managers and administrators (including farm managers)</td>
<td>ISCO 4: tradespersons</td>
</tr>
<tr>
<td>ISCO 2: professionals</td>
<td>ISCO 5: clerks</td>
</tr>
<tr>
<td>ISCO 3: para-professionals</td>
<td>ISCO 6: salespersons and personal service workers</td>
</tr>
<tr>
<td></td>
<td>ISCO 7: plant and machine operators, and drivers</td>
</tr>
<tr>
<td></td>
<td>ISCO 8: labourers and related workers</td>
</tr>
<tr>
<td></td>
<td>ISCO 9: farm workers</td>
</tr>
</tbody>
</table>


We eliminate this deficiency by collecting and calculating statistics on the total labour force and the number of workers employed under each skill level for every region. These are then combined with the information contained in our GTAP4 aggregation. **TABLE 5** displays the information. Data on the labour force, as a percentage of population, is easily available. On average, the labour force participation rate is 46% on the EU-labour market, whereas it is 49% in case of the CEEC. Information concerning the skill levels, in contrast, is only available for the EU. Following the definitions in

---

68 For further details see McDougall et al. (1998), chapter 18.
TABLE 4, 32% of all employees in the EU can be regarded as skilled and 68% as unskilled.

For the CEEC we have to follow a more complicated approach. We analyse their enrolment in first level, second level and post-secondary education and try to deduce the skill distribution from that. Enrolment in most educational levels can easily be related to skill levels. Enrolment in post-secondary education, for instance, can be assumed to lead to a skilled job afterwards. Likewise, no schooling and first level education will most likely result in an unskilled job. Second level enrolment, in contrast, is difficult to relate. Since its share is rather large (54%) we do not want to assign it to either one skill group. We therefore split this group up according to the average skill ratios observed for the three southern European countries (SEC), i.e. Greece, Portugal and Spain. This implies that 24% of the labour force in the CEEC are assumed to be skilled and 76% are believed to be unskilled.

3.9.3 TRADE PROTECTION AND SUPPORT

The GTAP4 dataset provides detailed data on the average level of import tariffs and estimated agricultural export and output subsidies. Protection data for our special aggregation have been calculated by taking average values of applied tariff rates by commodity and import region and aggregating them using trade-weights. In the case of agricultural products, where non-tariff-barriers have played a very important role in the past, the GTAP4 consortium has made use of direct and indirect estimates which were derived using OECD data and protection information from the GTAP3 dataset.

Output subsidies to agriculture are based on producer subsidy equivalent calculations performed by the OECD for the year 1995. These subsidies play an important role in the EU. The Common Agricultural Policy (CAP) of the EU leads to a system where a large share of farmers' revenue comes directly from price protection measures on EU-markets. Information about export subsidies has been derived from computations on the basis of price comparisons for exportables between domestic market price and world price.

---

69 For a detailed description see McDougall et al. (1998), chapters 4, 13.
### TABLE 5: TOTAL LABOUR FORCE AND OCCUPATION BY SKILL LEVELS

<table>
<thead>
<tr>
<th></th>
<th>Population</th>
<th>Labour force % of pop.</th>
<th>Skilled labour % of labour force</th>
<th>Unskilled labour % of labour force</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>ISCO 1-2</td>
<td>ISCO 3</td>
</tr>
<tr>
<td>Austria</td>
<td>7.9</td>
<td>46</td>
<td>13.6</td>
<td>14.1</td>
</tr>
<tr>
<td>Belgium</td>
<td>10.0</td>
<td>41</td>
<td>23.8</td>
<td>10.4</td>
</tr>
<tr>
<td>Denmark</td>
<td>5.2</td>
<td>57</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Finland</td>
<td>5.1</td>
<td>52</td>
<td>17.2</td>
<td>17.5</td>
</tr>
<tr>
<td>France</td>
<td>57.5</td>
<td>44</td>
<td>14.6</td>
<td>18.5</td>
</tr>
<tr>
<td>Germany</td>
<td>80.9</td>
<td>50</td>
<td>14.3</td>
<td>19.5</td>
</tr>
<tr>
<td>Greece</td>
<td>10.4</td>
<td>42</td>
<td>17.1</td>
<td>8.8</td>
</tr>
<tr>
<td>Ireland</td>
<td>3.5</td>
<td>37</td>
<td>25.6</td>
<td>4.1</td>
</tr>
<tr>
<td>Italy</td>
<td>57.1</td>
<td>43</td>
<td>11.7</td>
<td>13.9</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>0.4</td>
<td>37</td>
<td>16.0</td>
<td>14.6</td>
</tr>
<tr>
<td>Netherlands</td>
<td>15.3</td>
<td>46</td>
<td>21.7</td>
<td>18.2</td>
</tr>
<tr>
<td>Portugal</td>
<td>9.8</td>
<td>49</td>
<td>9.8</td>
<td>13.4</td>
</tr>
<tr>
<td>Spain</td>
<td>39.5</td>
<td>41</td>
<td>13.9</td>
<td>8.4</td>
</tr>
<tr>
<td>Sweden</td>
<td>8.7</td>
<td>54</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>U. Kingdom</td>
<td>57.9</td>
<td>50</td>
<td>28.9</td>
<td>8.0</td>
</tr>
<tr>
<td><strong>Weighted total</strong></td>
<td><strong>369</strong></td>
<td><strong>46</strong></td>
<td><strong>18</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>


---

<table>
<thead>
<tr>
<th></th>
<th>Population</th>
<th>Labour force % of pop.</th>
<th>Post secondary % of pop.</th>
<th>Second level % of pop.</th>
<th>First level % of pop.</th>
<th>No schooling % of pop.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria</td>
<td>8.9</td>
<td>51</td>
<td>15.0</td>
<td>35.7</td>
<td>44.4</td>
<td>4.7</td>
</tr>
<tr>
<td>Czech Rep.</td>
<td>10.3</td>
<td>53</td>
<td>8.5</td>
<td>58.6</td>
<td>31.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Estonia</td>
<td>1.6</td>
<td>54</td>
<td>13.7</td>
<td>45.1</td>
<td>39.0</td>
<td>2.2</td>
</tr>
<tr>
<td>Hungary</td>
<td>10.2</td>
<td>46</td>
<td>7.0</td>
<td>80.6</td>
<td>11.2</td>
<td>1.3</td>
</tr>
<tr>
<td>Poland</td>
<td>38.3</td>
<td>49</td>
<td>7.9</td>
<td>47.8</td>
<td>42.8</td>
<td>1.5</td>
</tr>
<tr>
<td>Romania</td>
<td>23.0</td>
<td>46</td>
<td>6.9</td>
<td>63.2</td>
<td>24.4</td>
<td>5.4</td>
</tr>
<tr>
<td>Slovakia</td>
<td>5.3</td>
<td>51</td>
<td>9.5</td>
<td>50.9</td>
<td>37.9</td>
<td>0.7</td>
</tr>
<tr>
<td>Slovenia</td>
<td>1.3</td>
<td>49</td>
<td>10.4</td>
<td>42.4</td>
<td>45.1</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>Weighted total</strong></td>
<td><strong>99</strong></td>
<td><strong>48</strong></td>
<td><strong>8</strong></td>
<td><strong>54</strong></td>
<td><strong>33</strong></td>
<td><strong>2</strong></td>
</tr>
</tbody>
</table>

Sources: UN Human Development Report 1996, tables 16 and 32.
Own calculations from UNESCO Statistical Yearbook 1998, table 1.3.

---

70 NB: Because of country-specific settings in the spreadsheet program, the figures in the following tables use a comma as decimal separator.
3.10 THE MODEL'S PREDICTIVE VALUE: CRITICAL REMARKS

3.10.1 THE TIME HORIZON

An important issue in the context of CGE-models concerns the time between two states of equilibrium. Unfortunately, it is extremely difficult to provide a precise answer to this question. If reality strongly resembled theory, economists would just have to observe a moment of general equilibrium, wait until the economy was shocked and count the years until the next state of equilibrium was reached. The inter-equilibrium time could then be determined easily. The first problem is that a state of general equilibrium in a real economy is something which is not easily identifiable, as there are always certain variables which are not in equilibrium. Unemployment, for instance, is an indication that demand does not equal supply on the labour market. Does the observation of a clear disequilibrium phenomenon such as unemployment imply a general disequilibrium (i.e. the economy is still on the way to the next state of general equilibrium) or just a local disequilibrium which can exist simultaneously within a general equilibrium? Secondly, assuming that we could identify a state of general equilibrium, there is the problem that economies do not tend to experience one clear shock every couple of years which could be used for the observation. In a way, economies are under successive, constantly changing shocks and there are all kind of rigidities with the corresponding effects on the markets.

Perhaps we could proxy the time horizon of a CGE model by analysing how flexible all kinds of prices are. After all, price flexibility ensures the next equilibrium. It is generally accepted nowadays that prices are sticky in the short-run and flexible in the long-run. But how much time does it take to reach the long-run? Harrison et al. (1997) argue that "[...] the model assesses an adjustment of about 10 years [...]" without providing an explanation for their perception.

Thus, the question concerning the time horizon has to be answered insufficiently using GE theory and remains a starting point for criticism. Due to this uncertainty with respect to the time horizon we are forced to employ a reasonable assumption. We assume a periodical length of about one year because: (i) the migration parameters reflect annual migration rates, (ii) we only focus on short-run static CGE-effects and neglect all long-run dynamic effects and (iii) the amount of investment in the GTAP4 dataset only relates to one year, 1995.

3.10.2 THEORY VS. REALITY

Discussion of the time horizon leads to another general issue: the question as to whether a CGE-model does a good job in reflecting reality. Critics argue that states of general equilibrium simply do not exist in reality, and nobody has been able to prove that they are wrong. This is so because equilibrium theory and applications tend to follow economic logic rather than empirical demonstrability. All ideas which are found in CGE...
models, such as market clearing, price adjustments or utility maximising agents, are
details which are not only advocated by general equilibrium modellers but are also part
of unquestionable basic economic theory which dates back to Adam Smith, David
Ricardo and Léon Walras. General equilibrium theory just combines these mostly
accepted elements to a model of the whole economy. Of course, certain forms of
intervention require special consideration in the model because they are not compatible
with standard economic theory. It is precisely the task of modellers to identify these
elements and take them into account.

Another mistake which is commonly undertaken by economists is that simulation
results are taken too literally. If results do not coincide with the real development, CGE
models are accused of being wrong. In this context it is important to point out that
policy analysis using CGE models always requires the use of the ceteris-paribus
assumption in one or the other form. On one side this assumption is very helpful since it
ignores all other potential influences in the analysis therefore being inevitable for a
modeller. On the other side one should keep in mind that it can also be very restrictive
and partially unrealistic. In our study, for instance, neither the monetary sector nor the
adaptation process of the CEEC nor questions of distribution of costs and benefits
within each region are considered. Therefore it is important to remember that CGE
models cannot foretell the whole future. They are only capable of showing up
tendencies when answering a clearly identified and restricted question. Eventually, a
convinced CGE user should perhaps claim that a general equilibrium does in fact exist
and then ask any opponent to disprove this claim.

3.10.3 MODEL STRUCTURE AND POLICY QUESTION: COMPATIBLE?

A third point which is often seen critically is the compatibility of the employed model to
the political question being analysed. Since same or similar CGE models are often
applied in a number of different fields, critics may argue that the model was originally
designed to analyse other issues than the one on which the researcher is focusing. In
our particular case the question may therefore arise as to whether the GTAP-in-GAMS
model which served as our model of orientation is useful for the question of EU-CEEC
integration.

CGE-models in general do not have an exclusive field of research to which they must
strictly adhere after they have been designed. In fact, a CGE model can analyse all those
questions which the SAM – and hence the model structure too – incorporates. As we
explained previously, we apply the model in order to study the effects of trade
integration (tariff and NTB reduction) between the EU and the CEEC and then factor
mobility according to our assumptions. These policy experiments are caught by our
model structure so that the compatibility between model and policy question must be
answered positively.

Besides the main model structure which is pre-determined by the SAM, it may be
necessary to additionally incorporate special characteristics of individual regions into
the model. On the one hand, this is ensured through the calibration process. As
explained in the previous chapter, calibration "tailors" the model to any individual
region by determining the specific shift and share parameters for the region. On the
other hand, modellers additionally have the choice between constant or increasing returns to scale and whether perfect or imperfect competition should be assumed, a question which we have already answered in section 3.3.2.

We would like to recall in this context that a modified version of the model has been applied in other studies concerning international integration. Harrison et al. (1995, 1996b, 1997), for instance, studied the effects of world-wide trade integration, and Hertel et al. (1997) as well as Brockmeier et al. (1998a) apply a similar model to questions of CEE integration. Their \textit{GTAP-model} is based on the same dataset but uses a different programming language.\textsuperscript{72} Hence the model seems to be well-suited for the present question.

3.11 \textbf{SUMMARY}

This chapter has provided a non-technical description of the computable general equilibrium model which we use for our policy simulations and which is based on the so-called \textit{GTAP-in-GAMS model}. It is also similar to the \textit{Uruguay model} applied in Harrison et al. (1995, 1996b, 1997). It is a comparative, recursive dynamic, open economy model with nine sectors of production and three international regions: The EU, the CEEC and the ROW. The predominant part of the model is comparative static. The recursive dynamic part models capital transfers, labour migration and intertemporal capital formation.

Production occurs according to a nested production function at constant returns to scale. Each sector and region uses different technologies due to varying calibrated shift and share parameters. Prices and quantities on the goods markets are assumed to be fully flexible in order to clear the markets. Factor markets are initially characterised by fixed endowments as well as perfect factor mobility inside a region but international immobility. Factor prices are also assumed to be fully flexible. In the course of our simulations, we allow for international capital and labour mobility and endowment changes.

Demand is characterised by households maximising utility subject to a budget constraint. Although there are two types of consumers, i.e. public and private households, overall wealth is measured using a Representative Agent who is a combination of both household types. The government share in total output is assumed to be constant. The RA earns income through the provision of productions factors (private income) as well as through the collection of taxes and tariffs (public income). Expenditure occurs for consumption and investment.

The most important link between different international regions is through trade in goods, except for the Savings and Investment Good which is non-tradable. Imports and exports are modelled according to the Armington assumption which assumes that domestic and foreign goods are imperfect substitutes. Tariffs and NTB hinder free trade in the benchmark equilibrium.

\textsuperscript{72} Section 5.7 discusses other CGE studies of CEE integration more in depth.
Real investment takes place according to an exogenously provided marginal propensity to save. If domestic investment deviates from domestic savings, the current account surplus or deficit ensures that income balance is achieved and the model is cleared. Capital transfers from West to East are simulated. In the recursive dynamic run, the current period's investment is assumed to lead to real capital formation with an increase in the next period's capital endowments.

International labour migration is modelled according to the migration parameters estimated in Chapter 4. We differentiate between skilled and unskilled labour which are both characterised by the same migration propensities and which are assumed to be non-substitutable. Workers who migrate are believed to earn the same level of income as their domestic colleagues.

We apply our own aggregation of version 4 of the GTAP dataset which benchmarks the model to the year 1995. Hence all policy simulations compare a counterfactual scenario with the original equilibrium in 1995.

This model is used to evaluate some of the components and characteristics of the eastern enlargement of the EU. Purely dynamic effects are neglected. Finally, the model is not capable of foretelling the future but should be seen as a device to quantify a few carefully identified policy experiments. The algebraic description of our model is provided in the Appendix.
**Figure 5: Graphical Description of the Static Model**

**Region r**

Production Factors

- **K**
- **LND**
- **L**

International Migration

Income from the Production of Goods & Services

Exports

Trade Balance

Imports

Exports Taxes

Import Taxes

Tax on public demand

Tax on private demand

Consumption expenditure

Private HH

Public HH

Representative Agent

Income balance condition

Income & Expenditure RA

Factors & Goods

Taxes & Tariffs

---

Production of Goods & Services

(Zero profit condition)

Factor Taxes

Primary Inputs

Payment for primary inputs

Intermediate Input Taxes

Intermediate Inputs

Goods for domestic market

Armington Goods & Services

(Market clearance condition)