Effects of Trade and Market Integration in a Small Open Economy - A Dynamic CGE Approach

Anders Due Madsen
amd@dreammodel.dk

Morten Lobedanz Sørensen
mls@dreammodel.dk

DREAM
Christiansborg Slotsplads 1
1218 København K
Denmark
www.dreammodel.dk

April 29. 2002

Preface

This report provides relatively detailed documentation of a simulation model that we applied in order to quantify the economic consequences of the East enlargement to the Danish economy. The extensive number of simulations goes to illustrate the order of magnitude of various economic mechanisms in the model. Hence the simulations should not be considered our final official assesment of the impacts of the enlargement to Denmark. Most notably terms of trade effects induced by catching up of CEE countries are considered important but remain unimplemented in the experiments presented in this report.

The work presented here would not have been possible without the fruitful discussion and insights of Lars Haagen Pedersen. Obviously, a simulation study of the kind presented here requires extensive amounts of data and we are grateful to our former colleagues at Statistics Denmark for guidance and provision of useful datasets. Tim Folke, Asger Olsen and Morten Werner have been very helpful in providing us with IO and capital data and have extended us the courtesy of guiding us through some of the intricacies of interpreting these figures. With respect to data queries specifically for international trade but also the operation of the database for ADAM we are grateful to Tony M. Kristensen.

The work presented here is the result of a joint effort. Morten Lobedanz Sørensen have primarily attended to the empiric foundation while the implementation of the model in the GAMS simulation software was attended to by Anders Due Madsen. The formulation of the model, experiment design and the interpretation of the results was conducted by the both of us. For contact information, please see the cover sheet.

Contents

1 Introduction

Following the collapse of the Soviet union and the subsequent demise of communist government in eastern and central Europe a decade of political and economic transition began in this region. The opportunity for influencing the path taken by the eastern and central Europe to the benefit of the common was soon realized by the countries of the European community. Ensuring peace, prosperity and political stability by formation of common political institutions and via integration of the western European economies had indeed proven a durable strategy and commencing efforts to extend the integration to include central and east European countries seems only natural.

The principal commitment to inclusion of the east and central European countries in the European union was officially announced in conjunction with the European Councils formulation of criterias for accession in Copenhagen 1993. These criteria accentuate the need for applicant countries to commit to market economy and formation of institutions ensuring compliance to legal standards and civil rights. The Copenhagen criterias for accession are

- stability of institutions guaranteeing democracy, the rule of law, human rights and respect for and protection of minorities
- the existence of a functioning market economy as well as the capacity to cope with competitive pressure and market forces within the Union
- the ability to take on the obligations of membership, including adherence to the aims of political, economic and monetary union

In essence the Copenhagen criteria summarize obligations of compliance to the principles of the acquis communitaire which lay out the common policies agreed on by the incumbent members of the European union in the treaties of Rome, Maastricht and Amsterdam.

The upcoming enlargement of the European union to include new countries from eastern and central Europe is expected to bring substantial growth and development to these regions of Europe. In this thesis we assert the economic effects of enlargement from the perspective of Denmark. The enlargement is expected to induce trade due to customs liberalization and market integration and these aspects are expected to benefit incumbent member states as well as the entrants. On the other hand enlargement is not a free lunch given the relative poverty of the new members and the implied pressure on EU budgets.

The formal plan for the east enlargement process was finalized by the European Council summit in Luxembourg in December 1997 and the process was started in March 1998. The enlargement process is started for thirteen applicant countries namely Bulgaria, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, the Slovak Republic, Slovenia and finally Turkey. Real negotiations of the terms of accession are intended to be completed before the end of 2002 for the applicant countries fulfilling the terms of accession. This may allow for effectuation of the enlargement, such that the new member countries may participate in the elections for the European Parliament in June 2004. This goal was announced by the European Council in Göteborg in June 2001. 10 applicant countries are expected by the Commision to be able to complete the preparations for accession within this timeframe given their current rate of progress in the reformation of legislation, economy and institutions. Romania and Bulgaria are planning for accession in 2007 while the Turkish fulfilment of the accession criteria is still to be determined.

Enlargement is not a one-shot event. The organization of the enlargement process imply gradual liberalization of trade and convergence of national legislation to meet EU standards. In the Europe agreements signed with individual applicant countries the EU agreed to lift customs on most manufactured products. The Europe agreements were the first step in the process aimed at ensuring political, economic, social and cultural convergence of the EU and partner states. The Europe agreements were signed in the period from December 1991 to June 1996 and were effectuated from February 1994 for Poland through February 1999 for Slovenia. For Cyprus and Malta association agreements covering similar issues as those of the Europe agreements have been reached as early as December 1970 for Malta and June 1973 for Cyprus.

Although the enlargement process is closing to its final stages some open ends remain. Most importantly it is still not finally decided how the organization of the political institutions is to be reformed in order to reflect the views of individual member states while maintaining resolute decision making bodies. Moreover the transitory arrangements likely to be suggested to new member states and the extent of budgetary expansion for the longer term are still to be agreed upon.

1.1 Economic elements of the enlargement

A central element in the motivation for the enlargement is to assure social and political stability by economic growth in the relatively poor central and east European countries. The means for mediating this development are introduction of well functioning market economy including its prerequisites such as judicial standards for intellectual and commercial property rights, well functioning financial markets, adherence to rules governing state subsidiation of production and acceptance of basic labour rights. In addition enlargement implies that the new member states should adhere to the preferential trade agreements of the European union towards third countries and abolishment of customs and non tariff barriers to trade vis-a-vis the incumbent members of the Union. Part of these objectives are already implemented by the Europe agreements and must be met fully at the time of accession.

Besides motivating maturity of the democratic institutions of the applicant countries the pre-accession agreements incorporate a wealth of initiatives to stimulate economic growth. Let us briefly survey some of the more important instruments used for achieving economic integration and growth in the CEE region.

1.1.1 Preferential trade agreements

The most widespread method of stimulating integration of the economies of geographic regions is arguably the formation of free trade areas. The association of the applicant countries to the European customs union is as mentioned already in effect in the Europe agreements but full membership of the European union will imply full participation in the preferential trade agreements of the union. The mutual protection by means of customs and non tariff barriers to trade among EU and the CEE coutries are therefore also to be abolished completely at the time of enlargement. Currently the European union maintains a level of protection for sensitive products such as iron and steel and agriculture but customs barriers towards the CEE countries are practically lifted by the EU for industrial products.

The reductions of tariffs in the pre-accession agreements have been completed by most applicant countries as of January 1997. The extent of the reductions of custom tariffs and non tariff barriers to trade inherent in the actual enlargement will be discussed and presented in greater detail in chapter 3.

1.1.2 The European single market

Besides the well established benefits of free trade agreements the countries of the European union rely on common rules for stimulating and levitating economic integration. The notion of the European single market reflect this objective. The ramifications of the CEE economies complying to the acquis communitaire are many but the most significant will probably arise due to the integration of these economies in the single market. The rules governing the single market are intended to improve economic integration by common product standards, rules for handling of customs and by common legal standards for civil liability and property rights.

Currently the level of trade between EU and the future member states are impeded by formal as well as informal barriers in addition to the customs barriers. Examples of impediments to trade are customs handling, technical barriers (in the form of product standards) and administrative routines required in order to be allowed to market products in foreign countries. By adhering to the product standards of the European union the new member states will experience eased access to the European markets. Conversely, the current member states will experience eased access to new and hopefully growing markets due to simplified customs administration and handling. The benefits of common product standards are also expected to benefit exporters in the incumbent states.

The formation of the single market is also intended to promote free mobility of labour and includes policies intended to promote the mobility of capital. It is still not quite clear to which extent the rights of free mobility of labour will apply immediately for citizens in the CEE countries. Fears have been expressed that extending the current rules for free mobility of labour to central and eastern Europe will strain the social security systems of the incumbent states to an unacceptable extent. In principle, citizens of the European community are guaranteed *national treatment* in the host country and are free to take job in any member state bringing their families with them.

The perceived risk of loss commercial and intellectual property rights reduce foreign direct investments. By adhering to the common laws of the European union the CEE countries are expected to be able to attract a larger level of foreign direct investments. In the event that enlargement implies increased levels of foreign direct investments, this will add to the growth potential og the CEE economies and obviously also imply benefits to incumbent member states if these investments adds to the profitability of financial portfolios.

1.1.3 Budgetary implications

As witnessed by table 1.1, that presents structural and economic indicators for the applicant CEE countries, the applicant countries are indeed poorer than the EU average. Especially Bulgaria, Romania, the Baltics and Turkey stands out as relatively poor measured by GDP per capita in percent of the EU average. Therefore extensive transfers from the European structural funds (ESF) for investments in infrastructure and regional development will probably arise. The extent of these transfers and the budget spending for such programmes of development are a likely source to political controversy raised by the less developed incumbent member states. These include Ireland, Portugal and Greece. The income gap between the applicant countries and incumbent member states are also key to the extent of immigration since the prospect of improved terms of living must be considered an important incentive for immigrants.

The applicant countries are arguably characterized by extensive rural production and large fractions of employment in the larger countries, most notably Bulgaria, Poland and Romania. The arable land in the CEE countries account for about half that of the present member state according to Keuschnigg and Kohler (2000). For reference agriculture accounted for 3.9 percent of employment in Denmark in 1998. Interests groups in the more agricultural oriented applicant countries are likely to exhibit some influence on the objectives of their national negotiators. On the other hand the expenditures for the common agriculture policy (CAP) will increase to unacceptable levels if the applicant countries are to be entitled to the same rate of subsidiation as the incumbent member states. Most likely, CEE countries will not be able to achieve full benefits from the common agriculture policy but will rather be offered transitory arrangements. A likely element of such arrangements is gradual reduction of the subsidiation of agriculture in the EU as such also in order for the EU to comply with WTO agreements.

The costs of additional CAP and ESF spending from addition of the CEE countries to the European union will partly be covered by increased payments of own-resources from entrant countries. However, the new entrants must be expected to be net beneficiaries and the incumbent countries will be required to finance part of the additional costs by increased own-resource payments, reduced ESF transfers or by cuts to CAP related expenditures. The extent of the budgetary implications and the part of these that must by a given incumbent state are highly uncertain. In the longer term the budgetary implications of the enlargement must be expected to improve as the economic development of entrant states gain pace.

Table 1.1: Structural characteristics of the CEE countries, 2000

	Area, square kilometres	Population, mill.	GDP per capita in Euros	GDP per capita in pct of EU average	GDP growth rate	Agricultures share of gross value added	Agricultures share of employment	EU share of total exports	EU share of total imports	FDI, net inflow, percent of GDP
Bulgaria	111	8.2	5400	24	5.8	14.5	–	51.2	44.1	7.1
Cyprus	9	0.8	18500	83	4.8	3.8	9.2	47.7	55.9	1.8
Czech Republic	79	10.3	13500	60	2.9	3.9	5.1	68.6	61.9	9
Estonia	45	1.4	8500	38	6.9	6.3	7.4	76.5	62.6	8
Hungary	93	10	11700	52	5.2	4.8	6.5	75.1	58.4	2.9
Latvia	65	2.4	6600	29	6.6	4.5	13.5	64.6	52.4	5.7
Lithuania	65	3.7	6600	29	3.3	7.6	19.6	47.9	43.3	3.4
Malta	0.3	0.4	11900	53	5	2.3	1.9	33.5	59.9	18
Poland	313	38.6	8700	39	4	3.3	18.8	69.9	61.2	5.3
Romania	238	22.4	6000	27	1.6	12.6	42.8	63.8	56.6	2.8
Slovakia	49	5.4	10800	48	2.2	4.5	6.7	59.1	48.9	10.8
Slovenia	20	2	16100	72	4.6	3.2	9.9	63.8	67.8	1
Turkey	775	65.3	6400	29	7.2	14.6	34.9	52.3	48.8	0.5

Source: The EU Commision (2001b)

1.2 Benefits of trade and market integration

Enlargement is expected to benefit incumbent member states of the union through the promotion of trade which according to conventional wisdom involves benefits for all involved parties. The classical case for trade liberalizations is that trade promotes the exploitation of comparative advances and that international worksharing allow for a more effective use of ressources. This section will briefly survey the theoretical arguments for the benefits of customs liberalization and market integration to a single small open ecomomy. We will start by presenting simple partial equilibrium arguments and proceed to introduce relevant considerations from modern theories of international trade. We abstract from monetary issues and consider a regime of fixed exchange rates.

1.2.1 Partial equilibrium arguments

We will in general and also in the following few sections let the customs barriers to trade represent by tariff equivalent ad valorem tax rates. These tariff equivalent rates reflect the joint effect of tariffs and quantity restrictions in a single parameter. This convention is often used in large scale simulation studies but also in analytical contributions to the issue. The argument goes that restrictions to international trade in the form of quotas generate rents and that these rents may be represented by ad valorem tariff equivalents. The quota rents may go to either the importer or the exporter depending on the type of quota. We assume that quotas are import quotas and that the rents therefore goes to the importer. With respect to the more abstract frictions to trade such as those targeted in the market integration initiatives one commonly resorts to the introduction of ad valorem rate of real decay for goods traded internationally[1]. Using these parameters, a stylized representation of customs liberalization and market integration is available.

Enlargement and imports

To appreciate the benefits to a small open incumbent economy of customs liberalization and market integration consider the following partial equilibrium argument for imports. Assume that the foreign region, in this context the CEE countries seen as an entity, produces a good that is considered an imperfect substitute for domestic products by domestic agents. Figure 1.1 presents a stylized indication of the benefits gained via imports of custom liberalization and integration of markets for goods. In the figure the aggregate demand for imports from the CEE countries is indicated by the linear inverse demand schedule $D_M(P^M)^{-1}$, which represent the demand for a given importers price P^M. The importers price include import customs ω levied by the domestic government and real costs of trade represented by the rate δ of ad valorem decay of internationally traded goods. Importers may be thought of as representing consumers as well as producers, since these are importing intermediaries used for production purposes.

For a given foreign producer price P^F and the aggregate domestic demand schedule for imported products from the CEE region figure 1.1 illustrates the potential gains to domestic agents via imports. In the initial equilibrium the domestic endusers price amounts to P_0^M and includes real costs of trade δ_0 and the import custom tariff ω_0 pertaining to

[1] Alternatively market integration may be operationalized by changing the parameterization of import and export demand functions see Harrison et al. (1996). We do not find this approach to be clean since it seems unatural to include essentially institutional parameters in the specification of preferences.

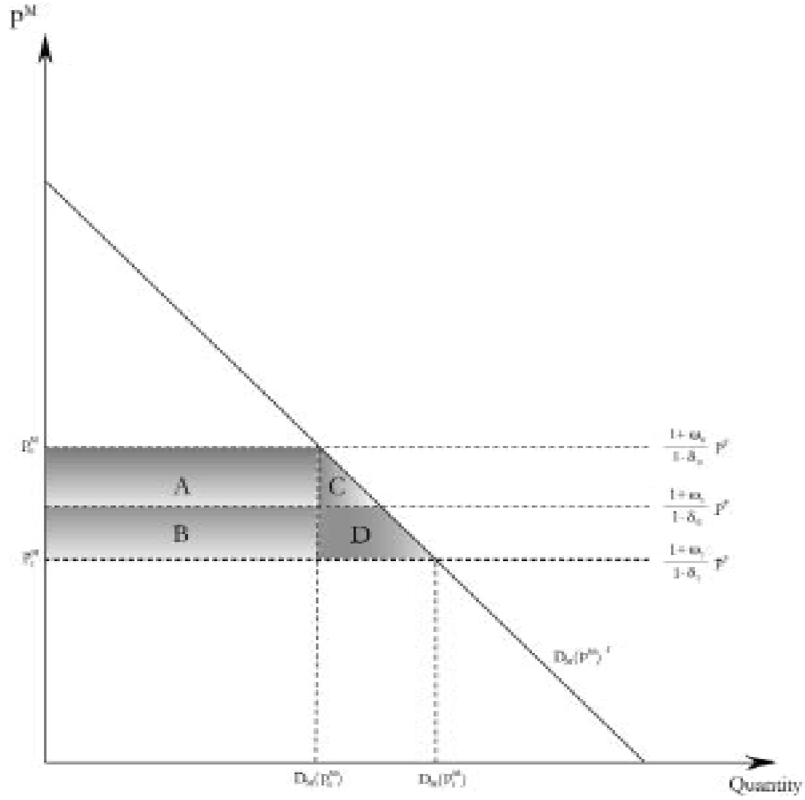

Figure 1.1: Effects of enlargement on imports in partial equilibrium.

imported goods prior to liberalization and integration. By lowering (or abolishing) import customs the domestic government looses the customs revenue indicated by the area A, but the value to end users of the customs liberalization amounts to the combined area of A and the triangle C. If the domestic government were to collect the customs revenue loss via lump-sum taxation the benefits represented by the triangular area C would still be realized and thus this area may be thought of as an efficiency gain from lowering the import custom tariff. The area B represents the initial value of the real costs of international trade, while the area D reflects the friction loss due to trade costs. By abolition of the real costs domestic end users of the imported good experience a price cut which is not hampered by any financing burden as the real costs simply burn up resources. The net effect of enlargement via imports is therefore in this simple setting increased imports, an efficiency gain from reduced tariff frictions (C) and a costless gain of value from the reduced real costs of trade (B+D). Note that this part of the gains to the domestic economy does not imply worsened terms of trade for the CEE countries since the ressource loss due to real costs of trade does not benefit any of the involved parties.

Enlargement and exports

Likewise we may provide a simple partial equilibrium example of the benefits of liberalization and integration arising from shifts in exports of a domestically produced good. Assume that the demand from CEE countries for a domestic good may be represented by a linear function $D_X(P, \delta, \omega)$, where P is the domestic price level, δ represents real costs of trade and ω is an import tariff levied by CEE countries. The price on delivery at the foreign destination is set to cover the real costs of delivery and includes customs charged by the foreign government such that the price paid by the foreign purchaser amounts to $\frac{1+\omega}{1-\delta}P$. Further assume that domestic demand and supply may be represented by linear functions that are unaffected by changes to the real costs of trade and foreign import tariffs. In this simple setting the effects of customs liberalization and market integration may be illustrated along the lines of figure 1.2.

In the figure the inverse domestic demand is denoted by $D_D(P)^{-1}$ and the inverse aggregate demand, which appear by horizontal addition of the demand for exports and the domestic demand is denoted by $D(P, \delta, \omega)^{-1}$. In the initial equilibrium the tariff rate ω_0 and the real costs of trade δ_0 apply. The initial domestic equilibrium price is given by the intersection of the inverse domestic supply schedule and the inverse aggregate demand schedule and is denoted by P_0. Given the price P_0, the domestic demand is determined to $D_D(P_0)$, the export demand amounts to $D_X(P_0)$ while the total demand is given as $D(P_0)$. Now, consider a reduction of the import tariff charged by CEE countries to ω_1 and a reduction of the real costs to δ_1. Such a reduction will shift the inverse export demand function outwards to $D_X(P, \delta_1, \omega_1)^{-1}$ and thereby imply an outward shift of the aggregate demand schedule to $D(P, \delta_1, \omega_1)^{-1}$. The new equilibrium is realized at the domestic price P_1 and given the assumption of fixed location of the supply and domestic demand schedules amounts to a reduction of domestic demand and an increase of exports.

To the domestic producers the surplus increase by the grayed areas A and B by the shift to the new equilibrium. The increaed equilibrium price level however implies that domestic purchasers experience a loss of surplus amounting to the area A. Net net effect to the domestic welfare is therefore given by B.

The arguments provided soforth for the benefits of customs liberalization and market integration are of course somewhat simplistic. The assumption of fixed positions of do-

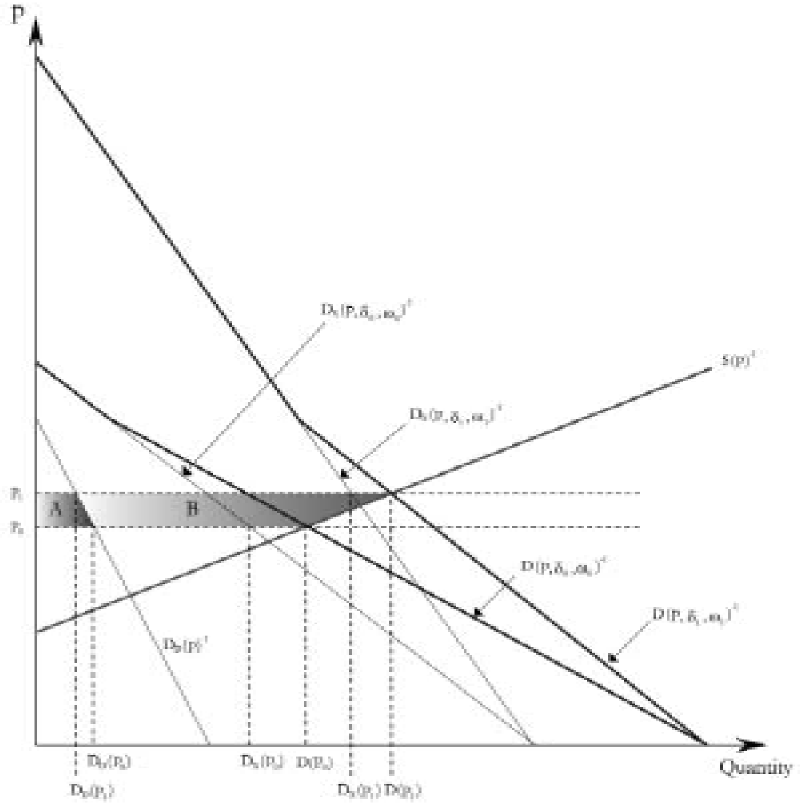

Figure 1.2: Effects of enlargement via exports in a partial equilibrium argument.

mestic demand and supply schedules are obviously false in general equilibrium and the presented comparative statics completely ignores composition effects in the presence of multiple goods and the costs of the dynamic transition to the new equilibrium.

1.2.2 General equilibrium considerations

In the discussion of the benefits achieved we assumed fixed locations of domestic demand and supply schedules, but this will hardly be the case in general equilibrium. The lowered price of imports from the CEE will imply lowered costs of production due to lowered prices of imported intermediaries and investment goods. This amounts to a positive supply side effect that also will have derived expansionary effects on the domestic demand schedule. Moreover the lowered price of imports from the CEE will lead to effects for the demand for domestic products and products imported from other regions. These demand side effects are caused by the usual substition and income effects arising due to shifts in relative prices and incomes. The fixed location of the demand schedule for imports from the CEE will therefore not hold in general equilibrium.

A negative supply side effect may however also arise due to increased export demands. If the increase in export demands lead to a higher price of domestic goods as in figure 1.2 this may imply increased costs of production since domestic products are also used as intermediaries and for investments in the production sector. The domestic supply schedule will therefore likely shift location in general equilibrium.

The general equilibrium modifications to the simple arguments for trade liberalization and integration provided above illustrates the unambigious nature of general equilibrium effects, even for a simplistic framework. If in addition multiple consumer goods, non traded goods and input factors are present in the model to capture sectoral effects the general equilibrium effects become prohibitively complex to comprehend in an analytical framework. The ambigious nature and magnitude of general equilibrium effects are for practical applications therefore only assertable in an computable general equilibrium study.

Another aspect to consider is the assumption of a fixed foreign output price. In the event of enlargement the expectation is that the CEE region will indeed be experiencing fundamental changes to the economic environment. The extent and direction of the change of foreign producers price may be addressed in a multicountry model of enlargement but this is beyond the scope of our study. Please bear in mind that the assumption of a fixed price level in the CEE region may be critical. Another point to make is that other trading partners with the CEE will also experience improved terms of trade and that substitution and income effects may change the world market demand for Danish products. Again this multicountry aspect of the issue of enlargement is not considered in our study since we adapt the perspective of a single country in our framework.

1.2.3 Transitional costs and accumulation effects

The comparative statics argumentation provided so far does not deal with any dynamic aspects. The suggested increase of the level of production requires that capital must be accumulated. To the extent that various sectors of the domestic economy is affected asymmetrically capital will also have to be redistributed among sectors. Such transitions may imply costs and bear with it effects on the distributiuon of wealth as well. In a rational expectations setting, increasing activity and thereby increasing value of capital will cause an immediate appreciation of wealth held in stocks. This affects the wealth of those holding stocks, and since wealth is distributed unevenly among consumers redistributive effects may occur. Households alive at the time of the realization of the enlargement will on the other hand need to increase savings and postpone part of their consumption in order for the economy to accumulate capital. This is not required for future inhabitants of the economy which therefore are likely to benefit more from the accumulative impacts of enlargement.

1.2.4 Imperfect competition and economies of scale

Modern contributions to the theory of international trade highlights the importance of imperfect competition and economies of scale to the evaluation of welfare effects of customs liberalization and market integration. In Krugman (1979) and Krugman (1980) imperfect competition in the formulation of Dixit and Stiglitz (1977) is introduced to analytical models of international trade. Agents consider different varieties of a product to be imperfect substitutes and each firm obtain a degree of niche market power used as levy for setting output prices above the average costs of production. Under such imperfect competition, policies of trade liberalization and market integration give rise to scale effects and love of variety effects. Expanding production gives rise to additional profits if the output price exceeds the average costs of production as is the case given the markup pricing of imperfectly competing industries. In addition economies of scale give rise to decreasing average costs of production amounting to an improvement of profitability. The concept of love of variety effects reflect the idea that the increased product diversity occuring through integration of markets benefits consumers and also productivity to the extent that technology allow for increased efficiency of alternative inputs.

1.3 Quantitative studies of the effects of enlargement

The prospects of enlargement have been addressed in numerous papers presenting quantifications of macroeconomic effects in various analytical frameworks. We have chosen to focus on computable general equilibrium (CGE) studies of recent date and specifically studies for single incumbent countries since these seem most relevant as a basis of comparison to our findings. Most of the studies have not been published in journals but rather as reports and working papers that are publically available from various institutions.

1.3.1 Multicountry studies

In Baldwin et al. (1997) several aspects of an enlargement of 7 CEE countries is analysed although not in a unified framework. Using a model of power politics the costs of enlargement is estimated but these costs are not introduced to the assesment of the effects of market integration and the introduction of the enlarged customs union. In a CGE model of 9 regions decreasing risk-premiums for foreign direct investments in CEE countries are introduced. These risk-premiums imply positive capital accumulation effects in the assesment of the positive consequences of enlargement presented. Excluding the risk-premium steady state increases of GDP of 1.5 and 0.2 percent are found for the CEE and incumbent member states respectively. By introduction of the risk-premium the increase of GDP is found to account for 18.8 percent for the CEE countries while the risk-premium is neutral to the effect on incumbent states. These figures however does not include the fiscal burden of increased EU budget expenditures.

Using a multicountry CGE framework Lejour et al. (2001) quantify the effects of custom liberalization, market integration and free movement of labour in a 7 country enlargement. Potential trade volumes after market integration is estimated in a gravity model and these estimates are used for representation of real costs of trade. Small positive effects of 0.1 percent of GDP are found for incumbent member states of market integration and custom union but this projection does not include adverse effects of cuts to CAP and ESF spendings. Also the consequences of immigration are analysed and these amounts to 0.6 percent of GDP for the incumbents.

Another multicountry framework study is presented in Breuss (2001) who incorporates an enlargement of 12 CEE countries. Market integration, custom union and factor movements (foreign direct investments and immigration of labour) is implemented in an applied model featuring estimated parameters. Small positive effects are found for incumbent member states seen as a whole and the effects of market integration are found to account for the largest contribution. For Denmark a drop of 0.11 percent of GDP is projected for 2010 reflecting the modest volumes of trade between Denmark and the CEE countries.

Finally, the GTAP model and database have been applied to the subject by focusing on agriculture and fishery. In for instance Jensen et al. (1998), Frandsen et al. (1998) and Frandsen and Jensen (2000) detailed aspects of the enlargement with respect to CAP programmes are analysed. In the latter paper various scenarios of CAP reforms induced by enlargement are presented and a welfare loss for Denmark is found to amount to 0.25 percent of national income.

1.3.2 Single country studies

Analyses for the effects to the Danish economy are somewhat sparse and thus we do not have that much litterature to compare our assesments for Denmark against. In Kristensen and Jensen (2001) a quantification of the effects of enlargement for Denmark is performed on the econometric model ADAM. The simulation study incorporates market integration, customs union and immigration and estimates for the part of the budget costs carried by Denmark. In their short run analysis a reduction of GDP in 2010 of 0.67 percent is projected. The long run analysis find effects to GDP amounting to an increase of 1.44 percent, which is almost entirely driven by increased immigration.

The methods and findings of studies of the situation for other incumbent member states are of course of interest both from a methodological and quantitative perspective. In a series of papers by Keuschnigg and Kohler the effects of the enlargement are quantified in a single country dynamic CGE model. The model features overlapping generations in the formulation of Blanchard (1985) that allows for analytical aggregation. The specification of production includes multiple production sectors, imperfect competition, convex installation costs of capital, high- and low skilled labour, and love of variety effects in intermediate inputs. In Kohler and Keuschnigg (2000) and Kohler and Keuschnigg (2001) the model is applied to the case of Austria and in Keuschnigg et al. (1999) and Heijdra et al. (2001) to the case of Germany. The latter paper introduces search unemployment to address labour market responses from immigration. The model framework allows for determination of welfare effects including potential losses from dynamic transition. For Austria, welfare gains of 0.58 percent of GDP are projected. For Germany, Heijdra et al. (2001) report gains of 0.45 and 0.69 percent of GDP (the latter projection includes immigration). The impact of market integration are in all of these papers found to exceed those of customs liberalization and it is noteworthy that the positive effects of increased trade are found to exceed the recessive impact of the financing burden. Á priori one must suspect that the potential gains from increased trade are larger for Austria and Germany than for most other incumbent states given the close proximity to the applicant countries.

Most of the listed studies find small positive effects of enlargement for the present member states. In multicountry studies the effects to individual countries are found to be different as a natural consequence of the geographical proximity to the newcomers. The part of the fiscal burden asummed to be carried by individual countries also plays an important role in the observed differences of projected economic consequences.

1.4 The present analysis

The present study of enlargement will focus on the modeling and quantification of the economic consequences of the east enlargement for Denmark. Using a framework inspired by Keuschnigg and Kohler, we will quantify macroeconomic effects, the extent of sectoral shifts of production and assess welfare implications. The quantifications cannot given the complexity and uncertainty of the issues at hand be expected to be conlusive. Rather projected implications should be considered to indicate the order of magnitude and qualitative nature of the likely outcome for Denmark. We have taken great care in the empiric foundation of the quantification but, as we will explain shortly, the exogenous nature of policy elements and the uncertainty of the magnitude of exogenous variables will influence the results.

Given the uncertain timeframe and size of the actual enlargement, we have decided to analyse an enlargement implemented in the year 2004 that includes 12 applicant countries excluding only Turkey. The timing of the enlargement is somewhat optimistic given the forementioned assertion of the European Commision, and the implementation of simultaneous inclusion of 12 countries is probably also too simple a representation of the process. However, it seems indeed very possible that the largest and most developed of the CEE countries will access in a short timeframe and implementing a full enlargement in 2004 is if not completely realistic then at least defendable on this account. We analyse the actual enlargement and do not treat the Europe agreements as an integral part of the enlargement.

1.4.1 Framework

In order to quantify the economic impacts we apply a dynamic overlapping generations model for the Danish economy. The model is for a small open economy and the representation of foreign countries is therefore to a wide extent specified exogenously. Interntational trade is modelled by implementation of the Armington assumption which states that goods produced in different countries exhibit distinct qualities and therefore are considered to be imperfect substitutes by agents. We assume perfect international mobility of financial capital and abstracts from monetary issues. This formulation imply that we cannot address the importance of foreign direct investments in CEE countries and their role for the Danish national income in a meaningful manner. Another important aspect of the long term implications of enlargement is the probable catching up of the CEE economies. In a long term perspective the CEE region is expected to experience increased productivity and wealth and this will imply that export markets in the CEE will grow and that cheaper imported products will be available. We will for the sake of simplicity assume that the growth rate of all foreign countries coincide with the domestic growth rate of labour productivity and hence abstracts from the likely catching up. In addition to simplicity this omission reflects the exogenous nature of the cathing up phenomenon in our single country framework.

Enlargement will affect the production structure in Denmark. Increased international worksharing will have impact on domestic industries from increased competition from imported goods. Specifically, the role of altered subsidiation of agriculture imply changes to the economic conditions facing this industry. Our model implements a simplified representation of the role of subsidiation and regulation of agriculture. To asses the magnitude of derived sectoral shift of production the model must incorporate multiple goods and production sectors. Since the transition to the altered international economic conditions will occur gradually the model must be formulated dynamically. The dynamic formulation of the model and a rich representation of the domestic demographic composition allows for determination of intragenerational welfare implications. The simulation model and its data foundation is presented in chapters 2 and 3 respectively.

1.4.2 Effects of custom liberalizations and market integration

As noted the enlarged customs union and European single market must be expected to benefit incumbent member states. Customs liberalizations will imply changes to tariff equivalent customs barriers and also the rate of subsidiation all represented by region and good specific ad valorem rates. The effects of market integration are captured by abolition of exogenously specified real costs of trade taking the the form of rates of decay of internationally traded goods. To address the magnitude of the benefits of the enlargement we conduct a simulation study in chapter 5 that abstracts from the budgetary implications. The abstraction from the costs of enlargement serves to single out the positive effects of increased international trade and the analysis presented in chapter 5 should therefore be considered a technical decomposition of model properties in this respect.

1.4.3 Costs of enlargement

Since enlargement as explained is considered to imply increased spendings for CAP and ESF the role of increased own-ressource payments and lowered net transfers must be included in order to arrive at an assertion of the impacts of a full enlargement. The positive effects of increased international trade comes at a cost to incumbent states and the recessive impact of these costs may exceed the positive implications for Denmark. This issue is analysed in chapter 6 where we present simulations for a set of four cost scenarios. Three of these scenarios reflect possible budget policy reactions of the European union while the last scenario represents a likely combination. The European union may opt for increasing own-ressourece payments or to reduce expenditures for the CAP and ESF payments to incumbent states. The combined scenario may be considered our basecase for the effects of enlargement to the Danish economy.

1.4.4 Issues of fiscal policy response

In the simulation framework the government must adhere to an intertemporal budget constraint and reduced transfers or increased own-ressource payments will directly affect the government budget. In addition derived effects on the government budget arise due to changes in the domestic activity level. These budget implications require a response in domestic fiscal policies for the government to satisfy its budget constraint. A number of possible responses are available and since behaviour is not neutral to fiscal instruments these responses will lead to different projections of the economic consequences of the enlargement. In chapter 7 we consider the merits of various domestic fiscal policy responses with respect to macroeconomics and welfare. We cannot conduct an analysis of optimal response given the complexity of the Danish tax system and the models rich representation thereof. Rather we look at three alternative tax policy responses and compare these.

1.4.5 Immigration

The importance of increased immigration is another important aspect of enlargement to the Danish economy. The promotion of free mobility of labour will likely not be extended fully to CEE citizens immediately, but in a longer perspective increased immigration will probably arise. In our model framework the representation of socioeconomic attributes across age and gender is an integral part of the underlying demographic projection. The introduction of additional immigration thus require rather strong assumptions with respect to the age and gender composition and the likely socioeconomic attributes of new immigrants. On this account the specification of increased immigration is somewhat problematic and is consequently not included in our basecase scenario. However we do conduct a simulation reflecting increased immigration in chapter 8 for completeness.

2 The simulation model

In order to quantify the effects of enlargement of the European union we apply a dynamic general equilibrium model based on the dynamic overlapping generations model DREAM[1]. Our simulation model is specified accoring to the modelling of institutions, income systems and assumptions of an small open economy adapted in DREAM. Hence we apply the same assumptions of perfect international mobility of financial capital, fixed exchange rates and the use of the Armington specification for explaining international trade.

Moreover, DREAM incorporates a full population forecast for specification of the household sector in order to provide realistic quantification of the importance of the ageing population. In its current version however, DREAM incorporates only three production sectors. These are public services, construction and a private sector. Since sectoral shifts in production is an important aspect of an analysis of the effects of trade and market integration we will extend the model in this respect and introduce a more disaggregate specification of production. A more detailed specification of production is also required in order to asses the importance of changes to the level of subsidiation of agriculture.

DREAM incorporates a fairly rich description of the Danish welfare state including a fully funded pension system implemented by means of a representative labour market pension fund. The modelling of the pension fund is based on auctuarial principles and is described in Pedersen et al. (1998). The income of households and the various transfers of income and goods from the government to the household sector is specified completely as in DREAM. Given our focus on the effects of enlargement we will only very briefly treat these aspects of the model but please refer to for instance Pedersen and Trier (2000) for a more detailed presentation.

In this chapter we will present the simulation model by focusing the presentation of the extensions we have made to DREAM. Section 2.1 presents the modelling of production and corporate behavour. In section 2.2 we will present the modelling of the household sector and introduce preferences for the multiple consumption goods introduced in our model. The Armington representation of export demands and the method for specification of real frictions and tariff barriers to trade are presented in section 2.3. Also in section

[1] Danish Rational Economic Agent Model

2.3 we introduce the balance of payments and the role of net transfers from the European union. Finally, section 2.4 introduces the modelling of the government budget along with the requirement of solvency for the government.

2.1 Production

The actual modelling of production is also based on that found in DREAM. We incorporate large group imperfect competition and installation costs of capital, and the conditions for funding of corporate activities are assumed to be the same as in DREAM. The interest rate of bonds is given by the rate of interest in international financial markets since capital income is assumed to be taxed on a residence basis and due to the assumption of perfect international mobility of financial capital.

We implement a more detailed description of the composition of aggregate production in order to shed light on the impact of trade and market integration on the sectoral composition of production. Also the likely impact on particularly agriculture of changes to the level of subsidiation from the European union calls for explicit inclusion of land as an input factor to production.

2.1.1 Industries

In our version of DREAM private production is executed by a corporate sector consisting of 8 private industries in addition to an industry representing the production of public services. Our 8 private industries are aggregations of the industries specification adapted by the Danish econometric model ADAM. The desire to operate with fewer industries reflects a wish to reduce the complexity of the computer model. Implementing a large number of industries increase the number of equations more than linearly and thus introduce a considerable computational overhead. Likewise, when specifying many industries in the model, the risk of ending up with relatively small industries that are very sensitive to changed conditions increase. Such industries would reduce the regularity of the model and may result in poor operational use of the model.

Aggregation may however affect the characteristics of the model. Ideally, the industry specification should reflect common attributes of the commodities and services such that the products of firms operating in a given industry have similar distinctive purposes in the real economy. However, since the industry specification is based on the type of firm rather

Table 2.1: Industries in the simulation model.

Label	Description	Share of total production value
ag	Agriculture, fishery, forestry etc.	3.43
en	Energy provision, refineries etc.	2.88
co	Construction	8.18
fo	Foods	6.15
mc	Metals, chemicals, transportation equipment etc.	15.85
om	Other manufacturing	5.56
tt	Trade and transportation services	17.75
os	Other services	20.00
pu	Public services	16.21
dw	Dwelling	3.99

than directly on a product specification, some degree of overlap between the products from various industries are present. Aggregation of industries tend to clutter the differences between the various industry goods even more. Therefore we have sought to aggregate only comparable types of industrial activities.

Also, aggregation tend to reduce the significance of differences in adapted technologies, the extent of orientation towards export markets and the extent to which industries are vulnerable to competition from imported goods. In our specification of industries we have sought to take into account the resulting size, capital intensiveness, import and export shares in addition to the types of industries entering an aggregate. Of course the listed industry sepcification reflects a trade-off between these multiple criteria and the importance of composition of the industry specification is consequently an obvious issue to address in future studies.

Agriculture, construction and public services are modelled a little differently than other industries. First of all agriculture benefits from subsidiation in the common agriculte policy (CAP). We will address this in subsection 2.1.8 on page 35. Construction also constitutes a special case, since the product of this industry is assumed not to be traded internationally. Our modelling of construction is therefore identical to the one used in DREAM. Finally, the public service sector is, as it is the case in DREAM, defined according to the ENS95 national accounting standard. Publically owned limited companies are designated to the private sector and the public service industry therefore excludes such limited companies that are considered to be operated as if they were privately owned. The public service sector represents the remaining activities in the public economy and includes public health care, defence, education kindergardens and similar publically funded activities. Given the nature of the services provided by the public service industry the production in this sector can not in a meaningful way be modelled along the lines of a profit maximizing limited company. We will comment briefly on the modelling of the public service industry in subsection 2.1.9. Finally it should be noted that the dwelling sector is not modelled as a production sector. Dwelling represents the rental value of houses used for residential purposes and is considered a book-keeping entity generating a gross operating surplus delivered to private dwelling consumption. We will return to the role of the dwelling sector in conjunction with our presentation of the preference structure of households.

In the mathematical exposition of the model we will let the set of industries denote by I and the set of private industries by I^P. These sets are defined by

$$I \equiv \{ag, en, co, fo, mc, om, tt, os, pu\}, \quad I^P \equiv I \setminus \{pu\}.$$

We will use the index $i \in I$ to refer to an industry and the letter j to represent a given firm operating in an industry.

2.1.2 Technology

All industries are assumed to comprise of a large finite number of firms, all producing a variety of the industry good. In order to produce, firms make use of a generally available production technology specifed by means of a gross production function. This function have the same functional form for all industries, but the parameterization of the function is distinct for an industry and soforth also for individual firms. The function is a nested CES (constant elasticity of substitution) function which combines input factors to form a quantity index representing the product variety produced by each firm. The nested structure of the production function reflects the idea of multistage budgeting found in most applied general equilibrium models. We make use of a so-called KLEM production technology and thus deviates from the production technology used in DREAM by treating energy inputs explicitly. Moreover capital services are represented by a nested CES subtechnology combining buildings and land with machinery. The implementation of multiple industries and hence the multiplicity of commodities and services calls for specification of how industry goods are combined to quantity indices representing intermediate inputs and investments.

Figure 2.1 illustrates the production function by a technology tree. The end nodes of the tree structure are with the exception of labour, all Leontief subtechnologies that will be presented shorthly. First, let us describe the overall structure of the production technology starting from capital services.

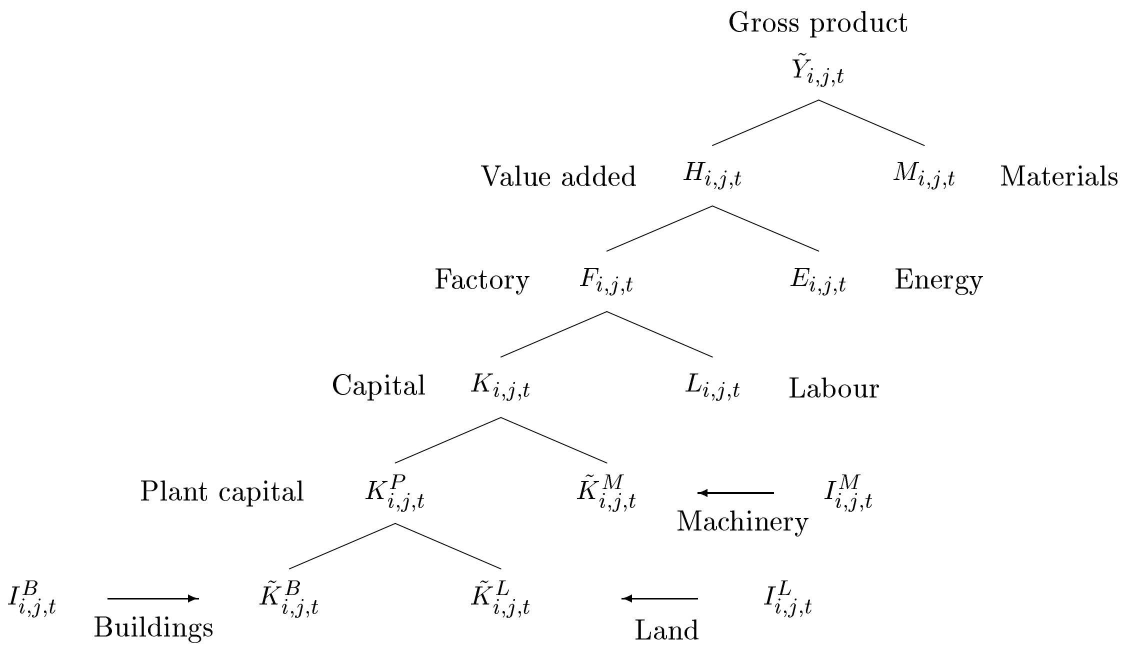

Figure 2.1: The production technology

Capital

Capital services are combined by CES composition of buildings, land and machinery. The inclusion of land in the production technology is a novelty compared to the modeling of the production applied in DREAM. Land is modelled to be of one of three types and all types are assumed to be available in fixed quantities. The three types of land reflect the three possible uses of land in the model. Land may be used as a capital input in production and the type of land used in rural production is considered to be of a special kind. Finally, land may be used for residential purposes which precludes it from being used in production. Land is assumed to exhibit Harrod-neutral growth of productivity by the rate n. The growth in the productivity of land is introduced in order to ensure existence of a long run steady state for the model. We will model growth of labour productivity and since land is available in a fixed quantity land must also exhibit growth of productivity for the model to have a steady state. The technological progress of land apply to the weighed stock entering the production function, and should be interpreted as improved technology driven abilities to exploit land rather than technological progress of land per se.

The combination of land and buildings is denoted by the superscript P and represents the notion of a production plant. As machinery are added to the plant, again by CES composition, we arrive at the capital aggregate. The tilde decoration introduced to the Leontief capital aggregates representing buildings, land and machinery indicates that these capital stocks are linear compositions of primo and ultimo stocks in the indicated period. The period length of DREAM is 5 years[2] and the implied lag of 5 years before capital becomes productive must be reduced in order for the calibration procedure to be meaningful. For the three types of capital entering the production function we have that

$$\tilde{K}^s_{i,j,t} = \kappa K^s_{i,j,t} + (1-\kappa) K^s_{i,j,t-1}, \quad s \in \{B, L, M\},$$

where $\kappa \in [0,1]$ is the weigth associated to the primo stock. The ultimo stock of capital of type s is given by the usual accumulation identity

$$K^s_{i,j,t} = \left(1 - \delta^s_{i,j}\right) K^s_{i,j,t-1} + I^s_{i,j,t}, \quad s \in \{B, L, M\},$$

where $\delta^s_{i,j}$ denotes the rate of physical depreciation and $I^s_{i,j,t}$ denotes investments. The rate of physical depreciation of land is zero, so land is included here to compress the mathematical exposition slightly.

Installation costs of capital

Following DREAM we will assume that real convex installation costs of capital must be defrayed by private firms as new investments are adapted in production. Such real costs introduce a lag in capital formation and reflect the required halt in production required for the physical installment of capital, running-in of new machinery, staff training etc. The installation costs of capital are specified to be increasing in the level of investments but decreasing in the existing capital stock

$$\Phi^s_{i,j,t}\left(I^s_{i,j,t}, K^s_{i,j,t}\right) = \phi^s_{i,j,t} \frac{\left(I^s_{i,j,t}\right)^2}{K^s_{i,j,t-1}},$$

where

$$\phi^L_{i,j,t} \equiv (1+n)^t \, \bar{\phi}^L_{i,j}.$$

[2]The period length of 5 years is used in order to reduce the dimension of the problem solved by the simulation software.

Our inclusion of installation costs of capital follow DREAM by letting the scaleparameter $\phi^s_{i,j,t}$ be distinct for each industry and so far also for each firm. The definition of the scale parameter for the installation costs of land follow from the specification of productivity growth. Given growth in the productivity of land, the installation costs for this capital input would otherwise diminish.

Labour inputs

The capital aggregate is combined with labour in the CES subtechnology forming the aggregate $F_{i,j,t}$ that we will call the factory. Individual workers are paid wages according to their level of productivity, which are gender and age specific[3]. To avoid introducing heterogenity of labour in the employment decision DREAM incorporates the assumption that labour is hired in terms of efficiency units such that only one type of labour exists as far as the firm is concerned. The firm is indifferent between hiring an individual with a given productivity and two individuals possessing half that productivity. This implicitly mandates the assumption that the firm is able to perfectly monitor productivity in order to avoid shirking and further that administration costs per employee are negligible. Labour is assumed to exhibit Harrod-neutral technological progress by the growth rate n and hence enter the production function as $(1+n)^t L_{i,j,t}$.

Intermediate inputs of energy and materials

In the KLEM specification of technology, a distinction between energy inputs and other intermediate inputs is used. Energy is assumed to be supplied exclusively by the industry energy provision, whereas intermediate inputs used for material inputs are assumed to be represented by Leontief composition of supplies from the remaining industries. The Leontief subtechnology of materials and investments will be explained shortly so for now consider material inputs and capital to be represented by quantity indices representing some subtechnology.

Gross and net production

The gross production of a firm j operating in an industry i is expressed in terms of the production function $G_{i,j,t}(\cdot)$, taking as its arguments the aggregates representing capital,

[3]The productivity distribution is determined from Danish labour market panel data referred to as the IDA database.

labour, energy and material inputs. The net output of a firm j operating in industry i is denoted by $Y_{i,j,t}$ and is defined by

$$Y_{i,j,t} \equiv G_{i,jt}\left(K_{i,j,t}, (1+n)^t L_{i,j,t}, E_{i,j,t}, M_{i,j,t}\right) - \sum_{s \in \{B,L,M\}} \Phi^s_{i,j,t}(I^s_{i,j,t}, K^s_{i,j,t-1}), \qquad (2.1)$$

where the capital index is given by

$$K_{i,j,t} = K_{i,j,t}\left(\tilde{K}^B_{i,j,t}, (1+n)^t \tilde{K}^L_{i,j,t}, \tilde{K}^M_{i,j,t}\right)$$

The net production function exhibits decreasing returns to scale of production factors that are variable in the short run. This is due to the presence of the real installation costs of capital. The predetermined level of capital entering the installation cost function causes the short run installation costs to be more than linearly decreasing in the level of investments. In steady state, all industries but agriculture operate under constant returns to scale. For agriculture, the long run return to scale is decreasing since land, which is a necessary input to agricultural production, is available in a fixed quantity.

2.1.3 Combining industry goods and origin

The quantity indices representing capital goods and material inputs are all assumed to represent Leontief technologies combining industry specific goods except the energy provision good. Figure 2.2 present the structure of the Leontief subtechnologies using the material input as an example.

The Leontief specification of composition of industry specific goods is naturally somewhat more restrictive than assuming CES composition. However, it seems hard to determine the required elasticities of substitution required when using a CES specification, especially given the orientation of the industry specification at type of industry rather than physical attributes of goods. For instance it is hard to provide an economic justification of substitutability of supplies from chemical industries and trade services. Rather the mentioned example involve a degree of complementarity in the sense that purchases of chemicals for material inputs are likely to involve a wholesale distributor to some extent. For these reasons we resort to the Leontief specification.

As indicated in figure 2.2, all elements entering the Leontief aggregate of industry specific products are quantity indices representing nested CES composition over origins of the good. These subtechnologies implements the Armington assumption that goods delivered from different origins are considered imperfect substitutes. First the inputs of goods from

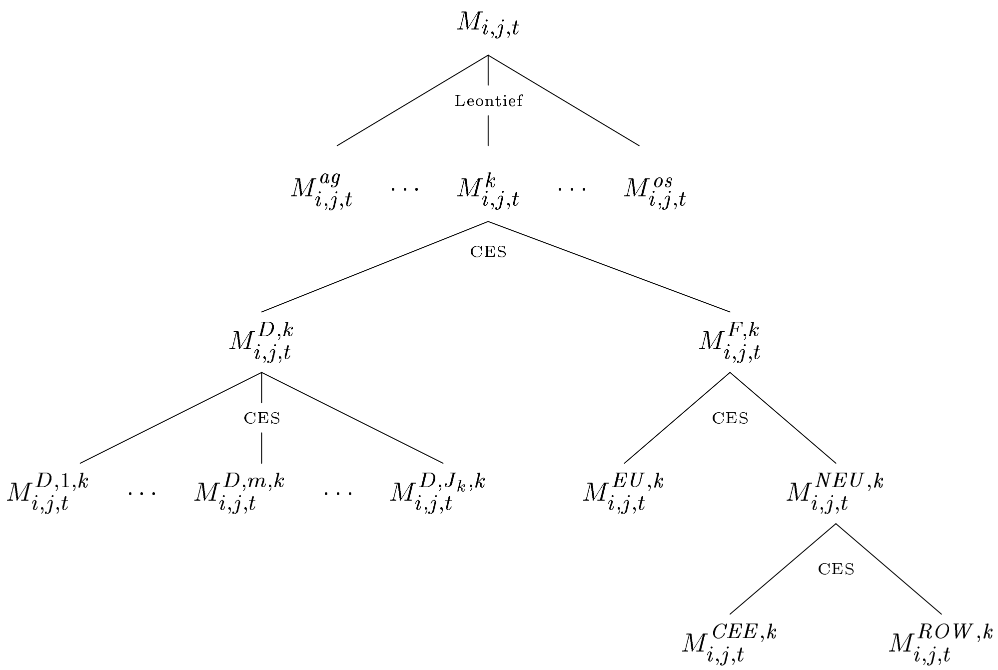

Figure 2.2: The compostion of industry specific goods

an industry is split into domestic and foreign quantity indices. The foreign quantity index represents nested CES composition of imports from three regions. These are the European union (EU), central and eastern European (CEE) countries and finally the rest of the world (ROW). The quantity index representing domestically produced goods represents CES composition of the varieties of the product from the delivering industry (denoted by the superscript index k.). The number of varieties coincide with the number of firms J_k operating in the delivering industry. The elasticity of substitution in the domestic delivery aggregate is assumed to exceed unity reflecting the assumption that varieties are imperfect substitutes. The outlined structure of quantity aggregates representing capital goods and intermediate inputs is also used for industry specific supplies to consumption goods.

2.1.4 Large group monopolistic competition

All domestic industries are as mentioned assumed to consist of a number of firms each producing a variety of the product of the industry. These varieties are not only considered imperfect substitutes in intraindustrial trade but so by all purchasers of supplies from the industry. Under the assumption that all agents of the economy have CES demand functions for the product variety from a given firm j and that these CES demand functions exhibit identical elasticities of substitution and scale parameters, the demand for variety j of the good produced in the industry i may be formalized by

$$Y_{i,j,t} = (\beta_{i,j})_i^E \left(\frac{P_{i,j,t}^Y}{P_{i,t}^Y} \right)^{-E_i} \Theta_t^i, \quad E_i > 1. \tag{2.2}$$

Here, $P_{i,t}^Y$ is a CES price index over the varieties of the product of industry, $\beta_{i,j}$ is a scale parameter and E_i denotes the constant elasticity of substitution between the product varieties. Finally, Θ_t^i denotes the aggregate demand facing the industry. Due to the assumption of identical scale parameters and elasticities of substitution, the price index $P_{i,t}^Y$ is identical for all purchasers having postive demands for the products of the industry. We will assume that that all industries consists of a sufficiently large constant number of competing firms to ensure that no single firm is able to influence the industry price index.

This specification amounts to incorporation of large group competition. The imperfect substitution between varieties leaves a degree of market power to each firm which is used to leverage pricing of products above the perfect competition equilibrium level. We do not specify any entry or exit barriers and the number of firms (and therefore varieties) is assumed constant for all industries. In for instance Keuschnigg and Kohler (1996) the number of varieties is determined by a zero profit condition stating that firms will start operating in an industry until competition drives down profits to zero or possibly a threshold level determined by entry barriers. Two problems incorporating such a modeling of imperfect competition arise in our setting.

First and foremost a zero-profit condition is logically incompatible with the presence of industry specific installation costs. As new firms enter an industry in a symmetric equilibrium setting they implicitly take over existing capital from incumbent firms. A justification of the absence of installation costs during intraindustrial redistribution of capital inherent in a symmetric formulation is not given to our knowledge. A second problem of logic related to positive profits paired with symmetric equilibrium arise. In symmetric equilibrium new firms will emerge if positive profits is present. These new firms will by definition of symmetric equilibrium employ the same production technology as incumbent firms. This seem counterintuitive since one would expect new firms to be less efficient than incumbent firms.

This problem has been addressed in Fæhn and Holmøy (2000) in which heterogenity of the productivity of firms is introduced in a fashion that allow for analytical aggregation of industries. Using this approach combined with entry and exit mechanisms Fæhn and Holmøy (2000) captures a source of decreasing returns to scale in an industry from variations in the number of incumbent firms. However, small effects are found for moderate changes to the number of firms in the model and therefore we choose to operate with a constant number of firms.

2.1.5 Corporate behaviour and optimization

All firms in the model are modelled as limited companies. Managers of the firms are assumed to hold rational expectations equivalent to perfect foresight given our deterministic framework. The objective of corporate managers is to maximize the value of the firm as represented by the current value of future dividend streams as perceived by the marginal investor. Like DREAM we follow the 'new view' of dividend taxation, according to which current profits are withheld in the firm to the extent that they may be profitably invested in the firm.

The convention that all private production is executed by limited companies is of course a simplification. In 1998 approximately 7.7 percent of employment were accounted for by self-employed individuals. In the setup of the base year dataset we take this problem into account, by viewing part of the gross operating surplus as compensation of self-employed.

With respect to financing of corporate activities and corporate behaviour we follow Knudsen et al. (1998a). Here we will briefly outline the central assumptions and institutions governing the incentives of firm executives. For mathematical details please refer to appendix A.

Financial dispositions and markets

In our model as it is the case in DREAM no explicit formulation of financial markets is incorporated. Rather the value of the outstanding stock of shares is determined from an arbitrage condition stating that the yeild after taxes from stocks should coincide with that acheived by placing the same investment in bonds. In our deterministic setting this arbitrage condition is always fulfilled.

Households, pension funds and foreigners are all assumed to hold financial assets, but only domestic agents are assumed to hold shares in domestic corporations. Since households and pension funds are subject to different capital income taxation, the arbitrage condition determining the value of shares can only hold for one of these types of investors. We follow DREAM and assume that only the institutional investor, that is the pension fund, considers the arbitrage condition. Households are assumed to follow a sub-optimal rule of fixed proportions of shares and bonds in their financial portfolio. The pension fund is assumed to require a risk premium ρ when investing in shares to ensure that the value of the firm remain bounded. Moreover to avoid fully funding of activities by either debt or shares a rule of a fixed debt-ratio g_i of debt to capital is introduced. Since debt and stock funding of activities are treated differently by the tax system, the method favoured would otherwise be the only funding method used.

We assume perfect mobility of financial capital in international bond markets, such that incestors are indifferent between holding domestic and foreign bonds. Further capital income taxation is assumed to be residence based and given fixed currency exchange rates the nominal interest rate on bonds i_t is given by the international nominal interest rate.

The dividend

The dividend paid by a firm to its share holders amounts to the gross operating surplus net of taxes, fiscal depreciation allowances and changes in the level of debt. The depreciation allowances are formalized in terms of an accumulation identity for the book-value of buildings and machinery capital stated by

$$\hat{K}^s_{i,j,t} = \left(1 - \hat{\delta}^s_t\right) \hat{K}^s_{i,j,t-1} + P^{Is}_{i,j,t} I^s_{i,j,t} \quad \text{for} \quad s \in \{B, M\}, \tag{2.3}$$

where $P^{Is}_{i,j,t}$ denotes the investment price of a capital good and $\hat{\delta}^s_t$ is the depreciation allowance for the book value of the capital good. Note that no depreciation of book-value is allowed for land and that the allowance by Danish legislation is identical for all firms and industries.

From equation 2.2 formulating the demand for a variety j of an industry product we may deduce that the turnover of the corresponding firm reads

$$\begin{aligned}\Lambda_{i,j,t}\left(Y_{i,j,t}\right) &= P^{Y}_{i,j,t}Y_{i,j,t} \\ &= P^{Y}_{i,t}\beta_{i,j}\left(Y_{i,j,t}\right)^{\hat{\mu}_i}\left(\Theta^{i}_{t}\right)^{1-\hat{\mu}_i},\end{aligned} \tag{2.4}$$

where

$$\hat{\mu}_i \equiv \frac{E_i - 1}{E_i}.$$

Now let $B_{i,j,t}$ denote the corporate debt in the firm. Further let $P^{M}_{i,j,t}$ and $P^{E}_{i,j,t}$ be CES price indices for material and energy inputs respectively. These two price indices include customs and excise taxation being represented by ad valorem equivalent net tax rates. Soforth these price indices are specific to the industry as well as the firm. Let W_t denote the wage paid per efficience unit of labour and let t^{a}_{t} denote the employers labour market tax rate. Now the dividend in period t may be stated by

$$\begin{aligned}D_{i,j,t} = {} & (1-t^{c}_{t})\left[\Lambda_{i,j,t}\left(Y_{i,j,t}\right) - P^{M}_{i,j,t}M_{i,j,t} - P^{E}_{i,j,t}E_{i,j,t} - (1+t^{a}_{t})\,W_t L_{i,j,t} - i_t B_{i,j,t-1}\right] \\ & - \sum_{s\in\{B,L,M\}} P^{Is}_{i,j,t}I^{s}_{i,j,t} - P^{SI}_{i,j,t}I^{SI}_{i,j,t} + t^{c}_{t}\sum_{s\in\{B,M\}}\hat{\delta}^{s}_{t}\hat{K}^{s}_{i,j,t-1} + \left(B_{i,j,t} - B_{i,j,t-1}\right).\end{aligned} \tag{2.5}$$

The first line of equation 2.5 represents the operating surplus net of corporate taxes and interest payments on corporate debts. The terms in the second line represents the total expenditures for new investments, a term catching changes in stocks and inventories as these are present in the national accounts, the value of the fiscal depreciation allowances and finally the change in the debt of the firm. Changes in stocks and inventories are assumed only to be present in the calibration year. In subsection 2.1.8 we present a slightly modified dividend expression for agriculture.

2.1.6 Optimization and symmetric equilibrium

The intertemporal optimization problem of the firm amounts to determination of an optimal production plan that maximizes the current value of the future stream of dividens after taxes applying to the pension fund. This problem is an optimal control problem that may be solved by application of Pontryagins maximum principle. In section A.2 of the appendix we formulate and solve the intertemporal problem for a given firm by derivation of a set of first order conditions.

Using the described formulation of large group monopolistic competition and the assumption of symmetric equilibrium, all domestic industries may be represented by representative firms producing CES quantity aggregates representing the varieties of industry products. The total demand facing the representative firm of a given industry is derived in section A.3 of the appendix by invokation of symmetric equilibrium. The demand amounts to

$$Y_{i,t} = (\beta_i J_i)^{-\frac{1}{\hat{\mu}_i}} \Theta_t^i, \tag{2.6}$$

where J_i denotes the number of firms operating in the industry. We see that the total demand facing the representative firm is increasing in the number of product varieties. This number is as previously explained constant in our model. The interpretation of benefits from product diversity may still support the understanding of why firms in some industries are able to exploit market power to a wider degree than in other industries. From 2.6 we may derive the marginal turnover of a unit increase in production to read

$$\frac{\partial \Lambda_{i,t}(Y_{i,t})}{Y_{i,t}} = \mu_i P_{i,t}^Y \quad , \tag{2.7}$$

where the constant markup that will be determined by calibration of the model is defined by

$$\mu_i \equiv \hat{\mu}_i (J_i)^{\frac{1-\hat{\mu}_i}{\hat{\mu}_i}} (\beta_i)^{\frac{1}{\hat{\mu}_i}} .$$

2.1.7 First order conditions for intertemporal optimization

By application of the assumption of symmetric equilibrium, the first order conditions can be restated as to characterize the optimal operation of the representative firm of a given industry. In subsection A.3.1 of the appendix these first-order conditions for symmetric equilibrium are presented along with a few remarks to support the understanding of their derivation. Here we present the economic interpretation of the conditions. The tax rates t_r^{rz}, t_r^{dz} and t_r^{gz} represent taxation of the pension funds interest income, dividend income and finally its capital gains. The shadow price of capital of type s is denoted by $\lambda_{i,t}^s$ and for book value of capital $\hat{\lambda}_{i,t}^s$. These shadow prices measure the marginal increase in the current value after taxes of the future dividend stream with respect to capital or the book value of capital.

Labour-, energy- and material-inputs

The first order conditions characterizing the optimal input of labour is

$$\frac{\partial G_{i,t}(\cdot)}{\partial L_{i,t}} = \frac{(1+t_t^a) W_t}{(1+n)^t} \frac{1}{\mu_i P_{i,t}^Y}. \tag{2.8}$$

This first order condition simply states that the representative firm will hire labour until the marginal productivity of labour equals the real marginal costs. The real marginal costs of labour includes the Harrod-productivity corrected nominal wage including the employers labour market contribution tax and is divided by the marginal turnover to arrive at the real value of the cost from the producers perspective.

For the optimal input of energy the first order condition is

$$\frac{\partial G_{i,t}(\cdot)}{\partial E_{i,t}} = \frac{P^E_{i,t}}{\mu_i P^Y_{i,t}}. \tag{2.9}$$

Just as is the case for labour inputs, this first order condition is a standard condition stating that the marginal productivity of energy in optimum should equal the real marginal costs of energy.

For material inputs the first order condition is

$$\frac{\partial G_{i,t}(\cdot)}{\partial M_{i,t}} = \frac{P^M_{i,t}}{\mu_i P^Y_{i,t}}. \tag{2.10}$$

Hardly surprising the interpretation of this condition is that the marginal productivity of material inputs in optimum equals the real costs of the input, again measured at the marginal turnover.

Investments

Due to the intertemporal nature of investments, the first order conditions characterizing the optimal levels of investments are a little more subtle to interpret than those of labour, energy and materials. For expositional reasons we will let $MPK^s_{i,t}$ denote the marginal product of capital of type s such that

$$MPK^s_{i,t} \equiv \frac{\partial G_{i,t}(\cdot)}{\partial \tilde{K}^s_{i,t}} \quad \text{for} \quad s \in \{B, M\} \tag{2.11}$$

and due to the growth of productivity in land that

$$MPK^L_{i,t} \equiv (1+n)^t \, \frac{\partial G_{i,t}(\cdot)}{\partial \tilde{K}^L_{i,t}}.$$

For investments in capital of type $s \in \{B, L, M\}$, the first-order conditions are

$$\frac{\lambda^s_{i,t}}{P^{Is}_{i,t}} + \hat{\lambda}^s_{i,t} = \frac{1-t^{dz}_t}{1-t^{gz}_t}\left[1 - g_i - (1-t^c_t)\,\mu_i \frac{P^Y_{i,t}}{P^{Is}_{i,t}}\left(\kappa MPK^s_{i,t} - 2\phi^s_{i,t}\frac{I^s_{i,t}}{K^s_{i,t-1}}\right)\right]. \tag{2.12}$$

The interpretation of these first order conditions should be seen in the light of the incentives for the marginal investor which as previously noted is a pension fund. The representative firm of industry i maximize the value of the firm as perceived by the pension fund. The equations 2.12 represent this in terms of the optimal level of investments by stating that the marginal benefits of the investment should equal the marginal costs of the investment, where benefits and costs are both seen from the perspective of the pension fund. The left hand side of equation 2.12 represents the benefits to the pension fund. The benefits are given by the shadow prices of capital and depreciation allowances since these represents the marginal value of the objective function from an additional unit of the capital and from future depreciation allowances respectively. Note that because the shadow price of the investment is denominated by the price index of investment the first term on the left-hand side amounts to Tobin's marginal q.

The marginal costs of investments in capital of type s are given by the right hand side and consists of the sum of the direct and indirect costs net of the tax adjustment factor applying to dividend payments to the pension fund. The direct costs are given by the share of the value of the investment that is financed by withheld dividends. This amounts to one minus the ratio of debt financing g_i. The indirect costs are given by the marginal installation costs adjusted for the fact that the share κ of the investment is immediately productive. The factor $(1-t_t^c)\,\mu_i P_{i,t}^Y$ is value to the producer net of corporate taxation of the indirect cost. To arrive at the real value, we must divide by the price of the additional unit of capital which is given by $P_{i,t}^{I,s}$.

Capital and bookvalue of capital

For the optimal level of capital a set of first-order conditions that may be interpreted as arbitrage conditions apply. For buildings, land and machinery $s \in \{B, L, M\}$ the conditions are

$$\begin{aligned}
&\left(i_t \frac{1-t_t^{rz}}{1-t_t^{gz}} + \rho \frac{1}{1-t_t^{gz}}\right)\lambda_{i,t-1}^s - \left((1-\delta_i^s)\,\lambda_{i,t}^s - \lambda_{i,t-1}^s\right) = \\
&\frac{1-t_t^{dz}}{1-t_t^{gz}}\left\{(1-t_t^c)\,\mu_i P_{i,t}^Y \left[(1-\kappa\delta_i^s)\,MPK_{i,t}^s + \phi_{i,t}^s \left(\frac{I_{i,t}^s}{K_{i,t-1}^s}\right)^2 - i_t g_i \frac{P_{i,t-1}^{Is}}{\mu_i P_{i,t}^Y}\right]\right. \\
&\left. + g_i\left((1-\delta_i^s)\,P_{i,t}^{Is} - P_{i,t-1}^{Is}\right)\right\}
\end{aligned} \tag{2.13}$$

The left hand side of this condition states the marginal costs of capital while the right hand side states the marginal benefits both concepts from the perspective of the marginal investor. The costs consists of the tax adjusted foregone interest payments plus the potential capital loss corrected for physical depreciation. The potential capital loss are stated in terms of the shadow prices of capital, that is the marginal value of the objective function in the maximization problem with respect to capital.

The benefits amounts to the positive net effect on the tax-adjusted value of the dividend from an additional unit of capital. This effect consists of additional production as measured by the marginal product of capital net of physical depreciation and the reduction of the marginal installation cost from additional stock of capital. The rate of physical depreciation is adjusted for the fact that capital enters the production with the weight κ. From this the effects on the interest burden of financing the capital must be substracted. These effects are all measured in terms of marginal turnover net of corporate taxation. The final element in the arbitrage condition is the change in the debt of the firm.

Finally, the following first order conditions governs the optimal levels of the book-value of buildings and machinery, $s \in \{B, M\}$

$$\frac{1-t_t^{dz}}{1-t_t^{gz}} t_t^c \hat{\delta}_t^s = \left(i_t \frac{1-t_t^{rz}}{1-t_t^{gz}} + \rho \frac{1}{1-t_t^{gz}} \right) \hat{\lambda}_{i,t}^s - \left(\left(1-\hat{\delta}_t^s\right) \hat{\lambda}_{i,t}^s - \hat{\lambda}_{i,t-1}^s \right) \tag{2.14}$$

This condition should also be seen in the light of the tradeoffs betweeen marginal costs and benefits. The benefits which are at the right hand side of the equation is the tax-adjusted value of a marginal unit of capital measured by the shadow-price. The costs have a very similar interpretation to the one already given for the conditions 2.13.

Using the listed first order condtions we may derive factor demands and demands for investments in the representative firm. In the section A.4 of the appendix we derive and present these factor demand functions.

2.1.8 Agriculture

The common agriculture policy (CAP) of the European Union have broad impact on the conditions facing European agriculture. The common agriculture policy is maintained to ensure stabile availability of food and to some extent to target environmental issues as well. To achieve this, the market for agricultural products are regulated by quotas, subsidies, tax instruments, tariffs and price interventions.

Subsidies to agriculture

The legislation implementing these regulations constitute a tour de force in the regulatory instruments available to influence a market. It would without any doubt be interesting to examine the effects of all these instruments and a rich litterature on the subject exists.

Regulatory instruments that target the supply of agriculture include quotas, subsidiation and price interventions. Various agriculture products are subject to different regulation and providing an aggregate representation of these arrangements on a single representative agricultural product is not possible. The outcome of the policies is a wedge between the supply and demand that would have prevailed in a deregulated market. Roughly a quarter of the EU budget for agriculture policies are spent on market intervention mechanisms for instance in order to uphold minimum prices. Since the consensus is that price intervention is a very distortionary and expensive policy the focus is shifting towards direct subsidiation of production and exports.

We have chosen to follow the majority of studies of EU enlargement by focusing on the role of direct subsidiation of production in agriculture. Moreover, we implement import customs and export subsidies and the rate of protection and subsidiation of agriculture is high for EU countries. The discussion of EU subsidiation of agriculture exports is deferred to section 2.3, which present the details of the Armington export specification and the implementation of net transfers to Denmark from EU. Here we will discuss the policy instruments that are introduced in the model to capture the part of the CAP that targets supply directly.

The dividend

Due to the presence of transfers and a tax applying to land used in agriculture introduced shortly, the dividend of a firm operating in agriculture deviates from that of firms in other private industries. Land used in agriculture is subject to taxation by the rate t_t^L, while subsidies of land is denoted τ_t^L. Including these elements the dividend for a representative firm operating in agriculture become

$$\begin{aligned} D_{ag,t} = & \left(1 - t_t^c\right) \left[P_{ag,t}^Y Y_{ag,t} - P_{ag,t}^M M_{ag,t} - P_{ag,t}^E E_{ag,t} - \left(1 + t_t^a\right) W_t L_{ag,t} - i_t B_{ag,t-1} \right] \\ & - \sum_{s \in \{B,L,M\}} P_{ag,t}^{Is} I_{ag,t}^s - P_{ag,t}^{SI} I_{ag,t}^{SI} + t_t^c \sum_{s \in \{B,M\}} \hat{\delta}_t^s \hat{K}_{ag,t-1}^s + \left(B_{ag,t} - B_{ag,t-1}\right) \\ & + \left(1 - t_t^c\right) \left[\left(\tau_t^L - t_t^L P_{ag,t}^{IL} \right) K_{ag,t-1}^L \right]. \end{aligned} \tag{2.15}$$

The notation of equation 2.15 suppress product subsidies granted by the EU to agriculture. The price index of the material inputs $P^{M}_{ag,t}$ includes subsidiation of materials used in agriculture paid to farmers by the EU in addition to the usual import tariffs and excise taxation. The land subsidy is granted the EU. The derivation of optimal operation of a firm operating in agriculture follow the same mechanics as that presented for other firms except the slight alteration to the dividend expression.

Intertemporal optimization in agriculture

Due to the differences in the dividend and in market conditions, the intertemporal optimization of the representative firm in agriculture should be characterized by a modified version of the maximization problem presented for the remaining private firms. However, since the maximization problem and first order conditions of agriculture bear such great resemblance to that of other private firms, we will introduce only the differences.

The criterion function is affected by the fact that the marginal properties of the dividend in agriculture is altered. This bounds in the fact that that subsidies and taxation applying to land have marginal effects on dividends with respect to the use of land capital.

Fortunately, the basic structure of the intertemporal optimization problem is in any other respect analog to the one faced by remaining private firms. The first order conditions of the representative firm in agriculture are all similar to the readily derived first order conditions applying in symmetric equilibrium with the exception that the first order condition applying to capital is affected by subsidies and taxation of land used for agriculture. We have enforced the fact that land does not depreciate $\delta^{L}_{ag,t} = 0$ and that no depreciation are allowed $\hat{\delta}^{L}_{t} = 0$. Thus for land the first order condition for the representative firm in agriculture read

$$\begin{aligned}
&\left(i_t \frac{1 - t^{rz}_t}{1 - t^{gz}_t} + \rho \frac{1}{1 - t^{gz}_t} \right) \lambda^{L}_{ag,t-1} - \left(\lambda^{L}_{ag,t} - \lambda^{L}_{ag,t-1} \right) = \\
&\frac{1 - t^{dz}_t}{1 - t^{gz}_t} \left\{ (1 - t^{c}_t)\, \mu_{ag} P^{Y}_{ag,t} \left[MPK^{L}_{ag,t} + \phi^{L}_{ag,t} \left(\frac{I^{L}_{ag,t}}{K^{L}_{ag,t-1}} \right)^{2} - i_t g_{ag} \frac{P^{IL}_{ag,t-1}}{\mu_{ag} P^{Y}_{ag,t}} \right] \right. \\
&\left. + g_{ag} \left(P^{IL}_{ag,t} - P^{IL}_{ag,t-1} \right) + (1 - t^{c}_t) \left(\tau^{L}_t - t^{L}_t P^{IL}_{ag,t} \right) \right\}
\end{aligned} \tag{2.16}$$

This condition have a similar interpretation to that of other private firms, though the land subsidy adds to the marginal benefits whereas the taxation of land obviously work in the other direction. The derivation of factor demand functions are analog to the method already introduced for private firms that are not operating in agriculture.

2.1.9 Public services

The production of public services is as mentioned undertaken by the public service sector. The output of this sector is used in public collective consumption as well for inputs in the activities of the economy. When used for activities in the households, as material inputs in industries, for exports and in machinery and buildings investments, the goods delivered from the public service sector are traded at market terms.

The public service sector is operated with other objectives in mind than sheer maximization of profits. Consequently, the behaviour of the public service sector is characterized by means of a rule of a fixed proportion of capital inputs to production and a number of simplifications vis-a-vis the modelling of private production are introduced. The assumption of real costs of installation of capital is abandoned for the public service industry. The real costs of installation of capital is introduced in the private production sector to obtain inertia in the formation of capital. Since the public service sector is assumed to determine capital inputs from the forementioned rule of fixed proportions of capital to production, this inertia is not relevant in the case of production of public services. Since no real costs of installation of capital is present in the case of the public service sector, no distinction is needed between the gross and net concepts of production. The production in the public service sector is therefore simply denoted by $Y_{pu,t}$. The technology used by the representative producer for the public service sector has the same functional form as that used by the private production sector, so $Y_{pu,t} = G_{pu,t}(\cdot)$. The public service sector is assumed to sell its product without profits. Thus, the product of the public service sector is assumed to be sold at prices covering the average costs of producing the goods. Activity specific quantity excise taxation are added to this price to arrive at the purchasers price.

2.2 The household sector

The modeling of the household sector is completely analog to that of DREAM except for the specification of the preferences for consumption. This section will briefly present the overlapping generations structure of households, that are considered decision units in the household sector. After this issue we procede to the treatment of instantaneous utility. Finally, we will present the structure of and solution to the intertemporal optimization problem characterizing optimal household behaviour.

2.2.1 The representative household

The decision units in the models specification of consumption and savings are representative households, each household representing a cohort of 5 generations and their children below age 17. The basis for construction of the households is the population projection documented in Pedersen (1999). For simplicity we use the term generation to refer to the cohorts of actual generations. Though individuals face uncertain life time, the assumption that the household retain undivided possesion of the stock of wealth the representative household features deterministic finite planning horizons.

Households are constructed using the following conventions: A household representing a generation consists of the men and women from the generation which are assumed to form couples. As in the current version of DREAM we ignore the observed agespan between men and women forming couples to simplify the dynamic structure of the household decision problem. Children are assigned to the household according to the observed and forecasted fertility rates of the women participating in the household. Children are assumed to account for half the consumption of an adult. This convention is implemented by use of an adult equivalent measure of the households size.

The size of a representative household change over time reflecting the gender and age specific mortality of the generations participating and since children by convention move out to form households of their own at age 17. Until then children are assumed to be provided for by their parents. The planning horizon of households is 60 years corresponding to a expected lifetime of individuals of 76 years. The household is assumed to be dissolved as the represented generation turns 77 at which age the household leave bequests for their heirs. Individuals surviving the planning horizon are assumed to be non-planning in the sense that they live myopically from current flow of income.

We will let gender index by $g \in G = \{F, M\}$ and let age denote by $a \in [17, \ldots, 101]$. The total number of adults of gender g of age a as of time t is denoted by $N_{a,t,g}$ where $N_{a,t}$ denotes the total number of individuals of age a as of time t. To denote the adult equivalent number of individuals in the household representing the generation having age a as of time t we use the symbol $N^E_{a,t}$.

The definition of household income and financial dispositions are completely analog to the specification in DREAM as it is documented in Pedersen et al. (1998). Households have incomes from labour market participation, transfers from the public, inheritance from parent households and from public and private pension arrangements. In addition the household sector are assigned lumpsum transfers from the government and the foreign sector. These lumpsum transfers are introduced for calibration purposes and ensure that the base year government budget and balance of payments can be reproduced by the model. The sum of these income types net of taxes and contributions to pension schemes is represented per adult and is denoted by $y_{a,t}$.

In addition to non interest incomes the household earn capital income from free savings placed in stocks and bonds. As previously explained the pension fund is assumed to take the role of the marginal investor and hence a suboptimal rule of fixed proportions of stocks and shares in the households financial portfolio is introduced. The financial wealth of the household is denoted by $a_{a,t}$ and the rate of return on financial wealth after capital income taxation is denoted by $\hat{r}_t$.

2.2.2 Preferences

Households will strive to maximize lifetime utility being represented by an intertemporal utility function valuing the intertemporal utility of a sequence of future instantaneous utility levels. The specification of the intertemporal considerations of the household is analog to that found in DREAM. However, the multiplicity of goods call for a disaggregated representation of the preferences for consumption goods.

Intertemporal utility

The intertemporal utility is given by the function U that discounts the future sequence of instantaneous utility levels given by the function Q which is presented shortly. The intertemporal utility of a household is given by

$$U_{a-1,t-1} \equiv \left[\sum_{i=a}^{77} \left(Q_{i,t-a+i} \right)^{\frac{S-1}{S}} \nu_{a-1,i} N^{E}_{i,t-a+i} \right]^{\frac{S}{S-1}} , \qquad (2.17)$$

where ν is a discounting factor and $S > 0$ denotes the intertemporal elasticity of substitution. Note that the instantaneous utility $Q_{77,t-a+77}$ enter the definition of the intertemporal utility function although this utility is obtained beyond the planning horizon. The inclusion of this utility is used in order to implement a joy of giving motive for leaving bequests. The utility level $Q_{77,t-a+77}$ thus represents the real value per adult equivalent of the bequests left for the descendant household. The weight associated with this utility element is denoted by ξ_{78} and enters the discounting factor ν, which is defined by

$$\nu_{a-1,i} \equiv \xi_i \left(\frac{1}{1+\theta}\right)^{i-a+1} , \quad \xi_i = \begin{cases} 1 & \text{for} \quad i = a, \ldots, 76 \\ \xi & \text{for} \quad i = 77 \end{cases} \tag{2.18}$$

A high value of ξ_{77} will increase the intertemporal valuation of the last period utility $Q_{77,t-a+77}$ and thus indicate a stronger preference for leaving bequests.

Instantaneous utility

As in DREAM we specify the instantaneous utility of households to be additively seperable in consumption and disutility of work. The instantaneous utility of a household representing the generation which is a years old as of time t is represented in adult equivalent terms and is given by

$$Q_{a,t} = C_{a,t} - Z_{a,t} \quad , \tag{2.19}$$

where $C_{a,t}$ denote the utility of consumption and $Z_{a,t}$ denote disutility of work endured by the working members of the household.

We let $\ell_{a,t,g}$ denote the supplied hours of labour per individual of gender g. This labour supply is determined under the assumption of worksharing meaning that the average individual of the household is partly unemployed. The time spent unemployed is given as the difference between the supplied hours of labour and the maximum number of hours an individual may work according to labour market agreements between employers and a monopolistic labour union. The maximum of hours are denoted by $\bar{\ell}_{a,t,g}$. The disutility of labour is now specified by

$$Z_{a,t} \equiv \begin{cases} \sum_{g \in G} R^{\ell}_{a,t,g} \frac{N_{a,t,g}}{N^E_{a,t}} \left(\frac{\gamma}{1+\gamma}\right) \bar{\gamma}_{a,t,g}^{-\frac{1}{\gamma}} \ell_{a,t,g}^{\frac{1+\gamma}{\gamma}} & \text{for} \quad a \in [17, \ldots, 76] \\ 0 & \text{for} \quad a \geq 77 \end{cases} \tag{2.20}$$

where $R^{\ell}_{a,t,g}$ denotes the labour market participation rate. Not all individuals in their working ages are actually participating in the labour market. The labour market participation rate reflects this and is constructed using registrer based labour market data (RAS). Please note that the definition of $Z_{a,t}$ does not per se exclude disutility of cohorts who are older than the retirement age of 65. However, the value of $R^{\ell}_{a,t,g}$ is effectively zero for such individuals. The weight parameter $\bar{\gamma}_{a,t,g}$ appearing in the definition of $Z_{a,t}$ is defined to ensure that the Harrod-neutral growth does not cause the impact on instantaneous utility from disutility of work to diminish as $C_{a,t}$ grow. Therefore, $\bar{\gamma}_{a,t,g}$ is defined by

$$\bar{\gamma}_{a,t,g} \equiv (1+n)^{-t\gamma}\,\bar{\gamma}_{a,t_0,g}. \tag{2.21}$$

Preferences for consumption goods

The disaggregation of production and the inherent increased number of industry specific products calls for an extended modeling of preferences for consumption. It is not obvious how consumption goods should be defined. Often consumption is represented by preferences for industry goods in applied general equilibrium models (see for instance Harrison et al. (1997) or Keuschnigg and Kohler (2000)). These goods are well defined in the representation of intraindustrial flows of goods but for consumption the industry supplying a good does not in itself bring much insight to the function of the good. Inspired by the concept of consumption goods used in the econometric model ADAM we will introduce preferences for 6 consumption goods listed in table 2.2. These consumption goods represent utility gained from consuming industry specific goods by Leontief composition. The introduction of consumption goods allow for the same multistage budgeting interpretation of the instantaneous utility function that apply to the production function. The specification of preferences for consumer goods is in essence introduced to obtain a more intuitive description of demand side effects to the composition of production.

Table 2.2: Consumption goods in the simulation model.

Label	Description	Share of total consumption
dw	Dwelling, maintenance and repairs etc.	19.66
ve	Vehicles and gas and oil for vehicles	9.51
en	Energy and electricity	6.03
fo	Food, beverages and tobacco	17.79
og	Other non durable goods	20.45
st	Services and transportation	26.57

The instantaneous utility of consumption $C_{a,t}$ is specified by nested CES composition of the consumption goods listed in table 2.2. At the top level we assume that the preferences for consumption amounts to CES combination of two subutility functions representing consumption of durable and non durable goods respectively. The utility of durables is comprised of consumption of vehicles and utility from the household residence. Although labelled 'durables' utility is gained from consuming flows of goods with the exception of the real estate entering the dwelling utility. Vehicles to most people are durable goods but the 5 year period length of the model imply that a car will almost deprecate fully within a single period. For this reason we opt for modelling the consumption of vehicles as a flow too. Figure 2.3 presents the nest structure of the preferences for consumption. The level of substitution at the depicted nests in the consumption utility function are presented in chapter 3.

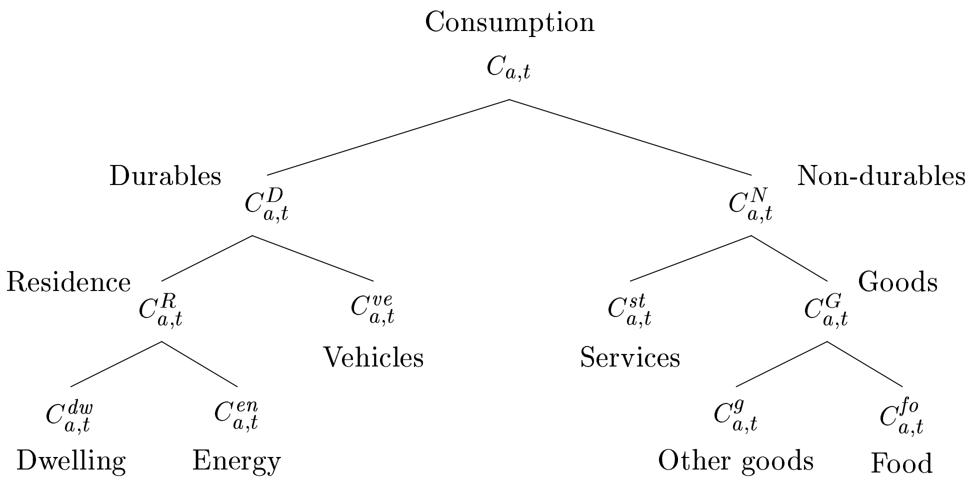

Figure 2.3: Preferences for consumption goods

The consumption goods of table 2.2 are as mentioned Leontief aggregates over compound industry specific goods. The industry specific composite goods have the same functional form as that introduced for the production technology and so they implement the Armington assumption on consumption preferences.

Dwelling consumption

In addition to industry specific composite goods the Leontief aggregate representing dwelling consumption includes the predetermined stock of real estate owned by the household. In the context of dwelling, industry specific composite goods represent consumption of goods used for maintenance and repairs. The utility of the stock of real estate owned by the household is denoted by $H^{E}_{a-1,t-1}$ and is represented by CES composition of residential land $H^{L}_{a-1,t-1}$ and buildings $H_{a-1,t-1}$. As is the case for land used in production and for agriculture, residential land is available in a fixed quantity and can not be used for other purposes than dwelling consumption. The Leontief composition of the stock of estate and industry specific composite goods consumed for maintenance and repairs imply complementarity among the goods. One could argue that better houses are not subject to the same maintenance needs and thus that a certain degree of substitutability should be specified. The structure of preferences for dwelling consumption is depicted in figure 2.4.

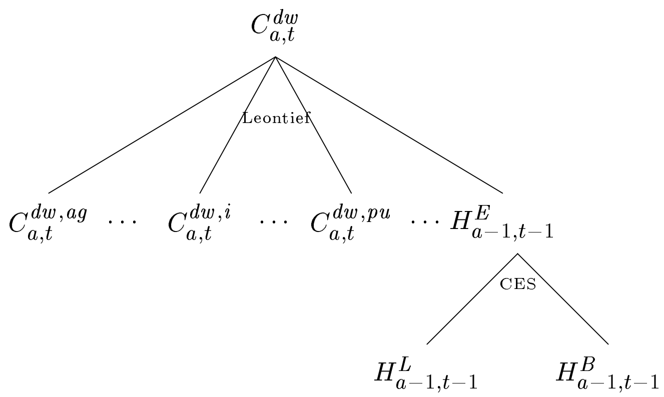

Figure 2.4: Preferences for dwelling consumption

2.2.3 Optimization

Households are assumed to hold rational expectations. Given the income after taxes, the price of consumption goods and preferences, households are assumed to maximize intertemporal utility by planning consumption over the remaining life cycle.

Savings identity

We will formulate the optimization problem faced by households under an intertemporal budget constraint. In the constraint the real value of the estate is considered an integral part of the households wealth since real estate may be considered a real asset. The household wealth including the value of the stock of real estate per adult equivalent is defined by

$$a_{a,t}^{H} \equiv a_{a,t} + P_t^{HE} H_{a,t}^{E}, \tag{2.22}$$

where P_t^{HE} is the CES price index corresponding to the stock of the composite real estate good.

By definition the consumer CES price index P_t^C includes usercosts of residential land and buildings, customs, excise taxation and the consumer good specific value added taxation

(VAT). The usercost expressions are derived and explained in section A.5 of the appendix. The usercosts include taxation of residential land and buildings in addition to a correction term introduced for calibration purposes. We follow DREAM by introducing possible unforseen capital gains on the existing stock of buildings in the event of shocks to the economy. In order to simplify the usercost expressions and hence the entire problem structure of households such capital gains appear directly in the savings identity that also include the calibration correction term. The savings identity may be expressed in adult equivalent terms by

$$a^H_{a,t} = (1+\hat{r}_t)\, a^H_{a-1,t-1}\frac{N^E_{a-1,t-1}}{N^E_{a,t}} + y_{a,t}\frac{N_{a,t}}{N^E_{a,t}} - P^C_t C_{a,t} + P^{AHB}_t I^{HB}_{a,t} + r^{NA}_t P^{HE}_t H^E_{a-1,t-1}\frac{N^E_{a,t}}{N^E_{a-1,t-1}}. \tag{2.23}$$

The savings identity 2.23 include terms capturing the change of the households adult equivalent size and excludes any representation of disutility of work taken into account by households as they plan consumption over the lifecycle. We would like to obtain a formulation taking these issues into account and therefore we define the interest rate of household wealth corrected for change to household size by

$$\tilde{r}_{a,t} \equiv (1+\hat{r}_t)\frac{N_{a-1,t-1}}{N^E_{a,t}} - 1. \tag{2.24}$$

To take into account the real value of the disutility of work define the real net household income per adult equivalent by

$$\tilde{y}_{a,t} \equiv y_{a,t}\frac{N_{a,t}}{N^E_{a,t}} - P^C_t Z_{a,t}. \tag{2.25}$$

Now using the definition of the instantaneous utility function 2.19 and equations 2.24 and 2.25 we may express the savings identity for the household which hold for the ages from 17 to 76 by

$$a^H_{a,t} = \left(1+\tilde{r}_{a,t}\right) a^H_{a-1,t-1} + \tilde{y}_{a,t} - P^C_t Q_{a,t} + P^{AHB}_t I^{HB}_{a,t} + r^{NA}_t P^{HE}_t H^E_{a-1,t-1}\frac{N^E_{a,t}}{N^E_{a-1,t-1}}. \tag{2.26}$$

This identity and two conditions for the initial and terminal level of wealth determines the intertemporal budget of the household. The initial condition is straigthforward since children by convention have no wealth of their own. The terminal condition is that all household wealth should be spent on consumption and bequests at the end of the planning horizon. In case wealth was positive the household could have realized a higher level of consumption and clearly this would not constitute optimal behaviour. In addition the household must be solvent due to the assumption of perfect markets for financial capital and perfect foresight.

Intertemporal optimization

Optimization of intertemporal utility is essentially a problem of optimal control. The control variables are the level of consumption and labour supply and the state variable is the total household wealth. The conditions governing the state variable are the savings identity 2.26 together with the initial and terminal conditions. Following the specification in DREAM we will assume however, that unforseen capital gains on houses are considered extern by the households and obtain a more simple dynamic problem structure. Also following DREAM we will assume that households do not take into account the intertemporal effects on incomes arising from participation in labour market pension and retirement schemes in the labour supply decision. All stock expressions entering the savings identity 2.26 are predetermined and under the assumption that the household ignores potential unforseen capital gains on houses when considering the usercosts of the dwelling the only control variables are indeed labour supply and consumption. Thus, by consolidation of the intertemporal budget constraint the intertemporal optimization problem may be represented in a more simple form.

In section A.6 of the appendix we derive the consolidated budget constraint. In order to arrive at this formulation we define a discounting factor representing the present value of future wealth by

$$\tilde{R}_{a,i} \equiv \begin{cases} \prod_{j=a+1}^{i} \frac{1}{1+\tilde{r}_{j,t-a+j-1}} & \text{for} \quad i > a \\ 1 & \text{for} \quad i = a \end{cases} \tag{2.27}$$

Note that the interest rate is that defined by equation 2.24, which takes changes to the adult equivalent size of the household into account.

By proper definition[4] of human capital and the present value of unforseen capital gains on houses and the technical calibration correction term, the intertemporal optimization problem of the household is equivalent to

$$\max_{\{Q_{i,t-a+i}\}_{i=a}^{77}} \left[\sum_{i=a}^{77} \left(Q_{i,t-a+i}\right)^{\frac{S-1}{S}} \nu_{a-1,i} N_{i,t-a+i}^{E} \right]^{\frac{S}{S-1}} \qquad s.t. \tag{2.28}$$

$$\sum_{i=a}^{77} \tilde{R}_{a-1,i} P_{t-a+i}^{C} Q_{i,t-a+i} = a_{a-1,t-1}^{H} + H_{a-1,t-1} + H_{a-1,t-1}^{NA} + H_{a-1,t-1}^{AHB}. \tag{2.29}$$

This maximization problem is a simple problem of optimization of a CES function under a convex and continuos constraint. To solve the problem let us start by noting that any

[4]See section A.6 of the appendix.

solution to the maximization problem must maximize the value of the human capital as well. This may be seen directly from the budget constraint and the fact that intertemporal utility is homogene with respect to instantaneous utility.

Optimal labour supply

Maximization of human capital amounts to maximization of the non interest income net of disutility of labour of the household. This subproblem of the optimization amounts to solving the following maximization problem for both genders in all future periods until the end of the planning horizon

$$\max_{\ell_{a,t,g}} y_{a,t} \frac{N_{a,t}}{N^E_{a,t}} - P^C_t Z_{a,t}. \tag{2.30}$$

Under the simplifying assumption that households ignore intertemporal effects on income from contributions to labour market pensions and early retirement schemes the solution to 2.30 may be represented by a wage curve which determines the optimal labour supply for an individual of gender g

$$\ell_{a,t,g} = \bar{\gamma}_{a,t,g} \left(\frac{(1-t^w_t)\left(1-t^\ell_t\right) w_{a,t,g} - \left(1-t^b_t\right) b_t}{P^C_t} \right)^{\gamma}. \tag{2.31}$$

Here, b_t denote unemployment benefits while t^w_t, t^ℓ_t and t^b_t denotes the average wage tax, labour market taxes and the average wage tax relevant to unemployment benefits. The wage curve express that labour supply is increasing in the real purchase power of wages. On the other hand labour supply will decline if the effective real rate of unemployment compensation increase. The simplicity of the derived wage curve is the result of the assumption of additive separability of consumption and disutility of work inherent in the specification of the instantaneous utility.

The assumption of the simplified perception of the intertemporal effects on non interest income from mandatory savings is introduced in order to maintain the simple structure of the intertemporal optimization problem. The simplification result in a slightly overstated labour supply compared to the one that would have prevailed otherwise. Only in the case of parity between the after tax yield in pension savings and the interest on free savings the simple wage curve derived above would prevail in a full specification. To see this consider the fact that contributions to pension arrangements increases the financial capacity of the household at the time of the receipts from these arrangements. We stipulate ignorance to this improvement of financial capacity and thus the household underestimate the future purchase power gained from increasing the labour supply in this respect.

2.2.4 Optimal consumption

Now that the optimal labour supply is derived we may return to the characterization of the optimal consumption plan. Given that the labour supply is chosen by the household such that the human capital stock is maximized, the intertemporal maximization problem collapses into a standard CES maximization problem.

The solution to the maximization problem stated by 2.28 and 2.29 is a sequence of utility levels $\{Q_{i,t-a+i}\}_{i=a}^{77}$. Since the problem is a standard CES problem, the solution is easily determined to amount to

$$Q_{i,t-a+i} = \frac{a^H_{a-1,t-1} + H_{a-1,t-1} + H^{NA}_{a-1,t-1} + H^{AHB}_{a-1,t-1}}{\eta_{a-1,t-1}} \left(\frac{\nu_{a-1,i} N^E_{i,t-a+i} \eta_{a-1,t-1}}{\tilde{R}_{a-1,i} P^C_{t-a+i}} \right)^S , \tag{2.32}$$

where the CES price index is defined by

$$\eta_{a-1,t-1} \equiv \left(\sum_{i=a}^{77} \left(\nu_{a-1,i} N^E_{i,t-a+i} \right)^S \left(P^C_{t-a+i} \tilde{R}_{a-1,i} \right)^{1-S} \right)^{\frac{1}{1-S}} . \tag{2.33}$$

The optimal level of consumption and thereby instantaneous utility depends on the real value of the household wealth as represented by the first fraction in expression 2.32. The household wealth including human capital is measured at the CES price index as defined by 2.33. A high level of this price index reflects high future consumer prices. The effects of a high CES price index on present consumption are twofold. First, a high level of the CES price index reduce the real value of wealth and human capital. On the other hand, high future consumer prices as represented by a high CES price level cheapens consumption today relatively. Which of the these effects are dominating depends on the intertemporal elasticity of substution S.

The Keynes-Ramsey rule of consumption smoothing

In order to establish a more transparent exposition of the intertemporal tradeoff we derive a condition similar to the Keynes-Ramsey rule of intertemporal consumption smoothing in section A.7 of the appendix. The Keynes-Ramsey rule is given as

$$\frac{Q_{i,t-a+i+1}}{Q_{i,t-a+i}} = \left(\xi_{i+1} \frac{1 + \hat{r}_{t-a+i+1}}{1+\theta} \frac{P^C_{t-a+i}}{P^C_{t-a+i+1}} \right)^S . \tag{2.34}$$

The interpretation of the Keynes-Ramsey rule is relatively straightforward. The growth rate of consumption net of disutility of work as represented by the instantaneous utility function is determined as a markup on the intertemporal price ratio to the elasticity of intertemporal substitution S. The markup is the interest rate, which represents the opportunity cost of consumption, corrected for the level of pure time preference. The intertemporal elasticity of substitution express the extent to which these considerations are actually in effect. A low level of intertemporal elasticity of substitution will tend to flatten the consumption path over the lifecycle.

Given the optimal intertemporal consumption plan the household faces the problem of composing consumption across consumption goods. This problem is atemporal in the sense that the optimal instantaneous utility for each period is achieved by minimizing the expenditure for a given level of instantaneous utility. Using standard expenditure minimization for a CES subutility function demand functions may be derived directly. We will not present the demand functions here but since stock expressions are entering dwelling consumption the optimal demand for dwelling is presented for completeness in section A.8 of the appendix.

2.2.5 Behaviour of elderly households

As it is the case in DREAM individuals may outlive the planning horizon of the representative households. Therefore we introduce the same concept of myopic behaviour for households representing elderly individiuals as that outlined in Pedersen et al. (1998). The special representation of the behaviour of elderly households is required in order to avoid that elderly households become very rich. Since surviving member of households are assumed to retain undivided possesion of the households stock of wealth, the fact that the number of surviving individuals decline at the end of the natural life of individuals would imply large fortunes of elderly households measured per adult equivalent.

The idea is that households are dissolved at the time it reaches the age of 77 at which time a bequest is left to the heirs of the household. The size of the bequest is determined by the joy of giving preference for leaving bequests and is thus determined by optimal intertemporal behaviour. The stock of wealth remaining at the end of the planning horizon hence exactly match the planned bequest to be left to the heirs. Once the bequest is left the elderly household is assumed to live myopically from current pension incomes.

The introduction of a non planning period in the life cycle of households serves as an ad hoc introduction of credit rationing of consumers. To see this consider the mandatory nature of labour market pension savings. Since part of the pension receipts occur after the end of the planning horizon, the households does not take these future receipts into account as they plan consumption over the lifecycle. This in turn imply that households are not able to perfectly offset the redistribution of wealth in time inherent in the labour market pension arrangements by lending against it. This amounts to credit rationing except of course that we are not implementing an actual rationing mechanism but rather an ad hoc specification of bounded rationality.

2.3 Trade and the European Union

Foreign countries are categorized in terms of three regions. These consist as already explained of the countries of the European union, the central and east European countries and the rest of the world. This section will present the incorporation of custom barriers and real costs of trade. Also the transfers related to the Danish membership of the EU and the models definition of the trade balance and the current account will be given.

2.3.1 Foreign regions and frictions of trade

Real costs of international trade are introduced as a depreciation of value of internationally traded goods and are meant to capture the real frictions related to customs handling, transportation costs and the costs of complying with product standards in the foreign market. The expansion of the European single market levitate frictions of trade between the EU members by means of common product standards and convergence of legislation regarding civil liability. Hence the real costs of trade provides an instrument through which the effects of goods market integration may be quantified.

Exports

We make use of an export specification by invocation of the Armington assumption that goods from different regions are considered imperfect substitutes. For each region $o \in \{EU, CEE, ROW\}$ such an export relation for the product of the goods produced by a non agriculture industry i may be specified by

$$X_{i,t}^{o} = \chi_{i,t}^{o} \left(\frac{P_{i,t}^{FM}}{P_{i,t}^{X,o}} \right)^{\sigma_i^{X,o}} \qquad \text{for} \quad i \in I \setminus \{ag\}. \tag{2.35}$$

Recall that the exports of agriculture is specified as to take into account the common agriculture policy of the EU. In equation 2.35 $\chi_{i,t}^{o}$ is a scale parameter and $\sigma_i^{X,o} > 1$ denote the elasticity of substitution. $P_{i,t}^{FM}$ denotes a price index representing the foreign markets alternatives to buying from the domestic country.

We will assume that a certain rate of inflation π_t is present in foreign markets such that

$$P_{i,t}^{FM} = (1+\pi_t)^t \, P_{i,t_0}^{FM} . \tag{2.36}$$

Note that the export specification is given for a small open ecomony and thus we may assume that the price index of the foreign market $P_{i,t}^{FM}$ remain unaffected by the price of exported good from domestic industries $P_{i,t}^{X,o}$. This price is given by

$$P_{i,t}^{X,o} = \left(1+\omega_{i,t}^{X,o}\right)\left(1+\omega_{i,t}^{MFM,o}\right)\frac{P_{i,t}^{Y}}{1-\delta_{i,t}^{TCX,o}}, \tag{2.37}$$

Where $\omega_{i,t}^{X,o}$ denotes the total export customs tariff (or subsidy) paid to (granted by) either EU or the domestic government whereas $\omega_{i,t}^{MFM,o}$ denotes the import customs tariff pertaining to the government of region o. Finally we have the real costs of trade associated with exports, which are denoted by $\delta_{i,t}^{TCX,o}$.

The total export costums tariff (subsidy) is given by

$$\omega_{i,t}^{X,o} = \omega_{i,t}^{X,G,o} + \omega_{i,t}^{X,EU,o}, \tag{2.38}$$

where $\omega_{i,t}^{X,G,o}$ and $\omega_{i,t}^{X,EU,o}$ denote the export custom tariffs (or subsidies) paid to (or granted by) the domestic government and EU respectively.

It will prove useful to redefine the Armington export demand function in terms of the domestic price $P_{i,t}^{Y}$. By use of equations 2.35 and 2.37 we arrive at

$$X_{i,t}^{o} = \chi_{i,t}^{o}\left(\frac{\left(1-\delta_{i,t}^{TCX,o}\right)P_{i,t}^{FM,o}}{\left(1+\omega_{i,t}^{X,o}\right)\left(1+\omega_{i,t}^{MFM,o}\right)P_{i,t}^{Y}}\right)^{\sigma_i^{X,o}} \tag{2.39}$$

We see that the exports of products from and industry is increasing in the price of the similar foreign good, decreasing in the domestic producers price, that real costs of trade reduce the export and naturally that custom tariffs does so as well.

Import price

The price of an imported good from an industry $m \in I$ have up until now been noted as to represent the domestic purchasers price excluding excise taxes. This price is denoted by $P_t^{o,m}$. However, imports are subject to customs and real costs of trade as well as is exports. Let $P_t^{F,o,m}$ denote the foreign producers price of the good from industry m in region o. Then the domestic purchasers price may be expressed as

$$P_t^{o,m} = \left(1 + \omega_{m,t}^{M,o}\right)\left(1 + \omega_{m,t}^{XFM,o}\right) \frac{P_t^{F,o,m}}{1 - \delta_{m,t}^{TCM,o}}. \tag{2.40}$$

Here $\omega_{m,t}^{M,o}$ denote the import customs tariff paid to the EU. The export customs tariff pertaining to the foreign government is denoted by $\omega_{m,t}^{XFM,o}$ while the real costs of trade of imported goods delivered by industry m from region o are denoted by $\delta_{m,t}^{TCM,o}$.

2.3.2 The trade balance

The value of the exports from domestic industries should be expressed by the unit price charged by exporters with addition of export tariffs (or subsidies). The real trade costs pertaining to exports are defrayed by the importing foreing region. The value of imports is given by foreign producers price with addition of the foreign regions export tariff (or subsidy) and depreciation of real costs of trade with the foreign region.

Imported goods are used for consumption, material use, energy inputs, machinery investments and public consumption. The superscript of the import elements represent foreign origin, the foreign industry producing the delivery and for consumption and machinery investments the type of final use, that the import is intended for.

Let TB_t denote the surplus on the trade balance and $m \in I$ the foreign industry delivering an import. We may then express the trade balance by the value of net exports

$$\begin{aligned} TB_t = & \sum_{i,o} \left(1 + \omega_{i,t}^{X,o}\right) P_{i,t}^{Y} X_{i,t}^{o} \\ & - \sum_{m \in I,o} \frac{\left(1 + \omega_{m,t}^{XFM,o}\right) P_t^{F,o,m}}{1 - \delta_{m,t}^{TCM,o}} \left[\sum_{a,k} N_{a,t}^{E} C_{a,t}^{o,k,m} + \sum_{i} \left(M_{i,t}^{o,m} + E_{i,t}^{o,m} + I_{i,t}^{o,M,m}\right) + G_t^{o,m} \right]. \end{aligned} \tag{2.41}$$

2.3.3 Net transfers from the European union

A number of transfers of income and wealth to and from abroad are present in the model. The majority of these transfers are bound in the Danish membership of EU. This subsection presents the transfers related to the membership of the European union.

Some of the transfers are designated directly to the household sector and the production sector while some is assumed mediated by the government. For instance we designate payments of customs directly to the involved agents, thereby shortcutting the fact that these transactions are in reality attended to by the government. Transfers representing member contributions or funds received as part of regional aid or similar EU programmes are however modelled as an integral part of the government budget.

Due to the number of different symbols required to specify the transfers to and from abroad, we opt for the convention of defining all crossborder transfers net from abroad.

Import custom revenues

Due to the membership of the European customs union, all customs are charged on behalf of EU. Member states are allowed to withheld a small fraction of customs revenues to cover administration costs but we will ignore this. Import customs fall on all purchases from outside the European common market. The transfer net from EU related to import custom revenues amount to

$$\Upsilon_t^{EU,M} = -\sum_{m \in I,o} \frac{\omega_{m,t}^{M,o}}{1+\omega_{m,t}^{M,o}} P_t^{o,m,Y} \left[\sum_{k,a} N_{a,t}^E C_{a,t}^{o,k,m} + G_t^{o,m} + \sum_i \left(M_{i,t}^{o,m} + E_{i,t}^{o,m} + I_{i,t}^{o,M,m} \right) \right]. \tag{2.42}$$

The convention of designating the customs transfer directly to the current account is defendable given the commitment of member states to pay all revenues directly to the EU.

Production and export subsidies

The EU grants subsidies to exports and a set of product specific subsidies as well. Both types of subsidies are by construction of the excise taxes present in our model already. However, the part of excise taxation that are present due to EU policy are reimbursed by a transfer from EU. For the sake of simplification we will assume that the transfer reimbursing subsidiation of products and exports may be represented by export subsidies only. The transfer net from EU related to export and product subsidiation is given by

$$\Upsilon_t^{EU,X} = \sum_{i,o} \omega_{i,t}^{X,EU,o} P_{i,t}^Y X_{i,t}^o, \tag{2.43}$$

where $\omega_{i,t}^{X,EU,o}$ denotes the net custom tariff applying to exports.

Subsidiation of factor use in agriculture

As an integral part of the common agriculture policy (CAP), the European union grants subsidies to land and materials used in agriculture. This role of these subsidies were presented in subsection 2.1.8. The total transfer from the European union for subsidiation of land and materials in agriculture as of time t is given by

$$\Upsilon_t^{EU,L} = \tau_t^L K_{ag,t-1}^L + t_{ag,t}^{M,EU} \sum_{j \in I} \left(P_{j,t}^Y M_{ag,t}^{D,j} + \sum_o P_{j,t}^{o,Y} M_{ag,t}^{o,j} \right), \tag{2.44}$$

where $t_{ag,t}^{M,EU}$ denotes the rate of subsidiation of materials defined as a net ad valorem tax rate.

Member contributions

The revenues from the customs union does not cover the budget of the European union which therefore also rely on contributions from the member states. The member contributions are based on the revenues of value added taxation (VAT) and on gross national income (GNI) and is assumed to lie with the government.

The VAT based constribution imply that a fraction τ_t^{VAT} of revenues from value added taxation in member countries must be paid to the EU. Value added taxation is modelled to lie on consumption and by construction includes other excise taxation than VAT. The transfer defined net from EU related to the VAT-based member contribution is denoted by $\Upsilon_t^{EU,VAT}$ amounts to

$$\Upsilon_t^{EU,VAT} = -\tau_t^{VAT} \sum_{k,a} t_t^{VAT,k} \left(\sum_i P_{i,t}^Y N_{a,t}^E C_{a,t}^{D,k,i} + \sum_{m \in I,o} P_t^{o,m} C_{a,t}^{o,k,m} \right). \tag{2.45}$$

The second type of member contribution is as mentioned based on gross national income and is denoted by $\Upsilon_t^{EU,GNI}$. The gross national income is defined by the gross national product plus interests from foreign asset holdings. In our notation the gross national income is given by

$$GNI_t = GDP_t + i_t A_{t-1}^F, \tag{2.46}$$

where the foreign assets A_{t-1}^F denote the value of domestic claims on foreign assets. Since we have assumed a single world market for bonds and the interest rate therefore is a world market interest rate, we need not qualify the region in which domestic claims exists.

The fraction of gross national income paid as contributions to the EU is denoted by τ_t^{GNI} while the transfer net from EU related to this constribution is denoted by $\Upsilon_t^{EU,GNI}$ and is given by

$$\Upsilon_t^{EU,GNI} = -\tau_t^{GNI} GNI_t. \tag{2.47}$$

The value of τ_t^{GNI} is calibrated to ensure compliance with the observed GNI based contribution of the base year.

Other net transfers from the European union

The transfers defined above represents the majority of the total net transfer from EU to Denmark. However, EU finance a number of other European activities as well. Such activities include programmes of regional development, educational and cultural programmes meant to strengthen international integration and funding of research and development. Transfers net from EU for such activities are designated to a residual transfer $\Upsilon_t^{EU,RES}$ which is assumed constant at the base year level. The residual transfer is allotted to the domestic government.

2.3.4 Other transfers from abroad

The assumption that only domestic citizens hold shares in the domestic corporate sector cause a residual part of the net transfers from abroad to remain unexplained even after specification of the transfers related to the Danish EU membership. We will designate these net transfers to the household sector in the following manner. Each period every adult citizen receive a net transfer from abroad. The transfer is denoted by τ_t^F and is defined such that the total value of such transfers remain constant at the base year level as observed in the national accounts. This convention may be stated as

$$\tau_t^F = \frac{\sum_a N_{a,t_0}}{\sum_a N_{a,t}} \tau_{t_0}^F, \tag{2.48}$$

where $\tau_{t_0}^F$ denotes the observed transfer per adult in the base year.

A similar residual transfer is defined for the domestic government to account for transfers that are not explicitly modelled or related to the membership of the European union. We define this transfer net from abroad and denote it by Υ_t^G.

2.3.5 The current account

Having presented all transfers of income an wealth crossing the border we are able to formulate the current account surplus of our model. Since we have defined all transfers net from abroad the current account surplus amounts to

$$\begin{aligned} CA_t = & TB_t + \sum_a N_{a,t}\tau_t^F + \Upsilon_t^{EU,M} + \Upsilon_t^{EU,X} + \Upsilon_t^{EU,L} \\ & + \Upsilon_t^G + \Upsilon_t^{EU,VAT} + \Upsilon_t^{EU,GNI} + \Upsilon_t^{EU,RES} + i_t A_{t-1}^F. \end{aligned} \tag{2.49}$$

Given the definition of the surplus of the current account we may proceed by defining the accumulation identity for foreign asset holdings. This identity is

$$A_t^F = A_{t-1}^F + CA_t. \tag{2.50}$$

The accumulation identity does not enter the model in the form given here. Rather we rely on an equilibrium condition for financial assets.

2.4 The government sector and fiscal policy

The government sector attends to welfare by means of income compensation and delivery of public consumption. In order to finance these activities and for purposes of affecting behaviour, the government collect taxes. This section will present the role of the government by presenting tax revenues, expenditures and mechanisms of indexation of expenditures. Please recall that we distinguish between the government sector and the industry which delivers public services. Though this public producer is considered part of the government sector, it is in the model considered an entity from which the government sector purchases goods used for public consumption.

2.4.1 The government budget

Public consumption may be divided into two categories based on whether consumption is a collective public good or an individual public good. Individual public goods are public goods that may be designated to individual users. Such public goods include nurseries, kindergardens, education, health care etc. Collective public goods include for example law-enforcement, defence and infrastructure. We will let G_t denote the total public consumption, whereas individual public consumption is denoted G_t^I. Collective public consumption will be denoted by G_t^C. The total public consumption is represented by a Leontief aggregate over deliveries from the industries in I all these deliveries being defined by CES composite goods over origin as previously introduced explained.

Government policy of public consumption

We will assume that the government let public consumption G_t grow at par with the real gross domestic product deflated by the government CES price index P_t^G. Moreover, total individual public consumption will follow the demographic development such that the growth corrected individual public consumption per head remain at the base year level.

Income transfers granted by the government are indexed to the real wage by a simplified implementation of the indexing rule actually followed in Denmark[5]. In the following income compensating benefits including public pay-as-you-go pensions will be denoted by the symbol $B_{a,t}^q$, where $q \in Q$ indicates the type of compensation an individiual may qualify for. The rate of a given age-gender group in the population that qualify for a type of compensation is denoted by $R_{a,t,g}^q$. The benefits present in the model are the same as those found in DREAM.

Tax revenues

The tax base include labour income, corporate turnover, capital income and excise taxation. We will present the total tax revenue in terms of the type of agent paying the tax. The activities of households, corporations (or firms) and pension funds are subject to taxation and these types of agents share the burden of excise taxation. We will briefly mention the sources of tax revenues here.

Households pay taxes based on labour income, unemployment benefits, pension incomes, taxed transfers, income compensating benefits, public pensions, value of their estate, dividend incomes and finally capital gains. In addition to these income sources own-contributions to early retirement arrangements and the mandatory labour market pension arrangements (ATP) are treated as taxes for the sake of simplicity. We will denote the aggregate revenues from taxation of household activities (excluding excise taxation) by T_t^H.

Corporate taxation amounts to taxes based on the turnover of firms net of depreciation allowances. In addition to corporate taxation, revenues are gained from the employers labour market tax and from taxation of land used for agriculture net of the subsidies. The aggregate revenue from taxation of the corporate sector is denoted by T_t^C.

Most activities in the economy are subject to an extent of excise taxation. Excise taxation include value-added taxation and customs tariffs. We distinguish between excise taxes

[5] This indexation policy is known as 'satsreguleringen'.

and tariffs such that an excise tax rate is defined for every type of good and tariffs are defined for each type of imported good. The aggregate revenue from excise taxation is denoted by T_t^E.

The final source of tax revenues is taxation of the pension fund. The revenue from taxation of the pension fund stems from taxation of interest and dividend income and capital gain taxation. The aggregate revenue from taxation of the pension fund is denoted T_t^Z.

The aggregate revenue of the government from taxation T_t may now be stated as

$$T_t = T_t^H + T_t^C + T_t^E + T_t^Z. \tag{2.51}$$

Now that we have properly introduced the expenditures and revenues of the activities of the government sector we are just about ready to formulate the budget balance identity.

The operation of the public service industry is not neutral to the government budget. For calibration purposes we are inclined to post an imputed capital gain and a correction term P^{YC} that ensures compliance with the gross operating surplus in the base year as defined by the national accounts. These two corrections are posted directly in the budget balance. Also appearing directly in the government budget balance are the expenditures for investments in the public service sector which are financed by the government.

Let A_t^G denote the asset holdings of the government, which for the Danish government are currently negative. Letting GB_t denote the surplus on the government budget as of time t, we may now state the government budget balance identity by

$$\begin{aligned} GB_t = {} & T_t + \Upsilon_t^G + \Upsilon_t^{EU,VAT} + \Upsilon_t^{EU,GNI} + \Upsilon_t^{EU,RES} + i_t A_{t-1}^G \\ & + \sum_{s \in \{B,M\}} P_{pu,t}^{I,s} \delta_{pu,t}^s K_{pu,t-1}^s + P^{YC} - P_t^G G_t - \sum_s P_{pu,t}^{I,s} I_{pu,t}^s \\ & - \sum_{a,g} N_{a,t,g} \left(TRT_{a,t,g} + TR_{a,t,g} \right) - \sum_{a,g} R_{a,t,g}^{\ell} N_{a,t,g} \left(b_t - k_t^u \kappa_t^{ATP\ell} \right) \left(\bar{\ell}_{a,t,g} - \ell_{a,t,g} \right) \\ & - \sum_{a,g,q \in Q} \left(R_{a,t,g}^q N_{a,t,g} B_{a,t,g}^q \right) - \sum_{a,g} N_{a,t,g}^{Z,A} \left(Z_{a,t}^{ATP\ell} + Z_{a,t}^{ATPw} + Z_{a,t}^{CS} + Z_{a,t}^{LD} \right) - \tau_t \sum_{a,g} N_{a,t,g} \end{aligned} \tag{2.52}$$

The last two lines in the government budget represent expenditures for taxed and non taxed transfers, unemployment benefits, income compensations, public pensions that require qualification and finally lumpsum transfers.

Given this definition of the surplus on the government budget we may state the accumulation identity for the asset holdings of the government sector by

$$A_t^G = A_{t-1}^G + GB_t. \tag{2.53}$$

2.4.2 The intertemporal government budget constraint

The government sector is subject to an intertemporal budget constraint requiring that the current value of future expenditures plus the initial debt does not to exceed the current value of future tax revenues. If this was the case, the government sector would be unable to fulfill its obligations to its creditors implying that rational agents in the financial markets would consider the bonds issued by the government worthless. To ensure that this situation will not arise we impose a condition often referred to as a No-Ponzi-game (NPG) condition.

The No-Ponzi-game condition

The NPG condition states that the current value of future tax revenues must at least cover the current value of planned future expenditures and the initial debt. The planned future expenditures include government consumption, investments, income transfers net from the government as defined by legislation plus any planned expenditures that may not yet by implemented in legal acts. We will denote the planned future expenditures excluding interest payments on debts of the government by $\bar{G}_t$ in order to distinguish them from the public consumption introduced above. The future revenues of taxation and transfers net to the government are denoted by $\bar{T}_t$.

The NPG condition applying to the government may be stated by

$$\sum_{s=t+1}^{\infty} \frac{\bar{T}_s}{\prod_{v=t+1}^{s}(1+i_v)} \geq \sum_{s=t+1}^{\infty} \frac{\bar{G}_s}{\prod_{v=t+1}^{s}(1+i_v)} + B_t^G. \tag{2.54}$$

The debt denoted by B_t^G represent the total registrered government debt at the time of planning while the nominal interest rate of the debt is denoted by i_t.

The policy reaction function

In order to ensure compliance with the NPG condition we are inclined to introduce a specification of the policy that the government follows in order to stay solvent. Technically the policy is specified by means of a policy reaction function, which endogenously determines one or more parameters representing policies of expenditures and financing. Given the fact that we have specified as many policy parameters as is the case, a large number of possible specifications of a policy reaction function are available. In this study we will focus on policies of financing taking the planned expenditures as given exogenously. This means that the actual policy reaction function will amount to a specification of a financing rule.

Choosing which financing rule to implement is an integral part of the specification of the counterfactual scenario. Thus the actual specification of the financing rule will depend on the effects that are subject to analysis.

2.5 Measuring welfare implications

To measure the welfare implications of enlargement we will use the notion of equivalent variation. The equivalent variation to a household of an experiment is defined as the compensation that would allow the household to achieve the same level of intertemporal utility in the reference scenario as in the counterfactual scenario under evalutaion. The compensation is determined given the price levels and tax rates of the reference scenario.

Due to the distinction between planning and non-planning households two expressions for the equivalent variation must be derived. Let $U^0_{a-1,t-1}$ and $U^1_{a-1,t-1}$ denote the intertemporal utility levels achieved in the reference scenario and counterfactual scenario. In appendix A.9 the equivalent variation of a planning household is derived to read

$$ev_{a-1,t-1} = \frac{U^1_{a-1,t-1} - U^0_{a-1,t-1}}{U^0_{a-1,t-1}} \left[a^H_{a-1,t-1} + H_{a-1,t-1} + H^{NA}_{a-1,t-1} + H^{AHB}_{a-1,t-1} \right] N^E_{a-1,t-1}. \quad (2.55)$$

Similarly, let the intertemporal utility of a non-planning household denote by $U^{NP,0}_{a-1,t-1}$ and $U^{NP,1}_{a-1,t-1}$. The equivalent variation for a non-planning household is also derived in appendix A.9 and amounts to

$$ev^{NP}_{a-1,t-1} = \frac{U^{NP,1}_{a-1,t-1} - U^{NP,0}_{a-1,t-1}}{U^{NP,0}_{a-1,t-1}} y_{a,t} N^E_{a-1,t-1}. \quad (2.56)$$

The equivalent variation is positive if the counterfactual scenario imply welfare improvements to the household. As noted the compensation is determined under the ceteris paribus assumption that prices remain at the levels of the reference scenario and this will in general not be the case. However, maintaining this assumption allow for comparison of several policy experiments using a common reference scenario. By considering the equivalent variation per adult equivalent, that is by exclusion of the population term in expressions 2.55 and 2.56, we are able to determine which households stand to benefit and which stand to loose from a given policy. Since a households wealth change over the life cycle intergenerational differences of the equivalent variation per adult equivalent may be considered a measure of the distributional effects of a policy.

2.5.1 Social welfare evaluation

It is not entirely obvious how to rank various policy experiments using the equivalent variation of individual households. If a Pareto criteria is used, an counterfactual scenario will fail to be considered a Pareto improvement if just a single household stands to loose from its realization. We may however relax the Pareto criteria and instead complete the ranking of scenarios by condsidering the total welfare impact by means of an aggregate measure of equivalent variation. The fundamental idea is to introduce a social welfare criteria according to which equivalent variations are aggregated in a manner representing a potential welfare gain if the aggregate is positive. For currently living households a scenario is considered to constitute a potential Pareto improvement if the sum of equivalent variations per household is greater than zero. For future households, the sum of equivalent variations must be discounted for this criterion to make sense. The reason for the need to discount the equivalent variations is that wealth cannot be transferred through time without costs. Which rate of discounting to apply is however not clear. We will use a rate of discounting based on the interest rate, but this choice is essentially just one of many.

Assuming that the economy reaches steady state in period $t+T$ and letting $D_{t,t+i}$ denote the rate of discounting for i periods aggregate equivalent variation may be defined by

$$\begin{aligned} EV_t = & \sum_{i=16}^{75} ev_{i,t} + \sum_{j=76}^{100} ev_{j,t}^{NP} + \sum_{k=1}^{T-1} D_{t,t+k} \left(ev_{16,t+k} + \sum_{m=76}^{100} ev_{m,t+k}^{NP} \right) \\ & + D_{t,t+T} \left(1 - \frac{(1+n)(1+\pi)}{1+r_{t+T}} \right)^{-1} \left(ev_{16,t+T} + \sum_{m=76}^{100} ev_{m,t+T}^{NP} \right). \end{aligned} \tag{2.57}$$

Here n is again the rate of Harrod-neutral technological progress while π denotes the rate of (imported) inflation.

2.5.2 Welfare implications of immigration experiments

The equivalent variation expressions are derived from the intertemporal utility function as described in appendix A.9. This means, given our formulation of intertemporal utility, that the equivalent variation measure of welfare is only well defined for constant numbers of adult equivalents in the representative households. Consequently, experiments affecting the composition of the population cannot be evaluated with respect to welfare implications by use of the introduced measures of equivalent variation.

3 Data, calibration and model setup

This chapter presents the empiric foundation of our model. In section 3.1 we discuss the construction of a model consistent io table. Section 3.3 presents the data foundation for the description and conditions of international trade. Finally, sections 3.4 discuss the calibration method.

3.1 Input-output data

The basis for calibration of the demand and production systems of the model are base year observations of flows of goods and capital in the economy. For a model of our kind an input-output (io) table in current prices is the only reasonable representation to use when assigning values to flow variables. Due to the OLG structure a social accounting matrix[1] would be prohibitively large.

The io system of our model may be represented by a 24×39 io table. The rows of an io table represents deliveries of goods, excise taxation and compensation of primary factors. Columns on the other hand represent the economic activities in which the delivered flows of goods are used. The io table highlights domestic flows of goods and we not specify the origin of imports nor destination of exports in the table. In appendix B the details of the layout of our io table are presented.

3.1.1 The io data sources

The primary datasource for the io table is the 1998 io table used by ADAM. This table unfortunenately have a sligthly incompatible layout and important figures are missing in the context of our model. Therefore we are inclined to impute a few subsystems in our io system using of additional data sources. For imputation of imports and investments we use coefficients from 1996 national accounting io tables and investment matrices and

[1]A social accounting matrix (SAM) is often used in CGE studies. Essentially a SAM is an io table augmented with additional cells describing micro level budget constraints. See Shoven and Whalley (1992)

rely on the databank for the econometric model ADAM for resolution issues of convention inconsistencies.

ADAM represent international trade of goods in terms of SITC chapters rather than by composite goods comparable to the goods produced by domestic industries. Also the ADAM io table lacks a specification of investments by investing industries. Finally a few conceptual differences exists and a few rows of the source tables need to be disaggregated in order to obtain the information required for the construction of our table.

3.2 Construction of the io table

The construction of an io table that complies with the conventions used in the model is completed in the following 3 steps:

1. **Compilation** Data for the io table is compiled using the ADAM 1998 io table as the primary data source. This step also involves imputation of missing submatrices and enforcement of model conventions.

2. **Aggregation** Once a consistent io table is obtained it is aggregated to the dimension required for the model. Some modifications enforcing model conventions are applied after the aggregation.

3. **Resolution of numerical issues** Due to the floating point precision of the computer software a few minor numeric inaccuracies are present in the io table. These are removed by a few simplifications and by application of a RAS procedure.

In the following we will explain the actions taken in general terms. For a more detailed presentation of the required operations on primary data please refer to appendix B.

3.2.1 Enforcement of model conventions

Once the missing submatrices are imputed, quite a few issues of differences of conventions needs to be addressed by operations on the compiled io table. This need for operations on input data arise from conceptual differences in national accounting notions of economic terms and the notions of the same terms in a macroeconomic model. The bookkeeping practices of national accounting systems does not always lead to economically interpretable entities. For instance it is hard to justify the concept of a negative import (as opposed to an export) as being anything but the result of a book-keeping practice. Likewise, the rationale for imputation and residual definition of national accounting entities need not make economic sense but often merely reflects the fact that these entities are hard to measure in practice. When modelling an economy in a general equilibrium framework, the luxury of leaving essentially endogenous economic entities unexplained is not an option. The required operations bound in these considerations and not in enforcement of any counterfactual assumptions of steady state as it is often the case in CGE modelling[2].

The following issues require operations on the io table in order to enforce consistency:

Imputed financial services In our model imputed financial services are consolidated with the private non financial production sector. This operation causes the models notion of gross domestic product to be defined net of imputed financial services.

Self emploment All working individuals in the model are employed and hence not self employed in liberal occupations. Therefore we must reassign a corresponding value from the row for gross operating surplus to the row for compensation of employees.

All imports are specified Unspecified imports of intermediate goods must be designated to industries. The model specifies all international trade by industry specific goods and therefore we must distribute unspecified imports at industries in a sensible manner.

Turism We do not model turism and consequently the expenditures of domestic citizens during turist travels are considered imports to consumption while consumption by visiting tourists are considered an export.

Dwelling Dwelling does in the model constitute an institutional rather than an actual production entitity. In the model no material inputs are defined for dwelling. We must therefore move flows from the columns for dwelling to columns representing material inputs to industries delivering to the dwelling consumption category.

Non traded goods In the model the public service good is not imported while the dwelling good and the output of construction industry are not traded internationally.

[2]For a discussion of the problems of the benchmark dataset approach to CGE data foundation see section 3.4 at page 71 ff.

The majority of the operations enforcing model consistency and logic on the io table is carried out at the disaggregated level, i.e. prior to the aggregation to the relevant set of industries and consumption categories. This reflects two considerations. First, if operations are tested to be carried out correctly at the disaggregated level, we can be confident that they are correct at the aggregated level. Secondly, in the event that sectors need to be redefined in future applications it is just about sufficient to change the aggregation key.

3.2.2 Dealing with numerical issues

Once the operations described are invoked and aggregation is completed we end up with a table that holds a few relatively small entries. Such small entries in the io system tend to reduce the efficiency of the simulation software considerably. First of all small numbers constitute potential problems in terms of large relative numerical inaccuracies due to the fact that calculations on computers are carried out using floating point precision. Secondly, all non zero entries in the io table are described by a relatively large set of equations, all of which must be evaluated by the software during simulation of the model. For these reasons it is for practical purposes appropriate to zero out such small cells. We zero out all positive values smaller than 1 million dkkr. Finally, it is crucial that the national accounting identity stating that inputs to domestic production exactly equals the total use of domestic deliveries, even to the slightest rounding. We ensure this by use of a RAS[3] procedure.

3.2.3 Capital stocks

The determination of the base year capital stock levels is based on the level of fixed investments as present in the io table and on additional data reported by ADAMs databank. Due to the 5 year length of periods in our model we need to establish the value of capital stocks primo and ultimo the base year. The ultimo stocks of machinery and buildings are reported directly in ADAMs databank along with data for the value of real depreciation. Using the ultimo stock, the reported value of depreciation and the fixed investments of the io table we may determine the primo stocks residually.

Let fKN^{s}_{i,t_0} denote the value ultimo the base year of the capital stock of type $s \in \{B, M\}$ in fixed prices as it is reported for industry i by ADAMs databank. Further let PI^{s}_{i,t_0} denote

[3]Row-And-column-Sum

the relevant price indices of capital goods and let $fINV^s_{i,t_0}$ be the value of real depreciation of capital in the base year. The current value of the ultimo stock of capital of type s in the base year is determined by

$$K^s_{i,t_0} = PI^s_{i,t_0} fINV^s_{i,t_0}. \tag{3.1}$$

The current value of the primo stock of capital of type s in the base year is now determined residually as

$$\bar{K}^s_{i,t_0} = K^s_{i,t_0} - I^s_{i,t_0} + PI^s_{i,t_0} fINV^s_{i,t_0}, \tag{3.2}$$

where I^s_{i,t_0} is the level of fixed investments in the io table.

With respect to stocks of land usable data sources are somewhat scarce. However we have estimates based on data from Danish tax authorities for the value of land owned by households, the government and the prodcution sector respectively. Households account for bill. dk. kr. 245, the government for bill. dk. kr. 48.6 and the production sector for bill. dk. kr. 174.6. The value of arable land, that is the land owned by farmers and fruit plantations amount to bill. dk. kr. 51.002. The residual value of land in the production sector to be distributed among non agricultural industries hence amounts to bill. dk. kr. 123.598. This amount of land is designated to industries using the level of building capital stock as the distribution key.

3.3 International relations

Data relating to international relations are collected from trade statistics and surveys of existing litterature on integration of enlargement of the European union.

3.3.1 Imports and exports

Naturally it is imperative that we obtain realistic specifications of the origin of imports and destination for exports. Our io table provides the total import by delivering industry (comparable to domestic industries) and the use of the product. The export total by an industry is not specified at destinations either. Therefore we must somehow introduce data specifying the origin and destination of international trade from other sources.

From Statistics Denmark we obtain trade data specifying the Danish cross border trade in 1998 by geographic regions. Unfortunately these data are specified at the SITC product specification and not by the industries engaging in the transactions. Moreover, the SITC specification is defined for commodities only, and consequently the international trade of services is not available in a region specification. The first problem is dealt with by construction of a mapping from SITC chapters to the 19 industries used in the national account specification. The mapping is constructed such that SITC chapters are designated to reasonable industries considered to produce comparable commodities. SITC chapters seeming ambigous according to this criterion are designated to industries such that the resulting distribution of the total import and export across industries approximately coincides with the observed distribution in the io table of 1996. The constructed mapping is used for aggregation of the import and export data to the set of industries producing commodities in the model. Hence we obtain the share of the industry specified import and export of commodities by regions.

With respect to services no data is currently available in a usable form. In lack of better alternatives we assume imports and exports of internationally traded services are distributed across origin and destination as is the total of imports and exports of commodities.

3.3.2 Tariffs and real trade costs

The quantification of the level of mutual protection through customs, border controls, technical barriers or other nontariff barriers poses a central problem in any study of the effects of integration. In our model we impose real costs of trade and apply ad valorem custom tariffs on internationally traded commodities.

The ad valorem custom tariffs are defined to represent the levitation of customs duties and quantity restrictions in a single tariff equivalent measure of the rate of protection. Conceptually, the level of import tariffs, and export and product subsidies are all well defined and may be quantified by studies of national legislation and statistics of trade. The inclusion of quantity restrictions in an ad valorem tariff equivalent measure is however more subtle. The wedges in trade from quotas generate quota rents understood as the difference between a theoretical equilibrium price in deregulated markets and the price actually observed.

Any sensible measure should reflect the extent to which customs duties and quantity restrictions are differentiated across trading partners. Trade and the extent of protection is differentiated by the formation of custom unions, bi- or multilateral free-trade agreements. For a discussion of appropriate definition of tariff equivalent measures of customs duties and quantity restrictions taking into account the direction of trade see Finger et al. (1996).

Table 3.1 present the levels of custom tariff equivalents and export subsidies (defined as ad valorem export tariff equivalents) in the base year. Not all goods are traded internationally and for services we assume complete absence of customs duties and quantity restrictions.

Table 3.1: Tariff equivalent rates levied (or granted) by the EU and CEE on international trade in the base year

	Danish import tariff		Danish export tariff		CEE tariff vs. EU	
	CEE	ROW	CEE	ROW	Import	Export
Agriculture	4.28	4.28	-6.00	-6.00	5.00	-3.00
Energy provision	0.00	0.40	0.00	0.00	1.80	0.00
Food	10.95	10.95	-10.00	-10.00	20.00	-3.00
Metals and chemicals	0.00	2.59	0.00	-3.80	6.36	0.00
Other manufacturing	0.00	4.36	0.00	-3.80	6.71	0.00

It has proven difficult to obtain good estimates of tariff equivalents for import customs and export subsidiation that are directly applicable in our setting. First and foremost sector specifications are not uniform but also the year of observation and the composition of international trade for Denmark and the CEE countries are problematic in this respect.

For tariff equivalents on imports of agriculture and foods to Denmark from CEE countries and rest of world we rely on tariffs for the product groups basic agriculture and food products reported in Boeri and Brücker (2000). Since the Europe agreements does not govern agriculture and foods we assume that similar customs duties and quantity restrictions are enforced towards CEE countries and the rest of the world for agriculture and foods. The tariffs on agriculture and foods are average tariff equivalents applied by the EU on imports from the CEEC-10 group and are based on Eurostat figures from 1996. For manufactures (metals and chemcials and other manufacturing) import customs and quantity restrictions directed at imports from CEE countries the Europe agreements imply complete abolition as of January 1st 1997. The remaining import tariff equivalents applied to imports from the rest of the world of energy, metals and chemicals and other manufacturing are EU average applied MFN tariffs obtained from Finger et al. (1996). These tariffs are based on trade statistics for the European union with countries not favored by free trade agreements and post Uruguay round tariff concessions. Due to differences of product specification we aggregate the statistics reported in Finger et al. (1996). Note that all tariff equivalents applied on imports are actually based on trade statistics for the European union seen as single market. Differences in the composition of Danish imports to the EU average may therefore constitute a probable source of bias to the listed import tariffs.

The tariff equivalents applied to imports by the CEE countries are for manufactures also based on applied post Uruguay round MFN tariffs reported in Finger et al. (1996). The tariff equivalents are based on statistics for only 4 Eastern European coutries, namely Czech and Slovak CU, Hungary, Poland and Romania. We assume that the composition of trade and the extent of protection via customs duties in the remaining CEE countries are similar to this group of countries. With respect to import tariff equivalents levied by CEE countries on agriculture and foods we rely on tariffs reported in Keuschnigg and Kohler (1999). These tariffs are based on Worldbank MFN rates and OECD statistics for Austrian trade in 1998. Again we need to assume that the composition of Austrian trade of agriculture and foods is not too different from Danish trade with the CEE countries.

All export subsidies are adapted from Frandsen and Jensen (2000) who rely on the GTAP database. The industry specification takes focus on agriculture products and is far from similar to the one used in our setting. For agriculture and foods the subsidies listed amounts to educated guesses. Export subsidies granted for exports of metals and chemicals and other manufacturing to the rest of the world is the one reported for maufactures. Again the underlying statistics used in the calculation of the level of export subsidiation concern the EU rather than Denmark specifically.

The listed levels of import and export tariff equivalents are very likely not correct for Danish trade patterns. However, the level of actually applied rates are adjusted in the calibration to ensure that customs revenues and expenditures for subsidation are determined correctly in the model. Danish import tariffs are adjusted by the same rate to match the total revenues. The so-defined scale factor is then applied to the import tariffs levied by the CEE such that the relative extent of import custom barriers is maintained. A similar procedure is applied to export subsidiation rates.

With respect to barriers to trade that does not take the form of customs duties and quantity restrictions we impose real costs of trade. We will asume that the EU impose regulations and practices resulting in more frictions to trade than the CEE countries do. In the base year we impose real costs of trade by 15 percent on goods imported from CEE countries while exports towards the CEE countries are assumed to carry a 10 percent ad valorem rate of real costs. These figures are on the high side of those applied by Baldwin et al. (1997) and especially Keuschnigg and Kohler (2000) in their assessment of the effects of enlargement. However we will apply the baseline assumption that gradual compliance to the acquis communitaire outlined in the Europe agreements will do away with 5 points of the real costs and thereby reach levels comparable to those applied in Baldwin et al.

(1997) for EU imports and in Keuschnigg and Kohler (2000) for EU exports towards CEE countries. In both papers the trade costs relate to the situation prior to enlargement and consequently includes reductions of real frictions due to the initiatives of the Europe agreements.

3.3.3 Data for transfers to and from the EU

The values of the transfers of wealth to and from the European union must be determined. For these figures we will also rely on data reported from ADAMs data bank, though not all the required values are reported directly in this source. According to ADAMs data bank all transfers of wealth to the EU in the base year may be summarized by the 5 elements listed in table 3.2.

Table 3.2: Transfers to the EU 1998

		Bill. DKK.
1	Customs revenue (charged on behalf of the customs union)	2220
2	Excise taxes paid by private sector	311
3	VAT based member contributions	4896
4	GNI based member contributions	5609
5	Other transfers to the EU	399

These transfers to the EU are represented in the model by customs (1), VAT contributions (2+3) and GNI contributions (4). Customs are paid directly to the EU while the VAT and GNI based contribution as previously explained are paid by the domestic government. The VAT contribution is calibrated to a fraction of total VAT revenues while the GNI contribution is determined as a share of gross national income.

Data sources for quantification of the various transfers from the EU are somewhat more scarce. According to ADAMs data bank the total value of transfers from the EU amounted to bill. dk. kr. 10053. Only the total value of transfers, FEOGA export subsidies (1), CAP subsidies for land and set-aside schemes (2) and other transfers from EU (4) are available in ADAMs data bank. Therefore we assume that the residual transfer mostly covers other production subsidies of the common agriculture policy, which in the model is represented as subsidiation of materials used in agriculture. The specification available in ADAMs data bank regarding transfers from EU are reported in table 3.3.

The total of transfers related to FEOGA and CAP (2+3) seems reasonable close to the total level of transfers related to agriculture as this is reported by Statistics Denmark.

Table 3.3: Transfers from the EU 1998

		Bill. DKK.
	Total	10053
1	FEOGA export subsidies	2495
2	CAP subsidies of land and set-aside scheme	4690
3	CAP production subsidies (residually defined)	1605
4	Other transfers from EU	1263

The residual transfers net from EU implemented in the model are given by (4) in table 3.3 minus (5) in table 3.2.

3.4 Calibration

Calibration is the process of assignment of numerical values to model parameters. The calibration procedure for historical reasons constitute a controversial issue. Some of the debate seem rooted in the opinion that the calibration procedure is inherently biased and hence that applied general equilibrium models does not incorporate empiric foundation in a satisfactory manner. However much of this critique of widely applied calibration methods have been addressed in the *dynamic calibration* procedure used by DREAM.

When calibrating dynamic CGE models it is common practice to construct a benchmark dataset expressing the base year as if it was a steady or stationary state. The construction of the benchmark dataset hence enforce steady state conditions on base year data. The calibrated model is now considered valid to the extent that the base year benchmark dataset is a reasonable representation of the observations of endogenous variables that would have prevailed had the base year been a steady state. The problem with the application of this traditional calibration method to dynamic models is that the base year is highly unlikely to constitute a state of affairs that may reasonably be considered as a steady state.

Alternatively the calibration may be performed using a method referred to as *qualitative calibration*, see Auerbach and Kotlikoff (1987). This approach restricts the calibration by the additional requirement that the model should possess marginal properties accepted as stylized facts of the impact of economic policy. In models incorporating forward expectations both the traditional and the qualitative method involves a methodological inconsistency: Great care is taken to ensure that intertemporal constraints are correctly implemented in the model but the alledged perfect foresight of agents with respect to effects of announced policy is absent in the constraints used for the calibration. It seem unnatural to model the transition dynamics of the economy only to ignore them during quantification of model parameters.

On a side note the use of a benchmark dataset constructed under counterfactual steady state assumptions imply that the model can not be expected to be able to reproduce reasonable projections of absolute levels of the endogenous variables. Consequently, one then restrict the analytical scope and applicability of model simulations to assesment of marginal properties. For examples of the approach using a benchmark dataset as the foundation of the calibration see Shoven and Whalley (1992) and Knudsen et al. (1998a, chapter 7).

3.4.1 A presentation of dynamic calibration

We can not rely on the presumption that the base year is compatible to a steady state since the dynamic demographics renders such an assumption senseless. Moreover we usually have the ambition of being able to produce realistic simulations of the baseline and consequently do not wish á priori to restrict ourselves only to address marginal model properties.

The dynamic calibration procedure takes offset in the recognition of the base year as being a temporal equilibrium on the transition path to steady state. Technically, dynamic calibration involves reversing part of the causual structure of the model in a calibration version of the model. In this model variant endogenous variables in the base year are restricted to their observed values in the base year while parameters to be calibrated are kept endogenous. The calibration version of the model hence incorporate the notion of the base year as a temporary equilibrium that the model is to be aligned to. For a presentation of how valid restrictions for dynamic calibration of parameters are deduced see Knudsen et al. (1998b, section 3.1).

When formulating the calibration version of the model, we specify the announced policy changes in recognition of the forward looking behaviour of agents. Announced policy affects optimal behaviour and hence the base year data are considered to reflect this. It should be noted that although we do not impose any steady state assumptions in the construction of our benchmark dataset, base year values of unobservable variables such as human capital and installation costs of capital must still be imputed. Also it should be noted that a majority of the parameters of the model concern atemporal equations and that these are determined by standard single equation calibration similar to the technique used for static models.

3.4.2 Parameters fixed á priori

A number of elasticity and scale parameters are determined á priori in the calibration. First and foremost all elasticities of substitution in the lower Armington nests of the demand systems for consumption goods, intermediate goods for material use and investments are assumed to be high. Also the elasticity of the Armington export demand functions are assumed to be high. All these elasticities are specified to the numeric value 5 to reflect near perfect elasticity of substitution. Values of 5 are higher than empiric estimates for Denmark but we follow the assesment in Pedersen et al. (1998) that long run elasticities of interntationally traded goods are likely large in a long run model for a small open economy.

For the production technology some of the parameters determined á priori are presented in table 3.4. All firms and thus representative firms of industries are assumed to use production technologies exhibiting the elasticities of substitution listed in the table.

Table 3.4: Technology parameters fixed á priori

κ	Share of productive primo capital in production function	0.9
σ^{KP}	Elasticity of substitution between land and buildings	0.2
σ^{K}	Elasticity of substitution between plant and machinery	0.2
σ^{H}	Elasticity of substitution between capital and labour	0.6
σ^{HE}	Elasticity of substitution between factory and energy	0.3
σ^{Y}	Elasticity of substitution between value-added and materials	0.25
ϕ^{M}	Scale parameter in installation costs of machinery	0.2
ϕ^{L}	Scale parameter in installation costs of land	0.2
ϕ^{B}	Scale parameter in installation costs of buildings	0.2
g	Corporate debt share	0.6
n	Harrod neutral growth rate of productivity	0.015
r	International rate of interest	0.0556
ρ	Risk premium for stocks	0.030225

The listed parameter values for most part coincides with the values used by DREAM. However, the nest representing the composite of factory and energy is not present in DREAM. We stipulate a value of 0.3 for the elasticity of substitution in this nest leaning on the empiric finding by Thomsen (1999, section 7.1) that energy and capital are complementary factors.

For the instantaneous utility function the parameters fixed á priori are listed in table 3.5.

The listed elasticities are common to all households regardless of age. For the elasticity of labour supply with respect to real award and for the elasticities of substitution having equivalent counterparts we again rely on values used in DREAM.

Table 3.5: Household preference parameters fixed à priori

γ	Elasticity of labour supply w.r.t. real award	0.1
S	Intertemporal elasticity of substitution	0.8
θ	Rate of pure time preference	0.0005
σ^C	Elasticity of substitution between durables and non durables	1.1
σ^N	Elasticity of substitution between goods and services	1.1
σ^G	Elasticity of substitution between food and other goods	0.6
σ^D	Elasticity of substitution between residence and vehicles	1.1
σ^R	Elasticity of substitution between residence and energy	0.5
σ^{HE}	Elasticity of substitution between res. land and houses	0.2

The levels of subtitution between composite goods not found in DREAM are all based on loose speculation on our part and are good candidates for further research. The line of reasoning we have followed is that consumption related to the dwelling including heating is likely to exhibit moderate substitutability this goes especially for substitution between residential land and houses.

3.4.3 Dynamically calibrated parameters

The essential dynamically calibrated parameters are the markup on the production costs μ and the parameter determining the preferences for leaving bequests ξ_{77}. Given the exogenous parameter values, the base year dataset and the observed lifecycle profile of wealth the preference for leaving bequests is calibrated to a value of approximately 2.344. The interpretation of this parameter value is that households plan to leave bequests amounting to the value of more than 11 years of consumption. The markup ratios are calibrated to values in the range from 0.007 to 0.068. These values may be compared to the findings of Hylleberg and Jørgensen (1998) that estimates markup ratios in the range from 0 to 0.25.

4 The baseline scenario

To assess the effects of enlargement we will rely on simulations that assess multiplier values of various policy scenarios from a baseline scenario. This section treats the specification of the baseline projection. The dynamic calibration version of the model includes specification of policies that was announced and therefore known to the economic agents in 1998. The purpose of the inclusion is to ensure that parameters are calibrated in a way that complies with the assumed perfect foresight of agents. In principle the projection of the dynamic calibration version of the model may be used for forecasts. However a number of policy initiatives have been introduced since 1998, and a proper baseline projection should include these in the form of surprise shocks. Hence the transition path of the dynamic calibration version of the model must be distinguished from that of the baseline projection.

With respect to the policy issued by the government in order to avoid violation of its intertemporal budget constraint we implement a financing rule of tax smoothing. This policy amounts to determination of a constant wage income tax system that exactly ensures solvency of the government for given commitments to other tax instruments, welfare, government consumption and public expenditures as such. The so-defined income tax system hence ensure a sustainable fiscal policy. There are many possible alternative rules of fiscal policy one may think of and given the conventionally adverse welfare effects of income taxation there is no guarantee that the sustainable income tax rate is optimal seen from a welfare perspective. However the tax-smoothing policy provides good indication of fiscal sustainability for otherwise status qou policies and is indisputably more realistic than closing the government bugdet using lump-sum taxation. For a definition of the sustainable income tax system see Pedersen and Trier (2000).

4.1 Policy assumptions and timing

We adapt the policy assumptions used by DREAM in the models 1998 calibration and additional assumptions reflecting the European agreements with applicant CEE countries.

The announced policies in the DREAM calibration are the tax reform of 1998[1], the abolition transitorial benefits and the reduction of age of retirement. The reform of the early retirement scheme is only partly implemented since the expected change in the retirement age from these policy initiatives are currently not modelled. For a more detailed presentation of announced policy see Pedersen and Trier (2000).

The announced policy of the Europe agreement consists of bilateral reductions of barriers to trade. The Europe agreements state that tariff barriers as well as nontariff barriers should be abolished with the notable exception of agriculture and food. For the EU member countries the Europe agreements is in full effect in 1998 while applicant CEE countries must have implemented the agreements fully in 2003 at the latest[2]. The implementation of the Europe agreements affects the tariff equivalents listed in table 3.1, such that the import tariffs charged by CEE countries on energy provision, metals and chemicals, and other manufacturing become zero from 1999 onwards in our simulation.

The real costs of trade pertaining to goods delivered from EU to CEE countries are reduced from 10 to 5 percent while the real costs of trade on goods imported into EU from CEE countries are reduced from 15 to 10 percent. The reduction of the real costs of trade bound in the Europe agreements, which besides tariff concessions specifies policies to enforce abolition of border controls, qouta restrictions and the removal of some technical barriers to trade. The reduction of the real costs of trade is also implemented from 1999 and onwards.

To arrive at the baseline scenario we introduce policies that were unknown in the base year as shocks. The taxation of the pension fund has been subject to changes to ensure uniform taxation of capital income. Moreover, the corporate tax rate has been reduced further and new labour market agreements imply reduction of the number of workhours per employee per year. Again these policy specifications are obtained from the DREAM version used in Pedersen and Trier (2000).

[1] In informal jargon this tax bill is known as 'Pinsepakken' and includes reductions of corporate taxation and changes to income taxation.

[2] Although the agreements are not required to be fully implemented in all CEE countries until 2003 some applicant countries have committed to comply to the agreements sooner.

4.2 Macroeconomics

In figure 4.1 we present the development of real GDP at factor prices, aggregate consumption and the effective labour supply of our baseline scenario. In general reported levels are presented in growth and inflation corrected terms[3]. The labour supply is dropping until 2040 due to the demographic development for Denmark. Note the strong correspondance between the effective labour supply and real GDP after the initial peak. This correspondance bear witness of the importance of perfect international capital market, the fixed interest rate and the numerically high Armington elasticities which are causing the endogenous terms of trade to be fairly constant. Bluntly put international conditions for constant corporate taxation and taxation of capital income in pension funds causes the usercosts of capital and wage rates and thereby the ratio between other input factors and labour to be practically constant. This imply that real GDP is given by the effective labour supply.

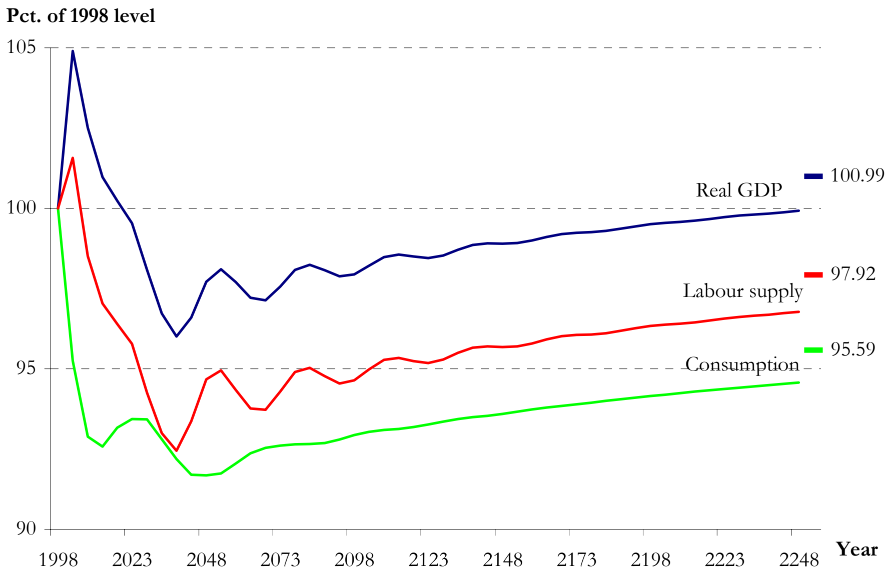

Figure 4.1: Baseline development of selected macro variables. Steady state percentages indicated.

The 1998 aggregate capital labour ratio is below the long run level reflecting the temporary nature of the base year equilibrium. Consequently, the corporate sector responds by

[3]The model is formulated in growth and inflation corrected terms to avoid that variables become numerically large.

increasing investments in the base year in order to drive up their capital labour ratio. This brings about the somewhat dramatic short run increase in production that by far supersedes the increase in the labour supply. From 2008 and onwards we observe the correspondance explained above. The fluctuations of the labour supply arise from the demographic composition of the Danish population as explained in Jensen et al. (2001).

The sharp initial decline of aggregate private consumption should be explained from public expenditures crowding out the purchase power of households. The ageing population causes government expenditures for consumption to increase over time peaking around 2040. Moreover the fact that government consumption is indexed to growth of real GDP causes an initial boom in government consumption following from the initial sharp rise in real GDP. Given the financing rule the income tax rate increases by 4.4 points from 2008 onwards in order for the government to remain solvent. This is forseen by households already in 1998 and consequently households respond by reducing consumption immediately. From around 2040 the ageing dependency ratio stabilizes and aggregate consumption gradually increase with real GDP.

Figure 4.2 illustrates the development of the current account and foreign assets. We see an improvement of foreign assets over time, which is induced by the decline of investments required to maintain the optimal capital labour ratio in aggregate production given the reduced labour supply. The alternative to placing savings in investments is to place them in foreign assets. The savings in the maturing pension funds increase and since households are not able to perfectly offset this capital accumulation by borrowing against their pension savings aggregate net savings increase. To see this note that the planning horizon of households is shorter than the planning horizon of the pension fund. Consequently part of the pension receipts from the pension fund occur after the end of the household planning horizon. These receipts are thus not forseen by households[4].

The macroeconomic properties of the baseline scenario are qualitatively similar to those found in Jensen et al. (2001) although the orders of magnitude are not in complete correspondance. Obviously we are not dealing with the same model but the more important reasons for the observed differences are bound in updates to the data foundation especially on data for socioeconomic properties of the representative household.

[4]This construction of time horizons serves as a shortcut modelling of young individuals being credit rationed.

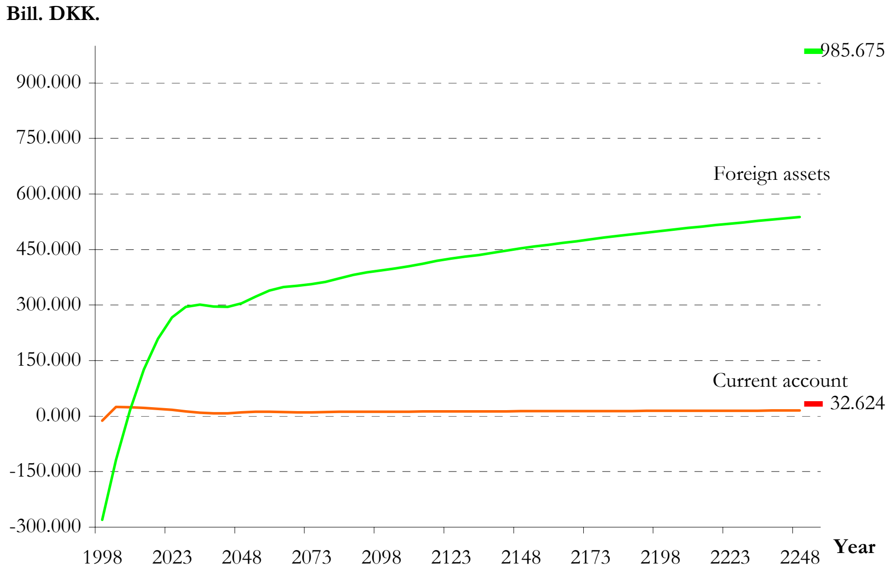

Figure 4.2: Baseline development of current account and foreign assets. Steady state values indicated.

4.3 The production sector

According to the traditional division of production into primary, secondary and tertiary sectors we may view the industries agriculture and to some extent energy provision to belong in the primary sector. The secondary sector, often referred to as manufacturing include the industries construction, foods, metal and chemicals, and other manufacturing. The tertiary sector includes industries producing services. In our model this sector is represented by the industries trade and transportation, other services, and public service. The motivation for this traditional sector distinction are based on sort of activity and does not necessarily bring much insight to the economic attributes of individual industries but do serve to group production.

Use of products

The characterisitcs of the production sector are presented in table 4.1 with respect to use of the product of the respective industries. The table presents the quantities delivered by industries in 2003 of the baseline scenario across the activities in which the products are used as inputs.

Table 4.1: Final use of production 2003

	Production	Materials	Energy	Machinery investments	Building investments	Private Consumption	Government consumption	Exports
	Quantity			—*Share of production*—				
Agriculture	65.636	75.44	0.00	0.00	0.00	4.13	1.57	18.86
Energy provision	58.557	0.00	47.24	0.81	0.00	27.57	0.00	24.37
Construction	152.209	22.15	0.00	0.09	60.91	12.18	4.67	0.00
Foods	119.820	19.07	0.00	0.08	0.00	21.25	0.00	59.60
Metal and chemicals	324.317	35.32	0.00	7.05	0.00	2.31	0.27	55.05
Other manufacturing	118.556	38.41	0.00	13.30	0.00	9.91	0.08	38.30
Trade and transportation	362.671	42.51	0.00	7.66	0.00	27.30	0.86	21.67
Other services	383.144	57.71	0.00	5.19	1.10	26.82	5.02	4.15
Public services	310.413	6.04	0.00	0.21	0.03	5.64	87.40	0.67

The primary sector primarily targets intermediate good markets and export markets. For agriculture as well as for energy provision relatively large quantities of their respective products are used for material inputs and energy inputs. The energy provision industry do deliver for use directly in private consumption as well.

The industries of the secondary sector does not per se serve the same categories of demand in the economy. First and foremost construction by convention delivers to domestic activities only. The majority of its output is used for investments in buildings by other production industries and household real estate. The deliveries to private consumption covers goods used for maintenance and repairs. The production of the construction good rely heavily on the level of activitiy in the macroeconomy due to the large dependency of demands for investments. The product of the food industry are first and foremost used for final consumption in households and to meet export demands. The largest manufacturing industry is metals and chemicals. The majority of their product is used for exports and as material inputs to production although the industry also delivers to investments in machinery. Other manufacturing is similar to metals and chemicals but delivers a little less to exports. Rather the industry goods are used for final domestic demand in machinery investments and private consumption.

Traditionally the view is that the service sector does not rely much on demand for exports. The industry trade and transportation of our model constitutes an exception to this, since it includes water transportation which features dramatic export ratios. By definition services provided in international waters are considered exports and the Danish fleet of container vessels is large even by international standards. All private industries in our service sector sell substantial shares of their products for use in material inputs and private consumption. By definition of the public service sector practically all of its product is purchased for use in government consumption.

4.3.1 Input factors

The use of input factors obviously have great importance as source of sectoral shifts arising from changes in relative prices. Such sectoral shifts arise from reasons similar to those of the Heckscher-Ohlin model of international trade. Table 4.2 lists the ratios of factor inputs to output in quantities.

Table 4.2: Factor inputs to output 2003

	Agriculture	Energy provision	Construction	Foods	Metal and chemicals	Other manufacturing	Trade and transportation	Other services	Public services
	—Ratio of factor input to output—								
Buildings to output	1.56	2.76	0.08	0.31	0.23	0.22	0.70	0.28	1.51
Land to output	0.78	0.47	0.01	0.05	0.04	0.04	0.13	0.06	0.16
Machinery to output	0.59	0.44	0.16	0.25	0.43	0.23	0.31	0.24	0.10
Labour to output	0.25	0.09	0.28	0.16	0.25	0.27	0.38	0.35	0.64
Energy to output	0.03	0.27	0.00	0.01	0.06	0.01	0.02	0.01	0.01
Materials to output	0.52	0.14	0.63	0.74	0.57	0.62	0.38	0.42	0.22

The primary sector relies on relatively large inputs of capital goods in the form of machinery and in particular land and buildings. With respect to other factor inputs agriculture relies more heavily on labour and material inputs than energy provision.

For the secondary sector all industries and in particular the foods industry relies on large ratios of material inputs to production. On the other hand the food industry use moderate levels of labour inputs compared to the other industries of manufacturing. With respect to capital intensities most industries of the secondary sector are moderate though metals and chemicals account for relatively large inputs of machinery capital to output.

In the service sector the most labour intensive production of our model is carried out while the ratio of material inputs to output are relatively low. With respect to use of capital th eindustries trade and transportation and public services adapt relatively widespread use of buildings for their production.

4.3.2 Level of international orientation

Naturally, the extent to which industries are engaged in export markets and the extent to which they face competition from imported goods constitute a primary source of sectoral shifts from changes in international relations. Also, the composition of the destinations of exports and origins of competing imports are important in this context. In table 4.3 we list the value of exports and competing imports and their composition on destinations and origins in 2003 of the baseline scenario. The fact that the distribution of exports and import across regions are identical for the tertiary sector bounds in the assumption that services are distributed using the average of the remaining products of the economy. As noted previously we have only been able to obtain data for international trade at SITC chapters which does not cover services.

Table 4.3: Value of exports and competing imports 2003

	Agriculture	Energy provision	Foods	Metal and chemicals	Other manufacturing	Trade and transportation	Other services	Public services
	—Percent of total, totals in Bill. DKK.—							
Total production value	65.636	58.557	119.820	324.317	118.556	362.671	383.144	310.413
Total value of exports	12.173	13.839	69.737	172.317	43.494	74.844	15.639	2.147
Destinations share of total exports								
European union	81.38	81.13	62.40	61.62	67.41	64.20	64.20	64.20
Rest of world	16.97	16.48	33.04	30.88	22.24	30.33	30.33	30.33
Central and Eastern Europe	1.65	2.40	4.56	7.50	10.35	5.47	5.47	5.47
Total value of compeeting import	9.754	24.533	29.722	173.873	76.281	14.184	12.138	0.000
Origins share of total imports								
European union	45.00	36.35	74.80	77.36	62.24	70.52	70.52	—
Rest of world	51.32	53.99	23.33	19.61	28.06	25.16	25.16	—
Central and Eastern Europe	3.68	9.66	1.88	3.03	9.70	4.32	4.32	—

For agriculture and energy provision exports account for 19.21 and 23.51 percent of the production value. These figures are lower than for manufacturing and especially the exports for CEE countries are moderate. With respect to imports agriculture does not face any substantial competition. This is certainly not the case for energy provision and furthermore imports from CEE countries account for nearly 10 percent of the total value of imports of energy.

For manufacturing except for construction large fractions of production are targeted at export markets. For metals and chemicals and in particular other manufacturing a relatively large share of these exports are directed at CEE markets. The level of imports of foods are moderate in comparison to domestic production and indeed very low from CEE countries. For metals and chemicals the value of imports of competing products roughly coincide with the value of exports. However, this industry is faced with competition from EU rather than CEE countries. For other manufacturing the value of imported competing products is large and imports originating from CEE countries account for almost 10 percent.

For the service sector, only trade and transportation account for any notable exports. The level of cross-border trade of services is negligible.

4.4 Households

Changes in relative prices affects the demand structure of private consumption. The extent to which such changes will have impact in the domestic economy depends on the level of imports to private consumption and also the composition of industry goods in the various consumption goods. Table 4.4 lists the value of inputs to private consumption goods while table 4.5 displays the composition of consumption goods by the origin of inputs.

With respect to the inputs seen from the perspective of industry inputs, the definition of the consumer goods is essentially based on types of input. As such it is not suprising that for instance energy composition consists largely of inputs from energy provision. Similar argumentation goes for the remaining consumption goods.

Inputs to dwelling consumption is delivered primarily by the dwelling sector, construction and other services and consequently practically all deliveries to dwelling consumption is from domestic industries (or dwelling). For consumption of services and trade and energy this goes as well. For private energy consumption it is hard to imagine any significant purchases of energy directly from foreign producers.

Table 4.4: Value of industry goods in consumption goods 2003

	Dwelling	Vehicles	Energy	Foods	Other goods	Services and trade
			—Bill.	*DKK.—*		
Total value of inputs	108.960	51.809	33.529	98.066	112.917	146.462
Agriculture	0.00	0.00	0.87	6.90	1.74	0.08
Energy provision	0.00	9.39	94.49	0.00	0.01	0.01
Construction	17.03	0.00	0.00	0.00	0.00	0.17
Foods	0.07	0.02	0.00	53.62	1.00	0.06
Metal and chemicals	0.94	0.93	0.42	0.28	25.02	2.15
Other manufacturing	0.15	62.17	0.00	0.05	33.23	0.76
Trade and transportation	0.76	27.49	4.23	39.16	38.99	18.06
Other services	14.27	0.00	0.00	0.00	0.01	65.42
Public services	0.00	0.00	0.00	0.00	0.00	13.28
Dwelling	66.78	0.00	0.00	0.00	0.00	0.00

For consumption of foods, other goods and in particular vehicles the value of imports account for larger shares of inputs. For consumption of vehicles and to some extent other goods imports from CEE countries are observed.

We will not provide detailed discussions of the effects to the composition of consumption in the following presentation of simulation results. Rather we will comment on aggregate consumption and the effects to the demand faced by individual industries from various domestic activities. One should bear in mind however, that shifts to the demand for consumption purposes faced by individual industries reflects substitution effects in the composition of consumption.

Table 4.5: Inputs to consumption by origin 2003

	Dwelling	Vehicles	Energy	Foods	Other goods	Services and trade
			—Bill. DKK.—			
Total	108.960	51.809	33.529	98.066	112.917	146.462
Domestic	108.717	17.307	32.246	77.378	63.539	141.430
European Union	0.184	20.737	0.498	13.881	33.838	3.606
Rest of world	0.050	10.482	0.668	6.316	12.390	1.209
Central and Eastern Europe	0.009	3.284	0.117	0.491	3.150	0.218
Origin share of total			*—Percent of total—*			
Domestic	99.78	33.40	96.17	78.90	56.27	96.56
European Union	0.17	40.03	1.48	14.15	29.97	2.46
Rest of world	0.05	20.23	1.99	6.44	10.97	0.83
Central and Eastern Europe	0.01	6.34	0.35	0.50	2.79	0.15

5 Custom liberalization and market integration

This chapter presents technical decompositions of the effects of customs liberalizations and integration of markets. To gain an understanding of the positive effects on the Danish economy of the east enlargement we will quantify the effects of customs liberalization and integration of markets while abstracting from the fact that the budgetary impacts are to be covered. We will start by analysing the customs union and then proceed to the issue of market integration. The effects of market integration are larger of magnitude and somewhat more complex than those found for the cuctoms union. Therefore we provide decompositions of the market integration effects into isolated trade cost experiments for exports and imports. After presenting the isolated effects of the customs union and market integration we conclude by presenting the compound effect of all these elements of the east enlargement. This experiment may be thought of as an unfinanced enlargement scenario.

The government budget is not affected by lowered customs revenues from the enlargement of the customs union since import customs are charged by the European union. Likewise the granted subsidiation of exports to CEE countries lies entirely on the EU. The enlargement of the European customs unions hence have no direct domestic budgetary effects. Still however, changes in the domestic level of activity will affect the budget via changed level of expenditures (recall that public consumption is pegged to real GDP) and revenues of income and excise taxation. We will assume that the domestic government issues a debt-targeting fiscal policy meaning that the government debt is held constant at the baseline profile. To achieve this, the government periodically ajusts the base tax rate of the income tax system[1]. At first sight the choice of using the base tax rate may appear odd due to the distortionay effects of income taxation. The alternative use of lumpsum taxation for closing the government budget however introduces intertemporal distortions in an OLG framework. Lumpsum taxation therefore cannot be expected to serve to isolate the effects of the issues analysed from those arising from effeciency losses generated

[1]By changes income tax systems base rate all tax rates applying to non interest incomes including income compensating transfers are affected.

by the domestic fiscal response. We therefore opt for implementing the use of the more realistic fical instrument.

5.1 Customs liberalization

We will start by analysing the effects of the customs union inherent in the full accession of the CEE countries. Most of the customs barriers to trade is already lifted in the baseline scenario due to the Europe agreements but until full accession custom tariff equivalents remain on trade of agriculture and foods with the CEE. The inclusion of the CEE countries in the EU implies that CEE countries must adapt the free trade agreements of the EU and that export subsidiation of exports to EU countries must be terminated. These obligations of course apply to the relation of EU countries to CEE countries as well.

Lifted import custom barriers by the CEE countries and removal of export subsidiation by EU countries affects the price entering the Armington export relations in opposite directions. The tariff equivalent to import customs and quantity restrictions levied by the CEE on agriculture and foods amounts to 3.76 percent and 15.03 respectively while subsidies granted by the EU on Danish exports of agriculture and foods amount to 6.13 percent and 10.22 respectively. The effective change of the price entering the Armington export relation consequently amounts to a rise of 2.61 percent for agriculture and a reduction of 3.27 for foods from 2004 onwards[2].

Likewise the compound effect on the price paid for imports of CEE countries abolishing export subsidiation and the removal of import customs and quantity restrictions on part of the EU may be expressed by an effective change. For agriculture the Danish import tariff equivalent amount to 3.22 while the CEE export subsidiation amounts to 3.07 percent resulting in an effective decrease of 0.05 percent of the price of imports from CEE countries. For foods the effective change of the import price amounts to a reduction of 4.91 percent equivalent to the reduction of the Danish import tariff equivalent amounting to 8.23 percent and removal of the export subsidy of 3.07 percent granted by CEE countries.

[2]The model is solved for a 5 year period length the year appearing in tables presenting effects are the year ultimo the period. A year indicated by 2008 thus represents the years from 2004 to 2008

5.1.1 Immidiate effects of the enlarged customs union

The removal by CEE countries of import customs duties and the abolishment of subsidiation of EU exports to CEE countries effectively imply a negative shock to the demand experienced by domestic agriculture. The net result is an increase in the purchasers price for agriculture in the CEE countries implying decreased demand for exports from these countries. For the domestic food industry the outcome is a positive demand shock since the price of foods imported from Denmark will decline in CEE countries.

The immediate compound effects on the import price of removal of customs levied on imports from CEE countries and removal of export subsidiation in the CEE countries is practically absent for agriculture but accounts for a reduction amounting to 4.91 percent on the purchasers import price for foods. For industries relying on relatively large inputs of foods from CEE to production the lowered import price takes form of a positive supply shock due to lowered costs of production. In addition to the supply side effect the lowered import price of foods conform to a positive demand shock from lowered consumer prices and hence increasing purchase power of households. This effect is small however, since CEE imports of foods are not entering consumption goods in large quantities.

Removal of the barriers to exports of foods to the CEE countries will bring about increased export demands, but the lowered price of imported foods will lead to substitution towards imports of competing food products from the CEE. The imports of competing foods from CEE countries amount to 1.88 percent of total value of food imports while the exports to the CEE countries account for 4.56 percent of the total value of food exports. Moreover the total value of exports is more than double the value of imports for foods. This means that although the effective price cut on imports is larger than the effective cut on export prices, the adverse effects of substitution towards competing imports from CEE cannot be expected to dominate the increased demand for exports by CEE countries.

For agriculture the effect of the enlarged customs union as noted amounts an increase in the price paid by CEE purchasers for domestic products and a very small decrease on the price of imported competing products. Hence domestic agriculture will face detoriating export demands which seen isolated will induce a reduction of the level of production and lowered output prices. However the forementioned expansion of the production in the food industry will increase the domestic demand for agriculture used for intermediate inputs to production since agriculture is a major supplier to material use in the food industry.

5.1.2 Results

One would suspect the macroeconomic effects of enlargement of the European customs union to be very moderate since only two industries are directly affected and only to a minor degree. This presumption is confirmed by table 5.1, which summarize the effects on the domestic economy by means of selected macroeconomic indicators.

Table 5.1: Macroeconomic effects of the enlarged customs union

	2003	2008	2018	2028	2038	∞
			—Baseline=100—			
Real GDP at factor costs	100	100.00	100.00	100.00	100.00	100.01
Real private consumption	100	100.02	100.02	100.02	100.02	100.02
Labour	100	100.00	100.00	100.00	100.00	100.00
Machine capital	100	100.02	100.02	100.02	100.02	100.02
Building capital[a]	100	100.01	100.02	100.02	100.02	100.02
Value of firm	100.08	100.03	100.03	100.02	100.02	100.02
Total household assets	100	100.03	100.04	100.04	100.04	100.05
Foreign assets	100	99.74	100.04	100.06	100.08	100.05

[a]Excluding dwelling

Real aggregate GDP is expanded slightly due to increased production in agriculture and food. The increase in the aggregate level of production causes the aggregate value of firms to increase and combined with the lowered consumer price level this leave room for an increase of aggregate private consumption.

Table 5.2: Effects on output levels from the customs union

	2003	2008	2018	2028	2038	∞
	Quantity		*—Baseline=100—*			
Agriculture	65.636	100.13	100.19	100.20	100.20	100.20
Energy provision	58.557	99.98	99.97	99.97	99.97	99.97
Construction	152.209	100.03	100.01	100.01	100.01	100.01
Foods	119.820	100.34	100.40	100.40	100.40	100.40
Metal and chemicals	324.317	99.96	99.95	99.94	99.94	99.94
Other manufacturing	118.556	99.95	99.94	99.94	99.94	99.94
Trade and transportation	362.671	99.98	99.98	99.98	99.98	99.98
Other services	383.144	100.00	100.00	100.00	100.00	100.00
Public services	310.413	100.01	100.01	100.01	100.01	100.01

Table 5.2 summarize the effects on the structure of domestic production. We observe that the production in agriculture, construction, foods and public services is increased while all remaining industries but other services respond by lowering their respective levels of

production slightly. The increased production of public services simply reflect the fact that government expenditures for consumption is pegged to real GDP. For agriculture the positive effect on the level of production is rooted in the increased demand for material inputs in the food industry which expands its level of activity to meet the increased demand. The assertion that the increase in demand for food exports from CEE countries dominates the adverse effects of domestic substitution towards imported foods is hence seen to be correct. The increased level of activity in agriculture, foods and public services and also the increased level of consumption affects the aggregate demand for investments in buildings and other goods supplied by the construction industry. This increase in demand causes the production and price of goods supplied by construction to increase. Likewise the wage rate wil rise moderately reflecting the increased level of aggregate production. The increase of the unit costs of production lead to adverse effects on the level of production and will tend to increase the output price in the remaining industries. As observed in table 5.2 the recessive effects on production in energy provision, metals and chemicals and other manufacturing are moderate given that the shock is relatively small. The decline of production in internationally oriented industries is explained in the simultaneous decrease in export and domestic demands that are caused by the increased output price levels. The industry other services is affected negatively by decreasing demand for exports but the level of exports are very moderate. Likewise the level of competing imports are very moderate and therefore no adverse substitution effects are observed in the domestic demand for other services. This explains why the enlargement of the customs union are practically neutral for other services. For trade and transportation which given the inclusion of water transportation do account for some exports the outcome is a reduction of activities.

5.1.3 Effects on patterns of trade

Table 5.3 summarize the effects of the enlargement of the European customs union on steady state trade volumes by industry and region. We observe a reduction of exports for all industries but foods. This is caused by the increase of the domestic level of production which raises costs of production and consequently the output price level. By the Armington specification of the export relation this causes export demands to decline. For the food industry the increase of total exports is generated exclusively by increasing demands from the CEE countries since exports to the EU and the rest of the world declines due to the same effect of the increased domestic price. Note the 12.4 percent decrease from baseline in exported quantities of agriculture to CEE countries. This decrease is primarily generated by the abolition of the subsidiation of this category of exports.

Table 5.3: Changes to volumes of trade in steady state from customs union

	Total exports	Exports to EU	Exports to ROW	Exports to CEE	Imports from EU	Imports from ROW	Imports from CEE
				—Baseline=100—			
Agriculture	99.71	99.92	99.92	87.55	100.21	100.21	100.46
Energy provision	99.91	99.91	99.91	99.91	100.01	100.01	100.01
Foods	100.75	99.96	99.96	117.39	99.93	99.93	126.99
Metal and chemicals	99.92	99.92	99.92	99.92	100.03	100.03	100.03
Other manufacturing	99.91	99.91	99.91	99.91	100.04	100.04	100.04
Trade and transportation	99.87	99.87	99.87	99.87	100.07	100.07	100.07
Other services	99.88	99.88	99.88	99.88	100.07	100.07	100.07
Public services	99.86	99.86	99.86	99.86	—	—	—

For the imports of most competing products from all origins the increased domestic price level and the resulting substitution leads to an increase. The exception is again the food industry for which the change of the relative price of imports from the different origins favors goods from the CEE countries. The natural response of the structure of imports is substitution directed away from EU and the rest of the world towards food products from the CEE countries.

The concepts of *trade creation* and *trade diversion* are traditionally used for highlighting welfare implications of preferential trade agreements. We find the use of these concepts to be problematic given their indeterminate welfare implications, see Pedersen (1993).

5.2 Integration of commodity markets

As the second technical decomposition of the impact of enlargement we analyse the effects of market integration. By integration of markets we refer to the lifting of barriers to trade other than those implied by customs duties and quantitity restriction. In the baseline we removed 5 points of the real costs of trade from 1999 onwards, reflecting the gradual compliance of CEE countries to the acquis communitaire as mandated in the Europe agreements. We assume that full integration of the CEE countries into the European single market will do away with the remaining 5 and 10 percent levels of real costs of trade pertaining to exports and imports vis-a-vis the CEE countries. One could argue that the remains of the real frictions will vanish only gradually over a period exceeding the 5 year period length of the model, but given the high uncertainty and exogenous formulation of the integration we feel that a one-shot removal is defendable.

We find it useful to apply the abolition of real costs of trade in two experiments in order to isolate the effects acruing via imports and exports. Of course the concept of unilateral reductions of real costs of trade is somewhat artificial from a policy evaluation perspective but do serve to bring insights into the mechanics of commodity market integration. Finally, we present the compound effects of commodity market integration in a single experiment. All experiments of integration implement the debt-targeting domestic fiscal policy response presented previously.

5.2.1 Real costs of trade on exports to CEE countries

To assess the effects of integration of markets via exports we apply a reduction of real costs of trade pertaining to exports to CEE countries from 2004 onwards. Trade costs are assumed to completely abolish from the level of 5 percent applying to goods exported to CEE countries in the baseline. By the definition of purchasers price in the CEE countries the removal of real costs cause the relevant export demands to increase for all industries but construction. Hence the policy constitutes a demand shock via increased demands for exports from the CEE countries.

The net effects of the policy application on macroeconomic indicators are presented in table 5.4.

We observe a moderate increase in the gross domestic production measured at factor costs. This expansion of economic activities are initially driven by the aggregate increase in export demands from CEE countries. Specifically, the industries other manufacturing and metals and chemicals experience relatively large increases in export demands reflecting that these industries have relatively large exports to CEE countries. The positive effect on aggregate demand drives up aggregate GDP. However, as we shall see not all industries increase their level of production.

Increasing export demands for metals and chemicals and other manufacturing bring about increases in the domestic price of their goods. Since metals and chemicals and other

Table 5.4: Macroeconomic effects of removal of real costs on exports to CEE countries

	2003	2008	2018	2028	2038	∞
			—*Baseline=100*—			
Real GDP at factor costs	100	100.03	100.04	100.04	100.04	100.04
Real private consumption	100	100.20	100.23	100.25	100.27	100.30
Labour	100	100.03	100.03	100.03	100.03	100.03
Machine capital	100	100.13	100.14	100.14	100.14	100.14
Building capital[a]	100	100.00	99.99	99.99	99.99	99.99
Value of firm	100.90	100.27	100.28	100.29	100.29	100.30
Total household assets	100	100.48	100.60	100.65	100.62	100.72
Foreign assets	100	106.93	101.77	101.77	102.01	100.92

[a]Excluding dwelling

manufacturing are the primary suppliers of inputs to materials and machinery investments the price raise in these industries drive up the costs of production for all industries. The total effect of the increased costs of production is a price raise on all domestic products.

The simultaneous increase of aggregate use of machinery and decline in aggregate use of buildings (excluding dwelling) should be understood as the result of changes in the relative price of these capital goods. Buildings are only supplied domestically and hence the increase of the domestic price of buildings cannot be offset by substitution towards imports. This is not the case for machinery or other intermediate inputs. The availability of foreign substitutes for domestically delivered machinery and intermediate inputs reduce the total impact of the domestic price raise on the costs of these production factors.

The increased level of activity in the economy induces an appreciation of the aggregate value of firms. Since firms are owned by households aggregate private consumption increase since household wealth increase. In addition the increased level of production combined with increasing share of capital to labour imply increasing wage incomes which also affect aggregate consumption upwards. Due to the smoothing of consumption over the life-cycle household behaviour also increase aggregate savings. The increased level of private savings implies accumulation of foreign assets[3]. The reason that private consumption exhibits a larger increase than GDP should therefore be understood from the improvement of the terms of trade.

[3]The seemingly large impact in 2008 on foreign asset claims are caused by the fact that the baseline value is close to zero.

Sectoral shifts in production

The reduction of trade costs petaining to exports towards the CEE countries have different impact on the levels of activity in domestic industries. The extent to which the abolition of real trade costs bear positive effects on the activity of an industry depends on the structure of demand for the industry product. Table C.1 in the appendix lists the effect on the production and demand structure of the industries.

The increase in private consumption will lead to increasing demand for all consumption goods leading to increased demand for domestically produced goods in general. This effect amounts to an income effect on domestic products. However, the increased domestic price level induce substitution towards imported goods for consumption. The net outcome on the demand for consumption facing domestic industries depends on which of these effects dominate.

For the domestic demand for intermediate and capital inputs to production an argument along the same lines apply. Aggregate GDP increases bringing about increased demand for intermediate goods and capital goods which ceteris paribus increase domestic demand. Again this effect is modified by the adverse effect on domestic demand arising from substitution towards imports due to the increasing domestic price level. For industries facing little or no competition from imported goods the effect of this substitution is of course minor or absent.

The last source of demand is that of exports. Unambigiously the demand for exports from CEE countries rise but the increase of the domestic price level will reduce demands from other export markets. The net effect on the demand for exports is determined by the extent to which CEE countries is a large export market.

Agriculture and energy provision experience recessive export demands due to the modest levels of exports to CEE countries. In general domestic demands are reduced due to substitution towards competing imports with exception of private consumption of energy provision. This is caused by limited substitutability of energy origins for households. The net effect on the aggregate demand for agriculture and energy provision is a reduction.

Manufactures, that is the industries food, metals and chemicals and other manufacturing experience declining domestic demand due to substitution towards imports. The relatively expressed orientation of metals and chemicals and other manufacturing towards CEE export markets, these two industries experience increasing demand for exports. Thus the increase in exports towards CEE countries more than offsets the decline in export demand from the EU and the rest of the world. The net effect for food is a contraction of all demands while metals and chemicals experience increasing aggregate demand.

The demand facing construction is not hampered by any direct substitution effects of origin from domestic price raises due to the convention that construction goods are not imported. However derived substitution effects from shifts in relative prices of capital goods are present. In our discussion of the aggregate level of capital use we focused on capital used for production. In table C.1 supplies to investments include buildings purchased for residential purposes and hence deliveries to investments account for a positive effect on demand. The positive effect of the demand for residential buildings stems from the increase in private consumption.

Service industries are only subject to modest competition from imports and export demands are practically absent. Therefore the increased domestic activity and consumption leads to increased aggregate domestic demand. Due to the modest level of export demands the adverse effect of domestic price levels on exports have practically no effect on the aggregate demand facing the service industries.

5.2.2 Real costs of trade on imports from CEE countries

The real trade costs pertaining to goods imported from CEE countries are reduced from the 10 percent remaining in the baseline to zero from the year 2004 and onwards. The reduction of real trade costs on imports from CEE countries causes these imports to cheapen regardless of the final use of the imported goods. The removal of real costs of imports from CEE countries hence causes the costs of inputs to production as well as the price of consumption to fall. The experiment thus have immediate expansionary supply and demand side effects.

In table 5.5 effects of the policy application on macroeconomic indicators are presented. Compared to the aggregate effects of lowered real costs on exports towards CEE countries (table 5.4) we observe qualitatively similar effects, but as we shall see these are brought about by other mechanisms.

The positive effect on domestic supply comes about from the reduction of the unit costs of production. Other effects equal, lowered costs of production lead to increased output and lowered output prices. In the second order, lowered domestic prices will cheapen domestically supplied intermediate inputs and investments thereby magnifying the supply effect of the price cut on imports from the CEE countries.

Table 5.5: Macroeconomic effects of removal of trade costs on imports from CEE

	2003	2008	2018	2028	2038	∞
			—Baseline=100—			
Real GDP at factor costs	100	100.04	100.06	100.07	100.07	100.07
Real private consumption	100	100.36	100.40	100.42	100.43	100.47
Labour	100	100.04	100.04	100.04	100.04	100.05
Machine capital	100	100.24	100.28	100.28	100.28	100.27
Building capital[a]	100	100.05	100.07	100.07	100.07	100.07
Value of firm	100.10	100.06	100.06	100.06	100.06	100.07
Total household assets	100	100.00	100.07	100.13	100.16	100.34
Foreign assets	100	103.18	100.94	101.08	101.36	100.68

[a]Excluding dwelling

The price reduction of imports from CEE countries causes the consumer price index to decline leading to increased purchase power of consumers. Increased purchasing power causes the level of consumption to rise. The extent to which increased demand for consumption targets domestic supplies depend on the relative price of domestic deliveries and imports. Substitution towards imports may hence dominate the positive effect of increased demand on individual domestic industries.

As seen from table 5.5 aggregate real GDP rise as result of the lowered aggregate costs of production. The initial rise is lower than the long run effect. This is due to the installation costs of capital which tend to make the adoption of new capital rigid. Again we observe that the effect on aggregate real consumption is larger than that for aggregate real GDP. This is again caused by the improvement of the terms of trade thath allow for the increase of aggregate domestic demand to be larger than the increase of domestic production.

Impact on domestic industries

The changes in the production level and demand structure facing domestic firms are presented in table C.2 in appendix C. Evidently, the effects on the production of a reduction of real trade costs depends crucially on the direction of the trade costs being removed. Two opposite domestic effects on the production of an industry is in play: Negative effects from substitution towards competing imports from CEE countries and positive effects from the increase in aggregate domestic demand. In addition the price cut of domestic industries will generate increased demand from all export markets. How an industry perform is best understood along these lines.

Metals and chemicals are not competiting with imports from CEE countries in a degree that offset the positive effects on exports from lowered prices on inputs. Hence the positive effect from exports dominate the adverse effects of domestic substitution towards imported metals and chemicals. The effect on exports is fairly large reflecting that this industry is indeed export oriented.

For the food industry the improved purchase power of consumers and the increase in exports more than offset the recessive impact from lowered demand for foods to inputs in domestic production. For food consumption the level of inputs of competing inputs from CEE imports are low. Consequently the positive effect from increased demand for food consumption more than offsets the adverse substitution effects from the lowered relative price of foods delivered from CEE countries.

For other manufacturing the increased competition from imported goods delivered to material use and private consumption by CEE countries causes a setback. The magnitude of competing imports from CEE countries is fairly large for this industry while the level of exports is small compared to manufactures as such. The increased level of exports are therefore not sufficiently large to avoid a reduction of activities.

For agriculture the impact on consumption of foods plays a large role. Since the food industry use considerable amounts of agriculture products as intermediate goods in production an increase in this demand category is experienced. Moreover export demands due to the lowered output price adds to the demand for agriculture product and the combination induce an increase in the activities of domestic agriculture. This may seem somewhat counterintuitive at first since one would expect agriculture to be sensitive to competition from CEE countries. However, agriculture use a high rate of intermediate inputs to output and hence the decline in input prices leaves room for a reductions of the agriculture output price that are sufficient to induce increased exports. Also, the import from CEE agriculture are very moderate and hence the substitution effect is moderate.

The industries construction, trade and transportation and other services are primarily supplying for domestic activities and are facing moderate or absent competition from imports. For these industries the positive effect of increasing demand is not to any considerable extent modified by adverse effects of substitution towards imported alternatives. The demand for material inputs from trade and transportation is the only declining demand category and although this category of demand have substantial weight it is not large enough to amount to a recessive impact on the aggregate demand facing the industry. The service sector hence increase the level of activity.

5.2.3 The compound effects of market integration

The total impact of abolition of the barriers to trade represented by real costs is quantified in the experiment presented in this subsection. From 2004 onwards all real costs of trade pertaining to trade with the CEE countries is set to zero such that the experiment presented here amounts to the compound effect of the two experiments for real costs presented above.

The collected abolition of real costs of trade inherent from integration of the CEE and EU markets lead to macro effects outlined in table 5.6.

Table 5.6: Macroeconomic effects of removal of trade costs on all CEE trade.

	2003	2008	2018	2028	2038	∞
			—*Baseline=100*—			
Real GDP at factor costs	100	100.07	100.10	100.10	100.11	100.11
Real private consumption	100	100.56	100.63	100.67	100.70	100.77
Labour	100	100.07	100.07	100.07	100.07	100.08
Machine capital	100	100.36	100.42	100.42	100.42	100.41
Building capital[a]	100	100.05	100.05	100.06	100.06	100.07
Value of firm	101.01	100.33	100.34	100.35	100.36	100.37
Total household assets	100	100.49	100.68	100.78	100.78	101.06
Foreign assets	100	110.14	102.72	102.86	103.39	101.60

[a]Excluding dwelling

As seen from table 5.6 the effect on aggregate domestic production of integration of commodity markets is an expansion of the aggregate level of activity. By comparing the macro effects to those presented in tables 5.4 and 5.5 we see that the compound effects are comprised of the effects of the individual contributions from the lifting of real costs on imports and export respectively.

The lowered costs of production induced by lowered prices of imports from the CEE countries tend to increase supply and lower output prices on the aggregate level. The lowered aggregate price level will lead to increased demands for exports from all foreign regions. General equilibrium effects from the response of the demand side will cause shifts in the sectoral composition of production. The increase in aggregate private consumption exceeds that of domestic real GDP, again reflecting that terms of trade have improved. It should be emphasized that the vanishing of real costs of trade will improve the terms of trade for all involved parties since real trade costs are introduced as real decay of the value of internationally traded goods. Hence the improvement of Danish terms of trade does not in this context imply worsened terms of trade for the CEE countries.

The lowered price of imports from CEE will tend to reduce the unit costs of domestic production and consequently the domestic output price levels. The increase in the demand for exports will on the other hand bring about domestic price increases. For the industries other manufacturing and metals and chemicals the net effect of these opposite effects are price increases due to the relatively large supply serving exports to CEE markets. Since these two industries are also major suppliers of intermediate goods used in other domestic industries the price raise of their products will affect the costs of remaining domestic industries upward. This upward pressure on production costs is only partly modified by the lowered costs of imported materials since intermediate goods is only supplied by CEE imports to a modest degree. The net result of the increased production costs is an increase in the domestic price level.

Per se the increased domestic prices will have adverse effects on exports to all foreign regions. The lowered costs of trade on exports to the CEE countries will however modify the net effect on total export demands. The ratio of exports directed towards CEE countries is therefore of crucial importance to the net effect on the total export demand facing a given industry. On the aggregate level we observe an increase in the value of exports. The only industries affected negatively with respect to the total demand for exports is agriculture and service industries. For agriculture the modest level of exports directed towards CEE explain the adverse effect.

Improvements in the purchase power of households will induce increased demands for industry goods for consumption. The extent to which this increased demand is directed at domestic goods depends on the level of substitution towards imported goods inherent in increasing domestic output price levels. For service industries and construction this level of substitution is either modest or absent by construction. Especially construction which is the major supplier of houses and maintenance and repairs in dwelling consumption experience increased demands from private consumption.

With respect to the impact on demand for material, energy and capital inputs to production facing domestic suppliers we may single out to opposite effects. First the overall increase in production will increase the level of demand for inputs factors at large. On the other hand substitution towards imports from CEE countries will have adverse effects on these categories of demand. The net effect on demand for production inputs faced by a given industry is determined by the level of substitutability and the composition of demand across purchasing industries. For the primary sector and most manufacturing industries the substitution of purchasers towards imported input factors tend to dominate the positive effect of the overall increase in demand. Hence only construction which is not facing competition from imports is experiencing a considerable positive net effect from increasing demands for buildings and goods adapted as input factors in domestic production.

For manufacturing the level of demand will in general increase though for different reasons. For the food industry, the increase of private consumption and the increased demand for exports by CEE countries result in a positive net effect on total demand. For metals and chemicals only export demands increase but this to a level that dominates the adverse effects on total demand from diminishing demand from other sources. The exception to the general picture in manufactures is the industry other manufacturing. This industry meet relatively heavy competition from similar imported goods and hence the diminishing domestic demand can not be offset by the increased level of exports.

For the primary sector a decline in production is the result again because the decline in domestic demand is not offset by a sufficient increase in export demands. For agriculture the demand for exports is even decreasing since agriculture only supply moderate quantities to CEE markets and the improved conditions on these markets are not sufficient to avoid the diminishing demand from EU and the rest of the world. For energy the modest level of exports towards CEE countries imply that the increased demand for exports is not sufficiently large to offset adverse effects of domestic subtitution towards imported alternatives.

For service industries the absence of imported competitive goods, the moderate dependence on export demands and the overall increase in domestic activities lead to unambigious increase in the demand facing these indutries.

Table 5.7 lists the steady state changes from baseline to traded volumes. In general exported quantities to EU and the rest of the world decline while the exported quantities to CEE countries rise. The rise of domestic prices explain the declining exports to EU and the rest of the world while the adverse effects of rising prices is more than offset by the positive effects of abolition of real costs of trade for exports to the CEE. The differences among industries on total exports are the result of the differences in orientation towards CEE markets.

With respect to imports, all industries experience increased imports of competing products from the CEE countries due to lowered purchasers price levels for these imports. For energy provision, metals and chemicals and other manufacturing a reduction of competing

Table 5.7: Volumes of trade in steady state after bilateral removal of trade costs

	Total exports	Exports to EU	Exports to ROW	Exports to CEE	Imports from EU	Imports from ROW	Imports from CEE
				—*Baseline=100*—			
Agriculture	99.38	98.90	98.90	127.81	100.01	100.01	169.36
Energy provision	100.66	99.96	99.96	129.18	96.99	96.99	164.25
Foods	100.44	99.12	99.12	128.10	100.32	100.32	169.89
Metal and chemicals	102.05	99.91	99.91	129.12	99.34	99.34	168.23
Other manufacturing	102.65	99.69	99.69	128.84	97.03	97.03	164.32
Trade and transportation	100.01	98.44	98.44	127.21	101.40	101.40	171.72
Other services	99.80	98.23	98.23	126.95	101.53	101.53	171.94
Public services	99.36	97.80	97.80	126.39	—	—	—

imports from EU and the rest of the world is experienced. For other industries the level of competing imports from these origins is the result. The share of imports originating from CEE countries amounts to approximately 9 percent for energy provisions as well as for other manufacturing. For metals and chemicals and agriculture the same share amounts to approximately 3 percent. However, for agriculture we observe a weak rise of competing imports from EU and the rest of the world while imports are declining for metals and chemicals. The reason for this is that domestic production of metal and chemicals has increased while domestic production of agriculture declines. Hence a larger quantity of metals and chemicals used domestically is supplied by the domestic industry.

5.3 Compound effects of unfinanced enlargement

The combination of the enlarged customs union and introduction of the participation of CEE countries in the European single market may be considered an unfinanced enlargement. To understand the compound effects of an unfinanced enlargement the description of effects in the technical decomposition of market integration effects are essentially sufficient. To see this consider the direct effective impact on import and export price levels on goods traded with the CEE countries which are summarized in table 5.8.

The direct effects of the customs union enlargement on import and export price levels are far smaller than those acheived by market integration. It therefore seems fair to presume

Table 5.8: Direct impact to import and export prices of goods traded with CEE by unfinanced enlargement

	Customs union		Market integration		Total	
	Import	*Export*	*Import*	*Export*	*Import*	*Export*
Agriculture	-0.05	2.61	-11.11	-5.26	-11.17	-2.52
Foods	-4.91	-3.27	-11.11	-5.26	-16.56	-8.70
Other except construction	—	—	-11.11	-5.26	-11.11	-5.26

that the simulation results representing an unfinanced enlargement will have great resemblance to those of the simulation of only market integration. Table 5.9 which presents the macroeconomic effects of an unfinanced enlargement confirms this presumption. For comparison the isolated effects on steady state levels for the customs union and integration experiments are reported in the table as well. The compound effects at the aggregate level appears to comprise of a near linear combination of the isolated effects of the customs union and market integration.

Table 5.9: Compound macroeconomic effects of unfinanced enlargement

	2003	2008	2018	2028	2038	∞	Customs union ∞	Market integration ∞
					—*Basline=100*—			
Real GDP at factor costs	100	100.07	100.11	100.11	100.11	100.12	100.01	100.11
Real private consumption	100	100.59	100.65	100.70	100.73	100.80	100.02	100.77
Labour	100	100.07	100.07	100.07	100.07	100.08	100.00	100.08
Machine capital	100	100.39	100.45	100.45	100.45	100.44	100.02	100.41
Building capital[a]	100	100.06	100.08	100.08	100.08	100.09	100.02	100.07
Value of firm	101.11	100.38	100.38	100.38	100.39	100.40	100.02	100.37
Total household assets	100	100.53	100.73	100.83	100.84	101.13	100.05	101.06
Foreign assets	100	109.81	102.77	102.94	103.50	101.67	100.05	101.60

[a]Excluding dwelling

The projected effects of the unfinanced enlargement scenarion are indeed small. The steady state effect on real GDP amounts only to a modest increase of 0.12 percent of the baseline value. For the aggregate level of real consumption a steady state increase of 0.80 percent is projected. These findings of moderate effects are not surprising given the modest level of trade with the CEE countries. The modest level of the aggregate effects however reflects some degree of sectoral shifts in production as witnessed by table 5.10.

Seeing that the isolated effects of the customs union and market integration almost add up linearly to the compound effect makes it tempting to presume that this property

Table 5.10: Compound effects of customs union and market integration on production

	2003	2008	2018	2028	2038	∞
	Quantity	—*Baseline=100*—				
Agriculture	65.636	99.86	99.88	99.86	99.84	99.82
Energy provision	58.557	99.56	99.29	99.26	99.25	99.24
Construction	152.209	100.30	100.16	100.16	100.16	100.17
Foods	119.820	100.56	100.64	100.64	100.63	100.61
Metal and chemicals	324.317	100.64	100.78	100.78	100.78	100.73
Other manufacturing	118.556	99.48	99.42	99.37	99.35	99.31
Trade and transportation	362.671	100.13	100.18	100.19	100.19	100.21
Other services	383.144	100.07	100.09	100.10	100.11	100.14
Public services	310.413	100.16	100.16	100.16	100.17	100.19

apply at the disaggregate level as well. This however, is not the case for all industries because of the differences in the relative changes of import and export price levels for agriculture and foods in particular. The direct impacts on import and export price levels for goods traded with the CEE is larger from integration than for introduction of the customs union. Therefore we will seek to explain the changes to the effects observed for the market integration experiment.

On the aggregate level addition of the customs union adds to the appreciation of the domestic price level since the customs union affects aggregate GDP positively. This price raise combined with the lowered price levels of imports of agriculture and food goods lead to domestic substitution towards imports from the CEE. With respect to exports in general and to the CEE countries in particular the addition of the customs union in general induce lowered exports because of the domestic aggregate price raise. This general observation is fortified for agriculture with respect to exports to the CEE since the effective price cut on prices faced by CEE customers is lowered by the abolition of EU subsidation. For agriculture the level of exports is hence reduced more than linearly.

Addition of the customs union to the market integration simulation adds to the direct cut of the price of food exports to the CEE countries. Consequently, the increase of export demands faced by the foods industry from CEE countries is enhanced compared to the simulation incorporating only market integration. Increasing export demands lead to increased production in the foods sector, which in turn lead to increased demand for domestic agriculture for use as intermediate goods. In the other direction the cut of the price of competing food imports from the CEE induce increased domestic substitution away from domestically delivered food products. For the food industry the increasing exports to CEE countries dominate the adverse effects on exports to other destinations and total export demands increase by more than the isolated effects of the customs union and market integration. The lowered price of competing imports do direct some domestic demand towards CEE imports especially this goes for demands for material inputs. These adverse effects are not large enough to dominate the positive demand from exports to the CEE and the domestic production of foods consequently rise more than linearly.

The merits of the food industry have large impact on domestic agriculture since agriculture is a major supplier of materials to this industry. The forementioned decrease in total export demands is thus more than offset by positive demand for material use in the food industry. The result is that the contraction of domestic production of agriculture is not as large as that suggested by the simulation incorporating only market integration.

The total effect of the customs union and market integration on trade volumes is presented in table 5.11. Hardly surprising the volumes of trade with the CEE change dramatically. All imports and export volumes traded with CEE countries exhibit large increases although the effects on imports are more expressed. Exports for other regions decline moderately for all industries while changes in imports from other regions than CEE are ambigious and reflect the previously described effects.

Table 5.11: Change to volumes of trade in steady state from custom union enlargement and market integration

	Total exports	Exports to EU	Exports to ROW	Exports to CEE	Imports from EU	Imports from ROW	Imports from CEE
				—Baseline=100—			
Agriculture	99.02	98.80	98.80	111.89	100.27	100.27	170.23
Energy provision	100.54	99.84	99.84	129.03	97.00	97.00	164.26
Construction	—	—	—	—	—	—	—
Foods	101.42	99.08	99.08	150.38	100.17	100.17	215.55
Metal and chemicals	101.95	99.82	99.82	129.00	99.37	99.37	168.28
Other manufacturing	102.53	99.57	99.57	128.68	97.08	97.08	164.41
Trade and transportation	99.85	98.28	98.28	127.01	101.49	101.49	171.88
Other services	99.65	98.08	98.08	126.75	101.62	101.62	172.10
Public services	99.18	97.62	97.62	126.16	—	—	—

5.3.1 Welfare implications

The welfare implications in the unfinanced enlargement scenario are unambigiuosly positive as seen from figure 5.1, which depicts the equivalent variation of the households per adult equivalent by the year of birth of the generation. The welfare gain is larger for young currently living and future generations than for older households. For older generations the welfare gains are the result of lowered consumer prices, increased financial wealth and increased incomes which all increase the purchase power. For young currently living generations the welfare gain is larger than for older generations since these generations will live longer under the improved economic conditions. Finally, future generations are better off since all structural adaption and capital accumulation is complete while they are alive. The aggregate equivalent variation of the unfinanced enlargement amounts to 3.65 pct. of 1998 GDP.

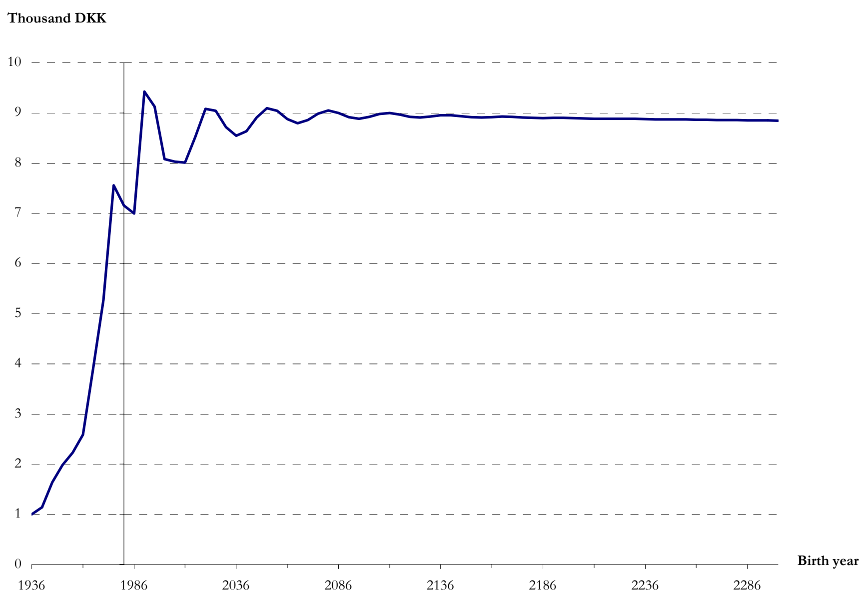

Figure 5.1: Equivalent variation per adult equivalent of unfinanced enlargement.

6 Enlargement

In our framework we are not able to quantify the EU budget implications endogenously and therefore we must resort to other studies of the issue. In Baldwin et al. (1997) the likely total costs of enlargement for present member states are estimated by means of a model of power politics. However the distribution of the budget implications on various types of transfers are not reported in an applicable form. Another econometric analysis of the costs of enlargement and their likely impact on individual incumbent member states is available in Keuschnigg and Kohler (1999). Using an econometric method accredited to Breuss and Schebeck the level of transfers are estimated using historical macroeconomic characteristics of member states as explanatory variables. The econometric study distinguishes between three of transfers: Direct member contributions, receipts from structural funds and finally receipts related to the CAP. Direct member contributions include the GNI and VAT based contributions and the revenues of customs. The budget implications and the effects on the transfers for the present member states are estimated for two scenarios of enlargement corresponding to either the accession of 5 or 10 CEE countries. Given our specification of enlargement the interesting estimates are those for the enlargement by 10 CEE countries. The estimated parameter values are used in four out of sample forecasts of the level of transfers for incumbent and future EU countries, each forecast representing a dataset containing (or forecasting) the macroeconomic characteristics of countries.

We have chosen to implement a forecast of the impact on transfers which implements 1997 figures for the EU15 published by the European Commission and 1995 data for CEE countries. The econometric model does not take regard to the requirement that the EU budget according to Agenda 2000 must balance. A set of policy reactions is therefore specified in order to ensure budget balance in Keuschnigg and Kohler (1999). These reflects alternative routes to funding the budget implications of enlargement and include increased member contributions, lowered transfers related to the CAP, lowered payments from structural funds, and finally a likely combination.

The estimated levels of transfers are reported by type and funding scenario in percent of 1997 GDP and do not coincide with the distribution of EU transfers presented in table

Table 6.1: Estimated impact on transfers in pct. of GDP by method of funding

	Member contribution	CAP transfers	ESF transfer
Increased member contributions	0.326	0	0
Reduced CAP spendings	0	-0.416	0
Reduced ESF spending	0	0	-0.107
Combined financing	0.138	-0.114	-0.031

Source: Keuschnigg and Kohler (1999)

3.2. We will assume however that the absolute change of the estimated level of transfers given unbalanced budget to those given the various methods of balancing are applicable. These changes are listed in table 6.1.

The listed effects on net transfers are estimated using historic data and does not incorporate legislation with respect to qualification for receipts of aid for regional development and subsidiation of agriculture. For instance the planned changes to the budget following from the enlargement is not taken into account. Moreover the estimates presents a static view and does not incorporate any specification of the dynamics of the EU budget. The likely economic catching up of the CEE countries will imply reductions of ESF spending and increased member contributions in the longer run. All these considerations are not taken into account and therefore our cost estimates are naturally prone to uncertainty.

For a given funding scenario the balancing of the EU budget is enforced by calculating the required total change to expenditures or revenues of the transfer(s) affected in the scenario. This change is then distributed across member states such that the transfer for each country is reduced or increased by the same percentage. Given this method the ESF scenario is the cheapest while the CAP scenario is the most expensive reflecting the size of transfers related to these programmes for Denmark. Since ESF spending reductions are integral parts of the combined funding scenario, this scenario is the next cheapest alternative for Denmark. By cutting the expenditures for regional and structural development the EU budget may be financed by more moderate reductions of CAP spendings and increases of direct member contributions. The CAP and GNI financed enlargement scenarios are the most expensive for Denmark. The design of the cost estimates is also for the implicit redistribution of EU budget spending across member states problematic and politically unrealistic.

To quantify the effects of enlargement and the reduced net transfers from the EU we apply four simulations corresponding to the financing method listed above. In all these four experiments we specify introduction of the customs union and the integration of markets and apply the same debt-targeting domestic fiscal policy used until now. For the increased member contribution and the scenario in which ESF spendings are reduced the costs of enlargement lies on the government. In the other two experiments agriculture will bear all or some of the costs.

6.1 Increased member contributions

When increasing the member contribution we must take into account which of the direct payments to the EU is to be increased. The direct payments include the GNI and VAT contributions and customs revenues. Since the EU is effectively prohibited from raising customs barriers towards the rest of the world by WTO agreements only the GNI and VAT contributions are viable instruments for covering the costs of enlargement. We choose to let the GNI contribution reflect the increased member contribution. Technically we determine the ratio of GNI to be paid by determination of the change to the ratio τ_t^{GNI} that ensures that the level of member contributions to the EU in percent of baseline GDP in 2004 increases by the 0.326 percent required according to table 6.1[1]. The increased GNI-based member constribution is increased from 2004 onwards along with the introduction the enlarged customs union and the removal of the real frictions to trade. In the following presentation of the effects of the increased GNI contribution we comment changes to the effects found for the unfinanced enlargement but tables lists the effects by the change from the baseline.

6.1.1 Macroeconomics

As noted the increase of the GNI member contribution lies entirely on the government which must increase the level of income taxation in order to meet its obligations to the EU. Increasing the level of taxation causes the purchase power of the private sector to diminish and in turn reduces aggregate private consumption. Moreover the increased taxation of income causes the households to reduce their labour supply. The increase of the base income tax rate imply that the rate of taxation of wage income and unemployment benefits increase by the same number of points. However, since the wage income per time unit is larger than that granted as unemployment benefits, the absolute change of the

[1] Since GDP and GNI will change already in 2004 this method is not completely innocent.

real reward of labour supply will decline for an increase of the base income tax rate. The lowered labour supply affects output negatively and obviously most so for industries using labour intensive production technologies.

The increased level of income taxation implies lowered labour supply amounting to a negative supply side effect. The lowered labour supply and the increased level of income taxation implies lowered levels of income such that domestic demand for consumption detoriates. The combination of these effects imply a lowered level of production and a decrease of the aggregate price levels. A modifying effect to the aggregate production is achieved from the increase in export demands that follows from the lowered domestic price level. Declining production is however not the outcome for all industries as we shall see shortly.

The macroeconomic effects of enlargement financed via increased GNI contributions for a debt-targeting domestic fiscal policy are summarized in table 6.2 along with the effects of an unfinanced enlargement.

Table 6.2: Macroeconomic effects of GNI financed enlargement

							Unfinanced
	2003	2008	2018	2028	2038	∞	∞
				—Baseline=100—			
Real GDP at factor costs	100	99.98	99.94	99.94	99.94	99.95	100.12
Real private consumption	100	99.72	99.59	99.57	99.58	99.63	100.80
Labour	100	99.94	99.94	99.94	99.94	99.95	100.08
Machine capital	100	100.37	100.42	100.42	100.43	100.42	100.44
Building capital[a]	100	100.01	99.97	99.96	99.97	99.97	100.09
Value of firm	100.19	100.00	99.87	99.89	99.91	99.90	100.40
Total household assets	100	99.49	99.27	99.12	99.09	99.47	101.13
Foreign assets	100	116.70	102.48	102.33	102.87	101.57	101.67

[a]Excluding dwelling

6.1.2 Sectoral shifts

Decreasing private consumption affects the domestic demand faced by the industries energy provision, foods, trade and transportation and other services since these industries rely on private consumption to a relatively large extent. Moreover the decreasing level of consumption also implies lowered dwelling consumption which means that construction faces decreasing demand for residential buildings and products used for maintenance and repairs. Oppositely the demand faced by industries relying relatively much on exports will rise due to the smaller rise of the domestic price level.

Table 6.3: Effect on domestic price levels of GNI financed enlargement

	2003	2008	2018	2028	2038	∞	Unfinanced ∞
				—Baseline=100 —			
Agriculture	100	100.09	100.09	100.09	100.08	100.08	100.24
Energy provision	100	99.76	99.86	99.88	99.88	99.88	100.03
Construction	100	100.06	100.11	100.10	100.10	100.10	100.26
Foods	100	100.07	100.05	100.04	100.03	100.03	100.18
Metal and chemicals	100	99.95	99.92	99.92	99.91	99.91	100.04
Other manufacturing	100	99.92	99.95	99.94	99.94	99.94	100.09
Trade and transportation	100	100.13	100.17	100.16	100.15	100.15	100.35
Other services	100	100.15	100.20	100.19	100.19	100.19	100.39
Public services	100	100.23	100.28	100.27	100.27	100.27	100.48
Dwelling	100	99.08	99.87	99.89	99.89	99.88	100.38

This relative increase of exports is important particularly for foods, metals and chemicals and other manufacturing. For these industries the relatively heavy orientation towards export markets imply that the adverse effects on domestic demand may be compensated for on export markets leaving the industries at a higher activity level than in the unfinanced enlargement scenario. In the industries trade and transportation and other services the relative reduction of domestic demand dominates the relative increase in exports and consquently these industries are faced with harder conditions than in the unfinanced scenario. Also the demand for energy provision goods increase from a relative increase of exports and is not as hard hit by lowered domestic demand for energy inputs to production. Agriculture grows because of the relative expansion of the food industry due to increased demand for their product for use as intermediate inputs in this industry. The effects on production and demand categories are listed in table C.5 in the appendix.

6.1.3 Effects on volumes of trade

The effects on traded volumes of the GNI funding of costs are best understood from the shift in domestic price levels that follows from the reductions of domestic activities. Since the domestic price changes are affected downwards relative to the unfinanced enlargement scenario, imports of competing products are somewhat lower. This reduction of the level of imports affect all imports regardless of product or origin. Especially imports of goods for consumption are affected due to the lowered after tax income of households. Imports of intermediate goods are also affected but not to the same extent since the material intensive domestic manufacturing industries respond by a relative increase of their level of production. With respect to exports the general impact of the introduction of the increased GNI member contribution is increased exports. For all goods the domestic price is lowered relative to the unfinanced scenario and consequently export demands unambigiously increase relatively. Table 6.4 summarizes the effects on trade volumes of a GNI funded enlargement.

Table 6.4: Volumes of trade in steady state given GNI financed enlargement

	Total exports	Exports to EU	Exports to ROW	Exports to CEE	Imports from EU	Imports from ROW	Imports from CEE
				—Baseline=100—			
Agriculture	99.81	99.59	99.59	112.78	99.44	99.44	168.83
Energy provision	101.33	100.63	100.63	130.04	96.80	96.80	163.93
Foods	102.18	99.83	99.83	151.51	99.36	99.36	213.81
Metal and chemicals	102.59	100.44	100.44	129.81	99.07	99.07	167.78
Other manufacturing	103.28	100.30	100.30	129.63	96.20	96.20	162.92
Trade and transportation	100.82	99.23	99.23	128.24	100.80	100.80	170.71
Other services	100.63	99.05	99.05	128.01	100.75	100.75	170.62
Public services	100.26	98.68	98.68	127.53	—	—	—

6.1.4 The government budget

When the impact of enlargement to the EU budget is funded by increased GNI contributions this expenditure as previously explained lies on the government. Prior to enlargement the GNI contribution amounted to 0.49 percent of GNI or 0.48 percent of GDP. After enlargement the increased level of member contributions lead to a GNI contribution amounting to 0.82 percent of GNI or 0.81 percent of GDP in 2004 just after the implementation of the enlargement. In steady state however, the percentage of GDP paid as GNI dependent member contributions is increased to 0.85 reflecting the increaed interest income from claims on foreign assets which is included in the definition of GNI.

The government finances the increased level of the GNI contribution by adjusting the wage income tax each period adapting to a debt-targeting fiscal policy as previously explained. In figure 6.1 the absolute change to the base tax is illustrated. The general increase in

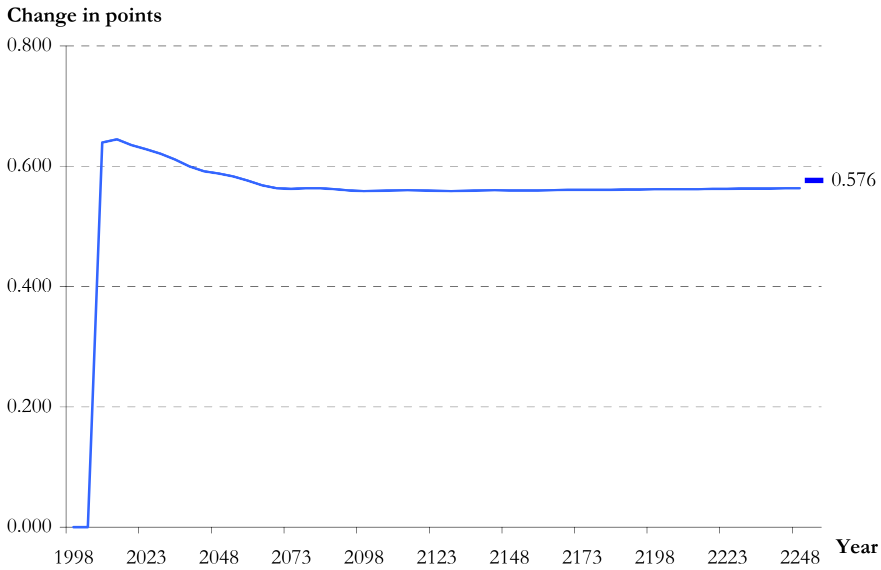

Figure 6.1: Change in base tax rate in GNI financed enlargement scenario. Steady state change indicated.

the wage tax rate is bound in the fact that the positive effects of enlargement to tax revenues are not sufficient to offset the increased pressure on the government budget from the increased GNI contribution. In view of the moderate macroeconomic effects of enlargement compared to the relatively large impact of the increased member contribution this general increase of the base tax seem reasonable. The large initial increase in the wage tax is caused by the fact that the GNI member contribution is increased immediately in 2008 whereas the positive effects of enlargement on tax revenues occur only gradually as the transition of production to the new economic environment is completed. Over time the revenues from taxation improves slightly leaving room for reductions of the wage tax. In the long run the claims on foreign assets accumulate and GNI increase more than GDP. This implies that the GNI contribution increase in terms of GDP and this leads to an upward pressure on the base tax.

6.1.5 Welfare implications of enlargement financed by member contributions

The equivalent variation per adult equivalent in the GNI based enlargement scenario is illustrated in figure 6.2. We comment on the welfare implications from the shift from the baseline scenario to the GNI funded enlargement scenario. Potentially, lowered consumer prices from price cuts on imports from the CEE are welfare improving. These positive implications are however offset by the negative welfare implications of increased income taxation and the lowered domestic activity level.

The generations entering the economy in the years from 1998 to 2058 are those affected most negatively by the GNI financed enlargement. This is due to the relatively high level of income taxation in the years from 2008 to 2068 required to finance the pressure on the domestic fiscal policy. Comparing the equivalent variation of generations to the change in the level of income taxation are depicted in figure 6.1 reveals this coherence, which is bound in the lowered purchase power following from increased income taxation. Younger generations living in 2008 (which entered the economy after 1998) are those worst off, since they experience increased income taxation throughout their worklife and especially in the years from 2008 to 2038. After 2156 the welfare loss starts to increase again due to the required increase in the GNI contribution caused by the relative increase in GNI compared to GDP.

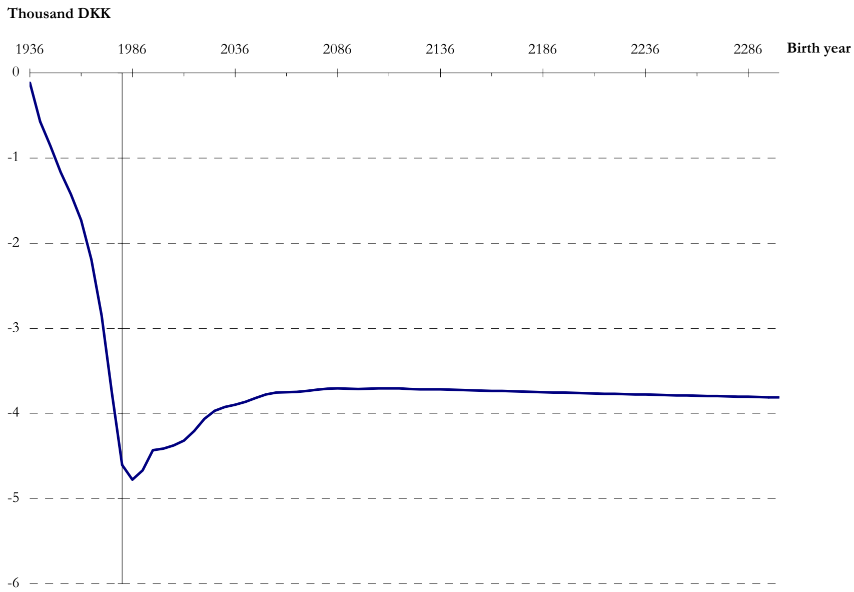

Figure 6.2: Equivalent variation per adult equivalent in GNI financed enlargement scenario.

The generation that suffer the largest welfare loss is born in 1986 and becoming economically active in 2003. At the time of enlargement the individuals of this generation are between 23 and 28 years old. One might suspect that the generation entering the economy at the time of enlargement would suffer a larger loss but the profile of wage earnings over the worklife of individuals peak when individuals are in the midsts of their forties. The period of high incomes and high income taxation coincide for the generation becoming economically active in 2003.

In general the older a generation is at the time of enlargement the smaller the welfare loss is. This is off course result of the fact that the number of years with high level of income taxation is decreasing in the remaining lifespan. The aggregate welfare loss of the GNI financed enlargement measured primo 1998 amounts to bill. DKK. 21.51 equivalent to 1.85 percent of GDP.

6.2 Reduced CAP spendings

As a second method for financing enlargement the EU may resort to a more modest common agriculture policy. Given the large rural sectors in the CEE countries admission of these countries to the CAP would dramatically inflate the EU budget. Therefore a sustained level of subsidiation of agriculture is not a viable alternative in the longer term. In Keuschnigg and Kohler (1999) the costs of fully funding the enlargement by reductions in CAP spendings are estimated and reported to imply a reduction of total transfers related to subsidiation of agriculture of 0.416 percent of GDP for Denmark.

This decrease of CAP related transfers enter the model via reduced subsidiation of materials and land used in domestic agriculture. The CAP related transfers are reduced from bill. DKK. 6.27 in 2003 to bill DKK. 1.13 in 2004. We assume that the reduction affects the land and material subsidies proportionally such that the subsiduation rate of land declines from 18.4 percent to 3.7 percent and that the subsidiation rate of materials declines from 13.2 to 2.6 percent.

6.2.1 Economic consequences

Financing EU enlargement entirely by reduced CAP spendings is the method that implies the largest reduction of the net transfer to Denmark as seen in table 6.1. Moreover the entire cost lies on a single industry and an educated guess would be that this method of financing the enlargement is the one that require the largest sectoral shift in Danish production structure. The costs of land and materials used in rural production will rise causing the domestic price of agriculture products to rise and the level of production to decline. Since domestic agriculture is a major supplier of intermediate goods used in food production the costs of food production rise as well. We comment on the effects seen in relation to those of the unfinanced enlargement scenario.

Table 6.5: Macroeconomic effects of CAP financed enlargement

	2003	2008	2018	2028	2038	∞	Unfinanced ∞
				—*Baseline=100*—			
Real GDP at factor costs	100	99.91	99.86	99.86	99.87	99.88	100.12
Real private consumption	100	99.38	99.47	99.56	99.63	99.76	100.80
Labour	100	99.92	99.96	99.97	99.97	99.98	100.08
Machine capital	100	99.78	99.72	99.71	99.72	99.71	100.44
Building capital[a]	100	99.48	99.21	99.17	99.18	99.20	100.09
Value of firm	89.08	94.92	95.02	95.13	95.25	95.43	100.40
Total household assets	98	98.40	98.67	98.96	99.15	99.56	101.13
Foreign assets	100	163.84	108.88	107.58	108.35	103.25	101.67

[a]Excluding dwelling

The immediate consequence of the decline in the production of agriculture and foods is a decline in the aggregate demand for labour, which given the level of labour supply drives down the wage rate. This reduce the unit costs of production for domestic industries leading to an outward shift of aggregate supply[2]. The lowered costs of production tends to lower the price level of domestically produced goods and in the event that a demand exists industries will expand their production. The demand for home products (construction and other services) will decline due to lowered private consumption. The export oriented industries will face increased demands for exports by the lowered domestic price level. Employment in energy provision, metals and chemicals, other manufacturing and trade and transportation will consequently increase to a level that almost offsets the lay offs in foods and agriculture.

The reduced activity of agriculture and foods will give rise to depreciation of the aggregate value of firms and since households place part of their financial income in shares they will experience a loss of financial wealth. In addition the lowered domestic activity level implies reduced labour incomes. This leads to declining private consumption and in turn reduced demand for domestically produced goods used in private consumption. The initial decline of consumption is larger than the long run decline. This is the result of

[2]In DREAM it is not possible to derive an explicit aggregate supply curve (see Knudsen et al. (1998a)). However as an abstract construct the concept of an aggregate supply curve serves to ease the interpretation of results.

the transition mechanism that households experiencing the negative impact on financial wealth are dissolved in the longer run. Aggregate consumption hence regain pace as the number of households that where alive in 2004 decline.

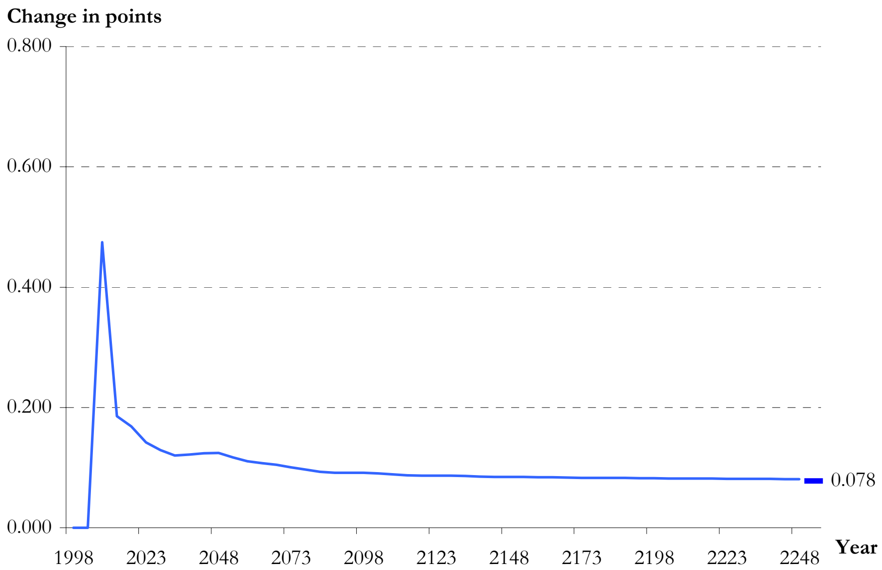

Figure 6.3: Change in base tax rate in CAP financed enlargement scenario. Steady state change indicated

The aggregate depreciation of the value of firms lead to lowered revenues of capital income taxation from households and pension funds as well. In addition the lowered level of consumption leads to recessive revenues from value added taxation. These two negative impacts on government revenues occur immediately and require a relatively large increase in the income tax in order to balance the budget given the debt-targeting fiscal policy. In the longer run the revenues from capital income and value added taxation improve as new households enter the economy and aggregate consumption and savings start to increase again. The base tax therefore decline gradually after the initial peak to end at a steady state level approximately 0.08 points above the baseline level. The required change to the base tax is illustrated in figure 6.3.

6.2.2 Welfare impacts of a CAP financed enlargement

The equivalent variation per adult equivalent of the CAP funded enlargement scenario is illustrated in figure 6.4. All generations suffer a welfare loss and the total equivalent variation amounts to a loss of bill. DKK. 25.82 corresponding to 2.22 percent of 1998 GDP.

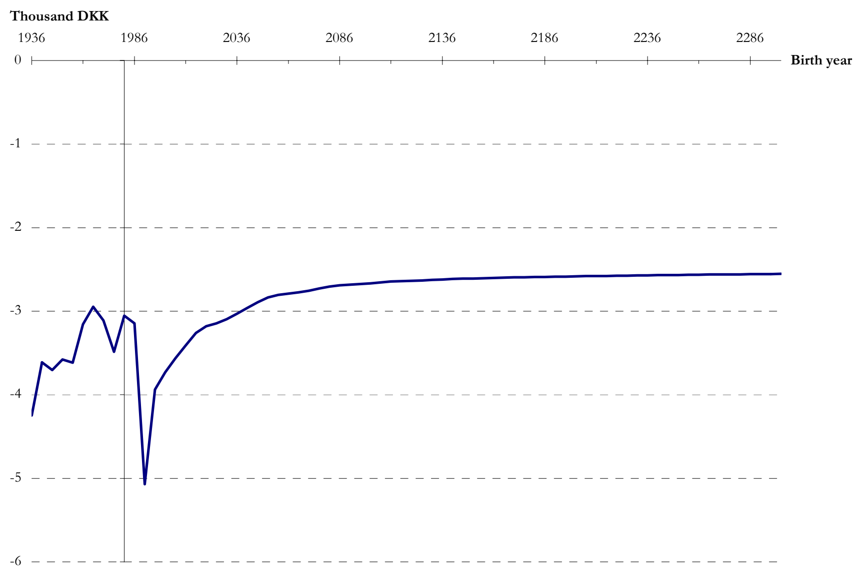

Figure 6.4: Equivalent variation per adult equivalent in CAP financed enlargement scenario.

For the generations entering the economy after the enlargement (generations born after 1991) we observe that the welfare loss decrease the later the generation is born. This property is the consequence of the high initial rise of the wage income tax. As the level of income taxation decrease the welfare loss of new generations diminish. The generation entering the economy in 2008 (the one born in 1991) is remarkably worse off than other initially young generations[3]. In general generations alive at the time of enlargement are worse off than future generations.

[3]Young generations holds negative financial wealth and positive wealth in real estate. In this experiment a decline of the value of the real estate is present and given the fixed portfolio of stocks and bonds, declines of the value of stocks will therefore imply a reduction of the value of financial debts. In the implementation of the model generations by convention have no financial wealth placed in stocks in the period where it become economically active and thus the generation born in 1991 does not benefit from the reduction of the value of its financial debts.

6.3 Reduced ESF spendings

Like it is the case for the GNI financed enlargement the cuts of transfers from the European structural funds (ESF) lies on the government. As such the effects of this method of funding are quite similar to those applying for the enlargement scenario financed by increaesed GNI based member contributions, although the amount of 0.107 is remarkably smaller than in the scenario financed by increased GNI contributions.

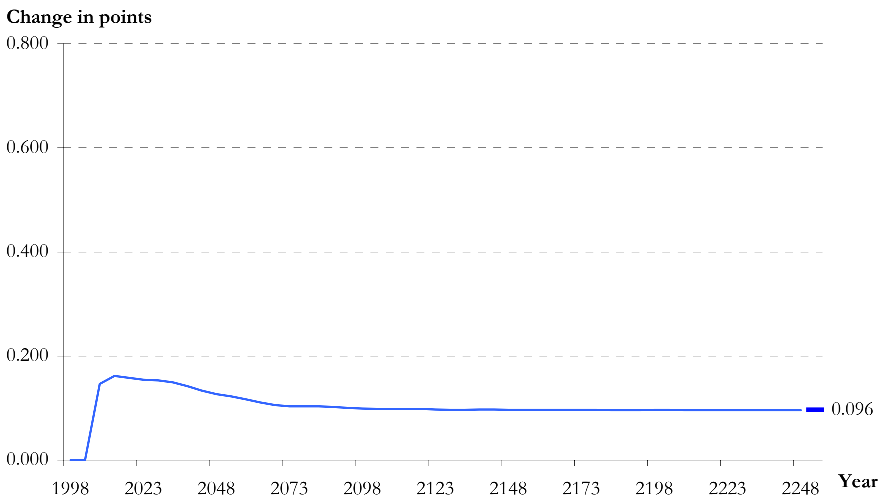

Figure 6.5: Change in base tax rate in ESF financed enlargement scenario. Steady state change indicated

A worsening of the government budget due to cuts of ESF transfers will lead to the development of the wage tax illustrated in figure 6.5. Just as it is the case and for the same reasons as in the scenario of increased GNI member contributions, the required increase in the wage tax is large initially and subsequently lower as the positive impact of enlargement propagates troughout the economy. Contrary to the scenario of reduced GNI based member contributions the long run base tax is not required to increase again. This difference is caused by the fact that the impact on the government budget is independent of the accumulation of foreign asset claims in the ESF policy scenario.

6.3.1 Macroeconomics

The macroeconomic effects of enlargement financed by reductions of ESF spending are summarized in table 6.6.

Table 6.6: Macroeconomic effects of ESF financed enlargement

	2003	2008	2018	2028	2038	∞	Unfinanced ∞
				—Baseline=100—			
Real GDP at factor costs	100	100.04	100.05	100.05	100.06	100.07	100.12
Real private consumption	100	100.30	100.31	100.33	100.36	100.45	100.80
Labour	100	100.03	100.03	100.03	100.03	100.04	100.08
Machine capital	100	100.38	100.44	100.44	100.44	100.43	100.44
Building capital[a]	100	100.05	100.04	100.04	100.04	100.05	100.09
Value of firm	100.81	100.25	100.22	100.22	100.23	100.25	100.40
Total household assets	100	100.19	100.25	100.27	100.26	100.61	101.13
Foreign assets	100	111.70	102.63	102.72	103.25	101.62	101.67

[a]Excluding dwelling

The increase of the base tax will lower the incentives to supply labour and consequently the aggregate labour supply is lowered compared to the unfinanced enlargement. Lowered supply of labour will lower employment and since the desired capital-labour ratio is relatively unaffected capital inputs and production decline. Lowered activity and higher income taxation will reduce household purchase power. The lowered household income reduce aggregate savings and thereby total household assets and this in turn implies lowered foreign asset accumulation.

The effects on the production structure of the reduced ESF transfer seen in relation to the unfinanced enlargement are very moderate. Therefore we will not present these but please refer to table C.7 in the appendix for the results.

6.3.2 Welfare impacts of the ESF funded enlargement

In figure 6.6 the equivalent variation of generations for the ESF financed enlargement is illustrated. We observe that all generations benefit from an ESF financed enlargement.

Due to the lowered price of CEE products and the increasing employment (compared to the baseline) human capital appreciates. Although the imports from the CEE countries are moderate, the import price cut which amount to approximately 10 percent dominates the activity induced raise of domestic prices. In the other direction raised income taxation

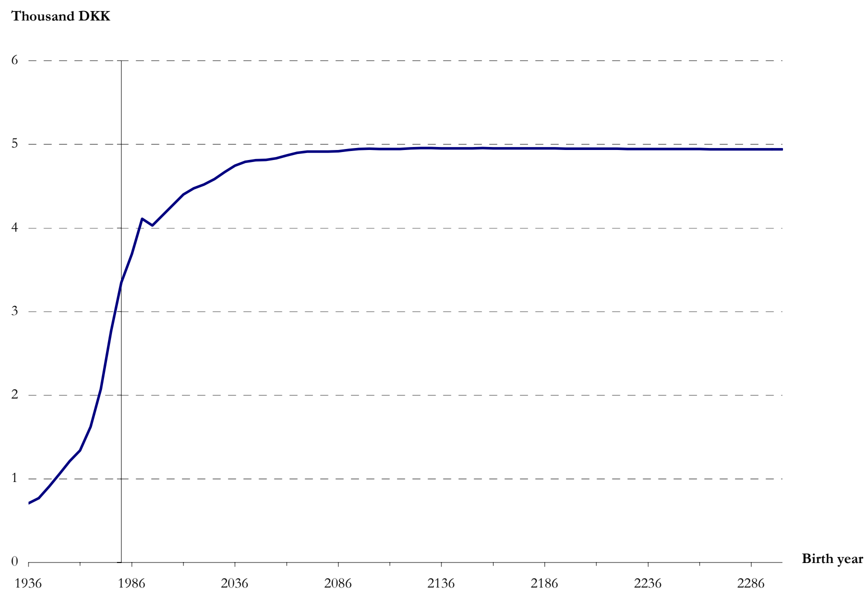

Figure 6.6: Equivalent variation per adult equivalent in ESF financed enlargement scenario.

will affect human capital negatively. Since the required increase in the income taxation is small the net effect is increasing human capital. From figure 6.6 we observe that the increase of human capital is not uniform across generations. The general pattern of who is relatively better off is the opposite as that found for the GNI financed enlargement: The benefits are largest for younger currently living generations and smaller for elderly households.

For households alive prior to 1981 we observe that the gains of the ESF funded enlargement decrease in the age of the household. This observation should be explained by the fact that the benefits of lowered consumer prices increase in the length of remaining lifespan. The aggregate welfare improvement amounts to 21.06 bill. DKK. corresponding to 1.81 percent of 1998 of GDP.

6.4 Combined financing

As a final scenario for the policies adapted by the EU for financing the budget implications of enlargement we implement a policy combining increased member contributions and cuts to the spendings of the ESF and the CAP. The impact on the net transfers to the EU amounts to a total of 0.283 percent of GDP. The change to individual transfers are listed in table 6.1.

6.4.1 Macroeconomic effects

The cuts to CAP expenditures are somewhat smaller than in the scenario of full funding via the CAP. Therefore more moderate effects on the structure of production should be expected. The partial effect of cuts to CAP spendings are as explained in subsection 6.2 and amounts to a shift in the structure of production towards export oriented industries. The immediate reduction of labour demand in the industries agriculture and foods lowers the wage rate and hence the unit costs of production. In addition the decline in other net transfers from the EU reduce the national income. On the aggregate level, domestic demand will therefore be reduced. The lowered domestic price level on the other hand leads to increased demand for exports. The net effect on aggregate GDP is a reduction and thus also aggregate consumption is reduced.

Table 6.7: Macroeconomic effects of enlargement financed by a combined EU policy

	2003	2008	2018	2028	2038	∞	Unfinanced ∞
				—Baseline=100—			
Real GDP at factor costs	100	99.98	99.95	99.95	99.95	99.96	100.12
Real private consumption	100	99.80	99.77	99.79	99.82	99.91	100.80
Labour	100	99.96	99.97	99.97	99.98	99.98	100.08
Machine capital	100	100.20	100.22	100.22	100.23	100.22	100.44
Building capital[a]	100	99.87	99.77	99.76	99.77	99.78	100.09
Value of firm	97.28	98.66	98.63	98.67	98.72	98.76	100.40
Total household assets	99	99.39	99.39	99.42	99.45	99.82	101.13
Foreign assets	100	128.62	104.31	103.89	104.48	102.03	101.67

[a]Excluding dwelling

The effects of increased member contributions and cuts to the ESF are very similar since these reductions of the net transfer from EU lie on the government. As previously explained the required response is an increase in the wage tax, which will reduce the aggregate private demands. This reduction of domestic purchase power primarily affects domestically oriented industries leading to a reduction of their level of production. The lowered level of production and prices in domestically oriented industries lowers the aggregate price level and this price cut leads to increasing demands for exports. The outcome is an improvement of the level activity in export oriented industries.

The combination of the mentioned effects of the Danish contribution to the funding of enlargement imply a decline in the production of agriculture and foods. The recessive impact on these two industries are however not as dramatic as in the scenario in which enlargement is financed entirely by cuts to CAP spendings. The production of exported goods increase and production in home market industries decline. Table 6.5 summarize the macroeconomic effects. From this table we observe a less dramatic reduction of real GDP than in the scenario using reductions of CAP spendings for funding enlargement. Consequently, the depreciation of the aggregate firm value is somewhat smaller and the initial decline of aggregate consumption is therefore also somewhat smaller. Please refer to table C.8 in appendix for a listing of effects on individual industries.

6.4.2 The development of the base tax

The initial decline of revenues from capital income and value added taxation imply an initial increase of the base tax higher than the 0.29 point required for the long run. The negative impact of increased net transfers to the EU to the government budget thus dominate the gain in revenues from the introduction of the customs union and the positive single market effects. The required change to the base tax is illustrated in figure 6.7.

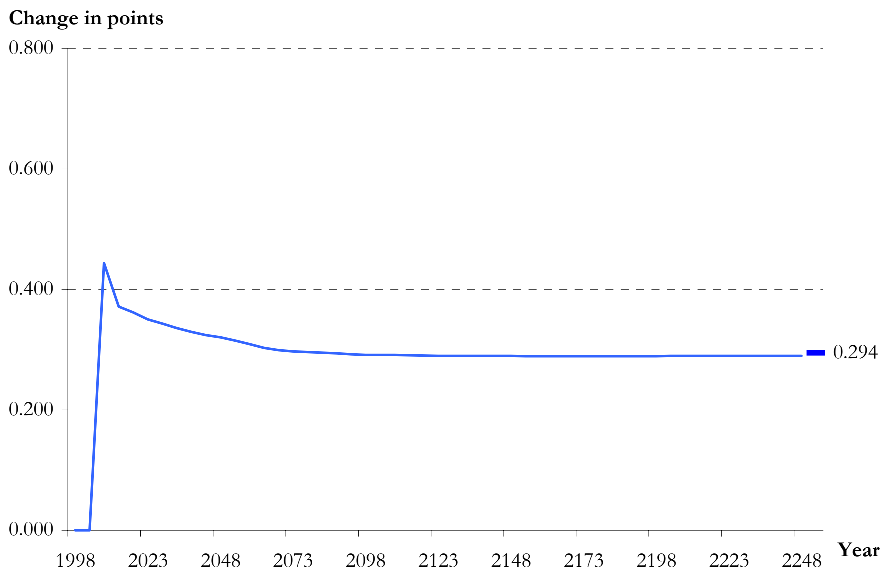

Figure 6.7: Change in base tax rate by enlargement financed by combination of sources. Steady state change indicated

The development of the base tax should be understood by the same line of reasoning presented for the CAP financed enlargement scenario in section 6.2 at page 114.

6.4.3 Welfare implications

Enlargement financed by combining increased member contributions and cuts to CAP and ESF spendings imply an aggregate welfare loss of bill. DKK. 10.18 corresponding to 0.87 percent of 1998 GDP. Again a loss of welfare as measured by the equivalent variation per adult equivalent is experienced for all generations including future ones (see figure 6.8). The increase of households purchase power from the lowered price of imports from CEE inherent in enlargement is dominated by the effects of the increase in the net transfers to the EU.

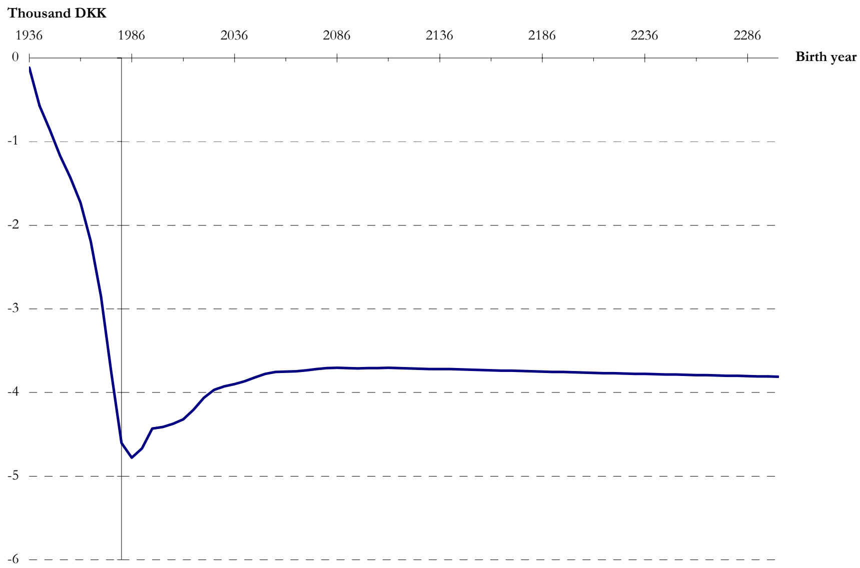

Figure 6.8: Equivalent variation per adult equivalent in combined financing of enlargement.

Again we observe that although all generations who become active at or later than the introduction of the enlarged EU suffer a welfare loss, the loss is not uniformly distributed across time of birth. For generations becoming active after 2008 (generations born after 1991) we observe decreasing losses of welfare in time of birth. Again this observation is to be explained by the fact that the required wage tax decrease over time. Future generations hence suffer a loss of human capital from income taxation smaller than that applying to young currently active generations.

The generation experiencing the largest loss of welfare is that born in 1991, that is the generation that becomes economically active in the period where enlargement is implemented. Again this large loss is to be explained from the absent decrease of the value of financial debts along the same line of reasoning applying for the CAP funded enlargement scenario.

For currently living generations born prior to 1981 a clear correspondance between time of birth and the experienced welfare loss is observed. Again this simply reflect that fact that elderly individuals are not going to experience as may periods of high income taxation as younger individuals.

6.5 Comparing impacts of EU financing policies

In this section we will compare the differences of impacts from the different scenarios corresponding to funding methods available to the EU. We will refer to the funded scenarios by the net transfer which is reduced. The scenario in which all sorts of net transfers from the EU are affected is arguably the most realistic outcome for EU budget policy responses to enlargement. Therefore we will refer to this financing scenario as the basecase.

6.5.1 Danish contribution to enlargement expenditures

First and foremost differences of the effects of the five enlargement scenarios are bound in different direct impacts to the net transfer from EU. Figure 6.9 displays the absolute level of net transfers from the EU by scenario.

There is no simple correspondance from the ranking of scenarios by level of increased transfers to the required increase in the base tax rate for the given debt target. The GNI and ESF scenarios directly affects the government budget, whereas the CAP and the combined funding scenarios imply that part of the reduction of transfers are financed by increased costs of production in agriculture. Actually the most expensive enlargement scenario (CAP) is the one requiring the lowest increase of the steady state base tax rate. This property is not as counterintuitive as it may appear at first. In the CAP scenario government revenues from taxation diminish as the consequence of lowered domestic activity and not directly by reduced transfers from the EU. The majority of the costs of

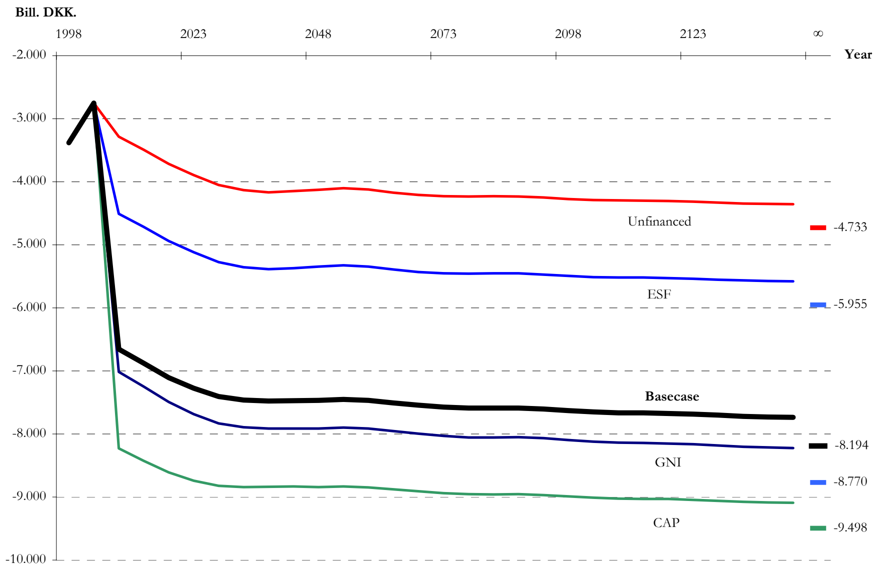

Figure 6.9: Net transfers from the EU by funding method of enlargement. Steady state value indicated

enlargement to the government therefore occur during the transition to the new production structure which occur in the short and medium term. Figure 6.10 summarizes the required base tax rate given by the debt-targeting fiscal policy and also provides insights to the timing of the ramifications to the government budget.

6.5.2 Macroeconomics

Table 6.8 compares the effects on macroeconomic indicators in steady state and total equivalent variation of the alternative scenarios for funding the enlargement available to the EU. For the two scenarios in which the Danish contributions to enlargement lie entirely on the government (GNI and ESF) we find opposite effects on the domestic level of activity. For the ESF scenario the negative impacts to domestic activity from increased wage taxation are small enough to allow the positive effects of enlargement to dominate. The ESF scenario is the only funded scenario that this property apply to. The more expensive GNI scenario on the other hand imply a reduction of the domestic activity.

For the two scenarios affecting the costs of production in agriculture and implicitly foods, we find that the reduction of real GDP depends crucially of the extent to which subsidiation is reduced. In the combined scenario a smaller reduction of the subsidies are

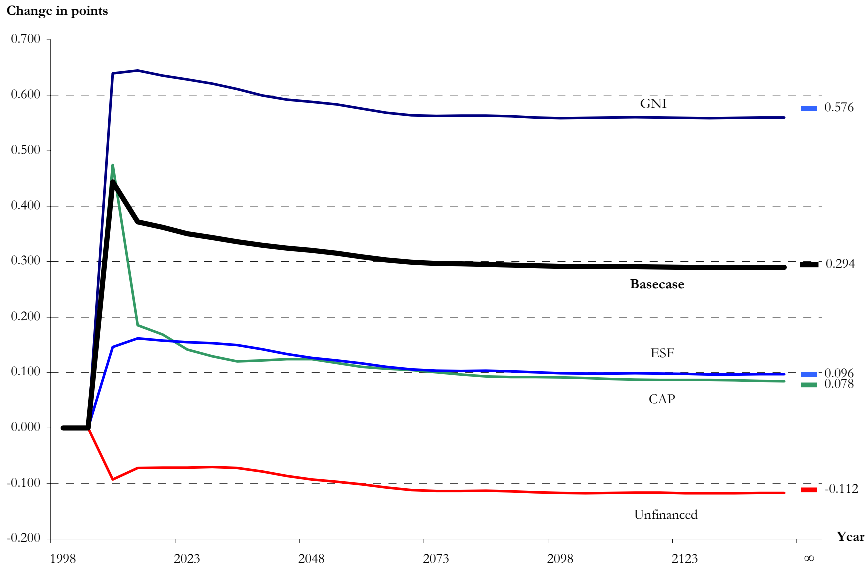

Figure 6.10: Changes to base tax rate by scenario. Steady state change indicated.

required, and hence the sectoral shift is smaller than in the CAP scenario. Obviously the more moderate recessive impact of the combined scenario is also the result of the fact that the total increase in the net transfer to the EU is somewhat smaller than for the CAP funded scenario.

The level of employment depends crucially on the level of income taxation, since high levels of income taxation drives down labour supply. Therefore it is hardly surprising that the GNI scenario that require the largest increase in the wage tax is also the scenario in which employment is affected most negatively. In the ESF scenario we find steady state employment to be higher than in the CAP scenario although the wage tax increase is larger. This is clearly the result of the increased level of domestic activity which lead to higher real wages after tax given the moderate increase in the income taxation required in this scenario. Finally, we find the effects on employment of the basecase and CAP scenarios to be identical even given the lower long run level of income taxation required in the CAP scenario. This seemingly counterintuitive observation reflects that aggregate production shift towards more labour intensive technologies in the CAP scenario.

The projected macroeconomic effects of the funded enlargement scenarios are small. Given the relative importance of the method of funding one should proceed with caution before drawing strong conclusions with respect to the likely macroeconomic impacts of the east

Table 6.8: Macroeconomic effects in steady state by scenario

	Unfinanced enlargement	GNI contribution	CAP spendings	ESF spendings	Combined policy
			—Baseline=100—		
Real GDP at factor costs	100.12	99.95	99.88	100.07	99.96
Real private consumption	100.80	99.63	99.76	100.45	99.91
Labour	100.08	99.95	99.98	100.04	99.98
Machine capital	100.44	100.42	99.71	100.43	100.22
Building capital[a]	100.09	99.97	99.20	100.05	99.78
Value of firm	100.40	99.90	95.43	100.25	98.76
Total household assets	101.13	99.47	99.56	100.61	99.82
Foreign assets	101.67	101.57	103.25	101.62	102.03
Total EV[b]	3.65	-1.85	-2.21	1.81	- 0.87

[a]Excluding dwelling
[b]Pct. of 1998 GDP

enlargement from a Danish perspective.

6.5.3 Production structure

The steady state effects on the production in the industries is summarized in table 6.9. For changes to the demand structure of industries in steady state please refer to table C.9 in the appendix. By comparing the effects in the GNI scenario to those of the unfinanced scenario, we achieve insights into the effects of an increased level of income taxation on the production structure. Increasing the wage tax reduces the purchase power of households and lowers domestic demand. As previously explained the domestic aggregate price level declines somewhat in the GNI scenario. The effects of introducing increased member contributions is therefore that the reduced domestic demand faced by construction, trade and transportation and other services leads to lowered production in these industries. For export oriented industries the lowered domestic price level imply increased levels of exports. Therefore energy provision, foods, metals and chemicals and other manufacturing end up being relatively better off than in the unfinanced scenario. The increased level of production in foods in turn imply that agriculture experience increased demand for its products.

In view of the effects of the GNI scenario we observe similar composition of effects in the ESF scenario compared to the unfinanced scenario. Changes to the production structure constitute similar shifts although the effects in the ESF scenario are much more moderate. For both the ESF and GNI scenarios we thus observe that domestically oriented industries such as construction and other services suffer more from the increased level of income taxation than does the remaining industries, that are able to exploit the domestic price cut on export markets. Since domestically oriented industries in general are more labour intensive we observe a tendency to more capital intensive aggregate production for these two scenarios. This may be seen from table 6.8 in which we observe that the use of machinery increase relative to employment.

Table 6.9: Effects on production in steady state of the various financing methods

	Baseline 2003	Unfinanced enlargement	GNI contribution	CAP spendings	ESF spendings	Combined policy
	Quantity			*—Baseline=100—*		
Agriculture	65.636	99.82	100.20	86.88	99.94	96.26
Energy provision	58.557	99.24	99.26	100.01	99.24	99.47
Construction	152.209	100.17	99.73	99.62	100.04	99.79
Foods	119.820	100.61	100.90	94.01	100.70	98.90
Metal and chemicals	324.317	100.73	101.20	102.76	100.88	101.55
Other manufacturing	118.556	99.31	99.66	101.43	99.41	100.10
Trade and transportation	362.671	100.21	100.01	100.65	100.15	100.24
Other services	383.144	100.14	99.74	99.90	100.02	99.86
Public services	310.413	100.19	99.93	99.78	100.11	99.94

For the CAP and combined funding of enlargement the direct impact on the costs of production in agriculture and thereby in the food industry causes the production of these industries to decline. For the CAP scenario we observe a dramatic decline in the production in agriculture of approximately 13 percent of the baseline level. For the basecase funding scenario the cut to subsidies are lower and therefore the recessive impact on agriculture amounts to a more moderate 4 percent. The lowered production in agriculture and foods imply a lowered aggregate demand for labour which for a given labour supply drives down the wage rate. This in turn imply that industries using relatively labour intensive technologies experience lowered unit costs of production and that they may reduce their output price. Such price cuts generate increased demands for exports and more moderate competition from imported product alternatives.

Just as it is the case on the aggregate the projected effects of funded enlargement leads to relatively small sectoral shifts in the production structure. The only industries that are projected to be subject to large effects are agriculture and the foods industry and this is only the case for the scenarios that involves changes to the CAP.

6.5.4 Welfare

On a first note the impact on aggregate welfare depends directly on the required level of Danish contributions to the funding of enlargement. The aggregate equivalent variation in percent of 1998 GDP is displayed in table 6.8. From this table we observe that the only funded enlargement scenario leaving a positive impact on aggregate welfare is the ESF scenario. The fact that higher contributions to the funding of enlargement imply higher likelihood of an aggregate loss of welfare should not surprise anyone. However, the aggregate loss of welfare also depends on whether the cost lies entirely on the government or whether the private sector (agriculture) bears a part. Comparing the aggregate welfare loss of the funded scenarios in view of the transfer increase to the EU indicates that direct impacts to the government budget are relatively expensive in terms of welfare. This observation corresponds neatly to the conventional wisdom that income taxation is distortionary to an extent that affects welfare negatively.

Although all funded enlargement scenarios but the ESF scenario imply welfare losses all projected equivalent variation measures are indeed small. The worse case scenario, that is the CAP scenario, imply an aggregate welfare loss of only -2.21 percent of 1998 GDP. The generation suffering the largest loss are projected to face a loss of approximately -5.5 thousand dkkr per adult equivalent (in 2008 prices) in the worse case.

7 Alternative domestic fiscal policies

In the preceding chapters the effects of enlargement was quantified under the assumption that the domestic fiscal policy targeted the baseline development of government debt. This specification is however only one of many available. This chapter will therefore proceed to analyse the relative impact of various domestic policy specifications.

A number of alternative fiscal instruments are available to the domestic government for covering the budgetary implications of the enlargement. Rather than using the income tax system the government may decide to use other fiscal instruments for covering the costs of enlargement. Since different tax instruments have different impacts on behaviour it seems only natural to analyze whether the projected economic impacts of enlargement may be altered by the use of other fiscal instruments. Also the stop and go nature of the debt-targeting determination of the income base tax may be replaced by determination of a *sustainable* income tax system. A tax rate is defined to be sustainable if the given tax rate exactly ensures intertemporal government budget balance for a given set of other fiscal instruments.

In this chapter we will assert whether the adoption of sustainable income, value added or corporate taxation may change the projected impacts of enlargement on macroeconomics and welfare. We will compare the projected impacts to the basecase scenario of the preceding chapter in which the government was assumed to commit to debt-targeting determination of the base income tax rate. By focusing on this change we single out the relative effects of the domestic fiscal policy under investigation.

7.1 Sustainable income tax system

Implementation of a sustainable income tax system amounts to endogenous determination of the smallest constant income base tax rate that ensures compliance to the dynamic budget constraint of the government. By comparing the sustainable level of income taxation to the debt-targeting enlargement scenario we observe that the initial level of the base tax in this scenario is higher until 2033. After 2033 the sustainable wage tax exceeds the base tax rate of the debt targeting scenario (see figure 7.1). By issuing a sustainable fiscal policy the government postpone the funding of the initial budget deficit occuring due to the increased transfer to the EU and reduced revenues from value added and capital income taxation arising from the decline in aggregate consumption and GDP. The sustainable income base tax rate is calculated to 40.00 amounting to an increase of 0.23 points from the sustainable rate of the baseline scenario. The impact to the domestic government budget of enlargement thus requires only a moderate increase of the base tax rate to be financed.

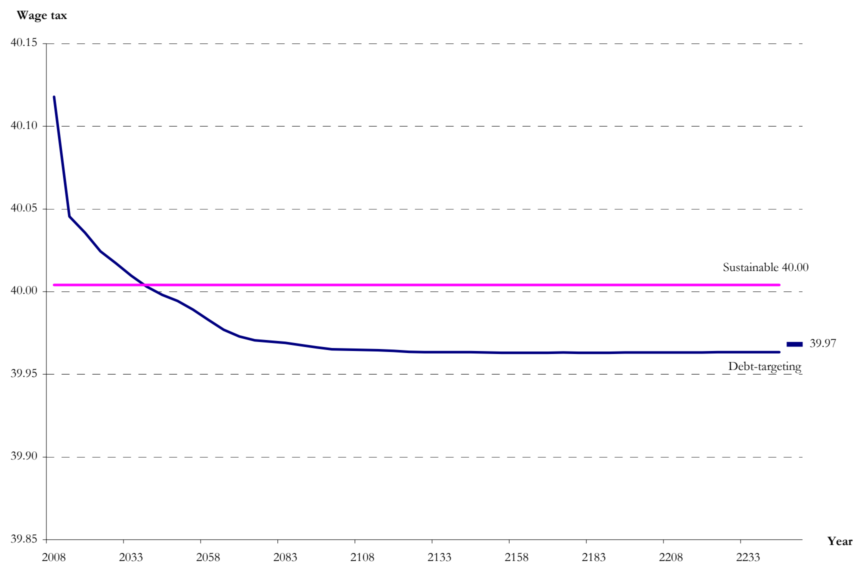

Figure 7.1: Sustainable and debt-targeting base income tax rate from 2008 onwards.

The change to the timing of the tax increase alters the intergenerational distribution of income. Generations alive at the time of enlargement benefits from the relative income tax relief bound in postponing part of the financing. Consequently these generations are able to increase their level of consumption. Gradually the level of income taxation will however exceed that of the debt-targeting scenario, and consequently the sustainable wage tax policy imply a loss of income and purchase power to future generations. Since households smooth consumption over the life cycle, households achieving reliefs of taxation will increase their savings where future households will lower their. This explains the observed change to the formation of household asset holdings. The decline of the accumulation of claims on foreign assets in the years following 2008 is caused by the initial rise of consumption that exceeds the modest initial increase of production. The lowered initial base income tax rate explains the rise of production since it leads to increasing labour supply. The increased domestic activity level will lead to an increase of the aggregate domestic price. As the change in the base tax imply a relative increase (from 2033 onwards), production is affected negatively but not as much as aggregate consumption and thus the value of claims on foreign assets rise again.

Table 7.1: Macroeconomic effects of shifting to sustainable income base tax.

	2003	2008	2018	2028	2038	2098	2248	∞
				—Debt-targeting=100—				
Change to wage tax[a]	0	-0.11	-0.03	-0.01	0.00	0.04	0.04	0.04
Real GDP at factor costs	100	100.01	100.01	100.00	100.00	99.99	99.99	99.99
Real private consumption	100	100.06	100.04	100.03	100.02	99.94	99.93	99.94
Labour	100	100.02	100.01	100.00	100.00	99.99	99.99	99.99
Machine capital	100	100.00	100.01	100.00	99.99	100.01	99.99	99.98
Building capital[b]	100	100.00	100.01	99.99	99.99	100.02	99.99	99.98
Value of firm	100.01	100.00	99.98	100.02	100.00	100.01	99.98	99.97
Total household assets	100.02	100.17	100.26	100.30	100.29	99.98	99.90	99.90
Foreing assets	100	94.91	98.69	98.50	97.98	97.32	97.92	99.71

[a]Absolute change in points
[b]Excluding dwelling

7.1.1 Production structure

The impact on the structure of production from changing the domestic fiscal policy to tax smoothing are modest. The short run increase in domestic aggregate demand is most beneficial to domestically oriented industries (construction, trade and transportation, other services and public services) due to the absent or modest availability of imported alternatives to their products. For the export oriented industries the short run effect of the increase of the domestic price level is a reduction in the aggregate demand faced, since export demands will diminish. However, as the change of policy reaction imply a relative increase of the base tax rate from 2033 onwards, private consumption and hence demand will detoriate and this change the long run effects to the opposite. Domestically oriented industries will reduce their level of production whereas export oriented industries will expand. For the effects to the production structure, please refer to table C.10 in the appendix.

7.1.2 Welfare implications

The aggregate welfare impact of the change from debt-targeting to tax-smoothing fiscal policy is a gain of bill. DKK. 0.29 corresponding to 0.02 percent of 1998 GDP. The equivalent variation per adult equivalent is illustrated in figure 7.2. All currently living and a few future generations experience welfare gains at expense of future generations.

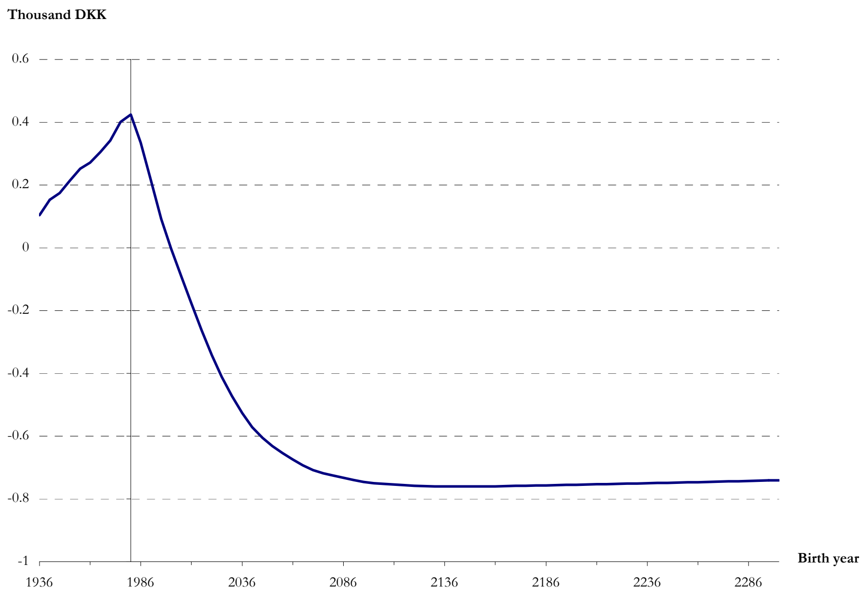

Figure 7.2: Equivalent variation per adult equivalent of sustainable wage tax.

The generation achieving the largest gain is born in 1981 corresponding to the age 27 at the time of enlargement. This generation experience greater gains than those of the generations born in 1986 and 1991 despite the fact that these two generations are economically active in a longer period of relatively lower wage taxation. However, the timing of the lowered wage tax must also coincide with the years of the life cycle income profile in which the largests incomes are earned. This explains why the generation born in 1981 are better off anyhow. Generations born after 1991 are not benefitting to the same extent as initially young generations since they do not gain as much from the initially lower base tax and since they are active during the relative increase of the base tax occurring from 2033 onwards. Generations born after 2016 are all experiencing a loss of welfare because they only benefit from lowered income taxation for a very short period or no periods at all. Currently living generations born prior to 1981 all benefit from the shift in domestic income taxation and these gains increase the younger the generation is in 2008. Obviously this negative correlation between age and welfare gain of currently living generations is to be explained by the number of years in which a generation remain active during low income taxation.

7.2 Sustainable value added taxation

Other fiscal instruments than the base income tax are available to the government for covering the costs of enlargement. One of these is the level of value added taxation, that is the ad valorem excise taxes pertaining to consumption goods. In the model all excise taxation including VAT are represented by a single rate and consequently these rates are not identical for all consumption goods. The part reflecting VAT is however identical since Danish VAT is not differentiated. An increase of value added taxation will have the same impact on the purchasers price of all consumption goods except dwelling consumption, which includes purchases of existing houses that are not subject to value added taxation. To ensure that the increase in value added taxation does not introduce distortions to the composition of consumption the required change is determined such that increase of the effective rate of value added taxation is the same for all consumption goods including dwelling consumption. We abstract from the intricacies of purchases of existing houses in dwelling consumption for simplicity. The income tax system is kept constant at the sustainable system calculated for the baseline scenario.

We use the same concept of sustainability for the level of value added taxation as for the base income tax. We determine the smallest constant level of value added taxation that ensures compliance to the intertemporal budget of the governemt. The required increase is equivalent to a resulting level of VAT of 25.62 percent compared to the 25 percent VAT rate of the baseline scenario.

7.2.1 Consequences

By conforming to sustainable value added taxation rather than a debt-targeting income tax, the domestic government redistributes the tax burden of enlargement through time. The high initial level of wage income taxation is replaced by a more moderate increase in the level of value added taxation. By use of a sustainable VAT rate part of the funding of the initial costs of enlargement are hence postponed to be carried by future generations.

The shift of fiscal policy thus implies a substantial short run relief of income taxation that in the longer run diminish. The sustainable value added taxation implies the same increase of VAT tax rates for all generations.

Lower income taxation improves the incentives to supply labour while the reduced purchase power of earned wages from increased value added taxation will have the opposite effect. This means that the positive effects on labour supply will diminish as time goes by. In the short run the net effect is increased labour supply and therefore an increase of aggregate domestic production. In the longer run the negative effects of lowered purchase power to labour supply cancels out the effect of the relative cut to income taxation. Hence the long run labour supply approximately returns to the same level observed in the debt-targeting enlargement scenario. The small initial improvement of the domestic activity level causes the value of firms to appreciate and this leaves a small capital gain to the household sector. We find small macroeconomic effects that are reported in table 7.2.

Table 7.2: Macroeconomic effects of shifting to sustainable value added taxation.

	2003	2008	2018	2028	2038	2098	2248	∞
				—Debt-targeting=100—				
Real GDP at factor costs	100	100.02	100.01	100.01	100.01	100.00	100.00	100.00
Real private consumption	100	99.95	99.97	99.99	100.00	99.95	99.94	99.95
Labour	100	100.03	100.02	100.01	100.01	100.00	100.00	100.00
Machine capital	100	100.02	100.01	100.02	100.01	100.02	100.00	99.99
Building capital[a]	100	100.02	100.01	100.02	100.01	100.02	100.00	99.99
Value of firm	100.02	100.02	99.99	100.02	100.01	100.02	99.99	99.98
Total household assets	99.97	100.23	100.52	100.74	100.84	100.69	100.62	100.62
Foreing assets	100	103.72	100.69	100.40	100.13	99.21	99.35	100.47

[a]Excluding dwelling

Initially the relative cut of the base income tax rate will benefit households having relatively large incomes. Such households include the young to the mid-aged that are about 55 year olds. The increase of VAT will impact all households but specifically the mid-aged households that exhibit relatively large levels of consumption. This in turn imply that the human capital of young households increase while the human capital of mid-aged generations decline. The net effect on aggregate consumption is an initial reduction since the consumption of mid-aged generation have larger weight. Gradually the mid-aged households are dissolved and as the initially young households age the level of aggregate private consumption increase. In the longer run generations alive at the time of enlargement die out and the level of consumption declines again. This is due to the fact that future generations are carrying a larger burden of the funding of the enlargement since part of the coverage of the costs are postponed. The real value of the income of future generations is therefore reduced compared to the scenario of the debt-targeting base tax.

Household asset claims decline initially despite of the appreciation of the value of firms. This is due to the decline in aggregate demand for consumption which imply lowered demand for houses. The reduced demand for houses lowers the price of residential buildings and hence the value of household assets. Over time the aggregate wealth increase. The reason for the increase of household wealth following immediately after enlargement is that the younger generations that benefits from the altered funding of enlargement account for the largest part of the aggreate financial wealth. Another element to the explanation is that the shift from income taxation to value added taxation induce savings, since the consumption profile is steeper than the income profile. Therefore households must increase their wealth in order to be able to sustain the consumption profile given the increased level of value added taxation.

7.2.2 Sectoral shifts

Effects to the composition of domestic production are qualitatively similar to those explained for the sustainable wage taxation. The decline of private consumption affects service industries negatively but on the other hand induce domestic price cuts that improves the level of export demands. We observe a decline in the production of construction and other services while the production of trade and transportation remain practically unaltered. The resulting production levels and demand structure of the individual industries from the shift to sustainable value added taxation are reported in table C.11 in the appendix.

7.2.3 Welfare

With respect to welfare we observe an aggregate loss amounting bill. DKK. 2.70 corresponding to 0.23 percent of 1998 GDP from shifting domestic fiscal policy from debt-targeting income taxation to sustainable value added taxation. In figure 7.3 we observe that young currently living generations and a few future generations are better off and that the aggregate loss is carried by the remaining generations.

Young currently living generations are primarily better off due to the intertemporal redistribution of the expenditures of the enlargement inherent in the adaption of a sustainable fiscal policy. From the perspective of the winners, the sustainable value added taxation imply avoidance of large initial income taxes in turn for a moderate permanent increase in the level of value added taxation. The generation benifitting the most is that born in 1981 since this is the generation that experience the largest relative cut of income taxation during years in which their level of income is high. Generations born shortly after 1981 are also experiencing a large implicit reduction of the wage tax, but this at a time of their lives where they are not earning quite as much as the 1981 generation. Hence their benefit from the altered fiscal policy is not quite as large.

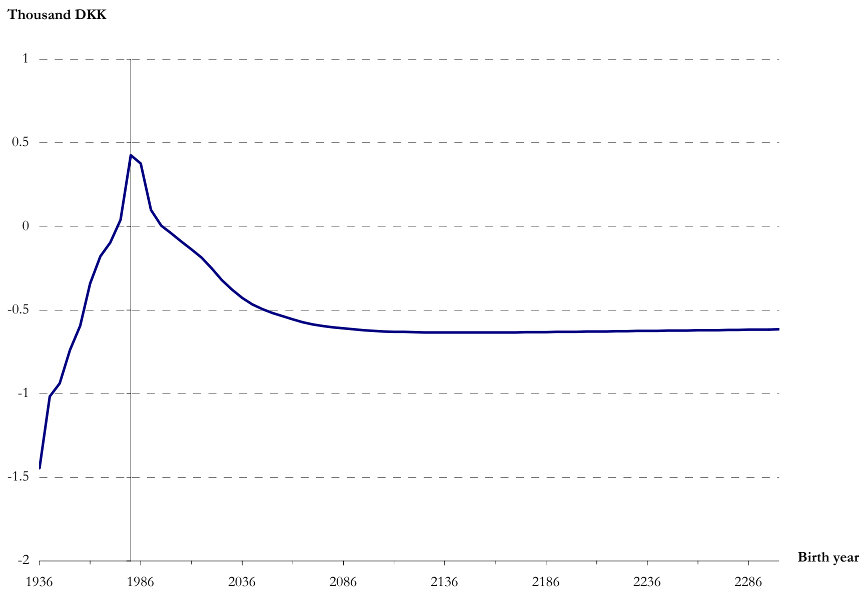

Figure 7.3: Equivalent variation per adult equivalent of sustainable VAT.

Future generations experince welfare losses for the simple reason that they must now bear a larger fraction of the costs of enlargement. The initially old generations are also experiencing a rather substantial loss of welfare. Elderly generations are not earning much income and do not benefit notably of the cut of the wage taxes. However, they do consume and the increase of the VAT rate therefore affects the expenditures of consumption to an extent that reduce their purchase power. An argument along the same lines apply to mid-aged households, but the higher level of income affected by the implicit reduction of the income tax does reduce the welfare loss of these generations somewhat.

7.3 Sustainable corporate taxation

The final alternative tax instrument that we will consider is a policy of a sustainable level of corporate taxation. By resorting to a sustainable level of corporate taxation while maintaining the income tax system of the baseline the government move the tax burden of enlargement costs from wage incomes to corporate taxation.

Changing the level of corporate taxation affects private producers by changing the usercosts of capital. Since producers in different industries use technologies of different capital intensiveness the change to the usercosts of capital will lead to sectoral shifts of production. We will seek to explain the observed impacts by the usercosts of capital in steady state.

In steady state the usercosts of buildings and machinery $\beta_{i,s}^{SS}$ expressed in growth and inflation corrected units may be decomposed as follows

$$\left(1+\kappa\left(\frac{\left(1-t^{rz}\right)i+\rho}{\left(1-t^{gz}\right)\left(1+\pi\right)}-\frac{\pi}{1+\pi}\right)\right)\beta_{i,s}^{SS}=\zeta_i^{F,s}+\frac{P_i^{I,s}}{\mu_i P_i^Y}\left(\delta_i^s-\frac{\pi}{1+\pi}\right)+\zeta_i^{\Phi,s}+\zeta_i^{\hat{\delta},s} \quad , \tag{7.1}$$

where $s \in \{B, M\}$ denote type of capital and the right hand side are components of the usercosts of capital that will be introduced shortly. The term preceding the usercost reflect that the fraction κ of the capital stock is immediately productive within a given period. This impact on the productivity of capital is corrected for capital income taxation relevant to the marginal investor and the risk premium. The rate of steady state inflation is denoted by π and in the following while the steady state growth rate is denoted by n. For the usercosts pertaining to land please refer to section A.10 of the appendix.

The components of the usercosts of capital as represented in the right hand side of equation 7.1 are respectively costs related to financing costs, physical depreciation, inflation, installation and finally fiscal depreciation. The financing costs are due to fiscal issues somewhat more complicated in DREAM than in standard textbook expressions and will be introduced shortly. The terms reflecting the usercosts related to physical deprecation and inflation are standard. Due to the installation costs of capital a term reflecting these are present and finally the non-neutrality of depreciation allowances gives to rise to the last term.

The term representing financing costs is for $s \in \{B, M\}$ given by

$$\zeta_i^{F,s}=\frac{1}{1+\pi}\frac{P_i^{I,s}}{\mu_i P_i^Y}i\left(g_i+\left(1-g_i\right)\frac{1-t^{rz}+\frac{\rho}{i}}{\left(1-t^{gz}\right)\left(1-t^c\right)}\right). \tag{7.2}$$

The interpretation of the financing costs is as follow: The first factor represents the real value of the interests to be paid for a unit capital of type s. The part g_i of the expenditure for acquiring a unit of capital is covered by debts while the value to the marginal investor of the withheld profits is represented by the second term inside the parenthesis. Raising the level of corporate taxation is seen unambiguously to increase the usercosts related to the funding of capital. In order to fund new investments a larger part of current profits are required to be withheld.

The usercosts related to the installation of capital are for $s \in \{B, M\}$ given by

$$\zeta_i^{\Phi,s} = -\theta_i^s \left(\delta_i^s + n\right)^2 + \left[\frac{\left(1-t^{rz}\right)i+\rho}{\left(1-t^{gz}\right)\left(1+\pi\right)} + \delta_i^s - \frac{\pi}{1+\pi}\right] 2\theta_i^s \left(\delta_i^s + n\right). \tag{7.3}$$

Here the first term express the lowered installation costs following from an expansion of the capital stock. As installation costs of capital are assumed the be convex, the unit costs of capital installation are decreasing in the capital stock. The second term represent the costs of reinvestments in steady state. The usercosts related to installation costs of capital are independent of the rate of corporate taxation.

The costs related to the fiscal treatment of depreciation is for $s \in \{B, M\}$ given by

$$\zeta_i^{\hat{\delta},s} = \frac{P_i^{I,s}}{\mu_i P_i^Y} \left(\frac{\left(\left(1-t^{rz}\right)i+\rho\right) t^c \left(\delta_i^s - \frac{\hat{\delta}_i^s+\pi}{1+\pi}\right)}{\left(1-t^c\right)\left(1+\pi\right)\left(\left(1-t^{rz}\right)i+\rho+\left(1-t^{gz}\right)\hat{\delta}_i^s\right)} \right). \tag{7.4}$$

The costs of depreciation depends on the size of the depreciation allowance granted by the tax system and the rate of physical depreciation. The term reflects the effects of the difference in the fiscal treatment of depreciation and the value of physical depreciation. If the depreciation allowance exceed the rate of physical depreciation the fiscal treatment imply a negative contribution to the usercosts. This negative contribution is caused by the fact that the value of the depreciation allowance is realized prior to the costs of the physical depreciation. Further if the rate of corporate taxation is increased this effect will be enhanced since the fiscal value of the depreciation allowance is increased.

7.3.1 Effects of financing via sustainable corporate taxation

Compared to the debt-targeting scenario the shift to sustainable corporate taxation imply an increase of the corporate tax rate of 16.07 points resulting in a corporate tax rate of 46.07 percent from 2004 onwards. The effects to the steady state usercosts of this shift of fiscal policies are presented in table 7.3 while table 7.4 displays the effects on macroeconomic indicators.

We observe that the usercosts of the composite capital good increase for most industries implying a lowered ratio of capital inputs to labour. The decline in the capital-labour

Table 7.3: Decomposition of effects to steady state usercosts of capital.

	Agriculture	Energy provision	Construction	Foods	Metals and chemicals	Other manufacturing	Trade and transportation	Other services
	—Percent change from debt-targeting—							
Usercosts of composite capital	0.133	0.546	1.328	0.612	0.485	1.413	1.460	1.255
Machinery total	1.107	1.251	1.255	1.258	0.638	1.820	1.862	1.745
Financing	10.066	9.435	10.026	9.982	10.016	9.873	9.700	9.971
Physical depreciation	0.134	-0.440	0.098	0.058	0.089	-0.041	-0.199	0.048
Inflation	0.134	-0.440	0.098	0.058	0.089	-0.041	-0.199	0.048
Fiscal depreciation	54.443	53.557	54.387	54.325	54.373	54.172	53.930	54.310
Buildings total	-1.375	0.299	1.926	-1.593	-0.148	-1.141	0.634	-0.268
Financing	9.980	9.310	9.919	9.907	9.923	9.775	9.580	9.871
Physical depreciation	0.056	-0.553	0.000	-0.011	0.004	-0.130	-0.308	-0.043
Inflation	0.056	-0.553	0.000	-0.011	0.004	-0.130	-0.308	-0.043
Fiscal depreciation	54.322	53.383	54.237	54.219	54.242	54.035	53.761	54.169
Land total	-3.854	-3.332	-2.794	-2.806	-2.791	-2.922	-3.094	-2.838
Financing	7.919	3.134	3.707	3.695	3.711	3.571	3.387	3.661
Inflation and growth	14.156	9.094	9.701	9.687	9.704	9.556	9.362	9.651
Taxation	0.093	—	—	—	—	—	—	—

ratio will other effects equal lower the level of production and give rise to a decline of the aggregate value of firms. In addition the lowered capital-labour ratio lowers the wage rate. One would suspect this to lower the labour supply, but the reltaive cut of the base tax rate inherent in this experiment leaves a small positive net effect on the labour supply such that employment is actually increased by 0.04 percent initially. In the longer run the relative decline of the base tax rate diminish and employment is reduced to the same level as in the debt-targeting scenario.

The decline of the wage dominates the increase of employment and the wagesum is therefore reduced in the short as well as in the long run. The combination of the lowered aggregate wagesum and value of firms lowers human capital as well as the financial wealth of currently living households. The consequence of these effects is a reduction of aggregate consumption. The long run adverse impact on aggregate consumption is larger than the short run impact since the wagesum gradually decline as employment decrease.

The increase of the usercosts of capital does not affect all industries to the same extent and therefore the impact of the introduction of sustainable corporate taxation is differ-

Table 7.4: Macroeconomic effects of shifting to sustainable corporate taxation.

	2003	2008	2018	2028	2038	2098	2248	∞
				—Debt-targeting=100—				
Real GDP at factor costs	100	99.89	99.82	99.82	99.81	99.80	99.80	99.80
Real private consumption	100	99.98	99.98	99.99	99.97	99.91	99.90	99.91
Labour	100	100.04	100.01	100.01	100.01	100.00	100.00	100.00
Machine capital	100	98.35	99.00	99.32	99.59	98.36	98.33	98.70
Building capital[a]	100	99.16	98.73	101.13	100.10	100.15	99.11	99.95
Value of firm	99.85	89.17	95.10	57.76	90.28	78.99	77.90	87.96
Total household assets	99.62	100.10	100.33	100.48	100.53	100.24	100.17	100.17
Foreing assets	100	97.34	99.86	99.45	99.37	98.41	98.74	100.31

[a]Excluding dwelling

ent across industries. In general increasing usercosts of capital will lead to substitution towards alternative input factors. In agriculture a small increase of the total usercosts of capital is observed largely due to lowered usercosts of buildings. The lowered costs of labour imply that the total unit production costs decline and consequently the price is lowered while production increase. The reduced price of agricultural products in turn lowers the costs of production in the food industry to an extent that dominates the adverse effects of the moderate increase in the usercosts of capital used in production in foods. Again the outcome is a lowered output price and increased production. Table 7.5 displays the effects on the level of production for individual industries while table C.12 in the appendix provides details on changes to the demand structure of the industries.

Table 7.5: Effects of sustainable corporate taxation on production.

	2008	2018	2028	2038	2098	2248	∞
			—Debt-targeting=100—				
Agriculture	100.07	100.18	100.19	100.18	100.18	100.17	100.17
Energy provision	99.22	98.65	98.54	98.48	98.48	98.50	98.51
Construction	99.84	99.79	99.79	99.70	99.74	99.76	99.76
Fods	100.02	100.09	100.09	100.10	100.09	100.09	100.08
Metals and chemicals	100.05	100.02	100.01	100.03	100.03	100.03	100.03
Other manufacturing	99.57	99.44	99.43	99.45	99.45	99.44	99.44
Trade and transportation	99.57	99.44	99.44	99.45	99.43	99.43	99.44
Other services	99.85	99.79	99.79	99.78	99.76	99.76	99.76
Public services	100.06	100.02	100.01	100.01	99.99	99.99	99.99

In service industries substantial increases in the usercosts of machinery are observed which dominates the effects on the costs of production from lowered labour costs, even despite the relatively large dependence on labour inputs. The required increase of the output price following from the increased costs of production causes the service sector to face declining demands from domestic (and foreign) purchasers. The outcome is a reduction of the level of activity in trade and transportation and other services. Specifically the declining aggregate level of consumption and lowered demands for use of services as material inputs brings this result about.

For the manufacturing industries metals and chemicals and other manufacturing the shift to sustainable corporate taxation imply opposite effects on the output price level and consequently demands faced. In metals and chemicals activity is increased moderately while other manufacturing exhibits recession. The difference is to be explained from the impact to the usercosts since both industries rely on comparable amounts of labour inputs. The increase of the usercosts of machinery are smaller for metals and chemicals than those observed for other manufacturing and the adverse effect on the costs of production is therefore largest for other manufacturing. The demand structure of metals and chemicals shifts towards export markets.

In energy provision we observe a moderate increase of the usercosts of capital but since the level of labour inputs are very small in this industry the net effect is an increased level of costs of production. Consequently energy provision accounts for the largeste increase in the output price and the largest reduction of production, as an increasing price of energy causes substantial substitution towards imports for domestic purchasers and decreasing demand from foreign purchasers.

Finally, the major supplier of inputs to buildings investments, that is the construction sector, suffers from the aggregate decline of the level of capital inputs. This loss of demands paired with a high increases of the usercosts of capital used in production of construction result in a lowered level of production and an increased output price.

7.3.2 Welfare implications

In figure 7.4 the equivalent variation per adult equivalent of the shift to sustainable corporate taxation is illustrated. This policy initiative is seen to benefit only a few young currently living generations and imply welfare losses for all other generations. The aggregate welfare loss amounts to 0.34 percent of 1998 GDP. Generations born prior to 1991 all hold financial wealth, real wealth and human capital in 2008. The reduction of the aggregate value of firms will given the rule of constant shares of bonds and stocks in the portfolio imply a decline in the value of financial debts for young generations and financial wealth of older generations. Moreover the decline of aggregate consumption imply a reduction of dwelling consumption which in turn is capitalized by a lowered price level for real estate. Hence the real wealth held in real estate depreciates for all generations although young generations about to enter the real estate market benefits from the price cut. The combination of these two effects on wealth explains which of the currently living generations gain and loose. The reason that the generation born in 1991 that becomes economically active in 2008 does not benefit is due to a technical detail in the modelling of the portfolio composition. Real estate is acquired in the period preceding the period in which a generation becomes economically active but the purchase of real estate is assumed to financed exclusively by bonds. Thus the generation becoming economically active at the time of enlargement, that is the generation born in 1991, is by construction excluded from achieving gains on financial wealth via changes to the aggregate value of firms.

All future generations are observed to experience welfare losses that are increasing as long as the implicit cut of the base income tax rate diminish. Again the welfare loss of future generations is to be explained from the simple fact that part of the required revenues for financing the increased net transfers to the European union is postponed in a sustainable taxation scenario.

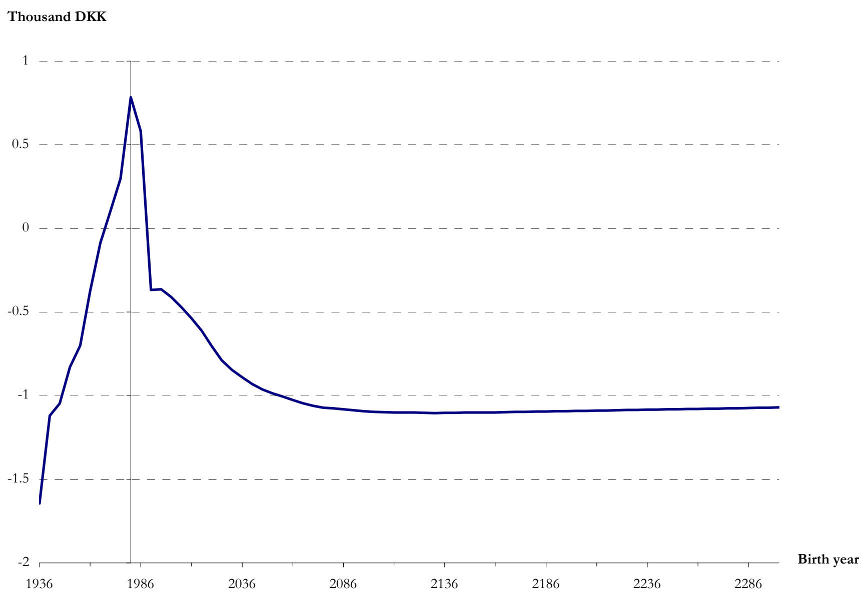

Figure 7.4: Equivalent variation per adult equivalent of sustainable corporate taxation.

7.4 Concluding remarks

All of the alternative policy specifications presented in this chapter are found to imply only moderate differences in the projected long run impact of enlargement. As previously noted the fiscal implications of enlargement are modest and the change of domestic policy response therefore only imply moderate shifts in the tax structure. However even if the additional revenue to be collected is small it is not without importance which tax instrument is used. The use of the corporate tax rate was found to imply larger macroeconomic implications than those found for shifting to sustainable income or value added taxation and this phenomenon is caused by the deeper implications of corporate taxation to optimal behaviour. The value added and income taxation does not imply the same first order effects to the incentives driving the private production sector.

The reason that the macroeconomic effects of shifting from debt-targeting to sustainable determination of the income tax system are found to be small is that this shift of policy essentially amounts to a shift of timing of the collection of revenues. Since the behavioural implications on labour supply are very similar for the value added taxation and the income taxation the implications of shifting to sustainable value added taxation are also found to be moderate.

The altered timing of the tax burden of enlargement does imply intergenerational redistribution of welfare and hence by construction of the aggregate welfare measure also aggregate welfare implications. The postponed collection of required tax revenues does for all sustainable policy specifications imply that future generations must bear a larger part of the burden of enlargement. For the debt-targeting enlargement scenario we found that currently living generations were projected to be relatively worse off than future generation and hence sustainable fiscal policies serve to even out the intragenerational distribution of welfare implications.

One might suspect that shifting part of the burden to future generations would tend to improve the aggregate welfare implications since currently living generations enter the aggregate measure of welfare with larger weight. For the shift to sustainable income taxation this is the case although the gain is indeed a very moderate 0.02 pct. of 1998 GDP. For the value added and for the corporate taxation the redistribution comes at the costs of negative aggregate welfare consequences. For the VAT scenario the aggregate welfare loss of the changed fiscal policy amounts to 0.23 pct of 1998 GDP while the aggregate loss for corporate taxation amounts to 0.34 pct. of 1998 GDP. The ranking of welfare properties of the different tax instruments are previously found for DREAM, see Madsen and Pedersen (2001). Compared to the welfare loss of the debt-targeting funded enlargement scenario of 0.87 pct. of 1998 GDP these additional welfare losses from domestic fiscal policies are significant[1].

[1] The welfare losses measured by the aggregate equivalent variation cannot be added to the base case welfare loss since the losses are measured at different prices.

8 Immigration

The European single market programme specifies rules promoting the free mobility of labour. The free mobility of labour are formulated as a set of the rights of EU citizens to seek employment, to be granted residence permit and entitlement to the same rights as national citizens. Additional rules apply to students and pension receipients, see The EU Commision (2001a). Concerns have been expressed that the east enlargement will imply an unacceptable level of immigration from the relative poor CEE countries, and that the entitlement to national treatment with respect to social rights will strain the social systems of incumbent member states. Transitory agreements and restrictions are hence likely to be introduced as explained in The EU Commision (2001a).

8.1 The extent of immigration to Denmark

To assert the effects on the Danish economy of immigration from the CEE countries following from enlargement we will assume that the freedom to take on employment in the EU is granted to citizens of the CEE countries as well. In order to quantify the extent of the immigration we rely on Boeri and Brücker (2000), who analyse the labour market effects of immigration from enlargement in an econometric framework focused on explaining immigration towards Germany. The extent of immigration to Germany is explained from historic observations of variables such as GDP per capita, common language, level of education etc in the respective home countries of immigrants. The model is then used for projecting the net immigration from CEE countries to Germany. The estimates for the number of immigrants in Germany are then extrapolated for other incumbent member states under the assumption that the ratio of CEE immigrants in a given country to the number of CEE immigrants in Germany remain constant. In general the conclusion is that the extent of immigration will be moderate except for border regions and for Germany. According to the projections in Boeri and Brücker (2000), Germany will be the country of choice for central and east European immigrants among other reasons due to the relatively short travel distance. The projection is reported in stocks of CEE immigrants and for Denmark the reported stocks are listed in table 8.1.

Table 8.1: Projected number of CEE immigrants in Denmark

Year	1998	2002	2005	2010	2015	2020	2025	2030
CEE immigrants 8863	12049	20650	30204	35708	38663	40034	40437	

Source: Boeri and Brücker (2000)

The majority of the immigration is expected to occur in the year from 2005 to 2015. The stocks of CEE immigrants can not be incorporated directly in the model. The premodel used for projecting Danish demographics is based on flow variables such as mortality and fertility rates and net immigration all specified by age and gender. The population projection is carried out for two groups of domestic citizens namely immigrants and others. Descendants of the immigrant group are designated to others[1]. Given this formulation the estimated stocks of CEE immigrants cannot simply be incorporated directly in the population projection. We must introduce assumptions for converting the reported stocks to flow variables. We will assume that immigrants from CEE countries on average have the same age and gender as other immigrants, such that the average immigrant from CEE is in his or her early twenties and migrate to stay in Denmark permanently. Further we assume that the net immigration from CEE countries imply a constant long run stock of CEE immigrants a little above the number of 40437 projected in 2030.

In the formation of the representative households, labour market participation rates and socioeconomic attributes are represented per group of domestic citizens. We assume that the additional net immigrants from the CEE are similar to the group other in these respects amounting to a somewhat positive view. Figure 8.1 illustrates the effects on the development of the population, labour force and the number of individuals outside the labour force of the assumed net immigration from the CEE given assumptions regarding labour market participation rates and socioeconomic attributes.

The labour market participation rate of the CEE immigrants is thus assumed to be significantly higher than that of other immigrants and the extent to which immigrants from CEE are assumed to receive social transfers is lower. These assumptions represents a simplification also when compared to the historic exeriences with immigrants from the CEE countries. A large fraction of immigrants from the CEE are observed to move back to their respective homeland within a few months or years reflecting the seasonal nature of the employment causing the migration in the first place. Also CEE immigrants

[1]In more recent versions of DREAM the population projection is based on a more disaggregate representation of population groups.

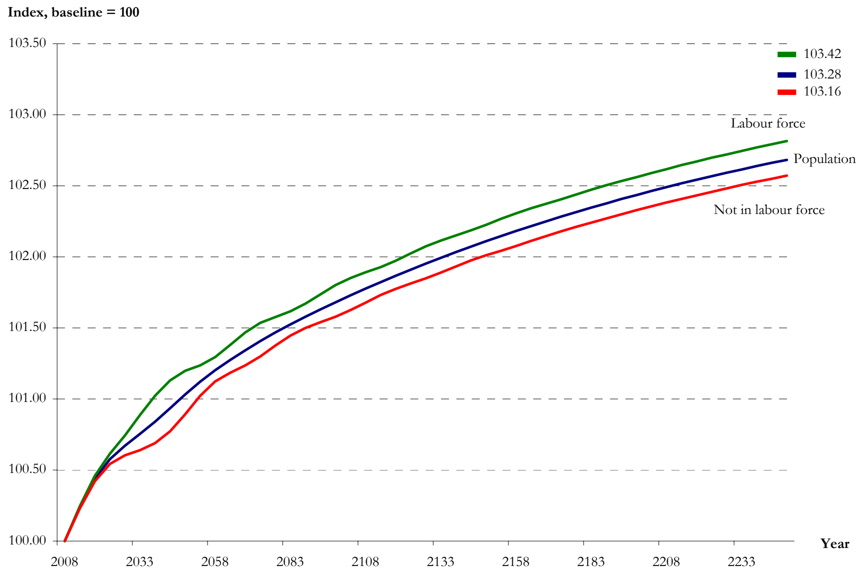

Figure 8.1: Labour force and population. Steady state change indicated.

living in the EU are actually observed to have lower labour market participation rates than other EU citizens. However, the historic observations regarding the labour market participation rate does not per se apply to the immigration following from enlargement, since immigrants previously included fugitives from the communist regimes. Refugees can not reasonably be thought of as representative for the future immigrants from the CEE.

8.2 Economic consequences of immigration

The increase in the total population due to immigration from CEE amounts to 1.68 percent in 100 years and 3.28 percent in steady state. The increase of the population gives rise to an increase of the labour force of 1.80 percent in 100 years and 3.42 percent in steady state. The fact that the labour force increase more than the total population is due to the assumption that CEE immigrants feature the same labour market participation rate as the population group others. This group exhibit labour market participation rates exceeding the average of the total population and the CEE immigrants hence increase the average labour market participation. This property of the immigration experiment may be illustrated by the labour market related dependency ratio, that measure the number of individuals outside the labour force per number of individuals in the labour force. The effect of the immigration from CEE countries on the labour market related dependency ratio is illustrated in figure 8.2.

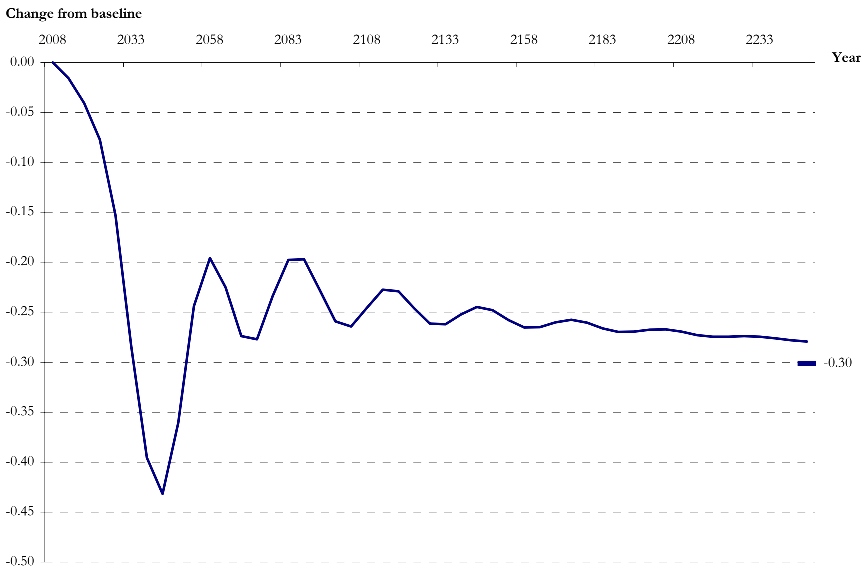

Figure 8.2: Labour market related dependency ratio. Steady state change indicated.

The dependency ratio drops by 0.43 points in 2043 reflecting the relief of the demographic ageing burden. After this peak, the dependency ratio diminish in cycles of yet smaller amplitude around a downward sloping trend. The cycles are caused by the feedback effects from descendant generations.

8.2.1 Macroeconomics

To assess the economic effects of the increased level of immigration of CEE citizens, we implement the immigration onto the basecase scenario for the enlargement costs under debt-targeting income taxation. Table 8.2 lists the additional effects of the immigration on leading macroeconomic indicators by comparison to the basecase.

The larger labour force will for a given aggregate capital-labour ratio imply an increase in aggregate production and private consumption. From table 8.2 we observe that the change to employment exceeds the effect on aggregate GDP. This is caused by the presence of the fixed production factor land, which imply decreasing returns to scale of the aggregate

Table 8.2: Macroeconomic effects of immigration.

	2003	2008	2018	2028	2038	2098	2248	∞
				—*Basecase=100*—				
Real GDP at factor costs	100	100.18	100.53	100.79	101.02	101.74	102.67	103.22
Real private consumption	100	100.20	100.46	100.62	100.80	101.54	102.41	102.89
Labour	100	100.22	100.59	100.86	101.10	101.83	102.80	103.38
Machine capital	100	100.08	100.69	100.72	100.98	101.90	102.57	103.11
Building capital[a]	100	100.04	100.63	100.60	100.88	101.73	102.35	102.70
Value of firm	100.66	100.88	101.39	98.06	101.56	101.47	101.33	102.88
Total household assets	100.57	100.59	100.68	100.76	100.80	101.30	101.91	102.21
Foreing assets	100	87.62	97.26	97.92	98.23	99.56	99.73	99.77

[a]Excluding dwelling

production technology. The development of foreign asset claims is to be explained from the fact that aggregate GDP due to consumption smoothing increases more rapidly than does aggregate GDP. In addition the required capital formation especially implies increased imports of machinery capital.

The effects on the aggregate level of production and consumption are large compared to previously presented experiments, but to conclude that households experience increased utility would be misleading since the number of individuals in the representative households have increased as well. As previously explained (see section 2.5 in chapter 2), we can not address welfare implications in a satisfactory manner using the equivalent variation measure as the number of individuals in the representative households change in the counterfactual. However, we may qualifiy statements regarding the likely welfare implications of immigration by comparing the scenarios in per capita terms. Figure 8.3 displays the effects on real GDP, consumption and employment per capita.

We observe an initial decline of aggregate GDP per capita. This decline is followed by improvements until the year 2038 after which an oscillating decline towards steady state is observed. This transition path is caused by the fact that time must elapse for the group of immigrants to arrive at its steady state age and gender composition. Initially the average immigrant is in his early twenties and thus the initial implication of immigration is that the labour force increase more rapidly than the population (review figure 8.1). In the years following 2038 the CEE immigrant group on average age causing the population increase more rapidly than the labour force. The effect on aggregate real private consumption per capita does not follow the development of aggregate real GDP per capita since households even consumption over the life cycle. Aggregate consumption per capita exhibits a decline of 0.13 percent of the base case value over the first two decades due to lowered human

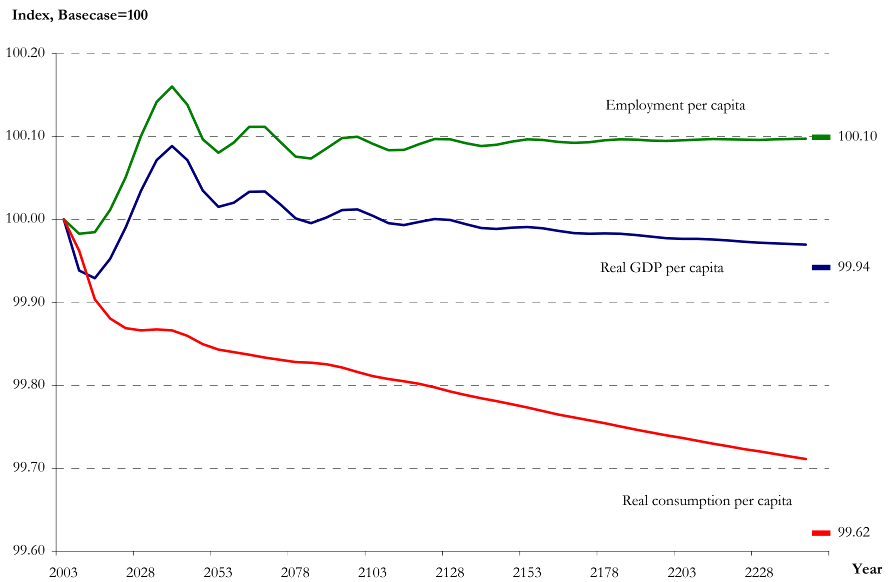

Figure 8.3: Effects of immigration on real GDP, consumption and employment. Steady state change indicated.

capital per capita, and proceeds to decrease as the income per capita detoriate.

8.2.2 Production structure

All industries increase their absolute level of activity and experience increased demands from all categories of demand (see table C.13 in appendix). The increase of production per capita is however more relevant for evaluation of the economics of the immigration. The following discussion of the production structure is therefore based on the development of production per capita.

The increased availability of labour drives down wages and cause a lower relative price of labour inputs to all other inputs. The steady state effect on the wage paid per efficiency unit is a decrease of approximately 1 percent of the basecase value. On the aggregate level this imply a shift towards more labour intensive production. Since land is available in a fixed quantity this input factor exhibits the largest price increase and cause industries relying on land to face higher total unitcosts of production. For arable land the steady state price increase by 1.34 percent and for land used in non rural production plants the price increase by 21.77 percent. In addition to these supply side effects, the reduced level of real private consumption per capita affects industries targeting consumer good markets negatively. With resect to exports per capita the demand decline for all industries but other services. Although the reduced unit costs of production allows for domestic price cuts, the positive effects on export demands are independent of the size of the domestic population, whereas domestic demand including demands for intermediaries are increasing in the population size. Hence the effect on export demands from the domestic price cut are not sufficiently large to exceed the effect on domestic demand and reduced exports per capita are therefore projected.

The effects on the level of production per capita in the industries are summarized in table 8.3 while table C.14 in the appendix includes the effects on categories of demand. From table 8.3 we observe that only two private industries increase their level of production measured per capita. The industry other manufacturing adopts a medium labour intensive production technology and hence benefits from the lowered wage and the reduction of export demands per capita is not as expressed nor as important for this industry as for other industries. For agriculture the steady state impact on production per capita is a moderate increase as well. Agriculture also features a medium labour intensive production technology, and the price increase on land is not as large for rural land as for other types. Consequently the price cut on products from agriculture induce increasing domestic demands for intemediaries to an extent that dominates the adverse effects on exports per capita.

Table 8.3: Effects of immigration on production per capita by industries.

	2003	2008	2018	2028	2038	2098	2248	∞
				—Basecase=100—				
Agriculture	100	99.86	99.91	100.05	100.14	100.10	100.13	100.16
Energy provision	100	99.81	99.73	99.79	99.83	99.62	99.33	99.13
Construction	100	100.27	100.16	100.17	100.20	99.93	99.72	99.60
Foods	100	99.86	99.88	99.99	100.06	99.97	99.92	99.90
Metal and chemicals	100	99.89	99.93	100.04	100.09	99.94	99.86	99.83
Other manufacturing	100	99.91	100.01	100.16	100.26	100.25	100.35	100.42
Trade and transportation	100	99.94	99.96	100.04	100.09	100.02	99.99	99.97
Other services	100	99.98	99.99	100.05	100.10	100.05	100.02	100.00
Public services	100	99.99	100.00	100.07	100.12	100.05	100.03	100.02

The most labour intensive private production is executed by the service industries trade and tranportation and other services. Although the service sector is faced with lower unitcosts of production due to the lowered wage, they are also to a large extent supplying their products for use in private consumption. As noted previously real private consumption per capita is reduced in the long run and this affects the service industries negatively.

In addition trade and transportation rely on export markets to an extent that affects the demand measured in per capita terms negatively. Both industries experience increasing demands for services for use as intermediaries and for other services this imply that the steady state effect on production per capita is practically zero. For trade and transportation the net outcome is a small reduction of the production per capita. The construction industry is by convention not subject to decreasing export demands per capita. However, the overall decrease of per capita activity causes the demand faced from consumers, other industries and investors to imply a reduction of the production measured per capita. Although the construction industry uses a medium labour intensive technology, the net outcome is therefore a reduction of 0.4 percent of production in per capita terms.

The production per capita in the manufacturing industries foods and metals and chemicals are both subject to a decrease. Metals and chemicals experience an increase of all domestic demand categories per capita, but also suffer from a considerable reduction of export demands per capita. The foods industry is not as hard hit by decreasing per capita demands for exports, but on the other hand the positive effects on domestic demand are also somewhat smaller.

Finally, energy provision accounts for the most severe setback in per capita production. Energy provision does not employ much labour and therefore does not benefit from the reduced wagecosts. Moreover, energy provision uses land extensively and given the large steady state price increase of land used in non rural production, this industry exhibits the smallest reduction of output price of all industries. Consequently all demands faced by energy provision decrease in per capita terms and specifically export demands are of significance in this respect.

8.2.3 Fiscal aspects of immigration

The introduction of increased immigration from the CEE countries will given the assumptions regarding labour market participation and age composition imply a relief of the pressure on public expenditures. The immigrants are given the specification of socioeconomic attributes net contributors to the public sector. The base tax may therefore be reduced. Figure 8.4 displays the development of the base tax. The initial decrease of the base tax is caused by the relatively large revenues from taxation of capital gains on shares. This positive effect on capital taxation revenues is however a one shot event and therefore the reduction of the base tax is smaller in the following period. From 2013 forward the base tax is pegged to the development of the dependency ratio although peaks are not expressed as clearly in the development of the base tax. This is due to the fact that consumption and thereby incomes are smoothed over the life cycle.

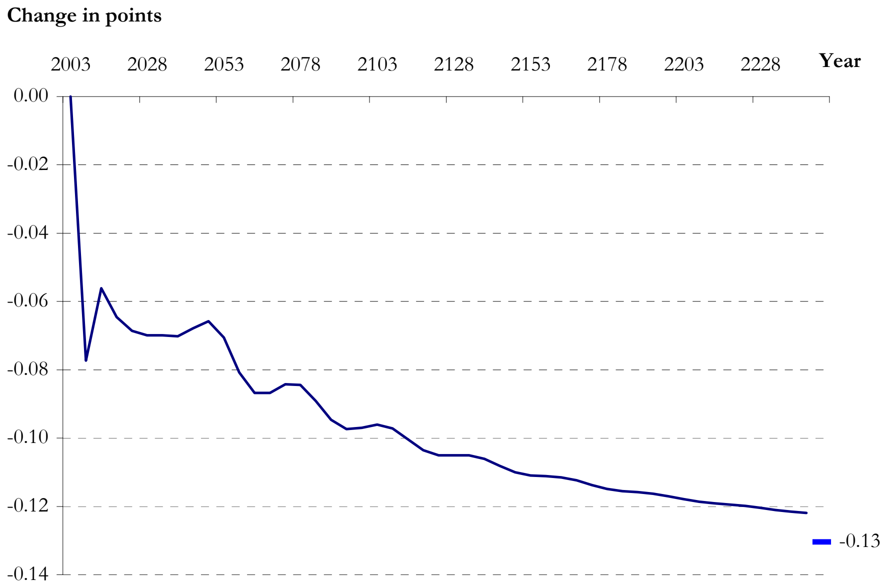

Figure 8.4: Change to wage tax rate (point change) in immigration scenario. Steady state change indicated.

Although the unambigious reduction of the wage tax in all future periods points to an improvement of the government budget, the extent of the improvement is hard to assess per se. By simulation of an experiment implementing sustainable wage taxation and comparing this to the corresponding sustainable wage tax in the basecase we obtain a better measure of the merits of immigration with respect to fiscal sustainability. The reduction of the sustainable wagetax inherent in increased immigration from the CEE countries is determined to account for 0.08 points. This reduction is not large reflecting that the suggested immigration is moderate and the fact that the aggregate production technology exhibits decreasing returns to scale given the fixed quantity of land available. The decreasing returns to scale imply that aggregate GDP does not increase on par with the labour force. Since tax revenues depend on aggregate GDP the contribution from immigrants to the government budget is indeed reduced by the decreasing returns to scale.

9 Sensitivity analysis

The quantifications of a simulation study is naturally subject to some uncertainty to say the least. The order of magnitude observed for the effects in policy simulations should therefore be tested for robustness by a sensitivity analysis. One usually focus on central behavioural parameters and exogenous policy parameters that are subject to the highest uncertainty. Exogenous variables and parameter values adapted from DREAM will affect the results. The most important exogenous variables are the interest rate, the income transfers and socioeconomic data and obviously the demographic forecast. With respect to policy parameters the tax system comes to mind, but these are subject to a rather detailed treatment by compilation of data from disaggregate sources, see Knudsen (1999). We cannot test for all possible parameter constellations however and will concentrate our discussion to the parameter values introduced specifically for this study.

Among the behavioural and technical parameters the elasticities of substitution assumed for consumer preferences and subtechnologies of the production function are central. Specifically the value of the Armington elasticity[1] is central to the order of magnitude of effects. We will test the order of the effects under alternative values of the Armington elasticities in section 9.1

Among the policy parameters in play in this study we also find many good candidates for sensitivity analysis. The real trade costs and the custom tariffs are very uncertain. Further, the assertion of the costs of enlargement are uncertain and the policies they are meant to reflect are still subject to political controversy. This is however more an issue of applicability than of sensitivity of results to the specification chosen. In chapter 5 we demonstrated that the effects of reduced real costs clearly dominate those of tariff reductions. Moreover the specification of market integration relies entirely on the parameter values for the real costs of trade. Therefore we will devote section 9.2 to the merits of alternative values of the real costs of trade.

The sensitivity analysis is performed on the basecase for the costs of enlargement under debt-targeting domestic fiscal policies. To assert whether the numeric specification of

[1] By the Armington elasticity we refer to the elasticity in the nests of the instantaneous utility function and in the production function that implements the Armington assumption.

the parameters under investigation are crucial a few alternative approaches are available. We may recalibrate the entire model for the alternative values of the parameters under investigation and then compare the outcome of the policy implementation of the resulting model parameterization to the one studied in chapter 6. This approach is however somewhat problematic since recalibration will also alter the values of other behavioural parameters. In other words recalibration actually implies a test for a *set* of alternative parameter values. To retain focus on the investigated parameters we alter the parameter value by specifying a baseline in which alternative parameter values are introduced as shocks. Upon this new baseline the basecase for the costs of EU enlargement are then applied in a counterfactual siumulation. Differences in the observed multipliers under the alternative parameter values may then be compared to the multipliers found in the the basecase simulation. This method highlights the isolated importance of the parameter under investigation and is more suitable for the purpose testing for sensitivity to individual parameters. It is however important to note that parameters should be calibrated as sets for applications of the model and that the described procedure only makes sense as a vehicle for sensitivity analysis.

9.1 Armington elasticites

The value of the Armington elasticities are crucial to the response in trade volumes to altered policies and thereby to the assertion of the activity and welfare impacts of funded enlargement. All Armington elasticities are in the base case simulation specified by a numeric value of 5. We test the sensitivity of the results of the funded enlargement basecase to alternative numeric values of these parameters of 3 and 7. We test for sensitivity for symmetric changes of the value of the elasticities but in principle the elasticity assigned to individual nests may be specified by different values.

9.1.1 Lowered Armington elasticity

Let us start by considering the case of a lowered numerical value of the Armington elasticity for aggregate production. A lowered elasticity of substitution in the nests implementing the Armington assumption on imports will imply a more moderate level of substitution towards CEE goods as the price is reduced by lowered customs and real costs of trade. In the household sector the lowered level of substitution will reduce the positive effect on total purchase power and thereby reduce consumer demand overall. In the corporate

Table 9.1: Macroeconomic effects of base case steady state by Armington value

	$\sigma = 3$	Basecase	$\sigma = 7$
	—Baseline=100—		
Real GDP at factor costs	99.97	99.96	99.95
Real private consumption	99.84	99.91	99.91
Labour	99.98	99.98	99.98
Machine capital	100.21	100.22	100.19
Building capital[a]	99.88	99.78	99.65
Value of firm	98.82	98.76	98.58
Total houshold assets	99.69	99.82	99.85
Foreign assets	101.61	102.03	102.30
Aggregate EV in pct of 1998 GDP	-1.27	-0.87	-0.85

[a]Excluding dwelling

sector lowered elasticity of substitution among origins imply reduced downward effects to the unit costs of production and thereby reduced positive supply side effects of trade liberalization and market integration. The positive effects of enlargement are also reduced by a lowered elasticity of substitution in the Armington export relations since price cuts on domestically delivered products experienced by foreigners will not lead to the same extent of increased demands for exports as in the basecase.

The effect on aggregate demand for domestically produced goods decline due to the lowered sensitivity of export demands to price changes. Other effects equal this will lower the domestic price level and thereby also the costs of intermediate inputs to production. This positive supply side effect of enlargement dominates. The combination of a lowered domestic output price level paired with the reduced level of substitution towards imported goods will result in higher domestic use of domestic products. In equilibrium aggregate domestic production is increased by the parameter change while the effects on exports diminish. Despite the increased level of domestic activity and the lowered exports, real private consumption decline. This is caused by the detoriation of the terms of trade inherent in lowered domestic prices. The combination of a lowered exports ratio and worsened terms of trade lowers the feasible level of consumption for a given level of domstic production. Another way to grasp this point is by the fact that the lowered domestic price level imply a relative reduction of usercosts of capital to the costs of labour. This implies a shift towards more capital intensive production which in turn implies a lowered wage rate. The labour supply is not very sensitive to changes in the wage rate since unemployment benefits are indexed to the development of the wage rate. Given this the reduced wage rate reduces labour incomes and hence consumption. The aggregate equivalent variation of the enlargement basecase under lowered Armington elasticities amounts to -14.75 bill dkkr or -1.27 percent of 1998 GDP. This should be compared to the more moderate -0.87 percent found in the basecase. The additional loss of welfare is caused by the lowered level of consumption, which is experienced by all generations.

9.1.2 Higher Armington elasticity

Now let us describe the case in which the numeric value of the Armington elasticitiy is specified to the higher value of 7. The sensitivity of export demands to lowered real costs and tariffs will be higher for this value of the Armington elasticity and the same hold true for demand for imports. The increased sensitivity of export demands will lead to increased positive effects on the demand for domestic products and also increase the upward effect on the domestic price level. Additional increases in the domestic price level amounts to a reduction of the supply side effects from lowered prices of domestically produced intermediaries. This in turn imply a shift towards labour inputs such that the wage rate increase. The increased wage rate implies higher labour incomes and consumption. From an aggregate perspective, the increase of the domestic price level implies improved terms of trade that in combination with the increased sernsitivity of export demands allows for increased imports and thereby consumption compared to the basecase.

The aggregate equivalent variation of the basecase for funded enlargement found under the higher Armington elasticities amounts to -9.88 bill. dkkr. equivalent to -0.85 percent of 1998 GDP. Higher Armington elasticities apparently tends to increase the welfare improvements of trade liberalization and market integration. In particular future generations are subject to reduced welfare losses since they are the ones benefitting the most from the improvement of the terms of trade.

9.1.3 Are the results sensitive to the Armington parameter?

We observed relatively small changes to the effects of the basecase for funded enlargement for alternative specifications of the Armington elasticities. The change to the steady state effects on aggregate GDP are in the range from -0.01 to 0.01 percent. For aggregate consumption the change to the multipliers are larger due to the terms of trade effect but a range of -0.07 to 0.07 point change must be said to be moderate. The welfare measures are more variable for alternative Armington elasticities. By lowering the Armington elasticity we found the welfare loss to increase by approximately 50 percent while a higher level of the Armington elasticity is found to reduce the calculated welfare loss of the enlargement by 0.02 points. Although a change of 50 percent to the calculated welfare measure appear to be large we must stress the relatively moderate absolute welfare loss that this change assertion is based on. In short we dont find our results to be very sensitive to the specification of the Armington elasticities.

9.2 Real costs of trade

We conduct two simulations of the basecase for funded enlargement to assert the sensitivity of the results to the specification of the real costs of trade. Again the sensitivity analysis are performed by assigning the alternative values of the real costs of trade as shocks to the baseline. On top of the modified baseline the counterfactual scenario representing the basecase for the funded enlargement is then simulated. By comparing the magnitude of multipliers to those found in the original basecase simulation we may establish whether the results are sensitive to alternative specification of the real costs of trade. Again we will concentrate the sensitivity analysis on symmetric changes to the parameters under investigation. In the first experiment presented the real costs of trade to be abolished from enlargement are reduced to 50 percent of the value used in the basecase simulation. In the second experiment presented we double the value of the parameters for the real costs of trade.

Table 9.2: Macroeconomic effects of base case steady state by value of real costs

	$\delta^{TCM} = 5.0$ $\delta^{TCX} = 2.5$	Base Case	$\delta^{TCM} = 20.0$ $\delta^{TCX} = 10.0$
		—Baseline=100—	
Real GDP at factor costs	99.91	99.96	100.05
Real private consumption	99.54	99.91	100.50
Labour	99.95	99.98	100.04
Machine capital	100.03	100.22	100.53
Building capital[a]	99.75	99.78	99.82
Value of firm	98.59	98.76	99.06
Total houshold assets	99.32	99.82	100.66
Foreign assets	101.27	102.03	103.32
Aggregate EV in pct of 1998 GDP	-2.47	-0.87	1.73

[a]Excluding dwelling

9.2.1 Lower initial real costs of trade

The initial rate of real costs of trade are reduced to 2.5 percent of imported value and to 5 percent for exports. The natural presumption is that the positive effects of the enlargement are reduced and that the calculated welfare loss associated to the enlargement deepens. The lowered initial real costs of trade imply that the reduction of the price of imports inherent in market integration is reduced. The positive effects to the purchase power of consumers is therefore smaller than in the basecase. To producers the lowered downward impact to the price of imported intermediaries reduce the extent of the positive supply side effect. On the exports side the projected increase of export demands are reduced and this combined with lowered domestic demand adds up to a decrease of aggregate demand for domestically produced goods. The combination of lowered demand and smaller supply side effects imply more recessive effects on domestic production and prices than found in the basecase and lowered terms of trade. Thereby the effect of lowered real costs of trade on aggregate consumption is a reduction. The aggregate welfare loss amounts to 28.8 bill. dkkr. equivalent to 2.47 percent of 1998 GDP.

9.2.2 Higher initial real costs of trade

If instead the initial level of real costs are doubled to 10 and 20 percent of import and exports respectively, the positive effects of enlargement from market integration are enhanced. The positive supply side effect of lowered costs of production from cheaper imported intermediaries increase in magnitude. Likewise the positive effect of increased export demands will be larger all adding up to increased domestic production and price levels in the projection. The increased positive impact on the terms of trade result in higher projected aggregate consumption. The reason that production increase unlike the observation made if higher Armington elasticities were introduced is that the decline in the costs of production via cheapened imports is much more expressed as the real costs are doubled. The increased level of aggregate consumption serves to reverse the projected welfare loss of the basecase to a gain of 20.11 bill. dkkr. or 1.73 percent of 1998 GDP.

9.2.3 Sensitivity of results to real costs

As the preceding discussion and tables illustrates the results are indeed highly sensitive to the extent of real costs of trade. In the unlikely case that the real trade costs account for the double of the value assumed in the basecase the projected welfare loss of the funded enlargement may even be reversed to actually amount to a welfare improvement. It is therefore vital to the Danish economy to which extent the enlargement and in particular the integration of markets will induce increased exports and lowered import prices. As previsously noted the basecase assumptions of the extent of the real costs of trade are on the high side of those implemented in Baldwin et al. (1997) and Keuschnigg and Kohler (1999).

In view of the models definitions of the importers price and the export demand relation we may however point out that catching up effects in the CEE economies may in the longer run imply similar effects to the Danish economy as those of reduced real costs of international trade. If the CEE economies in the longer run are able to increase their level of productivity and their purchase power this may very well induce increased export demands and lowered prices of imports. This aspect of the enlargement are just as extern to the model as is the specification of the real costs of trade, and are therefore also subject to extensive uncertainty. The fact that we do not impose any mechanism for capturing the CEE catching up aspect of the enlargement therefore suggests that the possible overstatement of the effects of market integration are less grave than they appear at first sight.

10 Concluding remarks

In chapter 5 we demonstrated that the customs liberalization and market integration indeed do imply positive welfare effects and increased level of domestic activity. The effects found are small however and only a 0.12 percent increase of long run real GDP is projected. This reflects the small volumes of trade with the CEE countries. Moreover we demonstrated that the effects of market integration as modelled by real costs of trade by far exceeds those of the customs liberalization. The isolated welfare implications of customs liberalization and market integration amounts to 3.65 percent of 1998 GDP as measured by aggregate equivalent variation. The welfare unambiguously improves for all generation, though future generations benefit the most since they are not faced with the burden of transition to the new international economic environment.

The benefits of enlargement are not a free lunch. Since part of the budgetary costs must be covered by Denmark recessive impacts of reduced net transfers from the EU are an integral part of the enlargement. In chapter 6 we demonstrated that for realistic specifications of EU budget policy these recessive impacts dominate the positive effects of increased international trade. In the worse case scenario where the budget implications are financed exclusively by cuts to CAP expenditures a long run decrease of real GDP of 0.12 percent and a 0.24 decrease of real aggregate private consumption are projected. This implies an aggregate welfare loss of 2.21 percent of 1998 GDP. In the basecase, that is the scenario we find to be most realistic, the aggregate welfare loss amounts to 0.87 percent of 1998 GDP. The welfare loss is most grave for generations that are young at the time of implementation of the enlargement but all generations including future generations are projected to experience losses of welfare. On long run macroindicators, the basecase implies a reduction of real GDP of 0.04 percent while aggregate private consumption accounts for a decrease of 0.09 percent.

In the analysis of the relative importance of the domestic fiscal policy response conducted in chapter 7 we found that the choice of fiscal response is indeed important. Since various tax instruments affects incentives and thereby behavoiur differently they will imply different projections of the effects of enlargement. A common feature of the presented domestic policy scenarios is the notion of sustainable determination of the required tax increase. Shifting from debt-targeting to sustainable fiscal policy does for all instruments imply that part of the burden of funding enlargement is postponed and thereby that currently living generations will be relieved of some of the welfare loss at the expense of future generations. For the specification of aggregate equivalent variation, that discounts the equivalent variation of future generations, this shift of timing imply a relative aggregate welfare improvement of 0.02 percent of 1998 GDP for the case of the income tax instrument. For the case of sustainable value added taxation the postponed burden of the funding does not benefit currently living generations to an extent that offsets the negative implications to future generations. A relative loss of this shift is found to amount to 0.23 percent of 1998 GDP. For the corporate taxation case a similar welfare distributive effect is found but the aggregate loss here amounts to 0.34 percent of 1998 GDP. This loss thus approximately amounts to an additional one third of the basecase loss and we must conclude that covering the costs of enlargement using value added or corporate taxation cannot be recommended. Many other fiscal instruments are available including capital income taxation and cutting government expenditures.

The positive view of immigration from the CEE countries presented in chapter 8 was found to imply substantial expansive effects on the macroeconomy. The long run real GDP increase by 3.22 percent while aggregate real private consumption rise by 2.89 percent. Measured per capita however, GDP and aggregate private consumption decline by 0.06 percent and 0.38 percent respectively. This is due to the decreasing returns to scale of aggregate production caused by the fixed quantity of land.

The projected economic consequences for Denmark of enlargement cannot be considered to be conclusive given the high degree of uncertainty of important exogenous parameters. The single country framework also precludes a satisfactory treatment of important and essentially endogenous effects of the enlargement in CEE countries and foreign countries as such. CEE countries likely catching up will reduce long term budgetary implications and will also imply increased purchase power and productivity in these countries. This may imply cheaper imported goods and increased demands for exports. The specification of the international rate of growth to coincide with the domestic growth of productivity of labour is for these reasons problematic. Likewise the assumption of a constant international price levels constitutes a problematic simplification. Most likely the dramatic expansion of the arable land in the enlarged European union will imply changes to relative international price levels for agriculture goods. The magnitude of such effects on relative prices are uncertain and cannot be addressed endogenously in our framework. In essence price effects just as most of the exogenously specified foreign relations require a multicountry framework to be addressed properly.

With respect to exogenous assumptions for behavioural and technological parameters some misspecification may be present in our study. This have implications to the projected sectoral effects of the enlargement. Specifically the specification of the Armington elasticities would á priori be expected to be of some importance. In the sensitivity analysis we demonstrated that the projected macroeconomic effects of enlargement are not very sensitive to the specification of the Armington elasticities but that the projected effects to the production structure may change somewhat.

More important than the Armington elasticities are the modelling of the impact of market integration. As demonstrated in chapter 9 the magnitude assumed for the real costs of trade is crucial to the projected economic consequences. If the reduction of real costs of trade following from enlargement are sufficiently large the projected aggregate welfare loss may revert to a welfare gain. However it seems highly unrealistic that market integration should correspond to such values of the real costs of trade. The relative importance of the custom tariffs and subsidiation rates are by comparison of less importance although these parameters must also be considered problematic.

Finally the asserted budgetary implications of the enlargement are uncertain and obviously also very important to our findings. We found in chapter 6 that the ranking of the various budget scenarios by welfare implications corresponded to the total impact on the net transfer from EU. Although the costs in the various scenarios affects the Danish economy through different channels we feel confident that this correspondance hold in general.

Seen from an economic perspective we find that the enlargement does not benefit Denmark. The projected welfare loss is however very small and may very well be considered an acceptable price for the realization of the political vision for a united and stabile Europe.

References

Auerbach, A. J. and Kotlikoff, L. J. (1987). *Dynamic fiscal policy*. Cambridge University Press.

Baldwin, R. E., Francois, J. F., and Portes, R. (1997). The costs and benefits of eastern enlargement: The impact on the EU and central Europe. CEPR Workingpaper.

Blanchard, O. J. (1985). Debt, Deficits, and Finite Horizons. *Journal of Political Economy*, 93(2):223–247.

Boeri, T. and Brücker, H. (2000). The Impact of Eastern Enlargement on Employment and Labour Markets in the EU Member States. European Integration Consortium: DIW, CEPR, FIEF, IAS, IGIER.

Breuss, F. (2001). Macroeconomic Effects of EU Enlargement for Old and New Members. WIFO Working Papers, No. 143.

Dixit, A. K. and Stiglitz, J. E. (1977). Monopolistic competition and optimum product diversity. *American Economic Review*, 67:297–308.

Fæhn, T. and Holmøy, E. (2000). Welfare Effects of Trade Liberalization in Distorted Economies: A Dynamic General Equilibrium Assessment for Norway. In Harrison, G. W., Hougaard Jensen, S. E., and Pedersen, L. H., editors, *Using Dynamic General Equilibrium Models for Policy Analysis*, chapter 6. Elsevier Science B.V.

Fæhn, T. and Holmøy, E. (2001). Trade Liberalization and Effects on Pollutive Emissions and Waste - A General Equilibrium Assesment for Norway. Discussion Papers No. 298, Statistics Norway, Research Department.

Finger, J. M., Ingco, M., and Reincke, U. (1996). *The Uruguay Round: Statistics on Tariff Concessions Given and Received*. The World Bank. Data was downloaded from http://www.worldbank.org/research/trade/urstat.html.

Frandsen, S. E. and Jensen, H. G. (2000). Economic Impacts of the Enlargement of the European Union - Analysing the importance of direct payments. SJFI – Working Paper no. 15.

Frandsen, S. E., Jensen, H. G., and Vanzetti, D. M. (1998). Expanding 'Fortress Europe' - Implications of European Enlargement for Non-Member Regions. SJFI – Working Paper no. 12.

Harrison, G. W., Rutherford, T. F., and Tarr, D. G. (1996). Increased Competition and Completion of the Market in the European Union: Static and Steady State Effects. *Journal of Economic Integration*, 11:332–365.

Harrison, G. W., Rutherford, T. F., and Tarr, D. G. (1997). Quantifying the Uruguay Round. *The Economic Journal*, 107:1405–1430.

Heijdra, B. J. and Keuschnigg, C. (2000). Integration and Search Unemployment: An analysis of Eastern EU Enlargement. Available for download at the internet URL http://www.eco.rug.nl/medewerk/heijdra/download.htm.

Heijdra, B. J., Keuschnigg, C., and Kohler, W. (2001). Eastern Enlargement of the EU: Jobs, Investments and Welfare in Present Member Countries. Available for download at the internet URL http://www.eco.rug.nl/medewerk/heijdra/download.htm.

Hylleberg, S. and Jørgensen, R. W. (1998). A note on the estimation of markup pricing in manufacturing. Working paper 1998-6, Centre for non-linear Modelling in Economics, University of Aarhus.

Jensen, H. G., Frandsen, S. E., and Bach, C. F. (1998). Agriculture and Economy-Wide Effects of European Enlargement: Modelling the Common Agriculture Policy. SJFI – Working Paper no. 11.

Jensen, S. E. H., Nødgaard, U., and Pedersen, L. H. (2001). Fiscal Sustainability and Generational Burden Sharing in Denmark. Paper prepared for the workshop "Generational Accounting in the Nordic Countries" in Reykjavik, February 24, 2001. Economic Working Paper Series 2001:1, Statistics Denmark.

Keuschnigg, C., Keuschnigg, M., and Kohler, W. (1999). Eastern Enlargement to the EU: Economic Costs and Benefits for the EU Present Member States? - The Case for Germany. Final Report. Study XIX/B/9801 for the EU Commission.

Keuschnigg, C. and Kohler, W. (1996). Commercial policy and dynamic adjustment under monopolistic competition. *Journal of International Economics*, 40:373–409.

Keuschnigg, C. and Kohler, W. (1999). Eastern Enlargement to the EU: Economic Costs and Benefits for the EU Present Member States? - The Case for Austria. Final Report. Study XIX/B/9801 for the EU Commission.

Keuschnigg, C. and Kohler, W. (2000). Eastern enlargement of the European Union: A Dynamic General Equilibrium Perspective. In Harrison, G. W., Jensen, S. E. H., and Pedersen, L. H., editors, *Using Dynamic General Equilibrium Models for Policy Analysis*, chapter 5. Elsevier Science B.V.

Knudsen, M. B. (1999). Dokumentation af Excel-pakken til DREAM. Computable General Equilibrium Modelling, Statistics Denmark.

Knudsen, M. B., Pedersen, L. H., Petersen, T. W., Stephensen, P., and Trier, P. (1998a). Danish Rational Economic Agents Model — DREAM, Version 1.2. Computable General Equilibrium Modelling, Statistics Denmark.

Knudsen, M. B., Pedersen, L. H., Petersen, T. W., Stephensen, P., and Trier, P. (1998b). Dynamic calibration of a CGE-model with a demographic application. Conference Volume Draft, Computable General Equilibrium Modelling, Statistics Denmark.

Kohler, W. and Keuschnigg, C. (2000). An Incumbent Coutry View in Eastern Enlargement of the EU, Part I: A General Treatment. *Empirica*, 27:325–351.

Kohler, W. and Keuschnigg, C. (2001). An Incumbent Coutry View in Eastern Enlargement of the EU, Part 2: The Austrian Case. *Empirica*, 28:159–185.

Kristensen, T. M. and Jensen, P. R. (2001). Eastern Enlargement of the EU: Economic Costs and Benefits for the Present Member States? - The Case for Denmark. Final Report. Study BUDG/B1/0001 for the EU Commission.

Krugman, P. R. (1979). Increasing returns, monopolistic competition, and international trade. *Journal of International Economics*, 9:469–480.

Krugman, P. R. (1980). Scale economies, product differentiation and the pattern of trade. *American Economic Review*, 70:950–959.

Lejour, A. M., de Mooij, R. A., and Nahuis, R. (2001). EU Enlargement: Economic Implications for Countries and Industries. CESifo Working Paper No. 585.

Madsen, A. D. (2000). Velfærdseffekter ved skattesænkninger i DREAM. Economic Modelling Working Paper Series 2000:5, Statistics Denmark.

Madsen, A. D. and Pedersen, L. H. (2001). Velfærdseffekter ved skattesænkninger i DREAM. *Nationaløkonomisk Tidsskrift*, 139:298–315.

Pedersen, L. H. (1993). Noter til international integration. Institut for økonomi, skov og landskab, Den kongelige veterinær og landbohøjskole.

Pedersen, L. H., Stephensen, P., and Trier, P. (1998). A CGE Analysis of the Danish Ageing Problem. Computable General Equilibrium Modelling, Statistics Denmark.

Pedersen, L. H. and Trier, P. (2000). Har vi råd til velfærdsstaten ? Economic Modelling Working Paper Series 2000:4, Statistics Denmark.

Pedersen, T. W. (1999). Befolkningsfremskrivningen i DREAM. Computable General

Equilibrium Modelling, Statistics Denmark.

Petersen, T. W. (1997). An introduction to CGE-modelling and an illustrative application to Eastern European integration with the EU. Economic Modelling Working Paper Series 1998:4, Statistics Denmark.

Shoven, J. B. and Whalley, J. (1992). *Applying general equilibrium.* Cambridge surveys of economic literature. Cambridge University Press.

Stephensen, P. (2001). DREAMs disaggregerede befolkningsfremskrivning til år 2100. Computable General Equilibrium Modelling, Statistics Denmark.

The EU Commision (2001a). The free movement of workers in the context of enlargement. Commision: Enlargement MD99/01 7.3.01.

The EU Commision (2001b). Making a success of enlargement. Strategy paper and Report of the European Commision on the progress towards accession by each of the candidate countries.

Thomsen, T. (1999). Efterspørgslen efter produktionsfaktorer i Danmark. Economic Modelling Working Paper Series 1999:1, Statistics Denmark.

A Derivations and mathematical details

Since our model documentation is somewhat sparse on the mathematical formulation of details especially those adapted from DREAM we provide this appendix. Most methods are similar or even identical to those applied in DREAM as these are documented by the DREAM group.

A.1 Determination of firm value

The outstanding number of shares of a firm is denoted $n_{i,j,t}$. The value of the outstanding stock of shares corresponds to the value of the firm, such that

$$V_{i,j,t} = n_{i,j,t} v_{i,j,t}, \tag{A.1}$$

where $n_{i,j,t}$ is the number of shares and $v_{i,j,t}$ denotes the quotation of a single share. We assume that the firm does not engage in new stock emissions and thus that the number of shares is constant and may by normalized to 1 such that the value of the firm coincide with the stock qoutation.

The pension funds are assumed to use a risk-premium ρ when valuing shares[1]. The arbitrage condition reads

$$\left(i_t\left(1 - t_t^{rz}\right) + \rho\right) V_{i,j,t-1} = \left(1 - t_t^{dz}\right) D_{i,j,t} + \left(1 - t_t^{gz}\right)\left(V_{i,j,t} - V_{i,j,t-1}\right) \tag{A.2}$$

where t_t^{rz}, t_t^{dz} and t_t^{gz} are the tax rates relevant to income in the pension fund from interests, dividends, and capital gains respectively. The left-hand side of equation A.2 is the gain after tax and risk-premium of placing an investment of $V_{i,j,t-1}$ in bonds and may be considered the alternative costs of investing that amount in shares. The right-hand side of the arbitrage condition states the value after taxes of dividend income and capital

[1] The risk premium is introduced to avoid situations in which the discounting factor in expression A.3 for the value of the firm tend to zero causing the firm value to tend to infinity.

gains from stoks. We assume that capital gains are taxed countinously at the end of each period rather than at the time of realization.

By solving the differential equation A.2 we arrive at the following expression for the value of a firm j operating in industry i as seen from time t.

$$V_{i,j,t} = \sum_{s=t+1}^{T} \frac{1-t_s^{dz}}{1-t_s^{gz}} D_{i,j,s} \prod_{v=t+1}^{s} \frac{1}{1+i_v \frac{1-t_v^{rz}}{1-t_v^{gz}} + \rho \frac{1}{1-t_v^{gz}}} \quad \text{for} \quad T \to \infty \tag{A.3}$$

The interpretation of equation A.3 is as follows: The value of the firm ultimo period t is the present value of the future stream of dividends adjusted for taxes. The tax adjustment term applying to the stream of dividends reflects the fiscal considerations of the marginal investor in the sense that the tax adjustment term represents the required marginal appreciation of the value of the share required to offset a unit decrease of the dividend.

The rate of discounting reflects the alternative costs for the pension fund of future dividend receipts. These alternative costs are the yields that could otherwise have been realized by placing the future dividends in bonds. These bonds would yield interests taxed by $1-t_t^{rz}$ and would have been risk-free. In addition placing the investment in the firm rather than in bonds will give rise to capital gains which are taxed by $1-t_t^{gz}$. The financing decision of the firm is modelled along the lines of the "New View of Dividend Taxation". The level of dividends are hence determined by the fraction of current profits for which the shareholders are able to realize at least as good a yield as the firm.

A.1.1 Financing rule

We follow DREAM by assuming that the debt $B_{i,j,t}$ of the firm constitute a fixed proportion $g_{i,j}$ of the capital stock. The assumption of a fixed debt share is introduced in order to avoid fully funding of the capital stock by either shares or debt. In absense of the assumption of a fixed debt share, the firm would fund its capital stock by the method (shares or debt) favoured by the tax system. The rule of fixed debt share is formalized by

$$B_{i,j,t} = g_{i,j} \sum_{s \in \{B,L,M\}} \left(P_{i,j,t}^{Is} K_{i,j,t}^{s} \right), \quad \forall (i,j) : 0 < g_{i,j} < 1, \tag{A.4}$$

where $P_{i,j,t}^{Is}$ is the price of new investments in capital of type s. These prices are not necessarily the original purchase price but rather the price that could be realized in the market for capital goods should the firm try to sell its capital stock.

A.1.2 Demand and turnover

As explained in the main text the demand faced by a firm j operating in industry i for its product variety may be formalized by the demand function

$$Y_{i,j,t} = (\beta_{i,j})^{E_i} \left(\frac{P^Y_{i,j,t}}{P^Y_{i,t}}\right)^{-E_i} \Theta^i_t \quad , \quad E_i > 1, \tag{A.5}$$

where $P^Y_{i,t}$ is a CES price index over the varieties of the product of indutry i, $\beta_{i,j}$ is the scale parameter and E_i is the parameter of constant elasticity of substition between the product varieties from industry i. Finally Θ^i_t is the aggregate demand for varieties from industry i. Due to the assumption of identical scale parameters and elasticities of substitution, the price index $P^Y_{i,t}$ is identical for all agents.

The turnover of the firm may now be defined by

$$\Lambda_{i,j,t}(Y_{i,j,t}) = P^Y_{i,j,t} Y_{i,j,t} = (Y_{i,j,t})^{\hat{\mu}_i} \left(\Theta^i_t\right)^{1-\hat{\mu}_i} \beta_{i,j} P^Y_{i,t}, \tag{A.6}$$

where

$$\hat{\mu}_i \equiv \frac{E_i - 1}{E_i} \tag{A.7}$$

The partial derivative of the turnover with respect to quantity sold expresses the increase in turnover from a marginal change in quantity sold and amounts to

$$\frac{\partial \Lambda_{i,j,t}(Y_{i,j,t})}{\partial Y_{i,j,t}} = \hat{\mu}_i (Y_{i,j,t})^{\hat{\mu}_i - 1} \left(\Theta^i_t\right)^{1-\hat{\mu}_i} \beta_{i,j} P^Y_{i,t}. \tag{A.8}$$

We have assumed that all industries have a sufficiently large number of compeeting firms to ensure that no single firm is able to influence the industry price index $P^Y_{i,t}$.

A.2 Intertemporal optimization of the firm

The intertemporal decision problem of management in a given firm j operating in an industry i amounts to the determination of the optimal plan for the levels of inputs of materials, energy, labour and capital investments. The production plan should maximize the current value of the future stream of dividends net of taxation applying to capital income of the marginal investor. Since agriculture is favoured by subsidiation of land and production the dividend expression and consequently the maximization problem appear slightly different for firms operating in this industry. The following hence apply to firms that are not operating in agriculture.

Assuming that managers behave rationally and have perfect foresight, the intertemporal optimization problem may be formalized as follow.

$$\max_{\{M_{i,j,t},E_{i,j,t},L_{i,j,t},I^s_{i,j,t}\}_{\tau=t}^{\infty}} \frac{1-t^{dz}_{\tau}}{1-t^{gz}_{\tau}} D_{i,j,\tau} + \sum_{t=\tau+1}^{\infty} \frac{1-t^{dz}_{t}}{1-t^{gz}_{t}} D_{i,j,t} \prod_{v=\tau+1}^{t} \frac{1}{1+\frac{i_v(1-t^{rz}_v)+\rho}{1-t^{gz}_v}} \quad \text{s.t.} \tag{A.9}$$

$$\begin{aligned}
D_{i,j,t} = &(1-t^c_t)\Big[\Lambda_{i,j,t}\left(Y_{i,j,t}\right) - P^M_{i,j,t}M_{i,j,t} - P^E_{i,j,t}E_{i,j,t} - (1+t^a_t)\,W_t L_{i,j,t} \\
&-i_t g_{i,j} \sum_{s\in\{B,L,M\}} P^{Is}_{i,j,t-1} I^s_{i,j,t-1}\Big] - \sum_{s\in\{B,L,M\}} P^{Is}_{i,j,t} I^s_{i,j,t} \\
&- P^{SI}_{i,j,t} I^{SI}_{i,j,t} + t^c_t \sum_{s\in\{B,M\}} \hat{\delta}^s_t \hat{K}^s_{i,j,t-1} \\
&+ g_{i,j} \sum_{s\in\{B,M\}} \left[P^{Is}_{i,j,t}\left(\left(1-\delta^s_{i,j}\right)K^s_{i,j,t-1} + I^s_{i,j,t}\right) - P^{Is}_{i,j,t-1}K^s_{i,j,t-1}\right] \\
&+ g_{i,j}\left[P^{IL}_{i,j,t}\left(K^L_{i,j,t-1} + I^L_{i,j,t}\right) - P^{IL}_{i,j,t-1}K^L_{i,j,t-1}\right]
\end{aligned} \tag{A.10}$$

$$\Lambda_{i,j,t}\left(Y_{i,j,t}\right) = \left(Y_{i,j,t}\right)^{\hat{\mu}_i}\left(\Theta^i_t\right)^{1-\hat{\mu}_i} \beta_{i,j} P^Y_{i,j,t} \tag{A.11}$$

$$Y_{i,j,t} = G_{i,j,t}\left(K_{i,j,t}, (1+n)^t L_{i,j,t}, E_{i,j,t}, M_{i,j,t}\right) - \sum_{s\in\{B,L,M\}} \phi^s_{i,j,t} \frac{\left(I^s_{i,j,t}\right)^2}{K^s_{i,j,t-1}} \tag{A.12}$$

$$\hat{K}^s_{i,j,t} = \left(1-\hat{\delta}^s_t\right)\hat{K}^s_{i,j,t-1} + P^{Is}_{i,j,t} I^s_{i,j,t}\,,\; s\in\{B,M\} \tag{A.13}$$

$$K^s_{i,j,t} = \left(1-\delta^s_{i,j}\right)K^s_{i,j,t-1} + I^s_{i,j,t}\,,\; s\in\{B,L,M\} \tag{A.14}$$

$$\tilde{K}^s_{i,j,t} = \left(1-\kappa\delta^s_{i,j}\right)K^s_{i,j,t-1} + \kappa I^s_{i,j,t}\,,\; s\in\{B,L,M\} \tag{A.15}$$

$$B_{i,j,t} = g_{i,j} \sum_{s\in\{B,L,M\}} P^{Is}_{i,j,t} K^s_{i,j,t} \tag{A.16}$$

This intertemporal optimization problem is one of optimal control. The state variables are the capital stocks $K^B_{i,j,t-1}$, $K^L_{i,j,t-1}$ and $K^M_{i,j,t-1}$ while $L_{i,j,t}$, $E_{i,j,t}$, $M_{i,j,t}$, $I^B_{i,j,t}$, $I^L_{i,j,t}$ and $I^M_{i,j,t}$ all are control variables.

The current-value Hamiltonian

The problem A.9 subject the constraints A.10 through A.16 may be solved by formulation of a current-value Hamiltonian and application of Pontryagins maximum principle. Please note that we do not model changes in stocks and inventories which are consequently assumed to be zero from period 2 and forward. Changes in stocks and inventories are included in order to reproduce the national accounts and are assumed to be withdrawn from dividends prior to payment to shareholders.

Let the discount factor R_t be defined by

$$R_t \equiv \begin{cases} \prod_{v=s+1}^{t} \frac{1}{1+i_v \frac{1-t_v^{rz}}{1-t_v^{gz}}+\rho \frac{1}{1-t_v^{gz}}} & \text{for} \quad t \geq s+1 \\ 1 & \text{for} \quad t = s \end{cases} \tag{A.17}$$

The current-value Hamiltonian $\mathcal{H}(\cdot)$ which omits the changes in stocks and inventories may now be stated as:

$$\begin{aligned} &\mathcal{H}\left(K_{i,j,t-1}^{B}, K_{i,j,t-1}^{L}, K_{i,j,t-1}^{M}, L_{i,j,t}, E_{i,j,t}, M_{i,j,t}, I_{i,j,t}^{B}, I_{i,j,t}^{L}, I_{i,j,t}^{M},\right. \\ &\left.\lambda_{i,j,t}^{B}, \lambda_{i,j,t}^{L}, \lambda_{i,j,t}^{M}, \hat{\lambda}_{i,j,t}^{B}, \hat{\lambda}_{i,j,t}^{M}\right) = \\ &R_t \frac{1-t_t^{dz}}{1-t_t^{gz}} \left\{ (1-t_t^{c}) \left[\Lambda_{i,j,t}\left(Y_{i,j,t}\right) - P_{i,j,t}^{M} M_{i,j,t} - P_{i,j,t}^{E} E_{i,j,t} - (1+t_t^{a}) W_t L_{i,j,t} \right.\right. \\ &\left. - i_t g_{i,j} \sum_{s\in\{B,L,M\}} P_{i,j,t-1}^{Is} K_{i,j,t-1}^{s} \right] - \sum_{s\in\{B,L,M\}} P_{i,j,t}^{Is} I_{i,j,t}^{s} + t_t^{c} \sum_{s\in\{B,M\}} \hat{\delta}_t^{s} \hat{K}_{i,j,t-1} \\ &\left. + g_{i,j} \sum_{s\in\{B,L,M\}} \left[P_{i,j,t}^{Is} \left(\left(1-\delta_{i,j}^{s}\right) K_{i,j,t-1}^{s} + I_{i,j,t}^{s} \right) - P_{i,j,t-1}^{Is} K_{i,j,t-1}^{s} \right] \right\} \\ &+ \sum_{s\in\{B,L,M\}} R_t \lambda_{i,j,t}^{s} \left[\left(1-\delta_{i,j}^{s}\right) K_{i,j,t-1}^{s} + I_{i,j,t}^{s} \right] \\ &+ \sum_{s\in\{B,M\}} R_t \hat{\lambda}_{i,j,t}^{s} \left[\left(1-\hat{\delta}_t^{s}\right) \hat{K}_{i,j,t-1}^{s} + P_{i,j,t}^{I,s} I_{i,j,t}^{s} \right] \end{aligned} \tag{A.18}$$

$\lambda_{i,j,t}^{s}$ for $s \in \{B, L, M\}$ are state-variables associated with the accumulation identities A.14 for buildings-, machinery-, and landcapital respectively, while $\hat{\lambda}_{i,j,t}^{s}$ for $s \in \{B, M\}$ are state variables associated with the accumulation identity A.13 of the bookvalue of capital.

A.2.1 First order conditions

The first order conditions for optimum are derived by application of Pontryagins maximum principle to the current-value Hamiltonian. In optimum the following conditions must hold:

$$\frac{\partial \mathcal{H}(\cdot)}{\partial L_{i,j,t}} = \frac{\partial \mathcal{H}(\cdot)}{\partial E_{i,j,t}} = \frac{\partial \mathcal{H}(\cdot)}{\partial M_{i,j,t}} = 0 \tag{A.19}$$

$$\frac{\partial \mathcal{H}(\cdot)}{\partial I_{i,j,t}^{s}} = 0 \text{ for } s \in \{B, L, M\} \tag{A.20}$$

$$\frac{\partial \mathcal{H}(\cdot)}{\partial K^s_{i,j,t-1}} = R_{t-1}\lambda^s_{i,j,t-1} \text{ for } s \in \{B, L, M\} \tag{A.21}$$

$$\frac{\partial \mathcal{H}(\cdot)}{\partial \hat{K}^s_{i,j,t-1}} = R_{t-1}\hat{\lambda}^s_{i,j,t-1} \text{ for } s \in \{B, M\} \tag{A.22}$$

Labour, energy and materials

The first order condition with respect to labour input is

$$\frac{\partial \Lambda_{i,j,t}(Y_{i,j,t})}{\partial Y_{i,j,t}} \frac{\partial G_{i,j,t}(\cdot)}{\partial L_{i,j,t}} = \frac{(1+t^a_t)\,W_t}{(1+n)^t} \tag{A.23}$$

For the level of energy inputs the first order condition become

$$\frac{\partial \Lambda_{i,j,t}(Y_{i,j,t})}{\partial Y_{i,j,t}} \frac{\partial G_{i,j,t}(\cdot)}{\partial E_{i,j,t}} = P^E_{i,j,t} \tag{A.24}$$

Material inputs must comply with the following first order condition

$$\frac{\partial \Lambda_{i,j,t}(Y_{i,j,t})}{\partial Y_{i,j,t}} \frac{\partial G_{i,j,t}(\cdot)}{\partial M_{i,j,t}} = P^M_{i,j,t} \tag{A.25}$$

Investments

The first order conditions for optimal investments in machinery, buildings and land are given by A.20.

Please note that due to the absence of depreciation of land we have that $\hat{\lambda}^L_{i,j,t} = 0$. For investments in buildings, land and machinery, that is for $s \in \{B, L, M\}$, the first order conditions are

$$\begin{aligned} &\frac{1-t^{dz}_t}{1-t^{gz}_t}\left\{(1-g_{i,j})\,P^{Is}_{i,j,t} - (1-t^c_t)\frac{\partial \Lambda_{i,j,t}(Y_{i,j,t})}{\partial Y_{i,j,t}}\left[\frac{\partial G_{i,j,t}(\cdot)}{\partial I^s_{i,j,t}} - \frac{\partial \Phi^s_{i,j,t}(\cdot)}{\partial I^s_{i,j,t}}\right]\right\} \\ &= \lambda^s_{i,j,t} + \hat{\lambda}^s_{i,j,t}P^{Is}_{i,j,t} \end{aligned} \tag{A.26}$$

Capital

With respect to capital conditions are given by A.21. Again due to the absence of depreciation of land, we have that

$$\hat{\lambda}^L_{i,j,t} = \hat{\delta}^L_{i,j,t} = \delta^L_{i,j,t} = 0$$

For $s \in \{B, L, M\}$ the first order conditions are

$$\frac{1-t_t^{dz}}{1-t_t^{gz}} \left\{ (1-t_t^c) \left[\frac{\partial \Lambda_{i,j,t}\left(Y_{i,j,t}\right)}{\partial Y_{i,j,t}} \left[\frac{\partial G_{i,j,t}\left(\cdot\right)}{\partial K_{i,j,t-1}^s} - \frac{\partial \Phi_{i,j,t}^s\left(\cdot\right)}{\partial K_{i,j,t-1}^s} \right] - i_t g_{i,j} P_{i,j,t-1}^{Is} \right] \right. \\ \left. + g_{i,j} \left[\left(1-\delta_{i,j}^s\right) P_{i,j,t}^{Is} - P_{i,j,t-1}^{Is} \right] \right\} = \frac{R_{t-1}}{R_t} \lambda_{i,j,t-1}^s - \left(1-\delta_{i,j}^s\right) \lambda_{i,j,t}^s \tag{A.27}$$

Book value of capital

Finally we have the conditions to which the book value of capital must comply. Since no fiscal depreciation allowance and thus no book value concept is defined for land the conditions apply only to buildings and machinery, that is $s \in \{B, M\}$

$$R_t \frac{1-t_t^{dz}}{1-t_t^{gz}} t_t^c \hat{\delta}_t^s + R_t \hat{\lambda}_{i,j,t}^s \left(1-\hat{\delta}_t^s\right) = R_{t-1} \hat{\lambda}_{i,j,t-1}^s \tag{A.28}$$

This completes our presentation of the first order conditions characterizing the solution to the intertemporal optimization problem of the representative private firm not operating in agriculture.

A.3 Symmetric industry equilibrium

In this section, we present the derivation of the demand and marginal turnover for the representative firm of an industry i. The derivations are carried out by imposing the assumption of symmetric equilibrium.

In symmetric equilibrium all agents purchasing the CES aggregate product from the representative firm of industry i have the same scaleparameter β_i and elasticity of substitution E_i over the varieties of the industry product. Let the number of firms in industry i denote by J_i and assume that no single firm is able to affect the CES price index relevant to the CES aggregate of the industry varieties. Further assume that all J_i firms of industry i are identical and therefore charge the same price $\bar{P}_{i,t}^Y$ for their product variety

$$\forall j = 1, \ldots, J_i : P_{i,j,t}^Y = \bar{P}_{i,t}^Y \tag{A.29}$$

Demand

Now the price index for the aggregate product of industry i is given by

$$P^Y_{i,t} = \left(\sum_{j=1}^{J_i} (\beta_i)^{E_i} \left(\bar{P}^Y_{i,t}\right)^{1-E_i}\right)^{\frac{1}{1-E_i}}$$
$$= (\beta_i)^{\frac{E_i}{1-E_i}} (J_i)^{\frac{1}{1-E_i}} \bar{P}^Y_{i,t} \tag{A.30}$$

The aggregate demand for the CES aggregate of varieties produced in industry i may now be derived from the demand for the product of firm j by enforcement of the symmetric equilibrium assumption

$$Y_{i,j,t} = (\beta_{i,j})^{E_i} \left(\frac{P^Y_{i,j,t}}{P^Y_{i,t}}\right)^{-E_i} \Theta^i_t \qquad \Rightarrow$$
$$\sum_{j=1}^{J_i} Y_{i,j,t} = \sum_{j=1}^{J_i} (\beta_i)^{E_i} \left(\frac{\bar{P}^Y_{i,t}}{P^Y_{i,t}}\right)^{-E_i} \Theta^i_t \qquad \Leftrightarrow$$
$$Y_{i,t} J_i = \sum_{j=1}^{J_i} (\beta_i)^{E_i} \left(\frac{\bar{P}^Y_{i,t}}{(\beta_i)^{\frac{E_i}{1-E_i}} (J_i)^{\frac{1}{1-E_i}} \bar{P}^Y_{i,t}}\right)^{-E_i} \Theta^i_t \qquad \Leftrightarrow$$
$$Y_{i,t} = \left(\beta_i (\beta_i)^{\frac{E_i}{1-E_i}} (J_i)^{\frac{1}{1-E_i}}\right)^{E_i} \Theta^i_t \qquad \Leftrightarrow$$

$$Y_{i,t} = (\beta_i J_i)^{-\frac{1}{\hat{\mu}_i}} \Theta^i_t \tag{A.31}$$

where

$$\hat{\mu}_i \equiv \frac{E_i}{E_i - 1} \tag{A.32}$$

Marginal turnover

In order to represent the first order conditions of the representative private firm for the non agriculture industry i it will prove convenient to derive the marginal turnover under symmetric equilibrium. Using equation A.8 and imposing the assumption of symmetric equilibrium, the marginal turnover in the representative firm of industry i is given by

$$\begin{aligned}
\frac{\partial \Lambda_{i,t}\left(Y_{i,t}\right)}{\partial Y_{i,t}} &= \hat{\mu}_i \left(Y_{i,t}\right)^{\hat{\mu}_i - 1} \left(\Theta_t^i\right)^{1-\hat{\mu}_i} \beta_i P_{i,t}^Y \\
&= \hat{\mu}_i \left[\left(\beta_i J_i\right)^{-\frac{1}{\hat{\mu}_i}} \Theta_t^i\right]^{\hat{\mu}_i - 1} \left(\Theta_t^i\right)^{1-\hat{\mu}_i} \beta_i P_{i,t}^Y \\
&= \hat{\mu}_i \left(\beta_i J_i\right)^{\frac{1-\hat{\mu}_i}{\hat{\mu}_i}} \beta_i P_{i,t}^Y \\
&= \hat{\mu}_i \left(J_i\right)^{\frac{1-\hat{\mu}_i}{\hat{\mu}_i}} \left(\beta_i\right)^{\frac{1}{\hat{\mu}_i}} P_{i,t}^Y
\end{aligned}$$

which implies that

$$\frac{\partial \Lambda_{i,t}\left(Y_{i,t}\right)}{\partial Y_{i,t}} = \mu_i P_{i,t}^Y \tag{A.33}$$

where

$$\mu_i \equiv \hat{\mu}_i \left(J_i\right)^{\frac{1-\hat{\mu}_i}{\hat{\mu}_i}} \left(\beta_i\right)^{\frac{1}{\hat{\mu}_i}} \tag{A.34}$$

A.3.1 First order conditions in symmetric equilibrium

This section will present the first order conditions for the representative firm of the non agriculture industry i. The first order conditions under symmetric equilibrium are derived from the first order conditions A.23 through A.27 using the equation for the marginal turnover under symmetric equilibrium A.33 and by imposing the assumption that all firms in industry i are identical.

Labour, energy and materials

The first-order condition for labour for the representative firm of industry i amounts to

$$\frac{\partial G_{i,t}\left(\cdot\right)}{\partial L_{i,t}} = \frac{\left(1+t_t^a\right) W_t}{\left(1+n\right)^t} \frac{1}{\mu_i P_{i,t}^Y}. \tag{A.35}$$

With respect to energy input the first-order condition is

$$\frac{\partial G_{i,t}\left(\cdot\right)}{\partial E_{i,t}} = \frac{P_{i,t}^E}{\mu_i P_{i,t}^Y}. \tag{A.36}$$

With respect to material inputs the first-order condition become

$$\frac{\partial G_{i,t}\left(\cdot\right)}{\partial M_{i,t}} = \frac{P_{i,t}^M}{\mu_i P_{i,t}^Y}. \tag{A.37}$$

Investments

In the first-order conditions for investments (and later for capital stocks) we will let the marginal product of capital of type s denote by $MPK^{s}_{i,t}$. The marginal product of capital is defined by

$$MPK^{s}_{i,t} \equiv \frac{\partial G_{i,t}(\cdot)}{\partial \tilde{K}^{s}_{i,t}} \quad \text{for} \quad s \in \{B, M\}. \tag{A.38}$$

For land the marginal productivity of capital should be corrected for growth

$$MPK^{L}_{i,t} \equiv (1+n)^{t} \frac{\partial G_{i,t}(\cdot)}{\partial \tilde{K}^{L}_{i,t}}. \tag{A.39}$$

The first-order condition for investments in buildings, land and machinery appear after enforcement of the assumption of symmetric equilibrium on equation A.27, reduction and rearrangement of terms. For investments in capital of type $s \in \{B, L, M\}$ the first-order conditions are

$$\frac{1-t^{dz}_{t}}{1-t^{gz}_{t}}\left[1-g_{i}-(1-t^{c}_{t})\,\mu_{i}\frac{P^{Y}_{i,t}}{P^{Is}_{i,t}}\left(\kappa MPK^{s}_{i,t}-2\phi^{s}_{i,t}\frac{I^{s}_{i,t}}{K^{s}_{i,t-1}}\right)\right]=\frac{\lambda^{s}_{i,t}}{P^{Is}_{i,t}}+\hat{\lambda}^{s}_{i,t}. \tag{A.40}$$

Capital

For capital stocks the first-order conditions are derived using equations A.27. Before we present the first-order conditions, please note that

$$\frac{R_{t-1}}{R_{t}} = 1 + i_{t}\frac{1-t^{rz}_{t}}{1-t^{gz}_{t}} + \rho\frac{1}{1-t^{gz}_{t}}.$$

Using this and applying the assumption of symmetric equilibrium, the first-order conditions for capital of types$s \in \{B, L, M\}$ appear as

$$\begin{aligned}
&\frac{1-t^{dz}_{t}}{1-t^{gz}_{t}}\left\{(1-t^{c}_{t})\,\mu_{i}P^{Y}_{i,t}\left[(1-\kappa\delta^{s}_{i})\,MPK^{s}_{i,t}+\phi^{s}_{i,t}\left(\frac{I^{s}_{i,t}}{K^{s}_{i,t-1}}\right)^{2}-i_{t}g_{i}\frac{P^{Is}_{i,t-1}}{\mu_{i}P^{Y}_{i,t}}\right]\right.\\
&\left.+g_{i}P^{Is}_{i,t}\left((1-\delta^{s}_{i})-\frac{P^{Is}_{i,t-1}}{P^{Is}_{i,t}}\right)\right\}=\left(i_{t}\frac{1-t^{rz}_{t}}{1-t^{gz}_{t}}+\rho\frac{1}{1-t^{gz}_{t}}\right)\lambda^{s}_{i,t-1}\\
&-\left((1-\delta^{s}_{i})\,\lambda^{s}_{i,t}-\lambda^{s}_{i,t-1}\right).
\end{aligned} \tag{A.41}$$

Book-value of capital

Finally we have the conditions to which the book-value of capital must comply. For capital of type $s \in \{B, M\}$ these are

$$\frac{1-t^{dz}_{t}}{1-t^{gz}_{t}}t^{c}_{t}\hat{\delta}^{s}_{t} = \left(i_{t}\frac{1-t^{rz}_{t}}{1-t^{gz}_{t}}+\rho\frac{1}{1-t^{gz}_{t}}\right)\hat{\lambda}^{s}_{i,t}-\left(\left(1-\hat{\delta}^{s}_{t}\right)\hat{\lambda}^{s}_{i,t}-\hat{\lambda}^{s}_{i,t-1}\right). \tag{A.42}$$

A.4 Factor demands

For reference this section will derive demand functions for the factors of production. As noted in the main text, the solution to the representative producers problem may be reformulated in terms of a system of CES factor-demand functions. Let us recapitulate this point.

The marginal product of capital $MPK^{s}_{i,t}$ may be viewed as the price of capital such that the first-order conditions A.35 through A.37 and the definitions of the marginal product of capital can be regarded the solution to the following maximization problem

$$\max_{\left(\tilde{K}^{s}_{i,t},L_{i,t},E_{i,t},M_{i,t}\right)} \mu_i P^{Y}_{i,t}\tilde{Y}_{i,t} - \left(\mu_i P^{Y}_{i,t} \sum_{s\in\{B,L,M\}} MPK^{s}_{i,t}\tilde{K}^{s}_{i,t} + \frac{(1+t^{a}_{t})}{(1+n)^{t}} W_t(1+n)^{t} L_{i,t} + P^{E}_{i,t}E_{i,t} + P^{M}_{i,t}M_{i,t}\right). \tag{A.43}$$

The objective function of this maximization problem does not have any direct economic interpretation.

Let us define the real price index of the capital aggregate $K_{i,t}$ as the CES aggregate of the price of plant and machinery capital

$$MPK_{i,t} = \left[\alpha^{i}_{KP}\left(MPK^{P}_{i,t}\right)^{1-\sigma^{i}_{K}} + \alpha^{i}_{KM}\left(MPK^{M}_{i,t}\right)^{1-\sigma^{i}_{K}}\right]^{\frac{1}{1-\sigma^{i}_{K}}} \tag{A.44}$$

where the plant capital price index is defined by

$$MPK^{P}_{i,t} = \left[\alpha^{i}_{KB}\left(MPK^{B}_{i,t}\right)^{1-\sigma^{i}_{KP}} + \alpha^{i}_{KL}\left(\frac{MPK^{L}_{i,t}}{(1+n)^{t}}\right)^{1-\sigma^{i}_{KP}}\right]^{\frac{1}{1-\sigma^{i}_{KP}}}. \tag{A.45}$$

Since the gross output $\tilde{Y}_{i,t}$ is given, the maximization problem A.43 is equivalent to cost-minization. Given the definitions of the price indices on capital and by viewing $\mu_i P^{Y}_{imt}$ as the CES price index of output the problem is a standard CES minimization problem from which factor-demand functions may be derived directly.

We will present the so-derived factor-demand functions from the lower end of the nested production technology used by the representative firm for industry i.

Capital demands

The demand for weighed building- and land-capital are given as fractions of the plant capital aggregate $K^{P}_{i,t}$. For buildings the optimal capital level is given by

$$\tilde{K}^{B}_{i,t} = \alpha^{i}_{KB}\left(\frac{MPK^{B}_{i,t}}{MPK^{P}_{i,t}}\right)^{-\sigma^{i}_{KP}} K^{P}_{i,t}. \tag{A.46}$$

For land the optimal level of capital is

$$(1+n)^t \tilde{K}^L_{i,t} = \alpha^i_L \left(\frac{MPK^L_{i,t}}{MPK^P_{i,t}} \right)^{-\sigma^i_{KP}} K^P_{i,t}. \tag{A.47}$$

The price index relevant to plant capital $MPK^P_{i,t}$ is given by A.45 while the price indices for buildings and land are both given by the marginal product of the relevant type of capital as noted in equation A.38.

Likewise, the demands for plant capital and machinery are given as fractions of the aggregate representing the total capital input $K_{i,t}$. The demand for plant capital is given by

$$K^P_{i,t} = \alpha^i_{KP} \left(\frac{MPK^P_{i,t}}{MPK_{i,t}} \right)^{-\sigma^i_K} K_{i,t}. \tag{A.48}$$

The demand for weighed machinery capital is given by

$$\tilde{K}^M_{i,t} = \alpha^i_{KM} \left(\frac{MPK^M_{i,t}}{MPK_{i,t}} \right)^{-\sigma^i_K} K_{i,t}. \tag{A.49}$$

The price index $MPK^P_{i,t}$ is defined by A.45 and the price index of machinery is again given by the marginal product of this type of capital as noted in A.38.

Optimal combination of capital and labour

As previously noted, capital and labour are combined to form the factory aggregate $F_{i,t}$. The demand for the capital aggregate is given by

$$K_{i,t} = \alpha^i_K \left(\frac{\mu_i P^Y_{i,t} MPK_{i,t}}{P^F_{i,t}} \right)^{-\sigma^i_F} F_{i,t}. \tag{A.50}$$

The demand for labour is given by

$$(1+n)^t L_{i,t} = \alpha^i_L \left(\frac{(1+t^a_t) W_t}{(1+n)^t P^F_{i,t}} \right)^{-\sigma^i_F} F_{i,t}. \tag{A.51}$$

where the price index of the factory aggregate is given by

$$P^F_{i,t} = \left[\alpha^i_K \left(\mu_i P^Y_{i,t} MPK_{i,t} \right)^{1-\sigma^i_F} + \alpha^i_L \left(\frac{(1+t^a_t) W_t}{(1+n)^t} \right)^{1-\sigma^i_F} \right]^{\frac{1}{1-\sigma^i_F}}. \tag{A.52}$$

Optimal combination of factory and energy

The value-added aggregate $H_{i,t}$ is a combination of the factory aggregate and energy. The optimal combination of these two components are given by the demand functions below starting with the optimal demand for the factory aggregate

$$F_{i,t} = \alpha_F^i \left(\frac{P_{i,t}^F}{P_{i,t}^H} \right)^{-\sigma_H^i} H_{i,t}. \tag{A.53}$$

The optimal input of energy is given by

$$E_{i,t} = \alpha_E^i \left(\frac{P_{i,t}^E}{P_{i,t}^H} \right)^{-\sigma_H^i} H_{i,t}. \tag{A.54}$$

where the CES price index for value added is given by

$$P_{i,t}^H = \left[\alpha_F^i \left(P_{i,t}^F \right)^{1-\sigma_H^i} + \alpha_E^i \left(P_{i,t}^E \right)^{1-\sigma_H^i} \right]^{\frac{1}{1-\sigma_H^i}} . \tag{A.55}$$

Value added and materials

Finally, we arrive at the optimal composition of value-added and materials entering the production, whioch are given by the following demand functions. The optimal level of the value-added aggregate is

$$H_{i,t} = \alpha_H^i \left(\frac{P_{i,t}^H}{\mu_i P_{i,t}^Y} \right)^{-\sigma_Y^i} \tilde{Y}_{i,t}. \tag{A.56}$$

The optimal level of material input on the other hand is given by

$$M_{i,t} = \alpha_M^i \left(\frac{P_{i,t}^M}{\mu_i P_{i,t}^Y} \right)^{-\sigma_Y^i} \tilde{Y}_{i,t}. \tag{A.57}$$

where the price index of the gross output is given by

$$\mu_i P_{i,t}^Y = \left[\alpha_H^i \left(P_{i,t}^H \right)^{1-\sigma_Y^i} + \alpha_M^i \left(P_{i,t}^M \right)^{1-\sigma_Y^i} \right]^{\frac{1}{1-\sigma_Y^i}} . \tag{A.58}$$

The factor-demand functions presented above completes the characterization of the cost efficient composition of inputs of factor aggregates. Together with the intertemporal optimality conditions A.26 through A.42 in which the marginal products of capital enters as well the demand system determines the optimal behaviour of the representative firm. The only remaining element in this story is the optimal composition the factor aggregates across suppliers and origin.

A.4.1 Disaggregate factor demands

The demand functions derived above are all expressed in terms of CES aggregates. The aggregates of commodities and services entering the production at the leafs of the 'technology tree', that is the aggregates $M_{i,t}$, $E_{i,t}$, and $I^s_{i,t}$ for $s \in \{B, L, M\}$, are all composed by Leontief aggregates of deliveries from the various industries (excluding energy provisions). These industry specific deliveries are on their part represented by nested CES-functions of deliveries from the domestic producers and foreign producers[2], the foreign producers being represented by nests over the region in which the foreign producer reside. All this should be familiar from the previous treatment of origin in the main text. However, a set of product taxes apply and therefore we will present the complete derivation of demands in the nest-structure using materials as an illustrative example.

Demands for industry-specific deliveries

The material aggregate is a Leontief aggregate over deliveries from the industries delivering to material use. These industries include all industries in the set I excluding the energy provisions, which is labeled 'en'. Minimizing the costs of the material aggregate may now be formalized as

$$\min_{\{M^k_{i,t}\}_{k \in I \setminus \{en\}}} \left(\sum_{k \in I \setminus \{en\}} P^{M,k}_{i,t} M^k_{i,t} \right) \quad s.t.$$
$$M_{i,t} = \min_{k \in I \setminus \{en\}} \left(\left\{ \alpha^i_{M,k} M^k_{i,t} \right\}_{k \in I \setminus \{en\}} \right),$$

where $M^k_{i,t}$ denotes the aggregate delivery from industry k.

Obviously, the solution to this minimization problem is for the firm to use the least possible quantity from any industry regardless of the price. That is

$$M^k_{i,t} = \frac{M_{i,t}}{\alpha^i_{M,k}} \quad , k \in I \setminus \{en\}. \tag{A.59}$$

The price for a unit of the material aggregate $P^M_{i,t}$ becomes a weighed sum of the industry specific output prices

$$P^M_{i,t} = \sum_{k \in I \setminus \{en\}} \left(\frac{P^{M,k}_{i,t}}{\alpha^i_{M,k}} \right). \tag{A.60}$$

[2]This does not apply to buildings and public services, which are assumed to be delivered domestically, and for obvious reasons not for land either.

Foreign versus domestic delivery

The material inputs delivered from industry k is as previously explained a nested CES aggregate over origin. At the top-level the firm is assumed to substitute between domestic and foreign deliveries. The optimal blend of foreign and domestic deliveries in the material input delivered from industry k is determined as the solution to the following cost-minimization problem[3]

$$\min_{\left(M_{i,t}^{D,k}, M_{i,t}^{F,k}\right)} \left(1+t_{i,t}^{M}\right) P_t^{D,k} M_{i,t}^{D,k} + P_{i,t}^{MF,k} M_{i,t}^{F,k} \quad s.t.$$

$$M_{i,t}^{k} = \left[\sum_{o\in\{D,F\}} \left(\alpha_{Mo,k}^{i}\right)^{\frac{1}{\sigma_{M,k}^{i}}} \left(M_{i,t}^{o,k}\right)^{\frac{\sigma_{M,k}^{i}-1}{\sigma_{M,k}^{i}}} \right]^{\frac{\sigma_{M,k}^{i}}{\sigma_{M,k}^{i}-1}},$$

where $M_{i,t}^{D,k}$ and $M_{i,t}^{F,k}$ denotes domestic and foreign deliveries of the good produced in industry k respectively. Note that the relevant price on domestic deliveries includes excise taxation $1+t_{i,t}^{M}$ which by construction are industry-specific as well as specific to the type of use of the product. Also note that the price of domestic deliveries is simply the purchaser price of the product from industry k which is assumed to be the same regardless of the use of the product. The price of the foreign deliveries to material inputs remains a CES price index at this nest level.

Again we are dealing with a standard CES minimization problem to which the solution is given by

$$\begin{aligned} M_{i,t}^{MD,k} &= \alpha_{MD,k}^{i} \left(\frac{\left(1+t_{i,t}^{M}\right) P_t^{D,k}}{P_{i,t}^{M,k}} \right)^{-\sigma_{M,k}^{i}} M_{i,t}^{k} \\ M_{i,t}^{MF,k} &= \alpha_{MF,k}^{i} \left(\frac{P_{i,t}^{MF,k}}{P_{i,t}^{M,k}} \right)^{-\sigma_{M,k}^{i}} M_{i,t}^{k}, \end{aligned} \tag{A.61}$$

where the CES price index $P_{i,t}^{M,k}$ is given by

$$P_{i,t}^{M,k} = \left[\alpha_{MD,k}^{i} \left(\left(1+t_{t}^{M}\right) P_t^{D,k} \right)^{1-\sigma_{M,k}^{i}} + \alpha_{MF,k}^{i} \left(P_{i,t}^{MF,k} \right)^{1-\sigma_{M,k}^{i}} \right]^{\frac{1}{1-\sigma_{M,k}^{i}}}. \tag{A.62}$$

[3]We present the problem for a given delivering industry but recall that no imports of public services take place and further that the energy provision industry does not deliver to material inputs.

Materials from EU versus non-EU countries

Foreign materials are represented by a CES function of deliveries from EU countries and non-EU countries. The deliveries from non-EU countries are represented by yet a CES aggregate where the deliveries from EU countries is present in the generic io-system of the model. The optimal composition of EU and non-EU deliveries of the product from industry k to material inputs in industry i is the solution to the following standard CES cost-minimization problem

$$\min_{\left(M_{i,t}^{EU,k}, M_{i,t}^{NEU,k}\right)} \left(1+t_{i,t}^{M}\right) P_{t}^{EU,k} M_{i,t}^{EU,k} + P_{i,t}^{MNEU,k} M_{i,t}^{NEU,k} \quad s.t.$$

$$M_{i,t}^{F,k} = \left[\sum_{o\in\{EU,NEU\}} \left(\alpha_{Mo,k}^{i}\right)^{\frac{1}{\sigma_{MF,k}^{i}}} \left(M_{i,t}^{o,k}\right)^{\frac{\sigma_{MF,k}^{i}-1}{\sigma_{MF,k}^{i}}}\right]^{\frac{\sigma_{MF,k}^{i}}{\sigma_{MF,k}^{i}-1}}.$$

Thus, the optimal material input levels of deliveries from countries inside and outside the European union are, respectively

$$\begin{aligned} M_{i,t}^{EU,k} &= \alpha_{MEU,k}^{i} \left(\frac{\left(1+t_{i,t}^{M}\right) P_{t}^{EU,k}}{P_{i,t}^{MF,k}}\right)^{-\sigma_{MF,k}^{i}}, \\ M_{i,t}^{NEU,k} &= \alpha_{MNEU,k}^{i} \left(\frac{P_{i,t}^{MNEU,k}}{P_{i,t}^{MF,k}}\right)^{-\sigma_{MF,k}^{i}}, \end{aligned} \tag{A.63}$$

where the CES price index of foreign inputs to materials are given by

$$P_{i,t}^{MF,k} = \left[\alpha_{MEU,k}^{i} \left(\left(1+t_{t}^{M}\right) P_{t}^{EU,k}\right)^{1-\sigma_{MF,k}^{i}} + \alpha_{MNEU,k}^{i} \left(P_{i,t}^{MNEU,k}\right)^{1-\sigma_{MF,k}^{i}}\right]^{\frac{1}{1-\sigma_{MF,k}^{i}}}. \tag{A.64}$$

Materials from CEE countries versus the rest of the world

At the lowest level of the technology tree we find the division of deliveries from non-EU countries on deliveries from the Central- and East-European countries (CEE) and deliveries from the rest of the world (ROW). For materials the optimal composition of deliveries from CEE countries and the rest of the world is characterized by the following standard CES cost-minimization problem

$$\min_{\left(M_{i,t}^{CEE}, M_{i,t}^{ROW}\right)} \sum_{o\in\{CEE,ROW\}} \left(1+t_{t}^{M}\right) P_{t}^{o,k} M_{i,t}^{o,k} \quad s.t.$$

$$M_{i,t}^{NEU,k} = \left[\sum_{o\in\{CEE,ROW\}} \left(\alpha_{Mo,k}^{i}\right)^{\frac{1}{\sigma_{MNEU}^{i}}} \left(M_{i,t}^{o,k}\right)^{\frac{\sigma_{MNEU}^{i}-1}{\sigma_{MNEU}^{i}}}\right]^{\frac{\sigma_{MNEU,k}^{i}}{\sigma_{MNEU,k}^{i}-1}}.$$

The solution to this problem is

$$M_{i,t}^{o,k} = \alpha_{Mo,k}^{i} \left(\frac{\left(1+t_t^M\right) P_t^{o,k}}{P_{i,t}^{MNEU,k}} \right)^{-\sigma_{MNEU}^{i}} \quad \text{for} \quad o \in \{CEE, ROW\}, \tag{A.65}$$

where

$$P_{i,t}^{MNEU,k} = \left[\sum_{o \in \{CEE,ROW\}} \alpha_{Mo,k}^{i} \left(\left(1+t_t^M\right) P_t^{o,k} \right)^{1-\sigma_{MNEU}^{i}} \right]^{\frac{1}{1-\sigma_{MNEU}^{i}}}. \tag{A.66}$$

This completes our walkthrough of how to derive the disaggregated factor demands from different origins. The structure of the problems are completely analog for all types of factor-inputs though different product taxes apply.

A.5 Derivation of usercosts of residential land and buildings

The stock of buildings for residential purposes measured per adult equivalent accumulate according to the following identity

$$H_{a,t}^{B} = \left(1-\delta^{H}\right) H_{a-1,t-1}^{B} \frac{N_{a-1,t-1}^{E}}{N_{a,t}^{E}} + I_{a,t}^{HB}, \tag{A.67}$$

where δ^H denotes the rate of depreciation of houses. The land in the household estate does not depreciate and the accumulation identity for this asset is therefore simply given by

$$H_{a,t}^{L} = H_{a-1,t-1}^{L} \frac{N_{a-1,t-1}^{E}}{N_{a,t}^{E}} + I_{a,t}^{HL}. \tag{A.68}$$

With respect to the price of residential buildings we will introduce an offset to the price of investments in new houses. This offset become relevant in the event of a shock announced ultimo period $t-1$ since we will assume that households may engage in trade of the existing stock of building estate. The price on houses for dwelling purposes now amounts to

$$P_t^{HB} = P_t^{IHB} + P_t^{AHB}. \tag{A.69}$$

The price differential P_t^{AHB} reflect possible capital gains in the event of a shock ultimo period $t-1$. Since households may engage in trade of the existing stock of buildings in this event, the prices P_t^{AHB} and P_t^{IHL} may jump in order to ensure that the existing aggregate stock of houses will be in demand. The implied capital gain from a jump in

P_t^{AHB} is temporary and will be exogenously set to zero as of time t. The price of land for residential purposes on the other hand may retain its new value.

Using equation A.69 to express the accumulated value of the stock of residential buildings in the household estate yeild

$$P_t^{HB} H_{a,t}^B = \left(1-\delta^H\right) P_t^{HB} H_{a-1,t-1}^B \frac{N_{a-1,t-1}^E}{N_{a,t}^E} + \left(P_t^{IHB} + P_t^{AHB}\right) I_{a,t}^{HB} \qquad \text{(A.70)}$$

Now, define the value of the household asset including the value of the housing estate by

$$a_{a,t}^H \equiv a_{a,t} + P_t^{HE} H_{a,t}^E. \qquad \text{(A.71)}$$

By this definition we are now able to express the accumulation of the households wealth including the value of real state

$$\begin{aligned} a_{a,t}^H = {} & (1+\hat{r}_t)\, a_{a-1,t-1}^H \frac{N_{a-1,t-1}^E}{N_{a,t}^E} + y_{a,t} \frac{N_{a,t}}{N_{a,t}^E} \\ & - P_t^{CN} C_{a,t}^N - P_t^{Cve} C_{a,t}^{ve} - P_t^{Cen} C_{a,t}^{en} - \sum_{i\in I} P_t^{Cdw,i} C_{a,t}^{dw,i} \\ & - \left[\left(r_t^H t_t^r + t_t^H + 1 + \hat{r}_t\right) P_{t-1}^{HB} - \left(1-\delta^H\right) P_t^{HB}\right] H_{a-t,t-1}^B \frac{N_{a-1,t-1}^E}{N_{a,t}^E} + P_t^{AHB} I_{a,t}^{HB} \\ & - \left[\left(r_t^H t_t^r + t_t^H + t_t^{HL} + 1 + \hat{r}_t\right) P_{t-1}^{HL} - P_t^{HL}\right] H_{a-1,t-1}^L \frac{N_{a-1,t-1}^E}{N_{a,t}^E} \end{aligned} \qquad \text{(A.72)}$$

From A.72 we are able to identitfy the usercosts of residential buildings directly from line 3. The usercosts of residential buildings are per unit

$$\left(r_t^H t_t^r + t_t^H + 1 + \hat{r}_t\right) P_{t-1}^{HB} - \left(1-\delta^H\right) P_t^{HB} - \frac{I_{a,t}^{HB}}{H_{a-t,t-1}^B} \frac{N_{a,t}^E}{N_{a-1,t-1}^E} P_t^{AHB}. \qquad \text{(A.73)}$$

Here we see the problem that the usercost expression depends on the investments in new buildings, and therefore that the usercost is generation specific. This problem do only occur in conjunction with temporary shocks to the economy causing the temporary price differential between new houses and the existing stock to be non zero. By definition of the price of the existing stock, the correction term may be written

$$\delta^H P_t^{IHB} - \left(\frac{I_{a,t}^{HB}}{H_{a-1,t-1}^B} \frac{N_{a,t}^E}{N_{a-1,t-1}^E} - \delta^H\right) P_t^{AHB}.$$

Obviously, the correction for temporary capital gains is proportionate the rate of gross investments in buildings. To ease the computational burden we would like to avoid the implementation of a usercost expression which is generation specific. In case we did, all prices above in the nest structure would also by generation specific as this would lead to a disproportionate computational burden in the simulation of the household demand system. The remidy is to let the correction for capital gains appear directly in the differential equation expressing the savings identity and thus to define the usercosts of buildings net of the generation specific correction term. Hence we stipulate ignorance with respect to temporary capital gains and that households do not take these into account when optimizing. We define the usercosts of buildings in the household estate by

$$\bar{P}_t^{CUHB} = \left(r_t^H t_t^r + t_t^H + 1 + \hat{r}_t\right) P_{t-1}^{HB} - \left(1 - \delta^H\right) P_t^{HB}. \tag{A.74}$$

Also from equation A.72 the usercosts of residential land appear (in line 4) and in unit terms these amounts to

$$\bar{P}_t^{CUHL} = \left(r_t^H t_t^r + t_t^H + t_t^{HL} + 1 + \hat{r}_t\right) P_{t-1}^{HL} - P_t^{HL}. \tag{A.75}$$

One issue remains before we are done defining the usercost expressions implemented in the model. In order to be able to reproduce the value of dwelling consumption as these are stated in the national accounts we must introduce yet a correction term. This correction is introduced in the usercost expressions and is balanced out in the savings identity of the household. The resulting definition of the usercosts of buildings and land are, respectively

$$P_t^{CUHB} = \left(r_t^H t_t^r + t_t^H + r_t^{NA} + 1 + \hat{r}_t\right) P_{t-1}^{HB} - \left(1 - \delta^H\right) P_t^{HB} \tag{A.76}$$

$$P_t^{CUHL} = \left(r_t^H t_t^r + t_t^H + t_t^{HL} + r_t^{NA} + 1 + \hat{r}_t\right) P_{t-1}^{HL} - P_t^{HL}. \tag{A.77}$$

By proper definition of the CES price index relevant to dwelling consumption and the consumer price index and by introduction of the correction terms, the savings identity A.72 may be transformed into the savings identity 2.23 appearing in subsection 2.2.3.

A.6 The consolidated dynamic budget

This section will demontrate how the consolidated budget constraint 2.29 appearing at page 46 may be derived as the forward solution to the savings identity by use of the terminal condition that the household financial wealth should equal zero at the end of the planning horizon.

The savings identity, describing the formation of the wealth of a household aged i at the point in time $t-1+i$ may be written

$$a^H_{i,t-a+i} = \left(1+\tilde{r}_{i,t-a+i}\right) a^H_{i-1,t-a+i-1} + \tilde{y}_{i,t-a+i} - P^C_{t-a+i} Q_{i,t-a+i} + r^{NA}_{t-a+i} P^{HE}_{t-a+i} H^E_{i-1,t-a+i-1} \frac{N^E_{i,t-a+i}}{N^E_{i-1,t-a+i-1}} + P^{AHB}_{t-a+i} I^{HB}_{i,t-a+i}, \tag{A.78}$$

where we have used the definitions of the household income and consumption corrected for disutility of work.

Define the discounting factor used for discounting household wealth from period i to period a by

$$\tilde{R}_{a,i} \equiv \begin{cases} \prod_{j=a+1}^{i} \frac{1}{1+\tilde{r}_{j,t-a+j-1}} & \text{for} \quad i > a \\ 1 & \text{for} \quad i = a \end{cases} \tag{A.79}$$

The interest rate used for discounting wealth is that incorporating changes to the households adult equivalent size. Note that

$$\left(1+\tilde{r}_{i,t-a+1}\right) \tilde{R}_{a-1,i} = \tilde{R}_{a-1,i-1},$$

and that

$$\tilde{R}_{a-1,a-1} \equiv 1.$$

By use of the definition of the discount factor, equation A.78 imply

$$\tilde{R}_{a-1,i} a^H_{i,t-a+i} = \tilde{R}_{a-1,i-1} a^H_{i-1,t-a+i-1} + \tilde{R}_{a-1,i} \left[\tilde{y}_{i,t-a+i} - P^C_{t-a+i} Q_{i,t-a+i} + r^{NA}_{t-a+i} P^{HE}_{t-a+i} H^E_{i-1,t-a+i-1} \frac{N^E_{i,t-a+i}}{N^E_{i-1,t-a+i-1}} + P^{AHB}_{t-a+i} I^{HB}_{i,t-a+i} \right]. \tag{A.80}$$

By iteration over i we get

$$\tilde{R}_{a-1,i} a^H_{i,t-a+i} = a^H_{t-1,t-1} + \sum_{j=a}^{i} \tilde{R}_{a-1,j} \left[\tilde{y}_{j,t-a+j} - P^C_{t-a+j} Q_{j,t-a+j} + r^{NA}_{t-a+j} P^{HE}_{t-a+j} H^E_{j-1,t-a+j-1} \frac{N^E_{j,t-a+j}}{N^E_{j-1,t-a+j-1}} + P^{AHB}_{t-a+j} I^{HB}_{j,t-a+j} \right]. \tag{A.81}$$

From equation A.81 and the terminal condition we get that

$$\tilde{R}_{a-1,77} a^H_{77,t-a+77} = a^H_{t-1,t-1} + \sum_{i=a}^{77} \tilde{R}_{a-1,i} \left[\tilde{y}_{i,t-a+i} - P^C_{t-a+i} Q_{i,t-a+i} + r^{NA}_{t-a+i} P^{HE}_{t-a+i} H^E_{i-1,t-a+i-1} \frac{N^E_{i,t-a+i}}{N^E_{i-1,t-a+i-1}} + P^{AHB}_{t-a+i} I^{HB}_{i,t-a+i} \right] = 0. \tag{A.82}$$

In order to arrive at the consolidated budget constraint as represented in equation 2.29 we must properly define human capital and expressions for the present value of the calibration technical correction term and capital gains on houses. The human capital is defined as to include disutility of work and is given by

$$H_{a-1,t-1} \equiv \sum_{i=1}^{77} \tilde{R}_{a-1,i} \tilde{y}_{i,t-a+i}. \tag{A.83}$$

The present value of the technical calibration correction term is given by

$$H^{NA}_{a-1,t-1} \equiv \sum_{i=1}^{77} \tilde{R}_{a-1,i} r^{NA}_{t-a+i} P^{HE}_{t-a+i} H^{E}_{i,t-a+i-1} \frac{N^{E}_{i,t-a+i}}{N^{E}_{i-1,t-a+i-1}}. \tag{A.84}$$

Finally, the present value of unforseen capital gains is given by

$$H^{AHB}_{a-1,t-1} \equiv \sum_{i=1}^{77} \tilde{R}_{a-1,i} P^{AHB}_{t-a+i} I_{i,t-a+i} HB. \tag{A.85}$$

By use of the definitions in equations A.83 through A.85 and by rearranging equation A.82 we finally arrive at the consolidated budget constraint as given in equation 2.29 of the main text.

A.7 The Keynes-Ramsey rule of consumption smoothing

This section will explain how the Keynes-Ramsey rule of consumption smoothing as expressed be equation 2.34 appear.

Start leading the equation for the optimal level of instantaneous utility 2.32 one period. Using division by the original expression and reduction we obtain the following equation for the relation between the instantanous utility of two consecutive periods. This applies for $i = a, \ldots, 76$

$$\frac{Q_{i,t-a+i+1}}{Q_{i,t-a+i}} = \left(\frac{\tilde{R}_{a-1,i} N^{E}_{i+1,t-a+i+1} \nu_{a-1,i+1}}{\tilde{R}_{a-1,i+1} N^{E}_{i,t-a+i} \nu_{a-1,i}} \frac{P^{C}_{t-a+i}}{P^{C}_{t-a+i+1}} \right)^{S}. \tag{A.86}$$

By the definition of the discount factor and the definition of the interest rate taking changes in the adult equivalent size of the household we have that

$$\frac{\tilde{R}_{a-1,i}}{\tilde{R}_{a-1,i+1}} = 1 + \tilde{r}_{a,t-a+i+1} = (1 + \hat{r}_{t-a+i+1}) \frac{N^{E}_{i,t-a+i}}{N^{E}_{i,t-a+i+1}}. \tag{A.87}$$

Also note that

$$\frac{\nu_{a-1,i+1}}{\nu_{a-1,i}} = \frac{\xi_{i+1}}{1+\theta}. \tag{A.88}$$

By use of A.87 and A.88 we find that A.86 is equivalent to

$$\frac{Q_{i,t-a+i+1}}{Q_{i,t-a+i}} = \left(\xi_{i+1} \frac{1+\hat{r}_{t-a+i+1}}{1+\theta} \frac{P^C_{t-a+i}}{P^C_{t-a+i+1}} \right)^S. \tag{A.89}$$

A.8 Optimal intratemporal dwelling consumption

The intertemporal behaviour of the representative household is represented by the optimal sequence of instantaneous utility levels. This section of the appendix explain the composition of consumption required to realize these using the case of dwelling consumption as an example. The structure of the instantaneous utility of consumption is outlined in the utility tree of figure 2.3 at page 43, which depicts the nested structure of the utility of consumption.

The method for derivation of the optimal composition of consumption on the various categories of consumption is completely analog to the on used for derivation of factor demands for the production sector. Where firms in each period seek to minimize the costs of production factors for a given level of production, the household face the problem of achieving the maximal instantaneous utility using the lowest expenditure possible.

A.8.1 Disaggregate demand for dwelling consumption

Since the consumption of dwelling constitutes a special case due to the inclusion of the stock of real estate we will present the derivation of demand functions relating to this category of consumption goods. The composition of the dwelling consumption aggregate is illustrated in figure 2.4 on page 44.

Dwelling consumption is as any basic consumption good represented by a Leontief aggregate of industry specific composite goods. For the dwelling category specifically, utility from the stock of estate enters the Leontief aggregate as well. We will therefore derive the disaggregate demand function for a given industry specific delivery as well as for the stock of estate. The derivation of the disaggregate demand for the industry specific deliveries applies to all the basic consumption categories. The method is completely analog for derivation of the consumption of dwelling, energy, vehicles, services and transportation, other goods and food. Therefore we will refrain from a presentation of these demand functions.

Decomposition of the dwelling Leontief aggregate

The optimal composition of the Leontief dwelling aggregate is derived by expenditure minimization for a level of the aggregate given by the intertemporal optmization of utility. This minimization problem may be formalized by

$$\min_{\{C_{a,t}^{dw,i}\}_{i\in I\cup\{dw\}}} \left(\sum_{i\in I\cup\{dw\}} P_t^{Cdw,i} C_{a,t}^{dw,i} \right) \quad s.t. \tag{A.90}$$

$$C_{a,t}^{dw} = \min_{i\in I\cup\{dw\}} \left(\{\alpha_{dw,i} C_{a,t}^{dw,i}\}_{i\in I\cup\{dw\}} \right) \tag{A.91}$$

$$C_{a,t}^{dw,dw} = H_{a-1,t-1}^{E} \frac{N_{a-1,t-1}^{E}}{N_{a-1,t-1}^{E}} \tag{A.92}$$

$$P_t^{Cdw,dw} = P_t^{CUHE} \tag{A.93}$$

where $C_{a,t}^{dw,i}$ denotes the dwelling consumption delivered from industry i. Obviusly, demand functions may again be derived directly from this simple problem. The demand from dwelling consumption delivered from a given industry amounts to

$$C_{a,t}^{dw,i} = \frac{C_{a,t}^{dw}}{\alpha_{dw,i}} \quad \text{for} \quad i \in I \tag{A.94}$$

and

$$H_{a-1,t-1}^{E} \frac{N_{a-1,t-1}^{E}}{N_{a,t}^{E}} = \frac{C_{a,t}^{dw}}{\alpha_{dw,dw}}. \tag{A.95}$$

The price index relevant to dwelling consumption is given as the weighed sum of CES prices of the elements entering the Leontief aggregate, that is

$$P_t^{Cdw} = \sum_{i\in I} \left(\frac{P_t^{Cdw,i}}{\alpha_{dw,i}} \right) + \frac{P_t^{CUHE}}{\alpha_{dw,dw}}. \tag{A.96}$$

Industry specific deliveries used for maintenance and repairs in dwelling consumption are as previously explained of a functional form identical to the one used in the production function, meaning that they represent nested CES aggregates over origin. The corresponding demand functions may be derived using the standard method.

Demand for stocks of residential land and buildings

The remaining component adding to utility of dwelling consumption is the stock of estate. The stock of estate is specified by CES composition of the stocks of residential land and buildings. The composition of the estate may be derived by expenditure minimization given the usercosts of buildings and land as these are perceived by the household. Since the demand for stock of estate is given by the demand function A.95 we may now state the problem of composing the stock of estate as

$$\min_{\left(H^L_{a-1,t-1}, H^B_{a-1,t-1}\right)} P_t^{CUHL} \left(1+n\right)^t H^L_{a-1,t-1} + P_t^{CUHB} H^B_{a-1,t-1} \quad s.t. \tag{A.97}$$

$$H^E_{a-1,t-1} = \left[\left(\alpha_{HL}\right)^{\frac{1}{\sigma_{HE}}} \left(\left(1+n\right)^t H^L_{a-1,t-1} \right)^{\frac{\sigma_{HE}-1}{\sigma_{HE}}} + \left(\alpha_{HB}\right)^{\frac{1}{\sigma_{HE}}} \left(H^B_{a-1,t-1} \right)^{\frac{\sigma_{HE}-1}{\sigma_{HE}}} \right]^{\frac{\sigma_{HE}}{\sigma_{HE}-1}} \tag{A.98}$$

In this formulation we make use of the fact that the correction for the adult equivalent size of the household disappear by reduction. The CES price indices by which the expenditure is valued are the user costs of land and buildings as these are given in section A.5 by equations A.76 and A.77. Please note that residential land must be corrected for the Harrod-neutral technological progress.

The solution to the expenditure minimization problem is given by two demand functions for stocks of residential buildings and land. For land the demand function is

$$H^L_{a-1,t-1} \left(1+n\right)^t = \alpha_{HL} \left(\frac{\frac{P_t^{CUHL}}{(1+n)^t}}{P_t^{CUHE}} \right)^{-\sigma_{HE}} H^E_{a-1,t-1}, \tag{A.99}$$

while the demand for buildings is given by

$$H^B_{a-1,t-1} = \alpha_{HB} \left(\frac{P_t^{CUHB}}{P_t^{CUHE}} \right)^{-\sigma_{HE}} H^E_{a-1,t-1}. \tag{A.100}$$

The CES price index of usercosts on the estate is given by

$$P_t^{CUHE} = \left(\alpha_{HL} \left(\frac{P_t^{CUHL}}{\left(1+n\right)^t} \right)^{1-\sigma_{HE}} + \alpha_{HB} \left(P_t^{CUHB} \right)^{1-\sigma_{HE}} \right)^{\frac{1}{1-\sigma_{HE}}}. \tag{A.101}$$

This completes the derivation of the demand functions related to the households consumption of dwelling.

A.9 Welfare measures

Here we derive the equivalent variation of households and the aggregation of these into an aggregate equivalent variation measure which may by used for evaluation of welfare implications of an experiment. The equivalent variation is defined for a household as the transfer, which for given policy parameters and prices in the reference scenario, would allow the household to achieve the same level of intertemporal utility in the reference scenario as the one achieved in the counterfactual experiment under evaluation. Given the division of the lifecycle in planning and non-planning periods the equivalent variation must be derived for planning as well as elderly non-planning households.

A.9.1 Derivation of equivalent variation for planning households

By insertion of the solution to the intertemporal optimization problem of a planning household as given by equation 2.32 on page 48 into the defintion of the intertemporal utility function (equation 2.17) we arrive at the indirect utility of a planning household. The indirect utility, which is defined for given prices, tax rates and income, may be shown to equal

$$V_{a-1,t-1}\left(\bar{P}_{a-1,t-1}, \bar{I}_{a-1,t-1}\right) = \frac{a^{H}_{a-1,t-1} + H_{a-1,t-1} + H^{NA}_{a-1,t-1} + H^{AHB}_{a-1,t-1}}{\eta_{a-1,t-1}},$$

where $\bar{P}_{a-1,t-1}$ denotes the set of prices and tax rates and $\bar{I}_{a-1,t-1}$ denotes the income. The CES-price index $\eta_{a-1,t-1}$ represents the unit price of intertemporal utility and the indirect utility function may thus be interpreted straightforwardly as the utility purchase power of the initial wealth.

From the definition of the indirect utility we may express the expenditure of acquiring a given utility level for given prices and tax rates. The expenditure is given by the function

$$E_{a-1,t-1}\left(\bar{P}_{a-1,t-1}, V_{a-1,t-1}\right) = \eta_{a-1,t-1} V_{a-1,t-1}.$$

The expenditure of acquiring a given level of intertemporal utility for given prices and tax rates $\bar{P}_{a-1,t-1}$ may be expressed by introducing a function $e_{a-1,t-1}\left(\bar{P}_{a-1,t-1}\right)$ representing the expenditure of a unit of intertemporal utility. In this formulation, the expenditure function is given by

$$E_{a-1,t-1}\left(\bar{P}_{a-1,t-1}, V_{a-1,t-1}\right) = e_{a-1,t-1}\left(\bar{P}_{a-1,t-1}\right) V_{a-1,t-1},$$

where

$$e_{a-1,t-1}\left(\bar{P}_{a-1,t-1}\right) \equiv E_{a-1,t-1}\left(\bar{P}_{a-1,t-1}, 1\right) = \eta_{a-1,t-1}.$$

The expenditure function represents the minimum income per adult equivalent that the household must have in order to realize a given level of intertemporal utility $V_{a-1,t-1}$ for the given prices and taxrates represented by the set $\bar{P}_{a-1,t-1}$. The human capital expressions may be interpreted as an initial stocks of wealth given the seperability in the instantaneous utility function. No matter what level of intertemporal utility is to be acheived it is as previously explained always optimal to maximize human capital with respect to the labour supply.

The equivalent variation per adult equivalent in a planning household may now be defined. Let $U^0_{a-1,t-1}$ denote the intertemporal utility as of $t-1$ in the reference scenario and let $U^1_{a-1,t-1}$ denote the intertemporal utility in the counterfactual scenario to be evaluated. The equivalent variation is the difference in the expenditure of these utility levels seen from the reference scenario, that is given the prices and tax rates of the reference scenario. The equivalent variation may therefore be expressed by means of the expenditure function as

$$ev_{a-1,t-1} = \left[E_{a-1,t-1}\left(\bar{P}_{a-1,t-1}, U^1_{a-1,t-1}\right) - E_{a-1,t-1}\left(\bar{P}_{a-1,t-1}, U^0_{a-1,t-1}\right)\right] N^E_{a-1,t-1}.$$

By use of the fact that the expenditure function is homogene of degree 1 in the level of utility, this definition of equivalent variation is equivalent to

$$ev_{a-1,t-1} = \left[U^1_{a-1,t-1} - U^0_{a-1,t-1}\right] e_{a-1,t-1}\left(\bar{P}_{a-1,t-1}\right) N^E_{a-1,t-1},$$

which by substitution using the definition of the expenditure function and the definition of indirect utility is equivalent to

$$ev_{a-1,t-1} = \frac{U^1_{a-1,t-1} - U^0_{a-1,t-1}}{U^0_{a-1,t-1}} \left[a^H_{a-1,t-1} + H_{a-1,t-1} + H^{NA}_{a-1,t-1} + H^{AHB}_{a-1,t-1}\right] N^E_{a-1,t-1}. \tag{A.102}$$

A.9.2 Derivation of equivalent variation for non-planning households

Using the same approach of definition of indirect utility and expenditure functions the equivalent variation of non-planning households may be derived as well. For non-planning households, that is for $a \in [77, \ldots, 101]$ the indirect utility is given by

$$V_{a-1,t-1}\left(\bar{P}_{a-1,t-1}, I^{NP}_{a-1,t-1}\right) = \frac{y_{a,t}}{\eta^{NP}_{a-1,t-1}},$$

where

$$\eta^{NP}_{a-1,t-1} \equiv \left[\frac{N^{E}_{a-1,t-1}}{1+\theta}\left(\frac{1}{P^{C}_{a-1,t-1}}\right)^{\frac{1-S}{S}}\right]^{\frac{S}{1-S}}.$$

The expenditure function for non-planning households is now given by

$$E_{a-1,t-1}\left(\bar{P}_{a-1,t-1}, V^{NP}_{a-1,t-1}\right) = \left(\frac{N^{E}_{a-1,t-1}}{1+\theta}\right)^{\frac{S}{S-1}} P^{C}_{a-1,t-1} V^{NP}_{a-1,t-1}.$$

Using the same method of substitution and replacements, the equivalent variation per adult equivalent in non-planning households may now be derived to read

$$ev^{NP}_{a-1,t-1} = \frac{U^{NP,1}_{a-1,t-1} - U^{NP,0}_{a-1,t-1}}{U^{NP,0}_{a-1,t-1}} y_{a,t} N^{E}_{a-1,t-1}. \tag{A.103}$$

A.9.3 Aggregate equivalent variation

The aggregate equivalent variation is defined as the sum of the equivalent variations of the households that are alive plus the discounted sum of the equivalent variations of future households. This may be expressed as

$$EV_t = \sum_{i=16}^{75} ev_{i,t} + \sum_{j=76}^{100} ev^{NP}_{j,t} + \sum_{k=1}^{\infty} D_{t,t+k}\left(ev_{16,t+k} + \sum_{m=76}^{100} ev^{NP}_{m,t+k}\right),$$

where the discounting factor applied to the equivalent variation of future households is defined by

$$D_{t,t+k} \equiv \begin{cases} \prod_{j=1}^{k} \frac{1}{1+r_{t+j}} & \text{for} \quad k > 1 \\ 1 & \text{for} \quad k = 0 \end{cases}$$

This definition of aggregate equivalent variation is not operational due to the presence of the infinite sum, but assuming that steady state is reached in period $t+T$ we may restate the aggregate equivalent variation as

$$EV_t = \sum_{i=16}^{75} ev_{i,t} + \sum_{j=76}^{100} ev^{NP}_{j,t} + \sum_{k=1}^{T-1} D_{t,t+k}\left(ev_{16,t+k} + \sum_{m=76}^{100} ev^{NP}_{m,t+k}\right) + \sum_{l=T}^{\infty} D_{t,t+l}\left(ev_{16,t+l} + \sum_{m=76}^{100} ev^{NP}_{m,t+l}\right).$$

In steady state the economy grows due to Harrod-neutral technological progress and inflation. Therefore we have for $g \in \mathbf{N}$

$$\begin{aligned} ev_{a,t+T+g} &= ev_{a,t+T}\big((1+n)(1+\pi)\big)^{g} \\ r_{t+T+g} &= r_{t+T} \end{aligned}$$

The infinite sum may therefore under the assumption that steady state is reached in period $t+T$ be written

$$\sum_{l=T}^{\infty} D_{t,t+l}\left(ev_{16,t+l} + \sum_{m=76}^{100} ev_{m,t+l}^{NP}\right) = D_{t,t+T}\left(ev_{16,t+T} + \sum_{m=76}^{100} ev_{m,t+T}^{NP}\right)\sum_{l=1}^{\infty}\left(\frac{(1+n)(1+\pi)}{1+r_{t+T}}\right)^{l-1}.$$

This expression will have a limit value if the infinite sum converges. This will be the case if the growth and inflation corrected steady state interest rate is positive. Assuming a positive growth and inflation corrected steady state interest rate we have that

$$\sum_{l=1}^{\infty}\left(\frac{(1+n)(1+\pi)}{1+r_{t+T}}\right)^{l-1} \longrightarrow \left(1-\frac{(1+n)(1+\pi)}{1+r_{t+T}}\right)^{-1}.$$

Finally, we arrive at an operational expression for the aggregate equivalent variation

$$\begin{aligned} EV_t = {} & \sum_{i=16}^{75} ev_{i,t} + \sum_{j=76}^{100} ev_{j,t}^{NP} + \sum_{k=1}^{T-1} D_{t,t+k}\left(ev_{16,t+k} + \sum_{m=76}^{100} ev_{m,t+k}^{NP}\right) \\ & + D_{t,t+T}\left(1-\frac{(1+n)(1+\pi)}{1+r_{t+T}}\right)^{-1}\left(ev_{16,t+T} + \sum_{m=76}^{100} ev_{m,t+T}^{NP}\right). \end{aligned} \tag{A.104}$$

A.10 Steady state usercosts of capital

In this section we present the foundation for the steady state usercosts of capital in growth and inflation corrected terms. The derivation of the steady state usercosts of capital are based on growth and inflation corrected steady state representations of the first-order conditions characterizing optimal investments, capital inputs and book-value. The rate of inflation will be denoted by π.

We have for buildings and machinery that

$$K_{i,t}^{s} = (1-\delta_i^{s})\frac{K_{i,t-1}^{s}}{1+n} + I_{i,t}^{s},$$

and in steady state, that

$$\frac{(1+n)\, I_i^{s}}{K_i^{s}} = n + \delta_i^{s}.$$

The first-order conditions for steady state building- and machinery-investments in growth and inflation corrected terms can be shown to equal

$$\frac{\lambda_i^s}{P_i^{Is}} + \hat{\lambda}_i^s = \frac{1-t^{dz}}{1-t^{gz}} \left[1 - g_i - (1-t^c) \frac{\mu_i P_i^Y}{P_i^{Is}} \left(\kappa MPK_i^s - 2\phi_i^s \left(n + \delta_i^s \right) \right) \right].$$

For capital the steady state first-order condition in growth and inflation corrected units for $s \in \{B, M\}$ read

$$\begin{aligned} &\left(\frac{(1-t^{rz} i + \rho)}{1-t^{gz}} \right) \frac{\lambda_i^s}{1+\pi} + \delta_i^s \lambda_i^s - \lambda_i^s + \frac{\lambda_i^s}{1+\pi} = \\ &\frac{1-t^{dz}}{1-t^{gz}} (1-t^c) \left[\mu_i P_i^Y MPK_i^s (1-\kappa\delta_i^s) + \mu_i P_i^Y \phi_i^s (n+\delta_i^s)^2 - i g_i \frac{P_i^{Is}}{1+\pi} \right] \\ &+ \frac{1-t^{dz}}{1-t^{gz}} g_i \left[(1-\delta_i^s) P_i^{Is} - \frac{P_i^{Is}}{1+\pi} \right]. \end{aligned}$$

Finally, the steady state first-order condition for book-value of capital in growth and inflation corrected terms may be written, for $s \in \{B, M\}$:

$$\left(\frac{(1-t^{rz}) i + \rho}{1-t^{gz}} \right) \hat{\lambda}_i^s + \hat{\delta}^s \hat{\lambda}_i^s = \frac{1-t^{dz}}{1-t^{gz}} t^c \hat{\delta}^s.$$

By introduction of the symbol $\beta_{i,s}^S S$ for representing the steady state usercosts MPK_i^s and by combination of the three preceding steady state first-order conditions we may isolate the usercosts as a function of taxes, prices and exogenous parameters. The usercosts are

$$\left(1 + \kappa \left(\frac{(1-t^{rz}) i + \rho}{(1-t^{gz})(1+\pi)} - \frac{\pi}{1+\pi} \right) \right) \beta_{i,s}^{SS} = \zeta_i^{F,s} + \frac{P_i^{I,s}}{\mu_i P_i^Y} \left(\delta_i^s - \frac{\pi}{1+\pi} \right) + \zeta_i^{\Phi,s} + \zeta_i^{\hat{\delta},s},$$

where the ζ's represents the components of the usercosts as explained in the main text. For land $(s = L)$ the steady state usercosts are given by

$$\begin{aligned} &\left(1 + \kappa \left(\frac{(1-t^{rz}) i + \rho}{(1-t^{gz})(1+\pi)(1+n)} + \frac{1-(1+\pi)(1+n)}{(1+\pi)(1+n)} \right) \right) \beta_{i,s}^{SS} = \\ &\frac{1}{(1+\pi)(1+n)} \frac{P_i^{I,s}}{\mu_i P_i^Y} i \left(g_i + (1-g_i) \frac{1-t^{rz} + \frac{\rho}{i}}{(1-t^{gz})(1-t^c)} \right) \\ &+ \frac{P_i^{I,s}}{\mu_i P_i^Y} \frac{1-(1+\pi)(1+n)}{(1+\pi)(1+n)} + \frac{\left(t^s P_i^{Is} - \tau^s \right)}{\mu_i P_i^Y}. \end{aligned}$$

The second last term corresponds to the inflation term of the usercosts of buildings and machinery but since productivity of land exhibits growth, this term must include growth corrections. The last term reflects the special subsidiation and taxation of arable land which is only defined for agriculture.

B Constructing the io data foundation

This section provides details on the construction of the io table we are using. We set of by describing the layout of the table before proceeding to the compilation of data sources into a table of the desired layout. Finally, the section is completed by a more detailed description of the operations required to bring the io table onto a model consistent form than that provided in the main text.

B.1 The layout of the io table

For the representation of our io system we construct a 24×39 table. The rows of the table represent the current value of inputs to activities. The rows are presented in table B.1. The number of rows amount is given by the 10 domestic and foreign industries, excise taxation and two rows for compensation of primary factors. Note our io table does not specify the origin of imported goods.

Table B.1: The rows of the io table by group.

Row No.	Description
1 − 10	**Domestic deliveries**
1 − 9	Deliveries from domestic industries
10	Deliveries from domestic dwelling
11 − 20	**Imports**
11 − 19	Imports from foreign industries
20	Import of foreign dwelling (all zero)
21 − 22	**Excise taxes**
21	Quantity excise taxes
22	Ad valorem excise taxes
23 − 24	**Compensation of primary factors**
23	Compensation of employees
24	Gross operating surplus

The number of columns is given by the number of economic activities modeled. Again we find 10 domestic industries all of which use materials and invests in machinery and buildings. Moreover, we find columns for consumption, exports and residual demand. The columns of the io table are listed in table B.2. We do not include the specification of destination for exported goods in the io table.

Table B.2: The columns of the io table by group.

Column No.	Description
1 – 10	**Domestic production**
1 – 9	Material use by domestic industries
10	Material use in domestic dwelling
11 – 17	**Consumption**
11	Government consumption
12 – 17	Private consumption of 6 categories
18 – 27	**Investments in machinery**
18 – 26	Investments in machinery by investing industry
27	Investments in machinery by dwelling (all zero)
28 – 37	**Investments in buildings**
28 – 36	Investments in buildings by investing industry
37	Investments in residential buildings
38 – 39	**Exports and residual demand**
38	Exports
39	Residual demand (live stock and inventories)

The io table is constructed by compilation and aggregation of io tables from ADAM and the national accounts. The following few subsections explain how this is carried out in practice.

B.1.1 Imputed submatrices of the io table

As noted in the main text, our io table is constructed by compilation of data from the 1998 io table of ADAM, figures from ADAMs databank as of 1998 and io and investment data from national accounts as of 1996. The primary source is ADAMs io table, but this table lacks investment matrices, imports are specified at SITC chapters rather than industries and the row for gross operating surplus is aggregated with 'other product taxes net'. Consequently, a few submatrices must be imputed and we must single out the value of gross operating surplus using the additional data sources. As the io tables from ADAM and the national accounts are specified for 19 compatible domestic industries we may impute the submatrices prior to the aggregation of ADAM industries to our industry specification. This allow for eased respecification of the industries in our model should that be desired in future applications. Figure B.1 illustrates how data from ADAMs databank and the io data of the national accounts is applied.

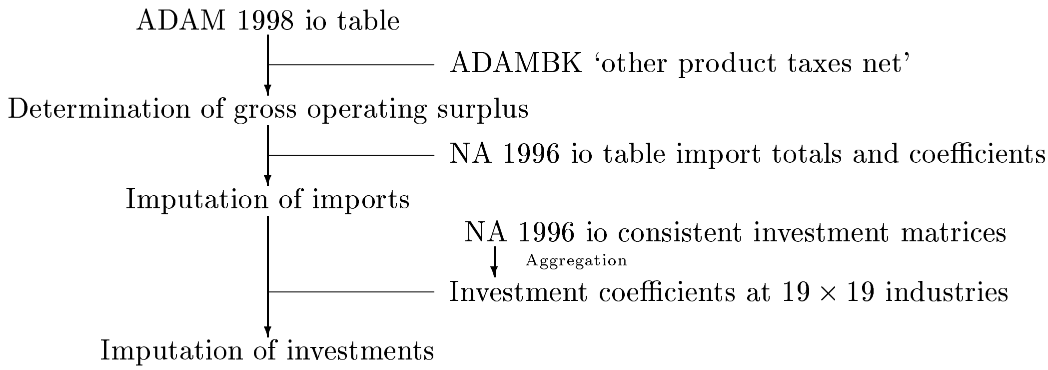

Figure B.1: Compilation of io data

First, the value of the gross operating surplus in domstic industries must be disaggregated. We obtain the value of 'other product taxes net' from ADAMs databank (ADAMBK) and move this vector of values from the row for gross operating surplus to the row for ad valorem excise taxation.

Secondly, we must impute the distribution of imports on foreign industries since imports are specified at SITC chapters in the ADAM table. We use the coefficients columnwise from the 1996 national accounting io table for distributing the total value of imports (including imports not specified by product) at the various activities the imports are used in.

Finally, we must impute the submatrices representing investment in buildings and machinery. From the national accounts a set of investment matrices are obtained. These matrices describe inputs to investments in 56 investing industries from 130 delivering industries. By aggregation of the investment matrices we obtain two matrices specifying inputs from 19 domestic industries, 19 foreign industries and rows for excise taxes to 19 investing industries. The coefficients of these matrices are used for distributing investment totals from the ADAM table across the imputed investment submatrices. Some investments (valuables for instance) can not be specified directly at industries. For these investments we assume the same distribution as that of investments in machinery.

B.2 Enforcing model consistency

After compilation of data, we arrive at an io table in which model conventions are still to be enforced. The majority of the required operations are enforced prior to aggregation. In the following we provide detailed information and discussion of the direct operations on the io table.

Imputed financial services The ADAM table reports the value of imputed financial services (FISIM) in a dedicated column. Imputed financial services reflect the estimated value of income from interest margins gained in the financial sector. Following the convention of DREAM the imputed value of financial services is to be consolidated with the private production sector. We assume that all industries but the financial sector must bear imputed financial services in proportion to their use of financial services as such. Consequently we move the corresponding value of FISIM from the row for gross operating surplus to the row for inputs delivered from financial services. Note that this operation affect the value of gross production it no longer coincides with that reported by the national accounts.

Self employment In the io table part of the reported gross operating surplus is withdrawn as wages by individuals in liberal occupations and firms owned by individuals. Consequently we must reassign part of gross operating surplus to the row for compensation of employees to reflect the model convention that all firms are corporations. Assuming that selfemployed individuals withdraw the implicit average wage of an industry and moving a corresponding amount enforce the model convention. We apply additional information on the number of employed and self employed in order to calculate the implicit average wage and to calculate the total to be moved within an industry.

Turist travels We do not model any consumption of tourist travels, but since such expenditures are actually present in private consumption we must deal with the issue. Expenditures by domestic citizens on tourist travels is treated as an import to private consumption and is assumed to be delivered in the proportions as imports to private consumption as such. Obviously this is not the actual case since it seems fair to assume that consumption during vacations consists of other goods than those used at home.

Expenditures by visiting tourists Expenditures for consumption by visting tourists is treated as an export. To enforce this convention we assume that the consumption by visiting tourists is delivered by industries in the proportions applying to goods other than public services and construction. We move corresponding values from the column for private consumption to the column for exports. Again the distribution assumption is propably in conflict with facts since tourists would be expected to buy more services from hotels etc. than domestic citizens.

The dwelling sector The dwelling sector is modelled as an institutional entity rather than a physical production sector. The role of the dwelling institution is to deliver rents consumed by the household sector, the rents being defined as the gross operating surplus of the dwelling sector. Since no actual production is modelled, no use of materials is defined in the model for the dwelling sector. To achieve consistency with the model we move the material inputs to the dwelling sector as reported in ADAM to material inputs in industries delivering physical goods to dwelling consumption using the industries share of the delivery of physical goods. To keep row and column sums consistent, the deliveries from the dwelling 'industry' to private consumption is reduced by the amount of inputs in dwelling in the io table such that the remaining delivery from dwelling to consumption equals the gross operating surplus generated in dwelling. With rescpect to the industries delivering physical goods to consumption these rows are kept on par with the appropriate column sums by increasing the delivery to consumption of dwelling by the sector. By design of the distribution of inputs pertaining to the dwelling sector across the industries, the levels of deliveries from these industries are increased such that the relative proportions between industries delivering physical goods to dwelling consumption category remain unaltered.

C Simulation results

Table C.1: Effects of isolated removal of trade costs pertaining to export to CEE on production by industries and final use

	2003	2008	2018	2028	2038	∞
	Quantity	—*Baseline=100*—				
Agriculture	65.636	99.64	99.53	99.50	99.49	99.49
Material inputs	49.513	99.73	99.64	99.61	99.60	99.60
Private consumption	2.711	99.58	99.47	99.46	99.46	99.49
Government consumption	1.033	100.06	100.05	100.05	100.05	100.06
Exports	12.379	99.25	99.05	99.01	99.00	98.98
Energy provision	58.557	99.79	99.67	99.66	99.66	99.66
Energy inputs	27.662	99.68	99.57	99.54	99.53	99.53
Investments	0.475	99.58	99.41	99.38	99.37	99.37
Private consumption	16.147	100.08	100.09	100.10	100.11	100.13
Exports	14.273	99.69	99.44	99.39	99.38	99.36
Construction	152.209	100.12	100.06	100.06	100.06	100.07
Material inputs	33.719	100.05	100.03	100.03	100.04	100.04
Investments	92.835	100.16	100.06	100.06	100.06	100.06
Private consumption	18.542	100.00	100.10	100.12	100.13	100.15
Government consumption	7.113	100.06	100.05	100.05	100.05	100.06
Foods	119.820	99.87	99.81	99.79	99.79	99.78
Material inputs	22.846	99.37	99.28	99.25	99.24	99.24
Investments	0.093	100.04	100.04	100.04	100.04	100.04
Private consumption	25.466	99.85	99.83	99.83	99.84	99.87
Exports	71.415	100.04	99.97	99.95	99.94	99.92
Metal and chemicals	324.317	100.28	100.34	100.34	100.34	100.31
Material inputs	114.537	99.59	99.62	99.61	99.60	99.59
Investments	22.878	99.32	99.38	99.36	99.35	99.35
Private consumption	7.492	99.43	99.49	99.51	99.52	99.54
Government consumption	0.861	99.24	99.27	99.26	99.26	99.26
Exports	178.550	100.89	100.97	100.96	100.96	100.95
Other manufacturing	118.556	100.33	100.37	100.36	100.35	100.33
Material inputs	45.541	99.64	99.67	99.65	99.63	99.63
Investments	15.763	99.59	99.65	99.63	99.62	99.62
Private consumption	11.751	99.36	99.41	99.42	99.42	99.45
Government consumption	0.091	98.88	98.92	98.91	98.90	98.90
Exports	45.409	101.53	101.59	101.59	101.58	101.56
Trade and transportation	362.671	100.02	100.03	100.04	100.04	100.05
Material inputs	154.156	99.98	99.98	99.98	99.97	99.98
Investments	27.790	99.98	100.01	100.00	100.00	100.01
Private consumption	98.999	100.25	100.25	100.28	100.29	100.33
Government consumption	3.122	100.06	100.05	100.05	100.05	100.06
Exports	78.605	99.82	99.84	99.82	99.81	99.79
Other services	383.144	100.02	100.02	100.03	100.03	100.05
Material inputs	221.120	100.00	100.00	100.00	100.00	100.01
Investments	24.111	100.12	100.13	100.13	100.13	100.13
Private consumption	102.764	100.06	100.08	100.10	100.11	100.14
Government consumption	19.235	100.05	100.05	100.05	100.05	100.06
Exports	15.914	99.78	99.79	99.77	99.76	99.74
Public services	310.413	100.06	100.05	100.06	100.06	100.07
Material inputs	18.739	100.07	100.06	100.07	100.07	100.08
Investments	0.761	100.10	100.13	100.13	100.14	100.14
Private consumption	17.503	100.12	100.14	100.16	100.17	100.21

Table C.2: Effects of isolated removal of trade costs pertaining to imports from CEE on production by industries and final use

	2003	2008	2018	2028	2038	∞
	Quantity		—*Baseline=100*—			
Agriculture	65.636	100.06	100.11	100.11	100.10	100.09
Material inputs	49.513	100.02	100.08	100.08	100.07	100.06
Private consumption	2.711	99.24	99.29	99.30	99.30	99.33
Government consumption	1.033	100.09	100.09	100.09	100.09	100.10
Exports	12.379	100.36	100.43	100.43	100.42	100.41
Energy provision	58.557	99.79	99.66	99.64	99.64	99.62
Energy inputs	27.662	98.71	98.58	98.56	98.55	98.54
Investments	0.475	98.49	98.29	98.25	98.23	98.22
Private consumption	16.147	99.94	99.93	99.93	99.93	99.96
Exports	14.273	101.68	101.38	101.34	101.33	101.31
Construction	152.209	100.15	100.09	100.09	100.09	100.09
Material inputs	33.719	100.10	100.10	100.10	100.10	100.11
Investments	92.835	100.20	100.09	100.08	100.09	100.09
Private consumption	18.542	100.00	100.06	100.08	100.09	100.11
Government consumption	7.113	100.09	100.09	100.09	100.09	100.10
Foods	119.820	100.26	100.33	100.34	100.34	100.33
Material inputs	22.846	99.84	99.92	99.91	99.91	99.90
Investments	0.093	100.21	100.30	100.31	100.31	100.31
Private consumption	25.466	100.06	100.12	100.13	100.14	100.18
Exports	71.415	100.47	100.54	100.55	100.55	100.53
Metal and chemicals	324.317	100.41	100.50	100.51	100.51	100.49
Material inputs	114.537	99.72	99.78	99.77	99.77	99.76
Investments	22.878	99.58	99.68	99.68	99.67	99.66
Private consumption	7.492	99.74	99.84	99.86	99.87	99.90
Government consumption	0.861	99.44	99.51	99.51	99.51	99.50
Exports	178.550	101.00	101.11	101.11	101.11	101.10
Other manufacturing	118.556	99.21	99.12	99.09	99.07	99.05
Material inputs	45.541	98.03	97.94	97.90	97.87	97.88
Investments	15.763	98.29	98.28	98.24	98.21	98.21
Private consumption	11.751	97.30	97.22	97.19	97.18	97.22
Government consumption	0.091	96.04	95.93	95.90	95.88	95.88
Exports	45.409	101.23	101.11	101.10	101.10	101.08
Trade and transportation	362.671	100.13	100.17	100.17	100.17	100.18
Material inputs	154.156	99.94	99.95	99.95	99.94	99.95
Investments	27.790	100.00	100.06	100.05	100.05	100.05
Private consumption	98.999	100.42	100.45	100.47	100.49	100.53
Government consumption	3.122	100.09	100.09	100.09	100.09	100.10
Exports	78.605	100.20	100.26	100.26	100.24	100.22
Other services	383.144	100.05	100.07	100.07	100.07	100.09
Material inputs	221.120	100.02	100.03	100.03	100.03	100.04
Investments	24.111	100.17	100.18	100.18	100.18	100.18
Private consumption	102.764	100.07	100.10	100.11	100.12	100.16
Government consumption	19.235	100.08	100.09	100.09	100.09	100.10
Exports	15.914	100.11	100.12	100.10	100.09	100.07
Public services	310.413	100.09	100.10	100.10	100.10	100.11
Material inputs	18.739	100.13	100.14	100.14	100.14	100.15
Investments	0.761	100.15	100.19	100.19	100.19	100.20
Private consumption	17.503	100.16	100.19	100.21	100.22	100.26
Government consumption	271.316	100.09	100.09	100.09	100.09	100.10
Exports	2.093	99.95	99.87	99.85	99.84	99.82

Table C.3: Effects of removal of real costs of trade with CEE on production by industries and final use

	2003	2008	2018	2028	2038	∞
	Quantity	—*Baseline=100*—				
Agriculture	65.636	99.69	99.64	99.61	99.59	99.58
Material inputs	49.513	99.75	99.72	99.69	99.67	99.65
Private consumption	2.711	98.82	98.76	98.76	98.76	98.82
Government consumption	1.033	100.14	100.14	100.14	100.15	100.16
Exports	12.379	99.61	99.47	99.44	99.41	99.38
Energy provision	58.557	99.58	99.33	99.29	99.29	99.27
Energy inputs	27.662	98.40	98.15	98.10	98.09	98.08
Investments	0.475	98.07	97.70	97.63	97.60	97.59
Private consumption	16.147	100.02	100.01	100.03	100.04	100.09
Exports	14.273	101.37	100.82	100.72	100.70	100.66
Construction	152.209	100.27	100.15	100.15	100.15	100.16
Material inputs	33.719	100.15	100.13	100.13	100.14	100.15
Investments	92.835	100.37	100.15	100.14	100.14	100.15
Private consumption	18.542	100.00	100.16	100.20	100.22	100.27
Government consumption	7.113	100.14	100.14	100.14	100.15	100.16
Foods	119.820	100.13	100.14	100.13	100.12	100.11
Material inputs	22.846	99.20	99.20	99.17	99.14	99.13
Investments	0.093	100.25	100.34	100.35	100.35	100.35
Private consumption	25.466	99.91	99.94	99.96	99.98	100.05
Exports	71.415	100.51	100.51	100.49	100.48	100.44
Metal and chemicals	324.317	100.69	100.85	100.86	100.85	100.80
Material inputs	114.537	99.31	99.40	99.38	99.37	99.35
Investments	22.878	98.90	99.06	99.04	99.03	99.01
Private consumption	7.492	99.16	99.33	99.37	99.39	99.44
Government consumption	0.861	98.68	98.78	98.78	98.77	98.76
Exports	178.550	101.89	102.08	102.09	102.08	102.05
Other manufacturing	118.556	99.54	99.50	99.45	99.43	99.38
Material inputs	45.541	97.66	97.61	97.55	97.51	97.51
Investments	15.763	97.87	97.93	97.87	97.83	97.83
Private consumption	11.751	96.67	96.63	96.62	96.61	96.68
Government consumption	0.091	94.96	94.89	94.84	94.82	94.81
Exports	45.409	102.77	102.72	102.70	102.69	102.65
Trade and transportation	362.671	100.15	100.20	100.21	100.21	100.23
Material inputs	154.156	99.92	99.94	99.92	99.92	99.92
Investments	27.790	99.98	100.07	100.05	100.05	100.06
Private consumption	98.999	100.67	100.71	100.76	100.79	100.86
Government consumption	3.122	100.14	100.14	100.14	100.15	100.16
Exports	78.605	100.02	100.10	100.08	100.05	100.01
Other services	383.144	100.07	100.09	100.10	100.10	100.13
Material inputs	221.120	100.02	100.03	100.03	100.03	100.04
Investments	24.111	100.29	100.31	100.31	100.31	100.31
Private consumption	102.764	100.12	100.18	100.21	100.23	100.30
Government consumption	19.235	100.14	100.13	100.14	100.14	100.15
Exports	15.914	99.88	99.90	99.87	99.84	99.80
Public services	310.413	100.15	100.15	100.16	100.16	100.18
Material inputs	18.739	100.19	100.20	100.21	100.21	100.22
Investments	0.761	100.26	100.32	100.32	100.33	100.34
Private consumption	17.503	100.29	100.33	100.37	100.40	100.47
Government consumption	271.316	100.14	100.14	100.14	100.15	100.16
Exports	2.093	99.60	99.48	99.43	99.40	99.36

Table C.4: Compound effects of customs union and market integration on production by industries and final use

	2003	2008	2018	2028	2038	∞
	Quantity		*—Baseline=100—*			
Agriculture	65.636	99.86	99.88	99.86	99.84	99.82
Material inputs	49.513	100.09	100.14	100.11	100.09	100.07
Private consumption	2.711	98.74	98.73	98.74	98.74	98.81
Government consumption	1.033	100.15	100.15	100.15	100.16	100.17
Exports	12.379	99.14	99.10	99.08	99.06	99.02
Energy provision	58.557	99.56	99.29	99.26	99.25	99.24
Energy inputs	27.662	98.39	98.13	98.08	98.06	98.05
Investments	0.475	98.04	97.64	97.57	97.54	97.53
Private consumption	16.147	100.02	100.02	100.03	100.05	100.10
Exports	14.273	101.29	100.71	100.61	100.58	100.54
Construction	152.209	100.30	100.16	100.16	100.16	100.17
Material inputs	33.719	100.16	100.14	100.14	100.15	100.16
Investments	92.835	100.42	100.17	100.15	100.15	100.16
Private consumption	18.542	100.00	100.17	100.21	100.23	100.28
Government consumption	7.113	100.15	100.15	100.15	100.16	100.17
Foods	119.820	100.56	100.64	100.64	100.63	100.61
Material inputs	22.846	99.04	99.12	99.09	99.06	99.04
Investments	0.093	100.41	100.56	100.56	100.56	100.55
Private consumption	25.466	99.65	99.71	99.74	99.75	99.82
Exports	71.415	101.36	101.48	101.47	101.46	101.42
Metal and chemicals	324.317	100.64	100.78	100.78	100.78	100.73
Material inputs	114.537	99.27	99.35	99.33	99.32	99.30
Investments	22.878	98.89	99.06	99.04	99.03	99.01
Private consumption	7.492	99.14	99.30	99.34	99.35	99.41
Government consumption	0.861	98.63	98.73	98.72	98.71	98.71
Exports	178.550	101.81	101.99	101.99	101.98	101.95
Other manufacturing	118.556	99.48	99.42	99.37	99.35	99.31
Material inputs	45.541	97.62	97.56	97.50	97.46	97.46
Investments	15.763	97.82	97.87	97.81	97.77	97.76
Private consumption	11.751	96.64	96.59	96.57	96.56	96.64
Government consumption	0.091	94.89	94.80	94.76	94.73	94.73
Exports	45.409	102.67	102.60	102.58	102.57	102.53
Trade and transportation	362.671	100.13	100.18	100.19	100.19	100.21
Material inputs	154.156	99.92	99.93	99.92	99.91	99.92
Investments	27.790	99.98	100.08	100.06	100.06	100.07
Private consumption	98.999	100.70	100.74	100.79	100.82	100.90
Government consumption	3.122	100.15	100.15	100.15	100.16	100.17
Exports	78.605	99.87	99.95	99.92	99.89	99.85
Other services	383.144	100.07	100.09	100.10	100.11	100.14
Material inputs	221.120	100.03	100.04	100.04	100.04	100.05
Investments	24.111	100.32	100.33	100.32	100.33	100.33
Private consumption	102.764	100.13	100.18	100.22	100.24	100.32
Government consumption	19.235	100.15	100.14	100.14	100.15	100.16
Exports	15.914	99.73	99.75	99.72	99.69	99.65
Public services	310.413	100.16	100.16	100.16	100.17	100.19
Material inputs	18.739	100.20	100.21	100.22	100.22	100.24
Investments	0.761	100.28	100.33	100.33	100.34	100.35
Private consumption	17.503	100.30	100.34	100.38	100.42	100.49
Government consumption	271.316	100.15	100.15	100.15	100.16	100.17
Exports	2.093	99.44	99.30	99.26	99.22	99.18

Table C.5: Effects of GNI financed enlargement by industry and final use

	2003	2008	2018	2028	2038	∞	Unfinanced ∞
	Quantity			*—Baseline=100—*			
Agriculture	65.636	100.19	100.20	100.20	100.21	100.20	99.82
Material inputs	49.513	100.42	100.44	100.44	100.44	100.43	100.07
Private consumption	2.711	98.04	97.99	97.98	97.98	98.03	98.81
Government consumption	1.033	99.95	99.95	99.95	99.95	99.96	100.17
Exports	12.379	99.75	99.75	99.79	99.81	99.81	99.02
Energy provision	58.557	99.69	99.33	99.26	99.26	99.26	99.24
Energy inputs	27.662	98.62	98.35	98.29	98.28	98.29	98.05
Investments	0.475	98.26	97.82	97.72	97.70	97.71	97.53
Private consumption	16.147	99.51	99.11	99.07	99.06	99.11	100.10
Exports	14.273	101.90	101.41	101.32	101.32	101.33	100.54
Construction	152.209	99.27	99.65	99.70	99.72	99.73	100.17
Material inputs	33.719	99.83	99.88	99.88	99.89	99.90	100.16
Investments	92.835	98.88	99.60	99.69	99.71	99.72	100.16
Private consumption	18.542	99.99	99.36	99.32	99.32	99.38	100.28
Government consumption	7.113	99.95	99.95	99.95	99.95	99.96	100.17
Foods	119.820	100.84	100.89	100.90	100.91	100.90	100.61
Material inputs	22.846	99.46	99.49	99.50	99.50	99.50	99.04
Investments	0.093	100.42	100.50	100.49	100.49	100.49	100.55
Private consumption	25.466	98.79	98.80	98.79	98.79	98.84	99.82
Exports	71.415	102.02	102.12	102.16	102.19	102.18	101.42
Metal and chemicals	324.317	101.01	101.16	101.21	101.23	101.20	100.73
Material inputs	114.537	99.39	99.57	99.60	99.61	99.60	99.30
Investments	22.878	99.29	99.39	99.41	99.42	99.41	99.01
Private consumption	7.492	98.56	98.56	98.57	98.58	98.63	99.41
Government consumption	0.861	98.80	98.88	98.90	98.91	98.92	98.71
Exports	178.550	102.38	102.53	102.57	102.59	102.59	101.95
Other manufacturing	118.556	99.84	99.70	99.69	99.69	99.66	99.31
Material inputs	45.541	97.88	97.76	97.73	97.71	97.72	97.46
Investments	15.763	98.17	98.13	98.09	98.07	98.08	97.76
Private consumption	11.751	96.03	95.89	95.86	95.84	95.91	96.64
Government consumption	0.091	95.25	95.11	95.10	95.10	95.12	94.73
Exports	45.409	103.38	103.23	103.27	103.29	103.28	102.53
Trade and transportation	362.671	100.05	100.00	100.00	100.00	100.01	100.21
Material inputs	154.156	99.90	99.90	99.90	99.90	99.90	99.92
Investments	27.790	99.99	99.99	99.98	99.98	99.98	100.07
Private consumption	98.999	99.61	99.62	99.61	99.61	99.66	100.90
Government consumption	3.122	99.95	99.95	99.95	99.95	99.96	100.17
Exports	78.605	100.93	100.76	100.80	100.82	100.82	99.85
Other services	383.144	99.75	99.72	99.71	99.71	99.74	100.14
Material inputs	221.120	99.85	99.86	99.86	99.86	99.87	100.05
Investments	24.111	99.77	100.04	100.06	100.07	100.07	100.33
Private consumption	102.764	99.32	99.18	99.16	99.16	99.22	100.32
Government consumption	19.235	99.94	99.94	99.94	99.94	99.95	100.16
Exports	15.914	100.86	100.58	100.62	100.64	100.63	99.65
Public services	310.413	99.92	99.91	99.91	99.91	99.93	100.19
Material inputs	18.739	99.95	99.97	99.97	99.98	99.99	100.24
Investments	0.761	99.88	100.00	100.01	100.02	100.03	100.35
Private consumption	17.503	99.32	99.28	99.27	99.27	99.32	100.49
Government consumption	271.316	99.95	99.95	99.95	99.95	99.96	100.17
Exports	2.093	100.45	100.20	100.24	100.26	100.26	99.18

Table C.6: Effects of CAP financed enlargement by industry and final use

	2003	2008	2018	2028	2038	∞	Unfinanced ∞
	Quantity			*—Baseline=100—*			
Agriculture	65.636	90.15	87.37	86.96	86.86	86.88	99.82
Material inputs	49.513	92.48	89.99	89.59	89.47	89.46	100.07
Private consumption	2.711	86.52	83.72	83.25	83.11	83.21	98.81
Government consumption	1.033	99.64	99.71	99.72	99.73	99.75	100.17
Exports	12.379	80.89	76.57	76.00	75.89	75.80	99.02
Energy provision	58.557	100.14	100.05	100.04	100.04	100.01	99.24
Energy inputs	27.662	98.78	98.63	98.59	98.58	98.55	98.05
Investments	0.475	99.05	99.03	98.99	98.98	98.95	97.53
Private consumption	16.147	99.41	99.31	99.38	99.44	99.56	100.10
Exports	14.273	103.48	103.50	103.47	103.45	103.38	100.54
Construction	152.209	98.58	99.47	99.59	99.61	99.62	100.17
Material inputs	33.719	99.37	99.52	99.56	99.57	99.59	100.16
Investments	92.835	97.96	99.42	99.59	99.60	99.60	100.16
Private consumption	18.542	99.99	99.52	99.59	99.65	99.77	100.28
Government consumption	7.113	99.64	99.71	99.72	99.73	99.75	100.17
Foods	119.820	96.23	94.30	94.07	94.05	94.01	100.61
Material inputs	22.846	93.57	91.33	91.02	90.97	90.97	99.04
Investments	0.093	98.79	97.93	97.86	97.88	97.90	100.55
Private consumption	25.466	96.41	95.68	95.58	95.58	95.70	99.82
Exports	71.415	97.01	94.71	94.42	94.39	94.28	101.42
Metal and chemicals	324.317	102.35	102.78	102.84	102.84	102.76	100.73
Material inputs	114.537	100.15	100.61	100.65	100.64	100.59	99.30
Investments	22.878	99.36	99.31	99.30	99.30	99.28	99.01
Private consumption	7.492	99.37	99.82	99.95	100.01	100.12	99.41
Government consumption	0.861	99.72	100.09	100.13	100.14	100.13	98.71
Exports	178.550	104.28	104.76	104.80	104.79	104.74	101.95
Other manufacturing	118.556	101.40	101.52	101.52	101.51	101.43	99.31
Material inputs	45.541	99.03	99.10	99.08	99.05	99.03	97.46
Investments	15.763	99.31	99.48	99.46	99.43	99.40	97.76
Private consumption	11.751	96.95	97.24	97.32	97.37	97.48	96.64
Government consumption	0.091	96.72	96.88	96.90	96.88	96.87	94.73
Exports	45.409	105.67	105.83	105.85	105.84	105.77	102.53
Trade and transportation	362.671	100.61	100.65	100.64	100.64	100.65	100.21
Material inputs	154.156	99.93	99.97	99.97	99.96	99.96	99.92
Investments	27.790	99.71	99.69	99.69	99.69	99.70	100.07
Private consumption	98.999	99.15	99.37	99.47	99.54	99.68	100.90
Government consumption	3.122	99.64	99.71	99.72	99.73	99.75	100.17
Exports	78.605	104.19	104.24	104.25	104.23	104.15	99.85
Other services	383.144	99.71	99.80	99.83	99.85	99.90	100.14
Material inputs	221.120	99.62	99.67	99.68	99.69	99.71	100.05
Investments	24.111	99.08	99.83	99.93	99.94	99.94	100.33
Private consumption	102.764	99.40	99.51	99.61	99.67	99.80	100.32
Government consumption	19.235	99.64	99.71	99.72	99.73	99.75	100.16
Exports	15.914	104.32	103.99	103.99	103.96	103.89	99.65
Public services	310.413	99.65	99.72	99.74	99.75	99.78	100.19
Material inputs	18.739	99.61	99.68	99.70	99.71	99.74	100.24
Investments	0.761	99.26	99.88	99.98	100.00	100.01	100.35
Private consumption	17.503	99.30	99.53	99.63	99.69	99.83	100.49
Government consumption	271.316	99.64	99.71	99.72	99.73	99.75	100.17
Exports	2.093	104.23	104.16	104.16	104.12	104.04	99.18

Table C.7: Effects of ESF financed enlargement by industry and final use

	2003	2008	2018	2028	2038	∞	Unfinanced ∞
	Quantity			*—Baseline=100—*			
Agriculture	65.636	99.97	99.98	99.97	99.96	99.94	99.82
Material inputs	49.513	100.20	100.23	100.22	100.20	100.18	100.07
Private consumption	2.711	98.51	98.49	98.50	98.50	98.57	98.81
Government consumption	1.033	100.09	100.08	100.09	100.09	100.10	100.17
Exports	12.379	99.34	99.31	99.31	99.30	99.26	99.02
Energy provision	58.557	99.60	99.30	99.26	99.25	99.24	99.24
Energy inputs	27.662	98.46	98.20	98.15	98.14	98.13	98.05
Investments	0.475	98.11	97.70	97.62	97.59	97.58	97.53
Private consumption	16.147	99.86	99.72	99.72	99.73	99.80	100.10
Exports	14.273	101.49	100.94	100.84	100.82	100.78	100.54
Construction	152.209	99.97	100.00	100.01	100.02	100.04	100.17
Material inputs	33.719	100.06	100.06	100.06	100.06	100.08	100.16
Investments	92.835	99.92	99.99	100.00	100.01	100.02	100.16
Private consumption	18.542	100.00	99.91	99.92	99.94	100.01	100.28
Government consumption	7.113	100.09	100.08	100.09	100.09	100.10	100.17
Foods	119.820	100.65	100.72	100.72	100.72	100.70	100.61
Material inputs	22.846	99.18	99.24	99.22	99.20	99.18	99.04
Investments	0.093	100.41	100.54	100.54	100.54	100.53	100.55
Private consumption	25.466	99.37	99.42	99.43	99.44	99.52	99.82
Exports	71.415	101.57	101.68	101.70	101.70	101.65	101.42
Metal and chemicals	324.317	100.76	100.90	100.92	100.93	100.88	100.73
Material inputs	114.537	99.31	99.42	99.42	99.41	99.39	99.30
Investments	22.878	99.02	99.17	99.16	99.15	99.13	99.01
Private consumption	7.492	98.95	99.06	99.09	99.10	99.18	99.41
Government consumption	0.861	98.69	98.78	98.78	98.77	98.77	98.71
Exports	178.550	101.99	102.16	102.18	102.18	102.15	101.95
Other manufacturing	118.556	99.59	99.51	99.48	99.46	99.41	99.31
Material inputs	45.541	97.70	97.63	97.57	97.54	97.54	97.46
Investments	15.763	97.94	97.95	97.90	97.87	97.86	97.76
Private consumption	11.751	96.44	96.36	96.34	96.33	96.42	96.64
Government consumption	0.091	95.01	94.90	94.87	94.85	94.85	94.73
Exports	45.409	102.90	102.81	102.81	102.80	102.76	102.53
Trade and transportation	362.671	100.10	100.12	100.13	100.13	100.15	100.21
Material inputs	154.156	99.91	99.92	99.92	99.91	99.91	99.92
Investments	27.790	99.99	100.05	100.04	100.03	100.04	100.07
Private consumption	98.999	100.35	100.38	100.41	100.43	100.53	100.90
Government consumption	3.122	100.09	100.08	100.09	100.09	100.10	100.17
Exports	78.605	100.22	100.21	100.21	100.19	100.15	99.85
Other services	383.144	99.97	99.97	99.98	99.98	100.02	100.14
Material inputs	221.120	99.97	99.98	99.98	99.98	100.00	100.05
Investments	24.111	100.14	100.23	100.24	100.24	100.25	100.33
Private consumption	102.764	99.87	99.86	99.88	99.89	99.98	100.32
Government consumption	19.235	100.08	100.08	100.08	100.08	100.10	100.16
Exports	15.914	100.10	100.02	100.01	100.00	99.95	99.65
Public services	310.413	100.08	100.08	100.08	100.09	100.11	100.19
Material inputs	18.739	100.12	100.13	100.14	100.14	100.16	100.24
Investments	0.761	100.15	100.22	100.23	100.23	100.25	100.35
Private consumption	17.503	99.98	99.99	100.02	100.05	100.14	100.49
Government consumption	271.316	100.09	100.08	100.09	100.09	100.10	100.17
Exports	2.093	99.76	99.59	99.58	99.56	99.51	99.18

Table C.8: Effects of combined funding of enlargement by industry and final use

	2003	2008	2018	2028	2038	∞	Unfinanced ∞
	Quantity			—*Baseline=100*—			
Agriculture	65.636	97.25	96.41	96.29	96.26	96.26	99.82
Material inputs	49.513	98.13	97.42	97.30	97.26	97.25	100.07
Private consumption	2.711	94.90	94.04	93.89	93.85	93.92	98.81
Government consumption	1.033	99.90	99.92	99.92	99.93	99.94	100.17
Exports	12.379	94.03	92.59	92.41	92.38	92.34	99.02
Energy provision	58.557	99.79	99.53	99.49	99.49	99.47	99.24
Energy inputs	27.662	98.62	98.39	98.34	98.33	98.32	98.05
Investments	0.475	98.44	98.13	98.06	98.04	98.03	97.53
Private consumption	16.147	99.59	99.35	99.35	99.37	99.44	100.10
Exports	14.273	102.23	101.87	101.80	101.79	101.76	100.54
Construction	152.209	99.28	99.70	99.76	99.77	99.79	100.17
Material inputs	33.719	99.76	99.83	99.84	99.84	99.86	100.16
Investments	92.835	98.93	99.66	99.75	99.77	99.77	100.16
Private consumption	18.542	99.99	99.57	99.58	99.60	99.67	100.28
Government consumption	7.113	99.90	99.92	99.92	99.93	99.94	100.17
Foods	119.820	99.51	98.99	98.93	98.93	98.90	100.61
Material inputs	22.846	97.72	97.10	97.00	96.98	96.98	99.04
Investments	0.093	99.97	99.79	99.76	99.77	99.78	100.55
Private consumption	25.466	98.31	98.12	98.09	98.10	98.18	99.82
Exports	71.415	100.50	99.91	99.85	99.85	99.81	101.42
Metal and chemicals	324.317	101.32	101.55	101.59	101.60	101.55	100.73
Material inputs	114.537	99.58	99.82	99.84	99.84	99.82	99.30
Investments	22.878	99.24	99.31	99.31	99.31	99.29	99.01
Private consumption	7.492	98.91	99.07	99.12	99.15	99.22	99.41
Government consumption	0.861	99.03	99.20	99.22	99.23	99.23	98.71
Exports	178.550	102.81	103.06	103.09	103.10	103.08	101.95
Other manufacturing	118.556	100.21	100.17	100.15	100.14	100.10	99.31
Material inputs	45.541	98.16	98.11	98.07	98.05	98.05	97.46
Investments	15.763	98.43	98.46	98.43	98.40	98.40	97.76
Private consumption	11.751	96.42	96.42	96.42	96.43	96.51	96.64
Government consumption	0.091	95.60	95.56	95.55	95.54	95.54	94.73
Exports	45.409	103.89	103.85	103.87	103.87	103.84	102.53
Trade and transportation	362.671	100.22	100.22	100.22	100.22	100.24	100.21
Material inputs	154.156	99.91	99.93	99.92	99.92	99.92	99.92
Investments	27.790	99.91	99.92	99.91	99.91	99.92	100.07
Private consumption	98.999	99.70	99.77	99.80	99.83	99.92	100.90
Government consumption	3.122	99.90	99.92	99.92	99.93	99.94	100.17
Exports	78.605	101.64	101.59	101.61	101.61	101.57	99.85
Other services	383.144	99.80	99.82	99.82	99.83	99.86	100.14
Material inputs	221.120	99.82	99.84	99.84	99.84	99.86	100.05
Investments	24.111	99.68	100.04	100.08	100.08	100.08	100.33
Private consumption	102.764	99.51	99.48	99.50	99.52	99.61	100.32
Government consumption	19.235	99.90	99.91	99.92	99.92	99.94	100.16
Exports	15.914	101.61	101.38	101.40	101.40	101.36	99.65
Public services	310.413	99.89	99.91	99.91	99.92	99.94	100.19
Material inputs	18.739	99.90	99.93	99.94	99.95	99.96	100.24
Investments	0.761	99.78	100.03	100.07	100.07	100.08	100.35
Private consumption	17.503	99.51	99.56	99.59	99.62	99.70	100.49
Government consumption	271.316	99.90	99.92	99.92	99.93	99.94	100.17
Exports	2.093	101.31	101.14	101.16	101.15	101.11	99.18

Table C.9: Steady state effects of the various funding of enlargement by industry and final use

	Baseline 2003	Unfinanced enlargement	GNI contribution	CAP spendings	ESF spendings	Combined policy
	Quantity			*—Baseline=100—*		
Agriculture	65.636	99.82	100.20	86.88	99.94	96.26
Material inputs	49.513	100.07	100.43	89.46	100.18	97.25
Private consumption	2.711	98.81	98.03	83.21	98.57	93.92
Government consumption	1.033	100.17	99.96	99.75	100.10	99.94
Exports	12.379	99.02	99.81	75.80	99.26	92.34
Energy provision	58.557	99.24	99.26	100.01	99.24	99.47
Energy inputs	27.662	98.05	98.29	98.55	98.13	98.32
Investments	0.475	97.53	97.71	98.95	97.58	98.03
Private consumption	16.147	100.10	99.11	99.56	99.80	99.44
Exports	14.273	100.54	101.33	103.38	100.78	101.76
Construction	152.209	100.17	99.73	99.62	100.04	99.79
Material inputs	33.719	100.16	99.90	99.59	100.08	99.86
Investments	92.835	100.16	99.72	99.60	100.02	99.77
Private consumption	18.542	100.28	99.38	99.77	100.01	99.67
Government consumption	7.113	100.17	99.96	99.75	100.10	99.94
Foods	119.820	100.61	100.90	94.01	100.70	98.90
Material inputs	22.846	99.04	99.50	90.97	99.18	96.98
Investments	0.093	100.55	100.49	97.90	100.53	99.78
Private consumption	25.466	99.82	98.84	95.70	99.52	98.18
Exports	71.415	101.42	102.18	94.28	101.65	99.81
Metal and chemicals	324.317	100.73	101.20	102.76	100.88	101.55
Material inputs	114.537	99.30	99.60	100.59	99.39	99.82
Investments	22.878	99.01	99.41	99.28	99.13	99.29
Private consumption	7.492	99.41	98.63	100.12	99.18	99.22
Government consumption	0.861	98.71	98.92	100.13	98.77	99.23
Exports	178.550	101.95	102.59	104.74	102.15	103.08
Other manufacturing	118.556	99.31	99.66	101.43	99.41	100.10
Material inputs	45.541	97.46	97.72	99.03	97.54	98.05
Investments	15.763	97.76	98.08	99.40	97.86	98.40
Private consumption	11.751	96.64	95.91	97.48	96.42	96.51
Government consumption	0.091	94.73	95.12	96.87	94.85	95.54
Exports	45.409	102.53	103.28	105.77	102.76	103.84
Trade and transportation	362.671	100.21	100.01	100.65	100.15	100.24
Material inputs	154.156	99.92	99.90	99.96	99.91	99.92
Investments	27.790	100.07	99.98	99.70	100.04	99.92
Private consumption	98.999	100.90	99.66	99.68	100.53	99.92
Government consumption	3.122	100.17	99.96	99.75	100.10	99.94
Exports	78.605	99.85	100.82	104.15	100.15	101.57
Other services	383.144	100.14	99.74	99.90	100.02	99.86
Material inputs	221.120	100.05	99.87	99.71	100.00	99.86
Investments	24.111	100.33	100.07	99.94	100.25	100.08
Private consumption	102.764	100.32	99.22	99.80	99.98	99.61
Government consumption	19.235	100.16	99.95	99.75	100.10	99.94
Exports	15.914	99.65	100.63	103.89	99.95	101.36
Public services	310.413	100.19	99.93	99.78	100.11	99.94
Material inputs	18.739	100.24	99.99	99.74	100.16	99.96
Investments	0.761	100.35	100.03	100.01	100.25	100.08
Private consumption	17.503	100.49	99.32	99.83	100.14	99.70
Government consumption	271.316	100.17	99.96	99.75	100.10	99.94
Exports	2.093	99.18	100.26	104.04	99.51	101.11

Table C.10: Effects on production and demand of shifting to sustainable wage tax system

	2003	2008	2018	2028	2038	2098	2248	∞
	Quantity			*—Debt-targeting=100—*				
Agriculture	65.636	99.99	99.99	99.99	99.99	100.02	100.02	100.02
Material inputs	49.513	99.99	99.99	99.99	100.00	100.02	100.02	100.02
Private consumption	2.711	100.05	100.03	100.02	100.01	99.96	99.95	99.96
Government consumption	1.033	100.02	100.01	100.00	100.00	99.99	99.99	99.99
Exports	12.379	99.97	99.98	99.98	99.99	100.04	100.05	100.04
Energy provision	58.557	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Energy inputs	27.662	99.99	99.99	99.99	100.00	100.01	100.01	100.01
Investments	0.475	99.99	99.99	100.00	100.00	100.01	100.01	100.01
Private consumption	16.147	100.03	100.04	100.03	100.01	99.95	99.94	99.95
Exports	14.273	99.97	99.97	99.98	99.99	100.04	100.05	100.04
Construction	152.209	100.07	100.01	100.00	99.99	99.97	99.97	99.98
Material inputs	33.719	100.03	100.01	100.00	100.00	99.99	99.98	99.99
Investments	92.835	100.09	100.01	99.99	99.99	99.97	99.97	99.98
Private consumption	18.542	100.00	100.03	100.02	100.01	99.95	99.95	99.95
Government consumption	7.113	100.02	100.01	100.00	100.00	99.99	99.99	99.99
Foods	119.820	99.99	99.99	99.99	100.00	100.01	100.02	100.02
Material inputs	22.846	99.99	99.99	99.99	99.99	100.02	100.03	100.02
Investments	0.093	100.01	100.00	100.00	100.00	100.00	100.00	100.00
Private consumption	25.466	100.06	100.04	100.03	100.01	99.95	99.94	99.95
Exports	71.415	99.97	99.98	99.98	99.99	100.03	100.04	100.04
Metal and chemicals	324.317	99.99	99.99	99.99	99.99	100.02	100.03	100.02
Material inputs	114.537	100.01	99.99	99.99	99.99	100.01	100.02	100.02
Investments	22.878	99.99	99.99	99.99	99.99	100.02	100.02	100.02
Private consumption	7.492	100.05	100.03	100.02	100.01	99.96	99.95	99.96
Government consumption	0.861	100.01	100.00	100.00	100.00	100.01	100.01	100.01
Exports	178.550	99.98	99.98	99.99	99.99	100.03	100.04	100.03
Other manufacturing	118.556	99.99	99.99	99.99	100.00	100.02	100.02	100.02
Material inputs	45.541	100.00	99.99	99.99	100.00	100.01	100.02	100.01
Investments	15.763	99.99	99.99	99.99	100.00	100.01	100.02	100.02
Private consumption	11.751	100.05	100.03	100.02	100.01	99.96	99.95	99.96
Government consumption	0.091	100.00	99.99	99.99	99.99	100.02	100.02	100.02
Exports	45.409	99.97	99.98	99.98	99.99	100.03	100.04	100.04
Trade and transportation	362.671	100.02	100.01	100.01	100.00	99.99	99.99	99.99
Material inputs	154.156	100.01	100.00	100.00	100.00	100.00	100.00	100.00
Investments	27.790	100.01	100.01	100.00	100.00	100.00	100.00	100.00
Private consumption	98.999	100.07	100.05	100.03	100.02	99.94	99.93	99.93
Government consumption	3.122	100.02	100.01	100.00	100.00	99.99	99.99	99.99
Exports	78.605	99.95	99.97	99.98	99.99	100.05	100.06	100.05
Other services	383.144	100.03	100.02	100.01	100.00	99.98	99.98	99.98
Material inputs	221.120	100.02	100.01	100.00	100.00	99.99	99.99	99.99
Investments	24.111	100.03	100.01	100.00	100.00	99.98	99.98	99.99
Private consumption	102.764	100.06	100.04	100.03	100.02	99.95	99.93	99.94
Government consumption	19.235	100.02	100.01	100.00	100.00	99.99	99.99	99.99
Exports	15.914	99.95	99.97	99.98	99.99	100.05	100.06	100.05
Public services	310.413	100.03	100.01	100.01	100.00	99.99	99.98	99.99
Material inputs	18.739	100.02	100.01	100.01	100.00	99.99	99.99	99.99
Investments	0.761	100.03	100.01	100.00	100.00	99.98	99.98	99.98
Private consumption	17.503	100.07	100.04	100.03	100.02	99.94	99.93	99.94
Government consumption	271.316	100.02	100.01	100.00	100.00	99.99	99.99	99.99
Exports	2.093	99.97	99.97	99.98	99.99	100.05	100.06	100.06

Table C.11: Effects on production and demand of shifting to sustainable value added taxation

	2003	2008	2018	2028	2038	2098	2248	∞
	Quantity			—*Debt-targeting=100*—				
Agriculture	65.636	100.05	100.03	100.02	100.02	100.03	100.03	100.03
Material inputs	49.513	100.05	100.03	100.02	100.02	100.03	100.03	100.03
Private consumption	2.711	99.97	99.99	100.01	100.01	99.98	99.97	99.97
Government consumption	1.033	100.02	100.01	100.01	100.01	100.00	100.00	100.00
Exports	12.379	100.06	100.05	100.03	100.02	100.04	100.05	100.05
Energy provision	58.557	100.02	100.02	100.01	100.01	100.01	100.01	100.01
Energy inputs	27.662	100.04	100.03	100.02	100.01	100.02	100.02	100.02
Investments	0.475	100.03	100.03	100.02	100.01	100.02	100.02	100.02
Private consumption	16.147	99.97	99.98	100.00	100.00	99.96	99.95	99.96
Exports	14.273	100.04	100.04	100.02	100.01	100.04	100.05	100.04
Construction	152.209	100.01	100.01	100.01	100.00	99.98	99.98	99.99
Material inputs	33.719	100.02	100.01	100.01	100.01	100.00	99.99	100.00
Investments	92.835	100.02	100.02	100.01	100.00	99.98	99.98	99.99
Private consumption	18.542	100.00	99.99	100.00	100.00	99.96	99.96	99.96
Government consumption	7.113	100.02	100.01	100.01	100.01	100.00	100.00	100.00
Foods	119.820	100.04	100.03	100.02	100.01	100.02	100.02	100.02
Material inputs	22.846	100.07	100.04	100.03	100.02	100.03	100.04	100.03
Investments	0.093	100.02	100.02	100.01	100.01	100.01	100.00	100.01
Private consumption	25.466	99.95	99.98	100.00	100.00	99.97	99.96	99.96
Exports	71.415	100.07	100.04	100.02	100.02	100.04	100.05	100.04
Metal and chemicals	324.317	100.06	100.04	100.02	100.01	100.03	100.03	100.03
Material inputs	114.537	100.06	100.04	100.02	100.02	100.02	100.03	100.03
Investments	22.878	100.06	100.04	100.03	100.02	100.03	100.03	100.03
Private consumption	7.492	99.98	99.99	100.00	100.01	99.98	99.97	99.97
Government consumption	0.861	100.06	100.04	100.02	100.02	100.02	100.03	100.02
Exports	178.550	100.06	100.04	100.02	100.01	100.03	100.04	100.04
Other manufacturing	118.556	100.06	100.03	100.02	100.02	100.03	100.03	100.03
Material inputs	45.541	100.06	100.04	100.02	100.02	100.02	100.03	100.03
Investments	15.763	100.06	100.04	100.02	100.02	100.03	100.03	100.03
Private consumption	11.751	99.98	99.99	100.01	100.01	99.98	99.97	99.98
Government consumption	0.091	100.09	100.05	100.03	100.02	100.03	100.04	100.04
Exports	45.409	100.07	100.04	100.02	100.02	100.04	100.05	100.04
Trade and transportation	362.671	100.02	100.01	100.01	100.01	100.00	100.00	100.00
Material inputs	154.156	100.04	100.02	100.01	100.01	100.01	100.01	100.01
Investments	27.790	100.02	100.02	100.01	100.01	100.00	100.00	100.01
Private consumption	98.999	99.93	99.97	99.99	100.00	99.95	99.94	99.95
Government consumption	3.122	100.02	100.01	100.01	100.01	100.00	100.00	100.00
Exports	78.605	100.11	100.05	100.03	100.02	100.05	100.06	100.06
Other services	383.144	100.01	100.00	100.01	100.01	99.99	99.99	99.99
Material inputs	221.120	100.03	100.01	100.01	100.01	100.00	100.00	100.00
Investments	24.111	100.01	100.01	100.01	100.01	99.99	99.99	100.00
Private consumption	102.764	99.95	99.97	99.99	100.00	99.96	99.95	99.95
Government consumption	19.235	100.02	100.01	100.01	100.01	100.00	100.00	100.00
Exports	15.914	100.12	100.05	100.03	100.02	100.05	100.06	100.06
Public services	310.413	100.02	100.01	100.01	100.01	100.00	99.99	100.00
Material inputs	18.739	100.02	100.01	100.01	100.01	100.00	100.00	100.00
Investments	0.761	100.01	100.01	100.01	100.01	99.99	99.99	99.99
Private consumption	17.503	99.94	99.97	99.99	100.00	99.96	99.94	99.95
Government consumption	271.316	100.02	100.01	100.01	100.01	100.00	100.00	100.00
Exports	2.093	100.14	100.06	100.03	100.02	100.06	100.07	100.06

Table C.12: Effects on production and demand of shifting to sustainable corporate taxation

	2003	2008	2018	2028	2038	2098	2248	∞
	Quantity			*—Debt-targeting=100—*				
Agriculture	65.636	100.07	100.18	100.19	100.18	100.18	100.17	100.17
Material inputs	49.513	100.03	100.11	100.12	100.12	100.11	100.11	100.11
Private consumption	2.711	100.10	100.20	100.22	100.20	100.15	100.14	100.14
Government consumption	1.033	100.07	100.03	100.02	100.02	100.00	100.00	100.00
Exports	12.379	100.27	100.46	100.48	100.47	100.47	100.47	100.47
Energy provision	58.557	99.22	98.65	98.54	98.48	98.48	98.50	98.51
Energy inputs	27.662	99.16	98.60	98.49	98.43	98.44	98.45	98.46
Investments	0.475	98.50	97.41	97.26	97.19	97.19	97.21	97.22
Private consumption	16.147	99.80	99.65	99.62	99.57	99.51	99.51	99.52
Exports	14.273	98.75	97.73	97.51	97.42	97.44	97.46	97.47
Construction	152.209	99.84	99.79	99.79	99.70	99.74	99.76	99.76
Material inputs	33.719	99.78	99.70	99.69	99.67	99.67	99.67	99.68
Investments	92.835	99.81	99.75	99.76	99.62	99.71	99.73	99.74
Private consumption	18.542	100.00	100.06	100.07	100.03	99.97	99.96	99.97
Government consumption	7.113	100.07	100.03	100.02	100.02	100.00	100.00	100.00
Foods	119.820	100.02	100.09	100.09	100.10	100.09	100.09	100.08
Material inputs	22.846	99.98	100.05	100.05	100.06	100.05	100.05	100.04
Investments	0.093	99.34	99.03	99.03	99.03	99.02	99.02	99.02
Private consumption	25.466	99.97	99.99	100.00	99.99	99.94	99.93	99.93
Exports	71.415	100.05	100.14	100.14	100.15	100.16	100.16	100.15
Metal and chemicals	324.317	100.05	100.02	100.01	100.03	100.03	100.03	100.03
Material inputs	114.537	99.94	99.89	99.88	99.87	99.89	99.89	99.89
Investments	22.878	99.47	99.09	99.08	99.09	99.09	99.10	99.09
Private consumption	7.492	100.10	100.11	100.11	100.11	100.06	100.05	100.06
Government consumption	0.861	100.21	100.17	100.16	100.17	100.17	100.17	100.16
Exports	178.550	100.20	100.22	100.20	100.23	100.24	100.24	100.23
Other manufacturing	118.556	99.57	99.44	99.43	99.45	99.45	99.44	99.44
Material inputs	45.541	99.59	99.49	99.48	99.49	99.49	99.49	99.48
Investments	15.763	99.28	98.88	98.86	98.88	98.88	98.89	98.88
Private consumption	11.751	99.69	99.63	99.63	99.63	99.58	99.57	99.58
Government consumption	0.091	99.75	99.63	99.61	99.64	99.63	99.63	99.63
Exports	45.409	99.61	99.54	99.52	99.56	99.56	99.56	99.56
Trade and transportation	362.671	99.57	99.44	99.44	99.45	99.43	99.43	99.44
Material inputs	154.156	99.69	99.61	99.60	99.59	99.59	99.59	99.59
Investments	27.790	99.25	98.75	98.74	98.73	98.73	98.73	98.74
Private consumption	98.999	99.96	99.95	99.96	99.94	99.89	99.88	99.89
Government consumption	3.122	100.07	100.03	100.02	100.02	100.00	100.00	100.00
Exports	78.605	98.93	98.67	98.63	98.67	98.68	98.68	98.68
Other services	383.144	99.85	99.79	99.79	99.78	99.76	99.76	99.76
Material inputs	221.120	99.79	99.72	99.72	99.71	99.70	99.71	99.71
Investments	24.111	99.56	99.11	99.08	99.03	99.07	99.07	99.08
Private consumption	102.764	100.02	100.04	100.05	100.03	99.98	99.97	99.97
Government consumption	19.235	100.07	100.03	100.02	100.02	100.00	100.00	100.00
Exports	15.914	99.96	99.96	99.94	99.99	100.00	100.00	99.99
Public services	310.413	100.06	100.02	100.01	100.01	99.99	99.99	99.99
Material inputs	18.739	99.84	99.78	99.78	99.77	99.76	99.76	99.76
Investments	0.761	99.49	99.03	99.01	98.98	98.99	99.00	99.00
Private consumption	17.503	100.03	100.04	100.04	100.03	99.98	99.97	99.98
Government consumption	271.316	100.07	100.03	100.02	100.02	100.00	100.00	100.00
Exports	2.093	101.20	101.37	101.35	101.43	101.44	101.43	101.42

Table C.13: Effects on production and demand of immigration from CEE countries

	2003	2008	2018	2028	2038	2098	2248	∞
	Quantity			—*Basecase = 100*—				
Agriculture	65.636	100.10	100.48	100.80	101.07	101.83	102.84	103.44
Material inputs	49.513	100.11	100.51	100.83	101.11	101.88	102.91	103.52
Private consumption	2.711	100.25	100.67	101.01	101.33	102.43	103.80	104.60
Government consumption	1.033	100.22	100.58	100.83	101.06	101.79	102.74	103.31
Exports	12.379	100.02	100.33	100.63	100.87	101.48	102.30	102.80
Energy provision	58.557	100.05	100.30	100.55	100.76	101.34	102.01	102.38
Energy inputs	27.662	100.10	100.44	100.75	101.03	101.73	102.60	103.09
Investments	0.475	100.05	100.36	100.66	100.93	101.63	102.45	102.89
Private consumption	16.147	100.11	100.36	100.53	100.73	101.43	102.21	102.63
Exports	14.273	99.91	100.00	100.18	100.33	100.53	100.69	100.74
Construction	152.209	100.51	100.73	100.93	101.14	101.66	102.42	102.87
Material inputs	33.719	100.25	100.57	100.81	101.03	101.71	102.59	103.11
Investments	92.835	100.71	100.88	101.06	101.26	101.69	102.40	102.82
Private consumption	18.542	100.00	100.28	100.46	100.66	101.32	102.05	102.46
Government consumption	7.113	100.22	100.58	100.83	101.06	101.79	102.74	103.31
Foods	119.820	100.10	100.46	100.75	100.99	101.70	102.63	103.18
Material inputs	22.846	100.15	100.65	101.06	101.40	102.37	103.65	104.42
Investments	0.093	100.12	100.47	100.73	100.95	101.66	102.56	103.09
Private consumption	25.466	100.25	100.61	100.86	101.11	102.05	103.19	103.85
Exports	71.415	100.03	100.34	100.61	100.82	101.36	102.09	102.53
Metal and chemicals	324.317	100.13	100.50	100.79	101.03	101.67	102.56	103.10
Material inputs	114.537	100.26	100.74	101.10	101.42	102.27	103.46	104.17
Investments	22.878	100.15	100.68	101.09	101.43	102.41	103.72	104.50
Private consumption	7.492	100.24	100.69	101.00	101.30	102.35	103.66	104.42
Government consumption	0.861	100.25	100.80	101.21	101.57	102.61	104.01	104.85
Exports	178.550	100.04	100.33	100.55	100.73	101.18	101.81	102.20
Other manufacturing	118.556	100.15	100.59	100.92	101.20	101.99	103.06	103.71
Material inputs	45.541	100.21	100.72	101.10	101.43	102.36	103.63	104.39
Investments	15.763	100.15	100.65	101.03	101.35	102.26	103.49	104.22
Private consumption	11.751	100.28	100.75	101.09	101.40	102.52	103.91	104.72
Government consumption	0.091	100.27	100.92	101.40	101.81	103.00	104.62	105.59
Exports	45.409	100.05	100.40	100.66	100.87	101.40	102.15	102.61
Trade and transportation	362.671	100.17	100.54	100.79	101.02	101.75	102.70	103.25
Material inputs	154.156	100.21	100.59	100.87	101.12	101.86	102.84	103.43
Investments	27.790	100.13	100.51	100.79	101.03	101.77	102.72	103.28
Private consumption	98.999	100.25	100.50	100.66	100.84	101.61	102.51	103.02
Government consumption	3.122	100.22	100.58	100.83	101.06	101.79	102.74	103.31
Exports	78.605	100.03	100.48	100.82	101.08	101.73	102.64	103.20
Other services	383.144	100.22	100.56	100.81	101.04	101.78	102.73	103.28
Material inputs	221.120	100.22	100.58	100.84	101.08	101.80	102.76	103.32
Investments	24.111	100.28	100.57	100.81	101.04	101.67	102.51	103.01
Private consumption	102.764	100.22	100.52	100.71	100.92	101.73	102.70	103.25
Government consumption	19.235	100.22	100.58	100.83	101.06	101.79	102.75	103.31
Exports	15.914	100.04	100.54	100.90	101.18	101.88	102.89	103.51
Public services	310.413	100.23	100.57	100.82	101.05	101.78	102.74	103.30
Material inputs	18.739	100.23	100.56	100.81	101.04	101.74	102.66	103.20
Investments	0.761	100.23	100.56	100.79	101.01	101.68	102.55	103.06
Private consumption	17.503	100.25	100.54	100.72	100.92	101.73	102.70	103.25
Government consumption	271.316	100.22	100.58	100.83	101.06	101.79	102.74	103.31
Exports	2.093	100.20	100.74	101.12	101.43	102.22	103.41	104.15

Table C.14: Effects on production and demand per capita of immigration from CEE countries

	2008	2018	2028	2038	2098	2248	∞
			—Basecase = 100—				
Agriculture	99.86	99.91	100.05	100.14	100.10	100.13	100.16
Material inputs	99.87	99.93	100.08	100.17	100.15	100.20	100.24
Private consumption	100.01	100.10	100.25	100.39	100.69	101.07	101.28
Government consumption	99.99	100.00	100.08	100.13	100.06	100.04	100.03
Exports	99.78	99.76	99.88	99.94	99.75	99.61	99.54
Energy provision	99.81	99.73	99.79	99.83	99.62	99.33	99.13
Energy inputs	99.86	99.87	100.00	100.09	100.01	99.90	99.82
Investments	99.81	99.78	99.91	100.00	99.90	99.75	99.63
Private consumption	99.87	99.78	99.78	99.79	99.70	99.52	99.37
Exports	99.67	99.43	99.43	99.40	98.82	98.04	97.54
Construction	100.27	100.16	100.17	100.20	99.93	99.72	99.60
Material inputs	100.01	99.99	100.06	100.10	99.98	99.89	99.84
Investments	100.48	100.30	100.30	100.33	99.96	99.70	99.56
Private consumption	99.77	99.71	99.71	99.72	99.59	99.37	99.20
Government consumption	99.99	100.00	100.08	100.13	100.06	100.04	100.03
Foods	99.86	99.88	99.99	100.06	99.97	99.92	99.90
Material inputs	99.91	100.07	100.30	100.46	100.63	100.92	101.11
Investments	99.89	99.89	99.97	100.02	99.93	99.86	99.82
Private consumption	100.02	100.03	100.10	100.17	100.32	100.48	100.55
Exports	99.79	99.77	99.86	99.89	99.63	99.40	99.28
Metal and chemicals	99.89	99.93	100.04	100.09	99.94	99.86	99.83
Material inputs	100.03	100.16	100.35	100.48	100.54	100.73	100.86
Investments	99.91	100.10	100.33	100.49	100.67	100.99	101.18
Private consumption	100.01	100.11	100.25	100.36	100.61	100.93	101.10
Government consumption	100.01	100.22	100.45	100.63	100.86	101.27	101.52
Exports	99.80	99.75	99.80	99.80	99.46	99.13	98.95
Other manufacturing	99.91	100.01	100.16	100.26	100.25	100.35	100.42
Material inputs	99.97	100.14	100.34	100.49	100.62	100.90	101.07
Investments	99.91	100.08	100.28	100.41	100.52	100.76	100.91
Private consumption	100.04	100.18	100.33	100.47	100.77	101.17	101.40
Government consumption	100.03	100.34	100.64	100.87	101.25	101.86	102.24
Exports	99.81	99.82	99.91	99.94	99.68	99.46	99.35
Trade and transportation	99.94	99.96	100.04	100.09	100.02	99.99	99.97
Material inputs	99.97	100.01	100.12	100.19	100.13	100.14	100.14
Investments	99.90	99.93	100.03	100.10	100.04	100.02	100.00
Private consumption	100.01	99.93	99.91	99.91	99.88	99.81	99.75
Government consumption	99.99	100.00	100.08	100.13	100.06	100.04	100.03
Exports	99.79	99.90	100.06	100.15	100.00	99.94	99.92
Other services	99.98	99.99	100.05	100.10	100.05	100.02	100.00
Material inputs	99.99	100.00	100.09	100.15	100.07	100.05	100.03
Investments	100.04	99.99	100.06	100.10	99.94	99.82	99.74
Private consumption	99.98	99.94	99.96	99.99	100.00	99.99	99.97
Government consumption	99.99	100.00	100.08	100.13	100.06	100.04	100.03
Exports	99.80	99.97	100.14	100.24	100.15	100.18	100.22
Public services	99.99	100.00	100.07	100.12	100.05	100.03	100.02
Material inputs	99.99	99.99	100.05	100.10	100.01	99.95	99.92
Investments	99.99	99.98	100.04	100.08	99.95	99.85	99.79
Private consumption	100.02	99.97	99.97	99.99	100.00	100.00	99.97
Government consumption	99.99	100.00	100.08	100.13	100.06	100.04	100.03
Exports	99.96	100.16	100.36	100.49	100.49	100.69	100.85

Table C.15: Steady state effects of base case under alternative parameters by industry and final use

	Baseline 2003	Base Case	$\sigma = 3$	$\sigma = 7$	$\delta^{TCM} = 2.5$ $\delta^{TCM} = 5.0$	$\delta^{TCM} = 10.0$ $\delta^{TCX} = 20.0$
	Quantity			*—Baseline=100—*		
Agriculture	65.636	96.26	97.48	95.11	96.44	95.94
Material inputs	49.513	97.25	98.13	96.43	97.40	97.00
Private consumption	2.711	93.92	95.93	92.08	94.43	93.11
Government consumption	1.033	99.94	99.94	99.93	99.87	100.06
Exports	12.379	92.34	95.08	89.70	92.60	91.88
Energy provision	58.557	99.47	99.82	99.03	99.82	98.90
Energy inputs	27.662	98.32	99.23	97.34	99.22	96.88
Investments	0.475	98.03	99.10	96.92	99.16	96.22
Private consumption	16.147	99.44	99.55	99.28	99.40	99.52
Exports	14.273	101.76	101.06	102.52	101.46	102.19
Construction	152.209	99.79	99.82	99.73	99.71	99.91
Material inputs	33.719	99.86	99.90	99.80	99.79	99.98
Investments	92.835	99.77	99.81	99.71	99.70	99.88
Private consumption	18.542	99.67	99.66	99.67	99.55	99.88
Government consumption	7.113	99.94	99.94	99.93	99.87	100.06
Foods	119.820	98.90	99.40	98.39	98.85	98.98
Material inputs	22.846	96.98	98.14	95.93	97.37	96.32
Investments	0.093	99.78	99.93	99.59	99.61	100.04
Private consumption	25.466	98.18	98.68	97.71	98.15	98.22
Exports	71.415	99.81	100.01	99.56	99.60	100.14
Metal and chemicals	324.317	101.55	101.05	102.04	101.17	102.17
Material inputs	114.537	99.82	99.96	99.72	100.13	99.32
Investments	22.878	99.29	99.70	98.94	99.76	98.53
Private consumption	7.492	99.22	99.47	98.98	99.48	98.79
Government consumption	0.861	99.23	99.56	98.96	99.81	98.28
Exports	178.550	103.08	101.86	104.36	102.10	104.72
Other manufacturing	118.556	100.10	100.30	99.87	100.39	99.64
Material inputs	45.541	98.05	98.95	97.23	99.21	96.22
Investments	15.763	98.40	99.20	97.68	99.41	96.79
Private consumption	11.751	96.51	97.99	95.08	98.04	94.09
Government consumption	0.091	95.54	97.57	93.62	97.96	91.75
Exports	45.409	103.84	102.36	105.35	102.57	106.04
Trade and transportation	362.671	100.24	100.12	100.35	100.13	100.41
Material inputs	154.156	99.92	99.95	99.90	99.96	99.87
Investments	27.790	99.92	99.99	99.84	99.89	99.96
Private consumption	98.999	99.92	99.85	99.92	99.51	100.58
Government consumption	3.122	99.94	99.94	99.93	99.87	100.06
Exports	78.605	101.57	101.02	102.27	101.57	101.57
Other services	383.144	99.86	99.87	99.84	99.80	99.97
Material inputs	221.120	99.86	99.90	99.81	99.84	99.90
Investments	24.111	100.08	100.07	100.06	99.94	100.32
Private consumption	102.764	99.61	99.61	99.58	99.46	99.85
Government consumption	19.235	99.94	99.94	99.92	99.87	100.05
Exports	15.914	101.36	100.91	101.96	101.46	101.20
Public services	310.413	99.94	99.93	99.92	99.85	100.07
Material inputs	18.739	99.96	99.96	99.95	99.86	100.14
Investments	0.761	100.08	100.06	100.08	99.92	100.35
Private consumption	17.503	99.70	99.66	99.71	99.48	100.07
Government consumption	271.316	99.94	99.94	99.93	99.87	100.06
Exports	2.093	101.11	100.78	101.62	101.42	100.61