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Athena

A multi-sector model of the Dutch economy

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Abstract in English

This document describes Athena, CPB's multi-sector model of the Dutch economy and illustrates the mechanisms of the model by presenting a number of applications. The model is used for policy analyses that require a sectoral dimension and for the construction of long-run scenarios. Athena is a dynamic, annual model with a strong focus on the long-run.
Roughly, the model can be described as follows. The production structure has been the focus of the recent research efforts resulting in the current version of the model. The theoretical foundation of the model assumes optimising behaviour of firms in 18 industries. On the labour market, the negotiation process for wages follows a right-to-manage approach. On the demand side, most consumers behave as in life-cycle theory, but some consumers are liquidity constrained. In the last block, the public sector (government, social security and pensions), some aspects are endogenised as the model is primarily aimed at long run structural analyses.
The applications of the model include CPB's latest long term scenarios for the Dutch economy, the analysis of a set of policy measures concerning lower corporate tax rates and the effects of five standard simulations.

Key words: multi-sector model, production structure, scenarios, policy simulations

Abstract in Dutch

Dit document beschrijft het multi-sector model van de Nederlandse economie, Athena. De werking van het model wordt geïllustreerd aan de hand van een bespreking van de resultaten van een aantal modelexercities.
In grote lijnen kan het model als volgt beschreven worden. De productiestructuur vormt de kern van het model en de recente onderzoeksinspanningen waren primair gericht op de ontwikkeling van het productieblok. Voor alle 18 bedrijfstakken zijn de relaties afgeleid onder de veronderstelling van optimaal gedrag van agenten. Het evenwicht op de arbeidsmarkt staat onder invloed van veranderingen in de wig, de replacement rate en de reële kapitaalkosten. De verdeling van de vraag over bedrijfstakken en binnenlandse en buitenlandse leveranciers hangt af van de ontwikkeling van relatieve prijzen en verschillen in inkomenselasticteiten. Het laatste blok, de publieke sector (overheid, sociale zekerheid en pensioenen), is op een aantal punten geëndogeniseerd opdat de structurele ontwikkeling geschetst wordt.
De toepassingen van het model betreffen een beschrijving van de resultaten van de meest recente lange termijn scenarios voor de Nederlandse economie, de effecten van een beleidspakket voor een verlaging van de vennootschapsbelasting en de effecten van een vijftal standaard varianten.

Steekwoorden: multi-sector model, productiestructuur, scenario's, varianten

Contents

Preface

This document presents a revised version of CPB's multi-sector model Athena. The model is primarily used for scenario analysis and for studies that asses issues where structural changes of the economy are involved.

Compared to the version of the 1990 working paper, the model has been revised in four major areas. First, the relations on the supply side of the model, the production structure, are now derived assuming optimising behaviour of firms. Second, equilibrium aspects enter the wage rate equations. Third, exports are explained in a more theoretically sound way and fourth, much attention has been paid to the long term properties of the model, a.o. by incorporating error correction mechanisms in the model.

Many (ex)-CPB staff members contributed to the current version of Athena. Peter Broer and Bert Smid have been the project leaders of the revision project concerning the new production structure. In addition Paul Arnoldus, Sjef Ederveen, Frank van Erp, Adriaan van Hien, Hans Lunsing and Martin Vromans participated in the project group. Arnold Verkade produced some of the figures in this document, Jannie Droog helped to prepare the final version. Berend Hasselman rendered indispensable support on the technical aspects of running the model. This report has been written by Bert Smid and Martin Vromans.

Henk Don,
Director

Summary

Athena is CPB's multi-sector model that is primarily used for scenario building and long term analyses with a sectoral dimension in which structural changes of the economy are involved. The model is frequently used for studies concerning the effects of infrastructure projects and environmental issues.

These types of applications impose strong requirements on the model. The model should be dynamically stable, i.e. it should possess well-defined long term properties. Moreover, it should include variables and relations that may be taken as a structural representation of the policy issues addressed.

In recent years much effort has been put in enhancing the usefulness of the model for structural policy analysis. Many behavioural relations of the model are derived from optimising behaviour of agents. This enables identification of structural shifts in terms of structural parameters. In principle, this requirement holds for all agents. In this report special attention is paid to the modelling of the production structure of the 18 industries of Athena. The supply side of the model explicitly distinguishes between the short run cost function and the long run cost function of an industry by using shadow prices for the fixed factors. Monopolistic competition is motivated by the existence of fixed costs in the production process. The fixed costs also enable us to explain endogenously the number of varieties within an industry. In this way it is also possible to introduce technology spill-overs between industries by allowing for exit and entry of firms based on performance considerations.

The opportunities for continued per capita economic growth depend on the rate of growth of labour productivity and the possibilities of increasing participation rates. On the labour market, the equilibrium rate of unemployment depends on the development of the wedge, the replacement rate and the real capital costs. Increases in the wage rates by industry follow the rise in the macro wage rate but wage levels differ by industry, e.g. because of differences in the quality (schooling level) of the workers and the degree of shift work. Labour supply is for the greater part exogenous but is also affected by real net wages and the discouraged worker effect.

Relative prices of Dutch producers and price substitution between the products of the different industries and utilization rates act as equilibrium mechanisms on the demand side of the model. The division in 18 industries enables an analysis of changes in the production structure of the economy.

In the public sector the model allows for structural developments in the expenditures of government, social security and pensions and life insurances. Government consumption grows with the rise in population growth and the increase in macro labour productivity to take into account the increase in general welfare. Consumption in kind and health care consumption follow not only the rise in GDP but also the change in composition of the population, to allow for the effects of ageing. The development of the fully funded pensions and life insurances depends

on the maturing process of the system which is still in its growth stage, the composition of the population and the difference between the nominal interest rate and the contractual wage rate.

The mechanisms of the model are illustrated by a number of applications of the model. First, the model was used for the construction of CPB's new long term scenarios for the Dutch economy. The scenarios contain a wide range of results for many variables. For instance, the level of GDP per capita in 2040 will be between 30% and 120% higher than the 2001 level. The scenarios with high growth are also characterized by more inequality and lower environmental quality. In all scenarios, ageing has a negative effect on labour supply and employment growth and on the ratio of the working to the non-working population. An increase in participation, especially of women and older workers, may counterbalance these effects. Sectoral production and employment shares will shift strongly, particularly from agriculture and manufacturing to services and health care. This shift is a continuation of a process that has already been going on for decades. In the future this process is also influenced by ageing which particularly raises the demand for health care.

Second, the working of the model is illustrated by representing the effects of a set of policy measures concerning a decrease of the corporate tax rate. This lower tax rate is primarily financed by raising other taxes for firms and households. Some taxes, for example on energy, are not evenly distributed over firms and the Athena model can handle this through its division in 18 industries. As a supplier of investment goods, the construction sector is positively affected by the boost in investments that results from the substitution in a more capital-intensive direction. The manufacturing industry particularly benefits from the tax shift because of an increase of its market share through the improvement of Dutch competitive prices.

The last model application concerns a set of five simulations (changes in world trade, in the wage rate, in labour supply, in value added taxes and in energy taxes). The results of these exercises can differ from the same exercises using a macro model. For example, a rise in energy tax rates has a more than average effect on agriculture and manufacturing industries as these sectors are relatively energy-intensive and labour-extensive. And, as concerns the value added tax simulation, the effects on the economy may be influenced by the uneven distribution of the value added tax over the various consumption categories.

1 Introduction and background

The Athena model is designed for analyses with a strong sectoral dimension. The usefulness of the model particularly lies in the possibility to construct long term scenarios and to analyse policy measures where changes in the structure of the economy are involved. The model combines dynamics and equilibrium. Dynamics are introduced by frequently using error correction mechanisms estimated with cointegration techniques. Equilibrium is reached by variables representing tension on the labour market (the unemployment rate) and goods markets (utilization rates) and by relative prices between domestic and foreign suppliers and price substitution between goods. The basic design of the model follows the bottom-up approach, where macro-economic aggregates are derived by adding up the sectoral outcomes. There is one exception: private consumption is characterized by a top-down approach. Consumption at the macro-level is largely driven by disposable income and consumer demand at the sector level follows from a three-stage budget allocation procedure.

The model is regularly used for long term projections with a sectoral dimension. This concerns, for instance, scenario studies in which alternative assumptions about markets and technology result in different projections of sectoral developments.[1] The Athena model is also frequently used to analyse the long term effects of structural policies. Examples include the studies of the effects of a high-speed railroad connection to Paris, an expansion of Amsterdam airport, and the effects of environmental taxes on the emission of CO_2 (CPB, 1997, 2000; Broer et al., 2002). These studies are carried out by changing the (inputs of the) model to some extent, in order to analyse the effects of structural changes in the economy. For instance a study about Amsterdam airport investigates the effects of implementing a ceiling on transportation services and the environmental study calculates the required size of the tax that realizes a given reduction in the emission of CO_2.

The first documentation of the model was published in CPB (1990), Vromans (1998) gives a concise description of the 1998-version of the model. Compared to previous versions, the current model has been improved in several respects. First, the most important change concerns the modelling of the production structure, in which all behavioural relations are now derived from optimising behaviour of firms. Second, in the model of the labour market more attention is paid to equilibrium mechanisms. Third, the equations of the exports of goods is based on a theoretical robust technique (see Ederveen (2000b)). Fourth, much attention has been paid to the long term properties of the model, a.o. by incorporating error correction mechanisms in the model.

[1] In the construction of CPB's four new long term scenarios for the Dutch economy, Athena played an indispensable role (Huizinga and Smid, 2004).

The next chapter gives an overview of the model followed by a description of the theory and the implementation of the production structure that forms the core of the model. Chapter 2 also discusses the labour market, consumption and international trade and ends with the description of the public sector. In chapter 3 the use of Athena is illustrated by discussing CPB's long term scenarios of the Dutch economy and a set of policy measures concerning a decrease of the corporate tax rate. Finally chapter 4 sketches the effects of a number of simulations.

2 The model

Broadly speaking the Athena model can be divided into four large components, namely the production structure, the labour market, the demand for goods and services and the public sector (including pensions and life insurances).

The production structure forms the core of the model. The relations on the supply side are derived assuming optimal behaviour of firms. An important role is reserved for the cost function where all production factors (labour, capital and material inputs) are combined. In the short run the firm decides about the use of its variable production factors and the price of its product. In the long run the quasi-fixed factors are variable as well and in this stage entry of new firms can occur. The demand for capital and labour is gradually adjusted to the desired level. Output prices result from the short run marginal costs which depend on the available stocks of the fixed production factors in relation to the level of production. Generally, the markup of a firm is assumed to be equal on all sales markets (e.g. consumption, exports).

Table 2.1 The industries in the Athena model

Agriculture	Agriculture, hunting, forestry, fishing
Manufacturing	Food, beverage and tobacco
	Chemical and rubber
	Metal industry
	Other industries
Energy	Petroleum industry
	Mining and quarrying
	Public utilities
Construction	Construction
Commercial services	Real estate
	Wholesale and retail trade and repair
	Transport
	Communication
	Banking, finance and insurance
	Temporary employment agencies and household services
	Other commercial services
Health	Medical and social services
Government	Government services

On the labour market, Athena assumes a right-to-manage bargaining model. The change in the wage rate is decomposed into a rise of the contractual rate, based on bargaining agreements of employers organisations and unions, and the incidental rate which stands for wage drift and changes in the composition of the work force. Labour supply is for the greater part exogenous, but is also affected by real net wages and the discouraged worker effect. The equilibrium rate of unemployment depends on the wedge, the replacement rate and the real costs of capital.

On the demand side, private consumption depends on disposable labour and non-labour income, transfers, wealth and the interest rate. The allocation over industries takes place in three stages. First, the consumption of medical care and the demand for houses is determined, which have an important institutional component. Second, the remaining consumption is allocated to energy, motorcars and a rest category. Third, the division of the rest category is based on allocation assuming welfare maximizing consumers. For the exports of goods it is assumed that geographic origin is a source for commodity differences (the Armington-approach). The division of domestic demand over imports and domestic production is determined by relative prices of Dutch producers and international specialisation. This latter non-price induced import penetration can be introduced by varying the rate of technological progress and/or the number of varieties of domestic and foreign intermediates. For imports of consumer goods the expenditure elasticities are above unity.

In Athena, the consumption of the public sector is assumed to follow the rise in population size and the productivity of the market sector. Consumption in kind (notably health care) follows the rise in GDP and is also affected by changes in the composition of the population to take account of ageing. The development of the premiums of pensions and life insurances depends on the (growth) stage of the fully funded system, the composition of the population and the difference between the nominal interest rate and the wage rate.

2.1 Production structure

The basis of the production structure of a firm is given by the cost function. The general specification of the cost function is

$$C(x, p_1, \ldots, p_n) = x\, p_x(p_1, \ldots, p_n) + \sum_{i=1}^{n} f_i p_i \tag{2.1}$$

In this equation x stands for gross production, p_i are the prices of the primary and intermediate inputs and the f_i denote the fixed costs of the production factors (e.g. overhead costs). Total costs consist of variable costs ($x\, p_x$) and fixed costs ($p_i\, f_i$) that are independent of the level of production. The functional form of p_x contains information about the separability structure and substitution elasticities of the production process.

The model distinguishes between the production factors capital, labour, intermediate inputs and inventories. The capital stock is subdivided into 9 types (equipment, buildings, infrastructure, residential dwellings, cars, other means of transport, immaterial assets, livestock, and land). Intermediate deliveries are subdivided into 18 inputs, corresponding to the sectoral division of the model. In principle for each intermediate input and for each capital good there exists both a domestic and a foreign supplier.

2.1.1 Factor Demand and Price Formation

The Athena model distinguishes three 'operational' decision stages: the short run, the medium run, and the long run. In the short run the firm decides about the use of its variable production factors and the price of its product. These decisions depend on the size of its quasi-fixed production factors, especially the capital stocks and labour, and on the market structure, that is the number of competitors and the degree of price competition. In the long run all factors are variable and firms decide about the optimal amount of capital goods and labour in view of the expected return to the required investment. In doing this, they take into account that the amount of competition in the market may change over time, due to entry and exit of firms. In the medium run, firms decide about the rate at which they adjust their stocks. In this stage new firms decide whether or not to enter.

Firm-level factor demand

Assuming a firm minimalises its costs it is possible, using Shephard's lemma, to write the long run factor demand equations as

$$q_i^* = \frac{\partial C(x, p_1, \ldots, p_n)}{\partial p_i} = x \frac{\partial p_x(p_1, \ldots, p_n)}{\partial p_i} + f_i, \tag{2.2}$$

where q_i^* is the long term demand for input i of a firm. The short run factor demand may differ from the demand in the long run, because in the short run some inputs are fixed. E.g. it is assumed that the size of the capital stock is fixed in the short run whereas employment is only partially adjustable. The relation for capital demand of type i for the individual firm is

$$k_i(t+1) = k_i(t) + \lambda_i(k_i^*(t) - k_i(t)) \tag{2.3}$$

The adjustment to the long run equilibrium is partial, the desired level of k^* results from equation (2.2). Investments of the individual firm follow from (2.3) as

$$i_i(t) = k_i(t+1) - (1-\delta_i)k_i(t) \tag{2.4}$$

where δ_i stands for the depreciation rate of capital good k_i. So, investments react immediately to a change in gross production x or input prices p_i, since this will change the desired capital stock k_i^*.

For labour a somewhat different specification is assumed

$$l(t) = l(t-1) + \mu(l^*(t) - l(t-1)) + \alpha(l^*(t) - l^*(t-1)). \tag{2.5}$$

So the change in labour demand is the sum of a partial adjustment to the firm's long run equilibrium demand, and an effect of changes in the long run equilibrium. In equations (2.3) and (2.5) the various capital goods k_i and employment l form part of the general input vector $(q_1, \ldots, q_n)$.

Short term rigidities of capital and labour also account for discrepancies between short and long term demand of the other production factors in (2.2). By using shadow prices the same functional form can be maintained. These shadowprices indicate to what price a firm is willing to sell or buy an additional unit of a production factor. In the short run these prices do not have to match the market prices because of rigidities of capital and labour. Output prices result from applying a markup over marginal costs. These costs depend on the available stocks of the fixed production factors in relation to the level of production. Formulated in terms of shadow prices

$$p_j = M_j p_x(\hat{p}_1, \ldots, \hat{p}_m, p_{m+1}, \ldots, p_n) \tag{2.6}$$

where M_j stands for the markup on sales market j, $\hat{p}_i, \ldots, \hat{p}_m$ for the shadowprices of production factors $q_1, \ldots, q_m$ which can not be fully adjusted in the short run (i.e. capital goods and labour).

Number of firms in an industry

A high markup involves high returns and imperfections on the output markets. The markup is necessary to cover fixed costs. However, in the long run positive profits are only possible if there is no free entry. Profits of a firm can be written as the difference between gross production and total costs:

$$\begin{aligned} \Pi &= px - x p_x(p_1, \ldots, p_n) - \sum_i^n p_i f_i \\ &= (M-1) x p_x(p_1, \ldots, p_n) - \sum_i^n p_i f_i \end{aligned} \tag{2.7}$$

The free entry condition implies that long run profits have to be nihil. If total output of an industry equals X, in equilibrium the number v^* of firms follows from equation (2.7) by determining the scale of production that is associated with zero profits:

$$0 = (M-1)\frac{X}{v^*} p_x - \sum_i^n p_i f_i \tag{2.8}$$

$$v^* = \frac{(M-1) p_x X}{\sum_i p_i f_i} \tag{2.9}$$

In the long run equilibrium, the markup on marginal costs just covers the fixed costs on the industry level, since $v^* \sum_i p_i f_i = (M-1) p_x X$. A higher markup causes the equilibrium number of firms to increase, in that case a smaller scale of production is enough to cover the fixed costs of a firm.

The entry equation is modelled with a Koyck lag structure on v^*

$$v(t+1) = v(t) + \phi_1(v^*(t) - v(t)) + \phi_2(v_e^*(t) - (v^*(t) - v(t-1))) \tag{2.10}$$

where v_e^* is the expected value of v^*. It is assumed that all firms in an industry have the same size. Consequently new entrants acquire the full size of the average capital stock. This holds also

for the volume of labour. The equations for investments and labour on an industry level (indicated by capital letters) are

$$I_i(t) = v(t)i_i(t) + (v(t+1) - v(t))k_i(t+1) \tag{2.11}$$

$$L(t+1) - L(t) = v(t)(l(t+1) - l(t)) + (v(t+1) - v(t))l(t+1) \tag{2.12}$$

In these equations the second term on the right-hand side stands for the effect of entry on investments and labour.

2.1.2 Adjustments for some specific industries

For the medical and social services and for the government sector the modelling differs somewhat from the general setup. Furthermore, there are some minor adjustments for the metal industry and for temporary employment agencies.

Medical and social services

The medical services are highly regulated. Prices are largely set by the 'College van Tarieven' (CvT, Board of Tariffs) and moreover, investments in industrial buildings (in particular hospitals) are subject to restrictions concerning the compensations, the volume of the employable production factors, etc. In 2006, a new health care system will be introduced with an insurance for all citizens covering the basic health care services. Insurance companies are obliged to accept all persons for this basic insurance. Besides, people have the opportunity to conclude voluntary supplementary insurances.

The Athena model assumes that the CvT sets prices in the medical sector based on the average long term cost price, including fixed costs. The CvT does not allow for utilization rate effects.[2] So, the price relation for the medical and social sector is subject to the restriction $\Pi = 0$ in the excess profits condition (2.8). This restriction determines the markup on marginal costs

$$M = 1 + \frac{\sum_1^n p_i f_i}{x\, p_x(p_1, \ldots, p_n)} \tag{2.13}$$

where x is actual production and the p_i the observed market prices. In the short run the industry can produce with gains or losses, but in the long run profits are zero, as the fixed costs have to be matched exactly by the markup $M > 1$.

As the CvT sets the tariffs in such a way that excess profits are zero, there is no incentive for entry or exit. Athena also assumes the CvT regulates entry of new firms. So, the entry-equation (2.10) does not apply for the medical and social services. Instead, the number of firms is assumed to grow by 2% a year.

[2] Moreover, the CvT does not allow for the possibility of decreasing marginal costs, i.e. a cost function in the form $C = x^{1/\xi} p_x + f$, for $\xi > 1$.

Public sector

The modelling of the public sector differs in two important aspects from the standard modelling. First, the sector does not allow for entry, the number of 'firms' remains unchanged (and equal to one). Second, profits in the sector are assumed to be nil following the conventions of Statistics Netherlands. In the model this is achieved by yearly adjusting the markup.

Other adjustments

- For the temporary employment agencies and household services it is assumed that the factor labour is flexible and for that reason directly and completely adjustable.
- Private consumption demand for metal products is divided in cars and other products.

2.2 Implementation of the production structure

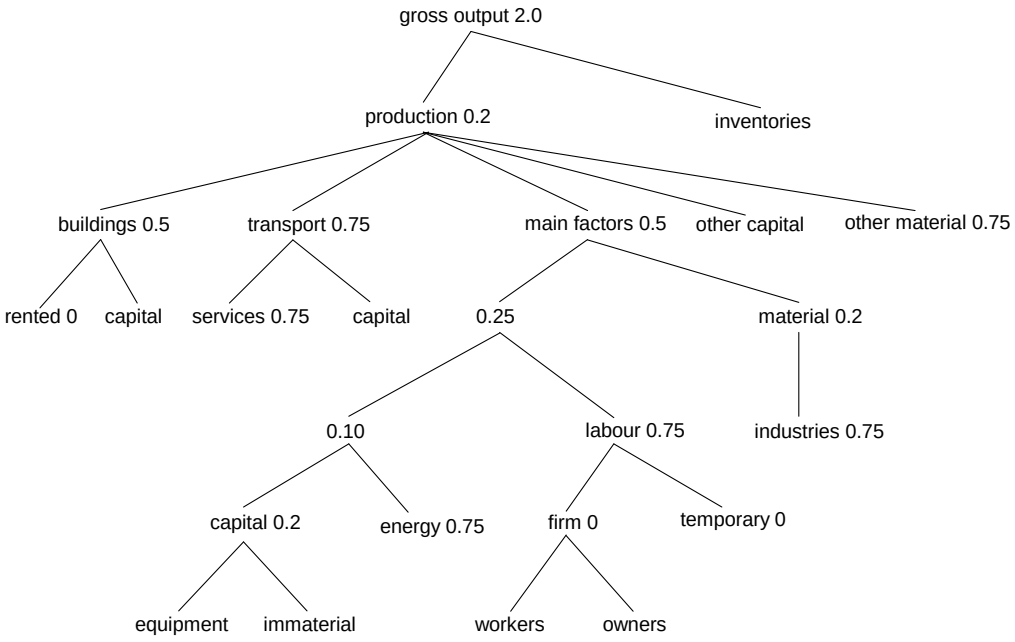
For the implementation of the production structure it is necessary to choose for each individual industry a nesting structure, substitution elasticities (σ_j) within this nesting structure and the scale effects through the fixed costs (f_i). Furthermore, the degree of technological progress of labour, the depreciation rates of the capital goods (δ_i), the rate of adjustment of the quasi-fixed production factors (α, μ, λ_i) and the markups (M_i) need to be determined.

2.2.1 The nesting structure

The nesting-structure and the substitution elasticities that go together with this structure are given in Figure 2.1. This is a general representation, nesting structures of individual industries are adjusted to the characteristics of the production process of the industry. The values of the elasticities in the nesting structure are based on three sources. First, CPB's industry specialists were asked about their perceptions regarding the possibility of substitution of the production factors. Second, sometimes estimates of Lesuis (1991) were used as guidelines. This study is one of the rare studies that estimates production functions for the Dutch economy on the industry-level. Third, the substitution elasticities of previous versions of Athena (in some cases estimated as well) were used.

Production and inventories are put together in the gross output nest with a substitution elasticity of 2. In the production nest the production factors have a substitution elasticity of 0.2. The choice for 0.2 links to the price elasticities in the previous versions of the Athena model. The more important factors are assumed to be mutually substitutable. Within the main factors nest labour, temporary employment, equipment, immaterial assets and energy are separated from the important material inputs. The substitution elasticity equals 0.5. Generally, manufacturing industry products are thought to be more involved with equipment, labour and energy than services, but which deliveries are important depend also on the character of an industry. A price rise of an important delivery influences the demand for labour not only through the substitution

Figure 2.1 Nesting structure and substitution elasticities



effect between both factors but also through the induced rise in costs of the composite production factor. The subdivision allows also for setting values on elasticities for important inputs that differ from other factors.

For the use of buildings, capital forms a nest with rented buildings on the assumption of a high substitution elasticity (0.5). For the same reasons capital of cars is nested with the use of transport services in the transport nest.

The less important deliveries and the rather complementary production factors (particularly services) are also placed in the production nest. These inputs have a substitution elasticity of 0.2, and the price elasticities has about the same value.[3]

Energy is put together with equipment and immaterial assets. The substitution elasticity 0.1 is low for reasons of complementarity between capital, labour and these intermediates. The flexibility of the nesting structure also allows for specific features of an industry. For example in the metal industry, the use of iron ore (non- competitive imports) is nested with energy and capital (in equipment and immaterial).

Equipment, immaterial assets and energy are combined with labour of employees, self-employed and temporary employees. The substitution elasticity 0.75 of the labour nest shows temporary labour to be easily substituted by employees and self-employed.[4] Employees and self-employed are assumed to be complements in the production process.

[3] The own price elasticity is to be written as $\varepsilon_{ii} = (1 - s_{ii})\,\sigma_{ii}$, , where s_{ii} is the budget share. As $s_{ii} \approx 0$, the price elasticity equals the substitution elasticity.

[4] In general temporary labour is more expensive than employees. For that reason the budget share in the year of calibration is low.

Basically, each intermediate input consists of a domestic and a foreign component. For the energy industries (mining and quarrying, petroleum industries and public utilities) the substitution elasticities between domestic and foreign use is rather high (1.50). For the other industries the elasticity is fixed on 0.75. Non-price induced import penetration can be introduced by differences in the growth rate of the number of varieties between domestic and foreign produced intermediate goods.

2.2.2 Fixed costs

Fixed costs apply to labour as overhead labour, on buildings, which need to have a minimal size to accommodate employees and equipment, on equipment where the minimal size depends on the state of technology (a production line must be of a minimal size) and on some services. The choice of the fixed costs affects the share of costs in the variable component of the cost function, as fixed and variable shares need to add to the observed budget share in the calibration year. The chosen values are given in Table 2.2. For ease of exposition, the fixed costs are presented as a fraction of the value of the concerning production factor in the base year. On the firm level these costs are assumed to be constant.

Table 2.2 Assumptions on fixed costs, share of costs in the base year

Capital	
Residential dwellings	0.04
Industrial Buildings	0.15[a]
Infrastructure	0.10[a]
Equipment	0.25[a]
Immaterial	0.04
Cars	0.04
Other transport	0.04
Livestock	0.04
Land	0.00
Labour	
Employees	0.25[a]
Self-employed	0.10
Intermediate inputs	
Deliveries rented buiding	0.35
Deliveries transport	0.15
Deliveries other commercial services	0.20
Deliveries other industries	0.04

[a] Average value, fixed costs can differ by industry.

The consequences of these choices can be illustrated for the fixed costs of labour. The value of 0.25 implies the variable cost share is 75% of total labour costs in the base year. So, a wage rise has a smaller effect on marginal costs compared to the situation of no overhead labour. In the

short run costs are not completely passed on to prices.[5] Furthermore, a rise in production provides for a less than proportional increase in labour as overhead labour does not change. In the absence of entry the structural production elasticity of labour equals 0.75. So, the production structure is characterized by increasing returns to labour on the firm level, a well documented fact in empirical literature (see e.g. Broer et al. (2000)).

For many categories (e.g. labour of employees, equipment, infrastructure and buildings) the fixed costs in Table 2.2 represent values for the 'average' industry. Special features of an industry can lead to an adjustment of the standard value. In some industries (transport, banking and insurances) it is assumed fixed labour costs are only 10% whereas for the government sector the value is put on 43%. For manufacturing industries relying heavily on processing industries (food, chemicals) the fixed capital costs are higher than the standard value. The same applies to mining and quarrying, where investments are a discontinuous process, and to communication where capacity is fixed by the choice of telephone exchanges and cable-laying.

2.2.3 Technological progress

Technological progress is assumed to be labour-augmenting and its growth rate is between 0.6% for the government sector and 4% for the chemical industry. Generally the values for services industries are smaller (about 1%) than for agriculture and manufacturing industries (about 3%). These figures are based on the growth rates in the past and the opinion of CPB industry specialists.. As the rates of technological progress are exogenous, they can easily be adjusted depending on the aim of a model application. In the four scenarios in *Vier vergezichten op Nederland* (Huizinga and Smid, 2004), the rates of technological progress are assumed to differ between scenarios.

Table 2.3 Economic and fiscal life spans

	Cars	Infrastructure	Buildings	Equipment	Immaterial	Real estate
Economic	10	35	45, 60[a]	10-30[b]	3	75
Fiscal	8	25	30	20	3	60

[a] On average 45 for agriculture and manufacturing industries (between 39 and 47), and 60 for services.
[b] About 10 for services and 30 for manufacturing industries.

2.2.4 Depreciation rates

The expected life spans of capital goods are derived from Table 4.11 of Meinen et al. (1998). The derived depreciation rates are the inverse of the life expectancies. Table 2.3 gives the economic and fiscal life spans for the various types of capital goods. Usually, the economic life spans of equipment is higher for manufacturing industries whereas for industrial buildings the

[5] In the long run this effect is adjusted by exit of firms.

life span for services is higher. Fiscal life expectancies and depreciation rates are usually supposed to be somewhat shorter than the economic ones.

2.2.5 Dynamics

The dynamics of the production structure are given by the lagged adjustment of capital (λ_i) and labour (μ, α) to the long term values and by the development of the number of firms (ϕ_1, ϕ_2) in equations (2.3), (2.5) and (2.10). Table 2.4 shows the rate of adjustment of the various factors. The average lag equals, for labour as well as for most capital goods, to 3.3 years, for immaterial assets 1.3 years, and for firms 6.7 years. For communication services the lag for capital is 2 years and for some other services (transport, banking and insurances and trade) this applies also to the adjustment of equipment.

Table 2.4 Adjustment rates of the quasi-fixed production factors

Firms	
ϕ_1	0.15
ϕ_2	0.02
Labour	
μ	0.30
α	0.50
Cars and immaterial assets	
λ_i	0.75
Infrastructure, equipment, buildings	
λ_i	0.30

2.2.6 Markets

The price elasticities of the equations for the different sales categories are primarily based on a study of Martins et al. (1996), but also information of CPB industry specialists is used.[6] The chosen values of the markups lie between 1.05 for temporary employment agencies and 1.42 for public utilities (gas, electricity). For agriculture and the manufacturing industries the markups are about 1.15-1.20. Only for chemicals, as partly a producer of high-quality goods, the markup is clearly higher (1.34). For most services the markups are somewhat higher (1.20 for government and other commercial services and 1.26 for health care) than for most manufacturing industries.

2.2.7 Calibration

Given all assumptions regarding the production structure, it is possible to calibrate the remaining model parameters. In particular, assumptions concerning the nesting structure, the substitution

[6] The elasticities do not have to match with the markups of the price equations for reasons of non-observed competition.

price elasticities, the fixed costs, the rate of technological progress, the depreciation rates, the life expectancies, the rates of adjustment and the markup are used in the calibration process. The calibration is performed using data of the National Accounts for the year 2001. In the calibration process the cost shares of the variable production factors, the shadow prices of the (quasi-)fixed production factors in the baseyear and the risk premium are determined.

2.3 Labour market

2.3.1 Wage determination

Athena assumes a right-to-manage bargaining model where the wage rate rise is the result of a negotiation process between employers and trade unions. The wage equations are the same as in SAFFIER (Kranendonk and Verbruggen, 2006).[7]

The long run labour cost equation is:

$$\ln(w^{mz})^* = \ln p_y^{mz} + \ln h^{mz} + 0.19 \ln \Lambda + 5.37 \ln(rp) u_{-1} + 1.13 u_{-1} \tag{2.14}$$

where Λ, the wedge, equals t_{wl} + t_{ww} + t_k (social security contributions of employers + employees + indirect taxes). This long run labour cost equation shows that in the long run the wedge, the replacement rate *rp* and unemployment *u* have a significant impact and that changes in prices p_y^{mz} and productivity h^{mz} of the market sector fully affect wages.

The change in the gross wage rate *w* is decomposed into a rise in contractual wages w_c and incidental wages w_i. The first component is the rise in wages due to an overall increase in collective bargaining agreements. This is the average wage increase in the unionised sector if workers do not receive any promotion or bonuses. The second component consists of the rise in wages due to changes in the composition of the workforce and the wage drift. The most important factors behind the change in the composition of the workforce are the changes in the average age and education level of the workforce and the increase in the participation rate of women. The distinction between contractual and incidental component is important because the minimum wage and many social security schemes depend mainly on the contractual wage increase. An overall one-time bonus payment does not affect welfare benefits and raises the gap between wages and these benefits, that is it lowers the replacement ratio.

[7] For an elaborate description of the theoretical background of the wage bargaining process, see the description in JADE (CPB, 2003, p. 21–26). The theoretical specification is the same in both models.

The equation for contractual wages in the market sector (w_c^{mz}) is:

$$\begin{aligned}\Delta \ln w_c^{mz} = {} & \Delta \ln p_y^{mz} + 0.34 \Delta \ln h^{mz} + 0.71(\Delta \ln p_c - \Delta \ln p_y^{mz}) + 0.11 \Delta \ln \left(\frac{1}{1 - t_{wl}} \right) \\ & - 0.11 \Delta \ln(1 + t_{ww}) + 0.18 \Delta \ln(rp) - 0.51 \Delta u_{-1} \\ & - 0.39 \left[\ln(w^{mz}) - \ln(w^{mz})^* \right]_{-1} \end{aligned} \tag{2.15}$$

where p_c represents the consumption price index. Given the error correction coefficient of 0.39 wages approach their long run level rather quickly. Note that the error correction term does not contain the contractual wage, but rather the market wage, w^{mz}, i.e. the wage including wage drift that results from incidental factors like ageing, job reallocation, etc. Productivity affects wages in the short run only partly through contractual and incidental wages, but in the long run productivity affects total wage costs with a coefficient of one. According to the contractual wage equation (2.15) in the short run 11% of an increase in the employers' social security contributions results in higher labour cost, 11% of an increase in direct taxes and social security contributions paid by employees and 71% of the rise in the real consumption price. In the long run all elements of the wedge have the same effect on labour costs: 19% of an increase in any element of the wedge is passed on.

The equation for incidental wage increases is:

$$\Delta \ln w_i^{mz} = 0.23 \Delta \ln h^{mz} - 0.04 \Delta u_{-1} + 0.5 \tag{2.16}$$

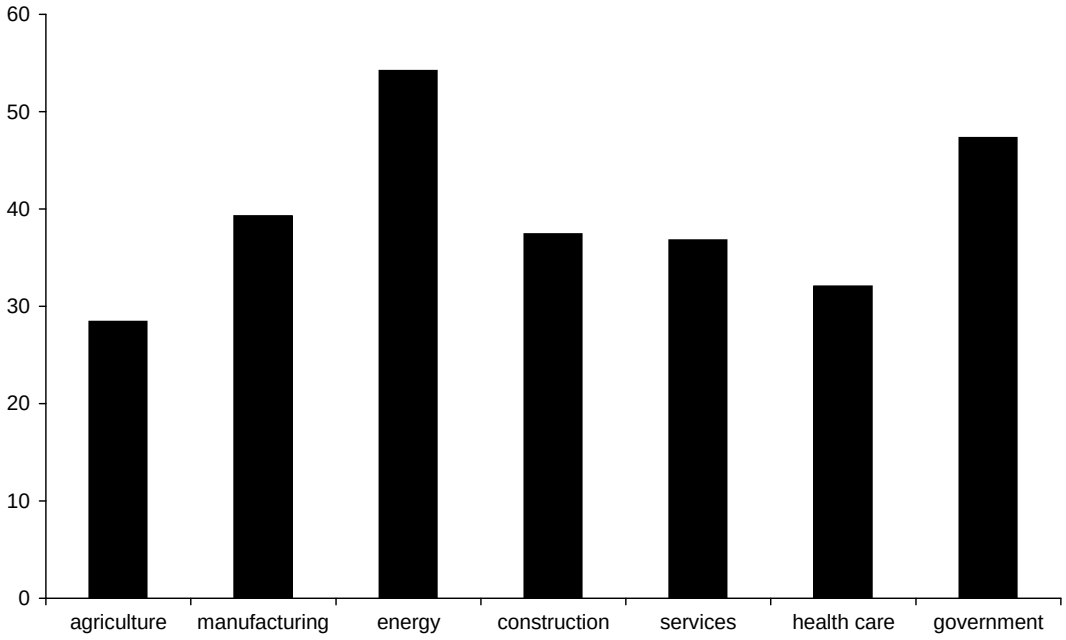
The incidental wage equation shows that total wage growth exceeds contractual wage growth by more than 0.5% (constant) if, ceteris paribus, productivity growth is positive or if the unemployment rate is falling.

Sectoral wages

Changes in sectoral wages follow changes in the general wage rate. But wage levels in the base year differ (see Figure 2.2) according to differences in the quality of the employees (e.g. education level) or specific circumstances (e.g. extent of shift work). Both factors explain the high wage level in the labour-extensive energy sector and the on average high schooling degree of government employees is expressed in the relatively high wages in the public sector. Within manufacturing the existence of shift work in the chemical and food industries positively affects the wage level. Services and particularly agriculture are characterized by a lot of low skilled jobs which diminishes the average wage level.

If there are reasons to assume a development that differs from the macro wage rate, the wage rate of a sector can be adjusted exogenously. A spreader mechanism guarantees the summing up of the sectoral wage bills to the macro aggregate.

Figure 2.2 Labour costs per employee in 1 000 euro, 2001



2.3.2 The equilibrium rate of unemployment

The equilibrium rate of unemployment is the rate of unemployment to which the economy adjusts in the long run (Broer et al., 2000)). The level of equilibrium unemployment depends on the wedge, the replacement rate and real costs of capital (see equation (2.17)). As a consequence of the new non-linear wage equation the elasticities of these variables are not constant.

$$u^* = \alpha \ln \Lambda + \beta \ln(rp) + \gamma(ln\ p_k - \ln c) \tag{2.17}$$

A rise of the wedge or replacement rate causes an increase of the wage rate. In order to maintain profitability, firms lower their demand for labour and equilibrium unemployment increases and this erodes the unions bargaining position and they will lower wage demands. In this way equilibrium will be restored.

An increase of real capital costs diminishes the room to cover labour and other costs but at the same time it induces firms to produce in a less capital-intensive way and, over time, this causes a fall in labour productivity. As a result wage demands decrease and unemployment rises less.

2.3.3 Labour supply

The equation for labour supply is specified as follows

$$\frac{\Delta l_s}{l_s^*} = \frac{\Delta {l_s}^*}{{l_s}^*} + 0.1\left(\Delta \ln \frac{w^f(1-s_l-t_d)}{p_c}\right) + 0.2\frac{\Delta l - \Delta {l_s}^*}{l_s^*} \tag{2.18}$$

where l_s denotes labour supply, l_s^* structural labour supply and $w^f\ (1 - s_l - t_d)/p_c$ the real average net wage rate for employees in firms.

The most important determinant of labour supply, the structural supply of labour, is exogenous in Athena. The factors behind structural labour supply are demographics and trends in participation rates. However, these factors are not modelled in Athena.

Both other determinants are endogenous. First, labour supply is determined by the real after tax wage rate. The higher the real after tax wage rate, the more labour is supplied. This implies that the substitution effect in the labour-leisure choice is more important than the income effect. Second, the change in the labour supply depends on the tension in the labour market, the so-called 'discouraged worker effect', the difference between the change in employment and structural labour supply relative to the level of structural labour supply. If there is less scarcity on the labour market, that is if unemployment is higher, the supply of labour is reduced because the probability to find a job decreases and search costs increase. The coefficient for the real net wage rate is fixed at 0.1. With a coefficient of 0.2 the discouraged worker effect is assumed to be rather small.[8]

Both endogenous factors are assumed to have only effects in policy and simulation analyses. In the construction of long term scenarios the influences of the tension on the labour market and the real net wage are incorporated in structural supply.

2.4 Private consumption

Volume changes in private consumption are determined in a number of consecutive rounds in Athena. In the top layer the macro consumption function is determined, this function is the same as in SAFFIER.

2.4.1 Total consumption

The consumption equation is based on a mixture of the behaviour of two types of households. Households of type I have free access to the capital market and behave according to the life-cycle theory of consumption. They consume a fraction ε of their total wealth, which consists of non-human wealth A and the discounted value of their expected income H. Households of type II are liquidity-constrained, and consume their current income Y in full. Three types of disposable income are distinguished: labour income YLL , transfer income YLO and profit income YZ . Labour and transfer income are both assumed to grow with the expected net wage rate Ψ and are discounted with rate κ to take into account the death hazard rate, the expected real

[8] The coefficients are the same as in SAFFIER (Kranendonk and Verbruggen, 2006) and were already used in FKSEC (CPB, 1992).

wage increase and a risk premium. Profit income on the other hand is assumed to grow with the expected consumer price inflation π and is discounted with the death hazard rate λ. Thus the long run consumption function can be stated as:

$$c^* = \varepsilon\,(A + (1-\phi_L)HL + (1-\phi_O)HO) + \phi_L YLL + \phi_O YLO \tag{2.19}$$

where ε, HL and HO are given by

$$\varepsilon = \gamma(\lambda+\mu) + (1-\gamma)(r_{ln} - (\pi - \lambda)) \tag{2.20}$$

$$HL = \frac{YLL}{r_{ln} - (\Psi - \kappa)} \tag{2.21}$$

$$HO = \frac{YLO}{r_{ln} - (\Psi - \kappa)} \tag{2.22}$$

and where γ represents the elasticity of intertemporal substitution, λ the death hazard rate, μ the rate of time preference, r_{ln} the relevant long run nominal interest rate (see Section 2.7.4 for the definition), HL the discounted value of labour income and HO the discounted value of transfer income, and ϕ_L and ϕ_O the fractions of wage earners and transfer income recipients that are liquidity- constrained. The fraction ε consists of two components. The first component reflects the desire of households to consume a fraction of their wealth that depends on their impatience (μ) and life expectancy (λ). The second component reflects the incentive to substitute future consumption for current consumption through saving. The higher the real interest rate the more consumers will save.

The parameters of the steady-state consumption equation are estimated directly on the basis of the cointegration relation that exists between the variables of this equation. The short run consumption equation used is obtained from the steady state equation by adding ad hoc dynamics, in the form of an error-correction mechanism (Kranendonk and Verbruggen, 2002).

$$\begin{aligned}\left(\frac{c-c_{-1}}{c}\right)_{-1} = {} & 0.55\frac{\Delta YLL/p_c}{c_{-1}} + 0.69\frac{\Delta YLO/p_c}{c_{-1}} + 0.37\frac{\Delta YZ/p_c}{c_{-1}} \\ & + 0.046\frac{\Delta A_{h_{-1}}}{c_{-1}} + 0.033\frac{\Delta A_{s_{-1}}}{c_{-1}} + 0.054\frac{\Delta A_{r_{-1}}}{c_{-1}} + 0.035\frac{\Delta hw}{c_{-1}} \\ & - 0.60\Delta r_{ln} - 0.30(\ln c - \ln c^*)_{-1}\end{aligned} \tag{2.23}$$

where c denotes the volume of private consumption excluding the privately financed consumption of health care, imputed rents on owner occupied houses and administration costs of pension funds and life insurance companies (*clp*), YLL the disposable labour income excluding the privately financed consumption of health care, YLO disposable transfer income, YZ profit income excluding imputed rents on owner occupied houses and administration costs of pension funds and life insurance companies. Furthermore A_h denotes the stock of residential dwellings owned by households, A_s the stock of share owned by households, A_r the other assets of

households and *hw* the revaluation of the stock of residential dwellings. For the long run the following parameter estimates have been obtained:

ϕ_L = 0.63, λ = 0.009, μ = 0.03, ϕ_O = 0.81, κ = 0.23, γ = 0.85

where the forecasting rule for net wage growth, ψ , is specified as a distributed lag of the actual net wage development:

$$\Psi = \Psi_{-1} + \Delta\pi + 0.6[(\dot{w} - \dot{p}_c) - (\Psi_{-1} - \pi)] \tag{2.24}$$

and where π, the expected change in the price of private consumption, is approximated by:

$$\pi = \pi_{-1} + 0.4(\dot{p}_c - \pi_{-1}) \tag{2.25}$$

2.4.2 Allocation of total consumption over industries

Total consumption (including *cwe*, *clp* and *ch*) is allocated to the different sectors of origin with the aid of consumer demand functions.[9] First the consumption produced by the non-market services sector (i.e. medical and social services *ch*) and the residential sector *cwe* is determined. This is because they do not depend much on income trends in the short run. The remaining outlays for consumption (including consumption by foreign tourists in the Netherlands) are allocated to consumption of oil refineries and public utilities, the consumption of motorcars, some residual groups of minor importance and (implicitly) a rest category. The consumption of both the energy industries and motorcars is treated separately because the first two are often adjusted based on information from industry experts of CPB. The lower layer analyses consumption of the rest category by sector of origin. The latter two types of consumer demand functions will be discussed in more detail.

For the consumption of oil refineries, public utilities, motorcars (and implicitly total rest consumption), equations are estimated in the following form (in percentage changes):

$$\dot{c}_j = \dot{pop} + \alpha_j\, \dot{ct} + \beta_j\, (\dot{c} - \dot{ct}) + \gamma_j\, \dot{p}_j^c/\dot{p}^c + \textit{constant} \tag{2.26}$$

where c_j represents consumption volume of industry j, *pop* is the population size, c is total consumption per capita, *ct* the trend of c and p_j^c/p^c the price of industry j relative to the price of total consumption.

The estimation results are shown in Table 2.5. The coefficients α_j and β_j can be interpreted as expenditure elasticities. As expected in view of the large share in total consumption, these elasticities are about unity for total rest consumption. The long term expenditure elasticity for oil refineries is rather high but this is in conjunction with the large negative constant. For public utilities the elasticity is somewhat lower than unity. This is plausible given a structural

[9] For a more elaborate description of the allocation model in Athena, see Lammertsma (1998).

Table 2.5 Elasticities for some consumption categories

	α_j	β_j	γ_j	Specific	Constant
Oil products	1.81	0.80	− 0.21	-	− 1.59
Gas, electricity, water	0.84	0.36	− 0.08	− 5.51	− 0.74
Motorcars	1.09	1.61	− 2.00	− 0.47,0.87,− 1.80	1.86
Total rest consumption	0.92	0.88	0.06	-	0.19

technologically induced energy saving (more efficient heating and electric home appliances) of about 1% per year and the constant of − 0.7 . The relative price elasticities are small, with the exception of that for motorcars (− 2.0). In the consumption equation for public utilities a temperature variable (first difference of the deviation of the normal temperature in the heating season, elasticity − 5.51) is added. The consumption of motorcars is also affected by the development of the relative price of oil products (elasticity − 0.47), the real interest rate (elasticity 0.87) and an anticipation effect of the special consumer tax on cars (elasticity − 1.80).

Table 2.6 Long term elasticities for the industries of the rest category in relation to the aggregate

	Share 2001	Expenditure elasticity	Price elasticity
Agriculture	0.04	0.9	− 0.9
Food and drinks	0.18	0.4	− 0.2
Chemicals	0.05	1.5	− 1.2
Metals excluding motorcars	0.07	1.0	− 0.8
Other manufacturing	0.21	0.6	− 0.3
Construction	0.01	1.8	− 1.3
Transport	0.04	2.3	− 2.0
Communication	0.05	1.4	− 1.3
Banking and insurance	0.09	1.0	− 0.1
Household services	0.01	0.4	− 0.1
Other market services	0.19	1.1	− 0.3
Dutch citizens abroad	0.06	1.2	− 1.0

Total consumption of the rest category is allocated to eleven industries and consumption by Dutch citizens abroad (spending on tourism). The utility functions of welfare maximizing consumers are based on the so-called Generalized Indirect Addilog Demand System (GIADS) (Nieuwenhuis, 1985).

First, the minimum expenditure by industry per head is determined, assigning an important role to habit-formation among consumers. A constant fraction of last year spending on consumer goods or services originating from the relevant industries is taken as the minimum expenditure. A consequence of this way of modelling is a strong impact of the rate of total consumption growth on the division over industries. The remaining budget is allocated as a function of relative prices. This gives the following equation for the budget share of the industries *i*:

$$c_i^r = c_i^{rmin} + \frac{b_i}{p_i}(C^r - \sum_k p_k c_k^{rmin}) \tag{2.27}$$

where:

$$b_i = \frac{\beta_i s_i^{1-\theta_i}}{\sum \beta_k s_k^{1-\theta_i}} \tag{2.28}$$

$$s_i = \frac{p_i}{C^{rc} - \sum p_k c_k^{rmin}} \tag{2.29}$$

with c^r (c^{rmin}, C^r) is (rest, minimum, value total rest) consumption per capita, b_i is share industry i and s_i is the normalised price of industry i.

Table 2.6 shows expenditure and price elasticities resulting from the above-mentioned approach. Both expenditure and price elasticities are high for transport, communication, chemicals (cosmetics and medicines etc.) and the construction industry (maintenance). About average is the elasticity for spending on tourism abroad. As expected, the elasticities for agricultural products (some food products and flowers) and food and drinks are less than unity.

2.5 International trade

2.5.1 Exports

The modelling of exports in Athena for the manufacturing industries and agriculture starts from a technique introduced by Armington based on the assumption that geographic origin is a source for commodity differences.[10] This technique assumes separable utility functions with respect to different commodity types. Each goods category consists of a number of differentiated commodities, based on their geographic origin. The optimisation process consists of two rounds: first, total expenditure on export goods is allocated among the various categories and, second, the expenditure per sector is allocated among the various suppliers (i.e. countries). For this second round a constant elasticity of substitution (CES) utility function is used.

Competitive exports

In Athena this approach is operated as follows. The relevant world trade (e^c) and the competitive prices p_{ei}^c are exogenous in the model. Then the macroeconomic world trade is divided. Competitive exports by industry e_i^c depend on total relevant world trade e^c and the relative price ratio between domestic and foreign prices p_{ei}^c / p_e^c.

$$\ln e_i^c = \rho_i \ln e^c - \theta_i (\ln p_{ei}^c - \ln p_e^c) \tag{2.30}$$

[10] For a more elaborate description of the export modelling in Athena, see Ederveen (2000a).

For agriculture the elasticity ρ_i is 0.87. For the manufacturing industries categories the elasticities are 1.00 for food, 1.41 for chemicals, 1.28 for metals and 1.00 for other products. The elasticity θ_i is − 0.18 for all five categories. The results of equation (2.30) are determined in such a way that total world trade always exactly equals the sum of the categories.

Long run exports

In the long run equation, exports by industry e_i^* depend on industry-specific relevant world trade e_i^c (competitive exports) and by relative prices p_{ei}/p_{ei}^c.

$$\ln e_i^* = \ln e_i^c - \theta_{ei}(\ln p_{ei} - \ln p_{ei}^c) + constant \tag{2.31}$$

Table 2.7 presents the coefficients for equation (2.31). For the five manufacturing industries the long run price elasticities are above one. The price elasticities of the two most important exporting sectors in the Netherlands, metals and chemicals, are about two. For agriculture and food the price elasticities are clearly lower but still above one.

Table 2.7 Long term export price elasticities

	Share 2001[a]	Price elasticity	Constant
Agriculture	0.06	− 1.55	− 0.11
Food, beverage and tobacco	0.14	− 1.12	− 0.07
Chemical industry	0.16	− 2.04	0.00
Metal industry	0.20	− 1.98	− 0.19
Other manufacturing industries	0.06	− 1.64	0.00
Other industries goods	0.12	− 2.00	-
Services	0.26	− 1.65	-

[a] Domestically produced exports.

Short run exports

The short run exports depend again on competitive exports and relative prices, but also on lagged deviations from the long run equilibrium level $e_i^* - e_i$.

$$\Delta \ln e_i = \alpha_i \Delta \ln e_i^c - \beta_i \Delta \ln(p_{ei}/p_{ei}^c) - \gamma\,(\ln e_i - \ln e_i^*)_{-1} \tag{2.32}$$

Table 2.8 presents the coefficients for equation (2.32). The short term price elasticities for the five manufacturing industries are about one in absolute value. The highest short run price elasticity results for the food sector. This is higher than the estimated long run elasticity for this sector. Furthermore, the elasticity of relevant world trade is in all five sectors below one. Finally, most sectors show a significant effect of the error correction term, although the adjustment speed is much higher for agriculture than in the manufacturing industries.
The elasticities for exports of goods for the other sectors (energy and services) and for export of services in Tables 2.7 and 2.8 are not separately estimated but based on the coefficients in JADE.

Table 2.8 Elasticities short term export equation

	Relevant world trade	Price elasticity	γ
Agriculture	0.90	− 0.94	− 0.68
Food, beverage and tobacco	0.92	− 1.34	− 0.36
Chemical industry	0.81	− 1.31	− 0.19
Metal industry	0.70	− 0.60	− 0.11
Other manufacturing industries	0.79	− 0.94	− 0.31
Other industries goods	1.00	− 0.75	− 0.35
Services	1.00	− 0.00	− 0.33

For re-exports (not further processed imports transported through a country to other countries)[11] the analogous equations for the various industries are kept simple. World re-exports of an industry are considered to grow somewhat faster than domestically produced exports (elasticity 1.1)[12] and Dutch re-exports of an industry increase in proportion to world re-exports.

2.5.2 Imports

The equations for imports of consumer goods are formulated according to the binomial linear logit model to prevent import shares from exceeding unity.

$$cmt_i/cp_i = \alpha_i cx_i + \beta_i(p_{cmai}/p_{cpi}) + \gamma_i(p_{cmti}/p_{cmai}) + constant \tag{2.33}$$

where cmt_i stands for consumption excluding taxes and import duties, cp_i for consumption from domestic origin at producer prices, cx_i for consumption excluding value added tax, *cmai* for imports including taxes and the different p's represent the prices of the consumption categories.

Table 2.9 Coefficients for import consumption categories

	α_i	β_i	γ_i	Constant
Agriculture	0.20	− 0.50	− 3.00	0.00
Food, beverages and tobacco	1.10	0.00	− 3.25	0.00
Chemicals	1.36	− 0.50	− 4.10	2.10
Motorcars	0.00	− 0.00	− 4.90	0.00
Other metal	0.80	− 1.32	− 4.90	3.10
Other manufacturing industries	1.32	− 1.30	− 5.95	0.00
Oil refineries	0.25	− 0.30	0.00	0.00
Services	0.00	0.00	0.00	0.00

Table 2.9 shows the coefficients for equation (2.33). Note that the coefficients do not represent elasticities. The value of the elasticities depend on the share of imports in the total consumption

[11] For imports, there has to be a transfer of property, otherwise the goods are transit goods.

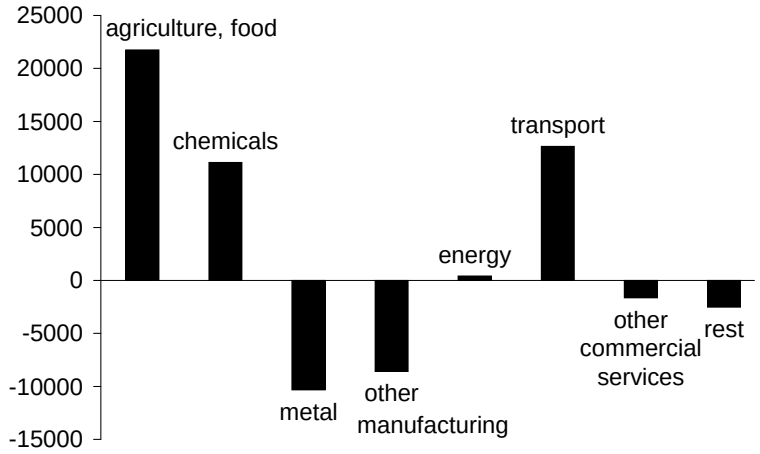
[12] In the past the elasticity was clearly higher but in the long run a value not too far from unity is more plausible.

of domestic and foreign origin of an industry: the larger the share of imports the smaller the values of the elasticities. However, it is clear that in all industries except motorcars the demand expenditure elasticities are larger than unity as all coefficients exceed zero. For half of the industries, the expenditure elasticities appear to be rather high as the demand coefficient α_i is about 1. The relative price elasticities compared to competitors seem to be quite small, for most categories the coefficient β_i is − 0.5 or (in absolute value) lower. Only for other metals and other products the coefficient is above one. Imports of services are (still) of minor importance and follow total consumption of services. The only significant category concerns the commercial services. As international trade shifts gradually from manufacturing industries to services its significance will growth in the future.

Foreign trade balances by sector

The Dutch economy is specialised in agriculture and food products, in chemicals and in transport services. For metals and other manufacturing goods the Netherlands are a net-importer.
The export surplus for agriculture and food is linked to the strong position of Dutch horticulture (flowers and greenhouse farming) and the food processing industry. The trade surplus of the chemical industry is a result of the advantageous location within Europe of the mainport Rotterdam for the arrival and transport of bulk products. The situation near the harbour of Rotterdam explains the significance of the distribution of goods as expressed in the high exports of the transport sector. Moreover, the importance of Amsterdam Schiphol as transfer airport boosts the exports of services. The Netherlands produces a very small number of passenger cars, this is reflected in the trade deficit of metal products.

Foreign trade balances by sector, mln euro, 2001



The division of investments and intermediate goods over domestic and foreign origin is determined by the substitution elasticity of the relative price of Dutch producers. For investments the elasticity equals − 2.00. For intermediates the elasticity is mostly − 0.75. Some industries generally producing highly homogenous products (energy and chemical industry) have a substitution elasticity of − 1.5 . Furthermore, non-price-induced import penetration as a consequence of international specialisation can be introduced by varying the growth rates of the number of varieties of domestic and foreign intermediates.

2.6 The public sector

The modelling of the public sector is analogous to the modelling in the SAFFIER model. Some exogenous variables in SAFFIER are made endogenous in Athena to guarantee stable developments of public expenditures in the long run. A distinction is made between the expenditures and receipts of the government and social security sector and pensions and life insurances.

2.6.1 Receipts and expenditures of the government and social security sector

Table 2.10 provides an overview of the various receipts and expenditures of the government and social security sector. Government expenditures consist of government consumption, investments, transfers to households, other transfers and other expenditures. Wage costs are by far the largest expenditure category. Social security expenditures consist of social security consumption, transfers to households and other transfers. Consumption in kind (for the greater part medical services) and transfers to households together make up more than 95% of total social security expenditures.

The volume of government and social security consumption is assumed to grow by the rate of the population and the productivity of the market sector. The volume of government wages depends on the number of government employees and their productivity. The value of administration costs of social funds follows the value of transfers to households of these funds. Consumption in kind is determined by the growth of GDP and an effect of the composition of the population to take account of ageing. Government investments are exogenous and depreciations are a fixed proportion of the capital stock. With the exception of transfers of a medical nature which depend on GDP growth and ageing, the volume of government transfers to households is exogenous. Households receive income due to two types of social insurance benefits: unemployment benefits and elderly and surviving relatives pensions. The volume of these pensions is exogenous. For the volume of unemployment benefits it is assumed that the change in the number of unemployment benefits paid by social security funds is 60 per cent of the change in number of unemployed persons.[13] The other income and capital transfers abroad mostly are linked to the growth in national income. In some cases there is a link to more specific variables (indirect taxes, import deliveries of agriculture to food) but these latter categories are of minor importance.

Most of the price components of the expenditures are linked to other prices. The change in the government wage rate is decomposed into a contractual and an incidental wage component. The change in contractual government wages follows the change of the contractual wage rate in

[13] This is the same assumption as in JADE (CPB, 2003, p. 38), in SAFFIER it is assumed that 63% of the new unemployed persons receive unemployment benefits.

Table 2.10 Receipts and expenditures of the government and social security sector in 2001 in billions of euro

	Government and social security expenditures			**Government and social security receipts**	
Government and social security consumption			Direct taxes		
gl	Government wages	43.4	*tl*	Taxes on wage and transfer income	33.7
go	Other government consumption	22.1	*tz*	Taxes on profit income	17.6
gz	Administration costs social security	2.3			
gg	Consumption in kind government	4.0			
gs	Consumption in kind social security	27.7			
Government investments			Indirect taxes		
eg	Investments	14.5	*tk*	Indirect taxes	57.9
dg	Depreciations	− 10.7			
Transfers to households			Non-tax receipts		
oy	Government	11.8	*zg*	Government	10.1
uh	Social security	34.8	*zs*	Social security	0.5
Other transfers			Social security contributions		
sp	Income transfers Europe	2.6	*ps*	Social security contributions	61.1
ss	Income transfers Non-Europe	4.4			
su	Other income transfers	7.5			
so	Capital transfers government	2.1			
sk	Capital transfers social security	0.0			
Other expenditures government			Other receipts government		
rg	Interest payments	15.3	*sg*	Sales of land	1.0
xs	Total expenditures	181.7	*ts*	Total receipts	181.8

Source: Macroeconomische Verkenningen 2004.

the market sector. The change in the incidental wage rate depends on the productivity in the government sector. The price change of government and social security consumption in kind follows the change in the price of total private consumption and medical and social consumption. The price change of the various income transfers depend on the change of the minimum wage, the price of private consumption and government wages. For interest payments it is assumed that 10% consists of debt renewal, assuming that the government finances its debt through 10 year bonds.

Governments receipts can be decomposed into direct taxes on wages and transfer income and profit income, indirect taxes, non-tax receipts and sales of land. Of these receipts indirect taxes are by far the largest income source of the government. Apart from indirect taxes levied on final sales on the domestic market, indirect taxes consist of taxes imputed to the enterprise sector, like for example import duties, excise duties and vehicle taxes. Sales of land depend on government investments in infrastructure.

Contributions to social insurance funds are based on a pay-as-you-go system. This implies that contribution rates are set in a such a way that they cover net costs. The net costs consist of

the expenditures (transfers to households, consumption in kind and administration costs) less non-tax receipts and government contributions. Contributions are levied on four different income categories, namely gross wages paid by firms, gross wages paid by the government, imputed wage income of self-employed, and transfer income. The contribution rates are determined exogenously.

In terms of Table 2.10 the financing balances for government gb and social security sb funds, with gc is government contributions to social security, are:

$$gb = tl + tz + tk + zg + sg - gl - go - gg - eg + dg - oy - sp - ss - su - so - rg - gc \quad (2.34)$$

$$sb = zs + ps - gz - gs - uh - sk + gc \quad (2.35)$$

The government balance according to EMU-dimension (EMU-balance) is the sum of equations (2.34) and (2.35).

$$eb = gb + sb \quad (2.36)$$

2.6.2 Receipts and expenditures of pensions and life insurances

Whereas the social security funds are based on a pay-as-you-go system, the pension funds and life insurances companies (corporate investors) are fully funded. The volume of benefits paid by pension funds and life insurances companies is exogenous. The benefits paid are indexed to the growth rate of private and government sector contract wages. The premiums for pension funds and life insurances are paid for employees in firms, for civil servants and for self-employed.

Table 2.11 Receipts and expenditures of pensions and life insurances in 2001 in billions of euro

Pensions and life insurances expenditures			**Pensions and life insurances receipts**		
Expenditures			Receipts		
ulp	Transfers	21.0	*plp*	Contributions	17.8
clp	Administrations costs	2.8	*zlp*	Investment returns	23.7
			olp	Capital transfers by the government	0.1
elp	Total expenditures	23.8	*rlp*	Total receipts	41.6

The difference between receipts and expenditures in Table 2.11 is the financing balance lpb of corporate investors.

$$lpb = plp + zlp + olp - ulp - clp \quad (2.37)$$

The development of premium level and financing balance depends on three factors, the maturing of the system, the composition of the population and the real interest rate i.e. the difference between the nominal interest rate on the capital market and the wage rate.

In 2001 the pension system is characterized by a maturing process, the system is still in its development stage. On average the pensioners have built up an incomplete pension whereas the present employees will receive a pension based on a larger number of pensionyears. So, in a fully funded system pensions are still characterized by increasing means. It will still take some time before the rights of pensioners exceed the rights of present employees so as to move the system in the direction of dissaving.

2.6.3 Disposable income

Disposable wage and transfer income, yl, is determined as:[14]

$$yl = ll + lz + uh + ulp + oy - (tl + tzl + ps + plp) - ch - ssh \tag{2.38}$$

where ll represents gross wage and transfer income, lz gross wage sum of self employed, tzl taxes on imputed wage income of self- employed, ch private health consumption and ssh stands for secondary transfers abroad.

Disposable profit income, yz, is determined as:[15]

$$yz = zhu - lz - tzr - cwe - clp \tag{2.39}$$

where *zhu* stands for profit income of households, *tzr* for corporate taxes paid by households and *cwe* for imputed rents on owner occupied houses.

Besides the effect on disposable income, taxes and social security contributions also affect the net long run rate of interest r_{ln} that is used in the macro consumption function 2.23 as follows:

$$r_{ln} = r_l(1 - t_{wl} - t_d) \tag{2.40}$$

where r_l is the nominal long run interest rate, s_l the social security contribution rate for employees and t_d the rate of direct taxes paid by labour. Furthermore they affect the wedge in the wage equation (2.14).

[14] Note that disposable wage and transfer income is adjusted for privately financed consumption of health care (*ch*) to take into account that it is assumed that its consumption share is unity.

[15] Note that disposable profit income is adjusted for the imputed rents on owner occupied houses (*cwe*) and the administration costs of pension funds and life insurance companies (*clp*) in order to take into account that it is assumed that their consumption share is unity (see Section 2.5.2).

3 Model applications

The model is used for long term projections with a sectoral dimension. This means, first, scenario studies in which alternative assumptions about markets and technology result in different projections for sectoral developments. Second, the Athena model is used to analyse the long term effects of structural policies. In the next sections the use of the model is illustrated by sketching the latest Dutch long term scenarios (Huizinga and Smid, 2004) and by the long run effects of a set of policy measures concerning a decline in corporate taxes (Broer et al., 2004).

3.1 Scenario analysis

3.1.1 Four scenarios

In 2004 CPB published a study on the developments of the Dutch economy for the period up to 2040: *Vier vergezichten op Nederland* (Huizinga and Smid, 2004). The four Dutch scenarios build on similar scenarios for Europe, *Four futures of Europe* (De Mooij and Tang, 2003). The Dutch report is the basis for follow-up studies for analysing policy options in the area of the physical environment, energy and space and the future of the welfare state.

In the construction of the four scenarios the Athena model was an important instrument. The same modelversion was used for all scenarios. The storylines in the scenarios lead to four different sets of exogenous variables of the Athena model. The differences in the exogenous variables drive the results. The most important drivers are population, labour supply, the volume of world trade, the prices of international competitors, the rates of technological progress, the growth rate of public expenditures and health care expenditures. The use of the Athena model ensures that the scenarios are internally consistent.

Just like *Four Futures of Europe*, *Four Futures of the Netherlands* is organised around two key uncertainties: the extent to which countries are willing and able to cooperate internationally and the degree of reform of the public sector. Combining these uncertainties leads to four different scenarios.

In the *Regional Communities* scenario, countries are strongly attached to their own sovereignty, which hinders the European Union in carrying out institutional reform. International trade liberalisation is also brought to a standstill, and the world falls apart into a number of trading blocks. International environmental issues are effectively shelved. Collective arrangements remain in place, with an emphasis on equal income distribution and solidarity.

In *Strong Europe*, much attention is paid to international cooperation on public issues. The European institutions are successfully reformed, and countries yield part of their sovereignty. Europe thus becomes an influential player in the international economic and political arena, able to tackle international environmental issues in a coordinated way. Social-economic policy is, as in *Regional Communities*, aimed at solidarity and an equal distribution of income—although some reforms do take place.

In the *Transatlantic Market* scenario, the expansion of the European Union is not a political success. Countries are too attached to their sovereignty and try to solve problems at the national level. A far-reaching trade agreement is made between the United States and Europe, however, which over time leads to a unified internal market. The scenario is characterised by governments that focus on the individual responsibility of citizens. The welfare state is cut back and public services are sobered down.

In *Global Economy*, the EU expands even further eastwards. In addition to Turkey, countries like the Ukraine also join. The WTO negotiations are successful, and international trade flourishes. Political integration does not get off the ground, however. International cooperation in areas other than trade fails. As in *Transatlantic Market*, the government in this scenario emphasises the individual responsibility of citizens.

3.1.2 Macro results

The differences between the scenarios in international cooperation and in the degree to which the public sector is reformed have great consequences for the economic outcomes in the scenarios. Developments of employment and of labour productivity are the driving forces behind economic growth. Employment development is influenced by the labour supply and the way the welfare state is organised. Table 3.1 provides an overview of the most important macroeconomic outcomes in the four scenarios.

Table 3.1 Main results of the four scenarios

		Regional Communities	Strong Europe	Transatlantic Market	Global Economy
	1971–2001	2002–2040	2002–2040	2002–2040	2002–2040
	yearly changes in %				
Population	0.7	0.0	0.4	0.2	0.5
Labour supply	1.1	− 0.4	0.1	0.0	0.4
Employment	0.9	− 0.5	0.1	0.0	0.4
Labour productivity	1.7	1.2	1.5	1.9	2.1
Volume GDP (market prices)	2.6	0.7	1.6	1.9	2.6
GDP per capita	1.9	0.7	1.2	1.7	2.1
	average level in % labour force				
Unemployment	5.5	7.3	5.7	4.6	4.1
	level end year				
Government expenditures share (% GDP)	42	51	47	38	36

Population growth declines in all scenarios compared to the average for the period 1971-2001 (see De Jong and Hilderink (2004)). The baby-boom generation gets older and the mortality rate

rises in all scenarios. The differences between the scenarios are mostly due to differences in migration and fertility. In *Regional Communities*, population growth is initially still positive, but after 2010 the population declines. In *Strong Europe*, population growth is higher—mostly because of a less austere immigration policy and a high birth rate. Immigration policy in *Transatlantic Market* is stricter, and aims primarily at bringing in knowledge workers. In *Global Economy*, net immigration is high because of a relatively open immigration policy towards labour migrants in general. Because the birth rate is also high, population growth is highest in this scenario.

The ageing of the population causes the labour supply to grow more slowly than the total population: an increasing share of the population is thus retired.[16] The elderly dependency ratio, measured as the ratio of the number of people aged 65 years or older to the number of people 20–64 years old, increases from 22% now to 43% in *Global Economy* and to 46% in *Regional Communities*.

The effect of ageing is most visible in *Regional Communities*, where labour supply falls on average by half a percent per year because of the combination of stagnating population growth and an increase in the elderly dependency ratio. In the other scenarios, the increase in the elderly dependency ratio is partly offset by a rise in the participation rate, especially of people older than 50 years and of women.

In the long run, unemployment is influenced by the tax wedge (the difference between the total labour cost and the net wage) and the replacement rate (the ratio between social benefits and wages); see Broer et al. (2000). In *Regional Communities*, the tax wedge and the replacement rate both rise. Unemployment, therefore, also rises—to more than 7%. Unemployment is somewhat lower in *Strong Europe*, due to a modest reform of the welfare state. In *Transatlantic Market* and *Global Economy*, cutbacks in social benefits and lower tax rates lead to a low level of unemployment—a little above 4%.

The central engine for the rise in labour productivity is technological progress, the important determinants of which are the incentives to innovate coming from the marketplace and the investments in human capital.[17] The market orientation in the *Transatlantic Market* and *Global Economy* scenarios therefore provides an important stimulus. In *Transatlantic Market*, the strong economic ties with the US cause an accelerated deployment of ICT, which raises productivity especially in the services sector. In *Global Economy*, success at the WTO leads to a rapid diffusion of knowledge, and thus also to extra creation of knowledge. In *Strong Europe*, the government provides high quality and affordable education for the entire population, which boosts labour productivity. On balance, the increase in labour productivity is highest in *Global Economy* and lowest in *Regional Communities*.

[16] See Roodenburg and Van Vuuren (2004) for an overview of the development of labour supply in the four scenarios.

[17] Smid (2005) puts the growth of labour productivity in the Netherlands in a historical and international perspective.

The growth rate of GDP equals, by definition, the sum of the growth rates of employment and labour productivity. Because the latter two growth rates are positively correlated in the scenarios, the range in GDP growth is substantial. For a proper evaluation of prosperity in the different scenarios, however, the growth of GDP per capita is a better yardstick. Using that measure, the differences are less pronounced, but still considerable. *Global Economy* exhibits the highest growth of prosperity. In *Regional Communities*, the growth is low because of the combined effects of ageing and a slow increase in labour productivity.

3.1.3 Sectoral results

What determines the development of industries in the long run? An important role is certainly played by the rise in labour productivity. In the long run, such an increase causes a proportional decrease in labour cost per unit of production. The (relative) reduction in price leads to a rise in demand. Demand also rises as a result of the general rise in prosperity. Another important factor is the development of domestic costs relative to the cost of producing abroad. If an industry is hit with competition from countries with much lower costs, domestic production will stagnate because domestic firms will shift production abroad or disappear altogether.

It is not clear at the outset which of these factors dominates. Industries with rapid growth of labour productivity will not necessarily also experience high growth of production and employment, for instance. Table 3.2 presents the growth rates of labour productivity in a number of aggregated sectors of the economy. The sector with the highest growth of labour productivity (for decades, now) is agriculture. From a historical point of view, food is indeed inexpensive, readily available and safe. Yet, agriculture is a declining sector. How can this be? Demand for agricultural products is not very sensitive to the prices of these products. The decline in prices has thus not led to a strong increase in demand. In addition, agriculture in general has not benefited much from the general rise in prosperity. Agricultural products mainly fill a basic need. Therefore, the sharp rise in labour productivity did not go hand-in-hand with a proportional increase in demand. As a result, employment in agriculture steadily declined.

The health care sector is at the other end of the spectrum, and exhibits relatively low labour productivity growth.[18] Many tasks in the care sector are difficult to automate. Still, health care is a high growth industry. Although slow labour productivity has led to relatively high prices, demand has not slowed down. Also here, demand is fairly insensitive to the price, and high prices did not hinder demand greatly. On the other hand, increases in prosperity and in technological possibilities did spur a rapid increase in demand. Another factor increasing demand in the future is the ageing of the population. Demand in the health care sector, therefore, rises much faster than labour productivity, so that employment expands strongly.

[18] Bos et al. (2004) describe the developments of the health care sector and the public sector in the scenarios in more detail.

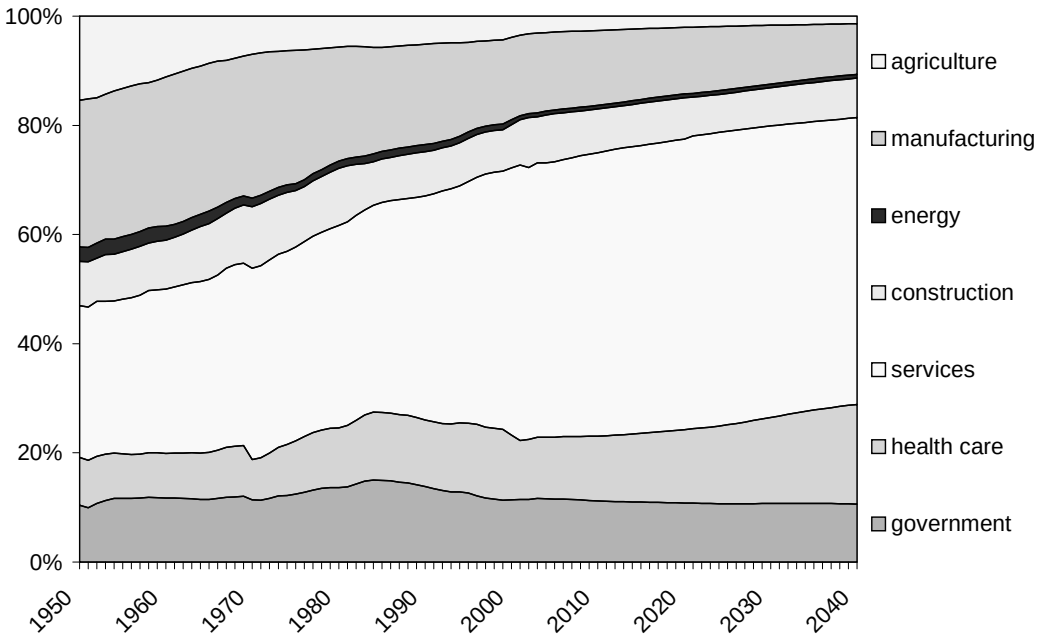
Table 3.2 Growth rates of labour productivity by sector

	1980–2001	Regional Communities 2002–2040	Strong Europe 2002–2040	Transatlantic Market 2002–2040	Global Economy 2002–2040
	changes per year in %				
Agriculture	3.6	2.6	2.7	3.0	3.8
Manufacturing	2.9	2.1	2.7	2.8	3.4
Services	1.1	1.4	1.8	2.4	2.5
Health care	− 0.3	0.5	0.6	0.7	1.0
Government	1.2	0.6	1.0	1.2	1.5
Total economy	1.3	1.2	1.5	1.9	2.1

Productivity in manufacturing, as in agriculture, has been relatively high, resulting in a strong decline of prices. Unlike in agriculture, however, the decline in prices and the growth in general prosperity greatly stimulated demand for manufactured goods. ICT products are a spectacular example. Productivity and demand, measured in units of capacity, grew manifold. Yet, demand has not completely kept up with labour productivity growth in manufacturing, resulting in steady de-industrialisation. In addition, parts of manufacturing face heavy foreign competition from low-wage countries. Some manufacturing industries have largely disappeared from the Netherlands. This process has been going on for decades and is expected to continue in the future. This does not imply, however, that manufacturing will disappear from the Netherlands altogether. The Dutch manufacturing sector is comprised of many firms producing high-quality intermediate goods. These (for the most part) relatively small companies function superbly in niche markets.

The real job engine in the Netherlands is the commercial services sector. The dominant factor here is the steady growth of prosperity, which stimulates demand for services. Traditionally, the services sector has always had a low productivity growth rate, because many services were characterised by personal interaction and were difficult to automate (consider the hairdresser as the standard example). The services sector covers a steadily broadening range of markets, however, with the focus increasingly on transporting and processing information. Examples include Internet, telecom, banking, insurance and logistics. In these areas, large productivity gains are possible by implementing ICT applications. Another factor influencing the commercial services sector: direct personal contact between producer and consumer is becoming less important, which makes it possible to produce at a distance. International trade and competition have thus become increasingly important factors in the sector, which is currently the fastest growing component of Dutch exports. All of this makes the distinction between manufacturing and services steadily less relevant. On the one hand, the manufacturing sector is shifting from the large-scale production of physical goods to areas like R&D, design,

Figure 3.1 Share in total employment, Transatlantic Market



marketing and intermediate products. On the other hand, the services sector is moving towards products that have a large knowledge component and can be traded internationally.
The interaction between supply and demand factors has, on balance, led to a sizeable shift in the employment shares of the different industrial sectors. Figure 3.1 shows these shares for the *Transatlantic Market* scenario. The other scenarios show quite similar pictures. In order to put the development in a historical perspective, the figure shows the developments from 1950 till 2040. The declining share of employment in agriculture and manufacturing is clearly visible, as is the rising share in the services and health care sectors.

Most remarkable is that this shift in employment shares in the period 1950-2040 is a continuous process, with most of the shift having already taken place (particularly in the 1970s). The figure sheds an interesting light on the question whether prosperity can still rise when increasing competition leads to outsourcing of activities abroad and to loss of employment in certain sectors, such as manufacturing. Economic theory, optimistic about this issue, predicts that international trade will lead to shifts in production and employment shares that will increase prosperity in the long run—even though the adjustment process may initially be painful. The historical development in the Netherlands supports this view. The large shifts in employment shares over the past decades have gone hand-in-hand with a dramatic rise in prosperity.

3.2 Policy analysis

In 2004 the Dutch cabinet proposed a set of policy measures, amended by parliament, aimed at lowering corporate tax rates and diminishing the distorting influence of taxes on the allocation of production factors so as to improve the Dutch competitive position. CPB analysed the macro and meso effects of these measures using the Athena model (Broer et al., 2004).

3.2.1 Set of policy measures corporate taxes

Table 3.3 recapitulates the set of policy measures.

Table 3.3 Set of policy measures corporate taxes and budgetary effects (in mln euro)

	2005	2006	2007
Intentions			
Reduction general corporate tax rate	1 185	1 580	1 775
Reduction tariff step	55	80	105
Self-employment deduction	165	230	255
Other intentions	20	20	30
Total	1 425	1 910	2 165
Financing sources			
Increase in energy taxes	370	450	525
Increase employers tax on save-as-you-earn deduction	200	200	200
Increase in unemployment insurance contributions	200	200	200
Unintentional use commercial car registration	300	300	300
Wage and income tax	115	440	475
Other sources	280	435	455
Total	1 465	2 025	2 155

A decrease of the general corporate tax rate by 4.5% points is the main measure reducing the tax burden of enterprises. For small firms not subject to corporate taxes the same reduction effect is achieved by raising the tax deduction for self-employed.

The financial backing of the reduction in government income is realized by a number of measures increasing the financial burden of firms and households. Energy taxes are raised by more than 500 mln euro and the contribution of employers to employee's insurances and the tax on save-as-you-earn deduction both rise by 200 mln euro. Besides, the government saves by restricting the use of commercial car registration (300 mln euro). Furthermore, wage and income revenues are raised through a number of measures by almost 500 mln euro and some smaller measures provide for another 455 mln euro.

About 5/8 of the total financing burden is imposed on firms whereas households are charged for the other costs. Since the additional costs for firms are deductible and thereby reduce the tax base of corporate taxes and the income tax of self-employed, total tax revenue is 400 mln euro smaller than the amount of the last line in Table 3.3. So, ex ante households and government pay about 55% of the tax reduction of enterprises.

3.2.2 Macro results

The macro economic results (see Table 3.4) are the outcome of the interaction of factors on the supply and demand side. On the supply side structural effects on GDP follow structural changes in labour productivity and employment. Labour productivity increases somewhat because the capital intensity in the production process increases. This is the result of the decrease of the user costs of capital. Structural employment equals labour supply minus equilibrium unemployment. Changes in equilibrium unemployment are caused by changes in the wedge, marginal capital and production costs and cost shares. The wedge rises through the set of policy measures, the employee wedge particularly as a result of higher contributions to employers insurances, the employer wedge because of the increase in wage and income tax. Lower corporate tax rates diminish marginal capital costs, notably for capital goods with a high life expectancy. The net reduction in the financial burden of enterprises causes a decline in marginal production costs. Furthermore, the share of capital costs is lower. The downward influence on equilibrium unemployment of the decline in marginal capital costs and capital cost share dominates the upward effect of a higher wedge and lower marginal production costs. Therefore, employment and GDP increase.

On the demand side lower sales prices improve competitiveness of Dutch producers on domestic as well as on foreign markets. These lower prices result because lower user costs of capital and consequently higher labour productivity are more important for the development of prices than the rise in income and indirect taxes. As a result Dutch exports and intermediate deliveries increase. In particular investments are positively affected as lower capital costs lead to substitution in the direction of a more capital-intensive production. Since lower capital costs increase the rate of return of Dutch enterprises, the rise in investments is not only an effect of more investments of already existent firms but also a result of entry of new firms. As a consequence of a high import share of investments in equipment the growth of imports is still substantial but lower than the rise in GDP. In the short run higher income taxes lower disposable income leading to a decline of the expenditures of households but ultimately also consumption increases.

For the finances of the government the effects are limited. As explained in Section 3.2.1 the EMU-balance decreases ex ante by 0.1%. In the long run particularly the positive effects on employment and production provide for a small improvement of the EMU-balance.

3.2.3 Sectoral results

Table 3.5 presents the results by sector. In the three sectors that are shown, the effect of decreasing corporate taxes and raising the self-employed deduction exceeds the effect of the financial backing, resulting in lower production costs. The extent to which costs decline particularly depends on the capital and energy intensity of a sector. The manufacturing industry is relatively heavily affected by the increase in energy taxes but simultaneously the sector uses a

Table 3.4 Long term macro economic effects set of policy measures corporate taxes

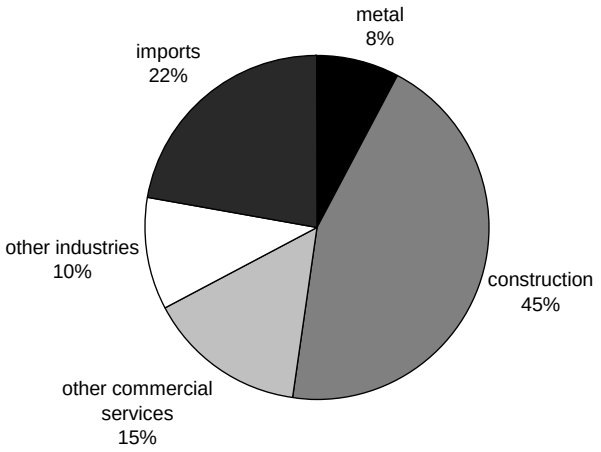
	Long run[a]
	changes in %
Prices	
Wage rate enterprises	− 0.0
Contractual wage rate market sector	− 0.4
Private consumption	− 0.5
Exports of goods excluding energy	− 0.6
Production market sector	− 1.2
Real labour costs market sector	1.1
User costs of capital	− 3.8
Volumes	
Private consumption	0.2
Investments in industrial buildings	1.6
Investments in equipment and infrastructure	1.7
Exports of goods excluding energy	0.9
Imports of goods	0.5
Production market sector	0.8
Real net national income	0.2
Gross domestic product	0.6
Labour productivity market sector	0.2
Employment market sector (fte)	0.6
Employment (fte)	0.5
Labour supply (fte)	0.1
Unemployment rate	− 0.4
	absolute changes
Ratios and wedge	
Labour income share market sector	1.0
Wedge (%)	0.4
of which indirect taxes	0.1
of which employers wedge	0.1
of which employees wedge	0.2
EMU-balance (%GDP)	0.0

[a] The long term effect is the cumulated effect in the 16th year (2022).

Investment goods producing industries

The production of investment goods is divided unevenly over industries. Almost half of all investments are produced by the construction sector. Houses and industrial buildings are for the greater part delivered by the construction sector but still a significant proportion comes from commercial services of architectural firms and engineering consultancy offices. A large part of investments in equipment is imported. The same applies to the investments in cars. For that reason the share in total investments of origin of the Dutch metal industry remains limited.

Division of investments over producing industries, 2001



lot of capital. The costs for other commercial services (a.o. architectural and engineering offices and advertising agencies) diminish to the same extent as for manufacturing industry because the sector is even more capital-intensive, as it invests strongly in industrial buildings and immaterial assets.

Table 3.5 Long term effects set of policy measures corporate taxes for some sectors

	Manufacturing industry excl. petroleum	Construction	Other commercial services
	changes in %		
Prices			
Production costs	− 0.7	− 0.5	− 0.7
User costs of capital	− 4.5	− 3.1	− 2.9
Volumes			
Investments in industrial buildings	2.3	1.0	2.0
Investments in equipment and infrastructure	2.2	0.8	1.2
Exports	0.9	1.0	1.1
Gross production	1.0	0.7	0.6
Employment (1 000 fte)	10	5	7

The construction sector, by far the most important supplier of investments in industrial buildings, houses and infrastructure, benefits from the increase in investments. Nevertheless, the increase in gross production is only marginally higher than for other commercial services and even lower than the increase in manufacturing industry. Gross production in the latter sector benefits from the rise in investments as the metal and other industry are producers of investments in equipment. Moreover, the decline in prices improves the competitiveness of Dutch producers resulting in higher exports and substitution of imports by production of domestic origin. Other commercial services are rather strongly positively affected since the sector still produces 20% of domestically produced investments. Furthermore, the sector is able to raise its domestic and foreign market share and still 20% of gross production is sold abroad and a same percentage is imported.

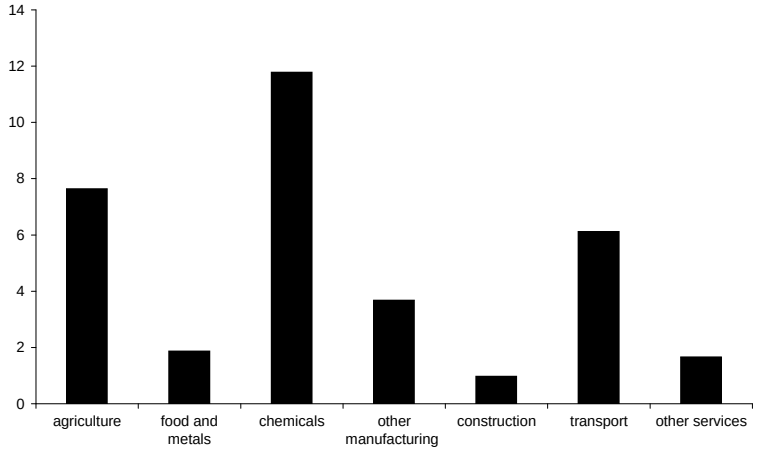
Energy intensity of industries

The need for using a multi-sector model in policy analysis particularly applies to issues where strong differences between industries are involved. An example is a policy aimed at decreasing the use of energy to tackle the problem of climate change.

The energy intensity of production differs between industries. Agriculture, the chemical industry and the transport sector are more energy-intensive than the other industries. Moreover, the use of energy is unevenly divided over sub-industries. Within the agriculture sector the bulk of the use of gas is concentrated in the glasshouse horticulture sector. Within chemistry the same applies to the petrochemical industry where naphtha is used as a feedstock in the production process. For the other industries the energy intensity is lower than 2% except for other manufacturing where the basic paper industry is a relatively large energy user. Although the basic metal industry (manufacturing of iron, steel and aluminium) is a large energy consumer, for the metal industry as a whole the energy intensity remains below 2% because of the small share of basic metals within total metal production.

In an attempt to decrease the greenhouse effect, the Netherlands has effectuated or proposed policies that recycle energy taxes to the economy by lowering income taxes. For competitive reasons highly energy-intensive (sub)industries can be compensated for the higher energy costs to prevent a loss of market share. The consequence of this is either a more limited decline in greenhouse emissions ór a significantly higher energy tax for consumers and sheltered industries. The economic effects differ strongly for the industries, highly energy-intensive sectors are confronted with a decline in production, particularly if they are not compensated for higher energy taxes. In labour-intensive and simultaneously energy-extensive industries production even rises if the policy is so arranged as to prevent a weakening of the competitive position of Dutch producers. The most effective and efficient policy will be a tax levy or the introduction of tradeable permits for CO_2-emissions on a worldwide scale but it is very difficult to get all countries behind such a policy (Lijesen et al., 2001; Broer et al., 2002).

Share of energy costs in % of gross production, by sector, 2001



4 Simulation analysis

To show the properties of Athena this section presents a number of simulations. In each simulation a one-off impulse is given to the rate or absolute change of a certain exogenous variable. So, in levels the impulses are permanent.

The results of the simulations depend upon the underlying base path. This base path has a technical nature and is based on simple assumptions for the development of exogenous variables. The most important ones are the growth rates of world trade, foreign prices, labour supply and technical progress of labour by industry. The response of the model is tracked by calculating the cumulated differences between the values (levels) of the model variables in the simulation path and those in the base path. In all simulations the impulse is given in 2002.

The simulations are carried out under the assumption that the government and EMU balances do not change. The EMU balance is kept constant as a percentage of GDP by adjusting wage and income taxes.

To illustrate the main properties of Athena we present simulations for a change in world trade, in the wage rate, in labour supply, in energy taxes and in the value added tax. As Athena will be primarily used for long term analyses, we are particularly interested in the long run properties of the model.

4.1 A 1% increase in world trade

In this simulation foreign prices are unchanged. Actually, this is an improper effect as prices of competitors will also rise, so this simulation has a technical character. The ultimate long run increase in world trade of an industry may be lower or higher than the initial impulse due to price substitution between goods.

4.1.1 Macro results

The increase in foreign demand boosts sales and production. The initial impulse is amplified through positive effects on domestic expenditures. At the same time productive capacity is largely fixed as the use of capital and labour can not be adjusted in the short run. As a consequence of increased utilization rates, marginal costs increase and these costs are directly passed on to prices. Since it is assumed that foreign prices do not change, this affects the rise in exports which turns out substantially lower than the increase in world trade. Due to a deterioration of the competitiveness of the economy, Dutch producers are confronted with a loss of market share on foreign as well as on domestic markets. Hence a large part of the increase in demand is satisfied through additional imports. This applies particularly to the short run because the increase in demand asks for more investments to meet the need for more capacity, and a

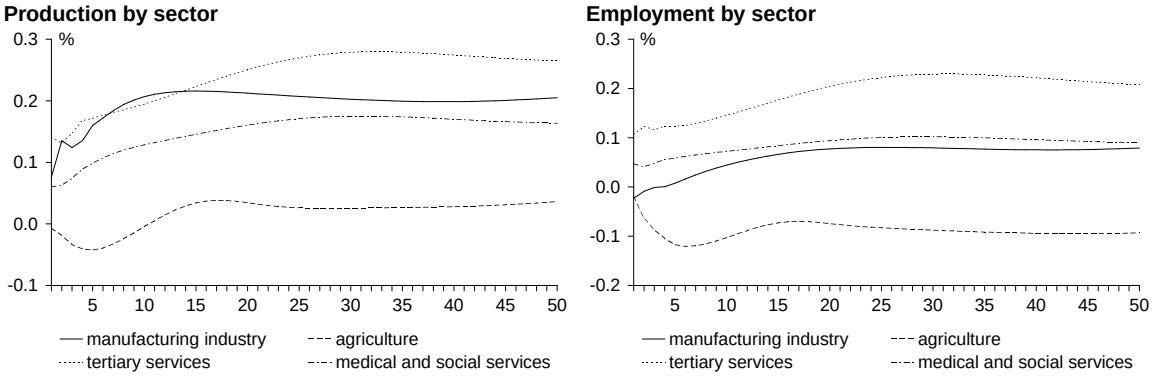
substantial part of investments is satisfied out of imports. Besides the effect of the increase in general demand, the rise in private consumption is positively affected as higher government receipts are adjusted through a decrease of wage and income taxes.

The direct and immediate effect of a demand impulse on prices determines the simulation results. Prices and volumes do not change a lot initially. It does not take a long time in Athena to reach a new equilibrium. In the long run exports rise by 0.3% and GDP by 0.2%. The effect on national income is larger due to a terms of trade effect. Wages increase by about 1% and prices by half the wage rise. Employment is 0.1% higher and, as a consequence of a decrease in unemployment and an increase in real net wages, labour supply is slightly higher.

Table 4.1 Effects of an increase in world trade volume by 1%, balanced budget

	Year 5	Year 10	Year 20	Year 50
	changes in %			
Prices				
Wage rate enterprises	0.9	0.9	0.9	1.0
Contractual wage rate market sector	0.8	0.8	0.9	1.1
Price private consumption	0.5	0.5	0.5	0.5
Price exports of goods excluding energy	0.5	0.4	0.4	0.4
Price production market sector	0.8	0.7	0.7	0.8
Real labour costs market sector	0.2	0.2	0.2	0.2
Volumes				
Private consumption	0.3	0.4	0.5	0.7
Investments excluding dwellings	0.4	0.3	0.4	0.3
Exports of goods excluding energy	0.3	0.4	0.4	0.4
Imports of goods	0.5	0.6	0.6	0.7
Gross domestic product	0.1	0.2	0.2	0.2
Real net national income	0.4	0.4	0.4	0.5
Production market sector	0.2	0.2	0.2	0.2
Labour productivity market sector	0.1	0.1	0.1	0.1
Employment enterprises (fte)	0.1	0.1	0.2	0.2
Labour				
Total employment (persons)	0.1	0.1	0.2	0.2
Total labour supply (persons)	0.1	0.1	0.1	0.1
Ratios				
Unemployment rate (%)	− 0.0	− 0.1	− 0.1	− 0.1
Labour income share market sector	0.0	0.0	0.1	0.1
Current account (% GDP)	0.1	0.1	0.0	0.0
Tax burden (% GDP)	− 0.0	− 0.0	− 0.0	− 0.0
of which Direct taxes households (% GDP)	− 0.0	− 0.0	− 0.0	− 0.0
of which Indirect taxes (% GDP)	− 0.0	− 0.0	− 0.0	− 0.0
Social security premiums (% GDP)	− 0.0	− 0.0	− 0.0	− 0.0
EMU balance (% GDP)	0.0	0.0	0.0	0.0

Figure 4.1 Effects of an increase in world trade volume by 1%, by sector, balanced budget



4.1.2 Sectoral results

Figure 4.1 presents the results for production and employment by sectors. The results for services are more favourable than for manufacturing industry and particularly agriculture. A number of factors determine the effects for the various sectors. On the one hand manufacturing industry and agriculture are more export-intensive than services and the demand elasticities for most of the individual manufacturing industries are above unity which boosts demand, on the other hand manufacturing industry and agriculture are more subject to competition because of the more homogeneous character of their products. In the long run the rise in exports is even lower than for consumption as decreasing income taxes raise the demand of households. As the development of services depends for a larger part on consumption this explains the larger production effect on tertiary services in comparison to manufacturing industry. The production effect for agriculture is negative and lower than for manufacturing industry because of a demand elasticity below unity and a relatively high cost increase.

The picture for the development of employment resembles that for production but it is more pronounced. Besides an effect of increasing demand there is a negative effect on employment because of the rise in costs. Generally, in manufacturing industry and agriculture labour is more sensitive to a rise in costs than in the services industries.

4.2 A permanent increase in wage rates by 1%

The wage rate impulse is modelled as a permanent 1% upward shift in the level of the equation for contractual wages (2.15). Intuitively, the impulse may represent an increase in the relative bargaining strength of labour unions.

4.2.1 Macro results

Table 4.2 shows that the actual wage outcome is considerably higher in the short run than the ex ante increase in wage demands. The increase in wages drives up production costs and output prices and in Athena costs are immediately passed on to prices. In the long run the rise in wages decreases as the higher unemployment level weakens the fall-back position of workers. This negative feedback effect acts as a stabilizing force on wage inflation and in the long run diminishes the rise in real labour costs and the labour income share.

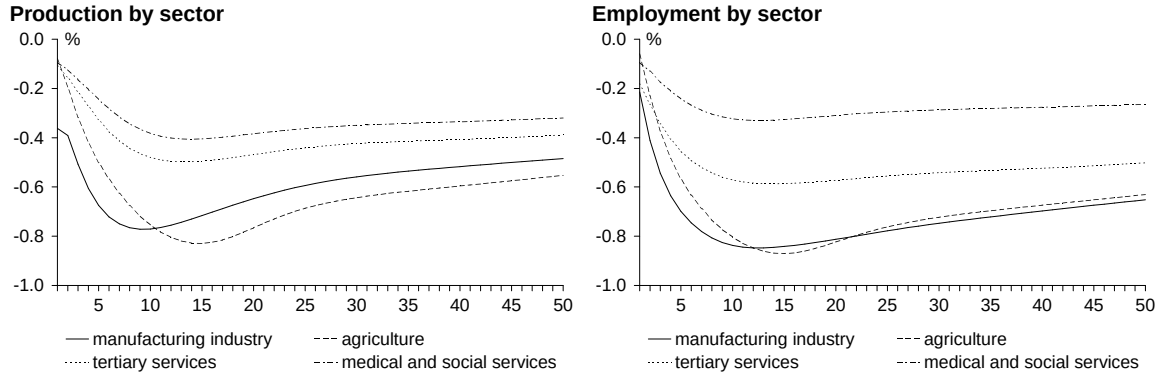
In the short run higher wages involve a rise in disposable income for wage earners. Disposable income of other households also increases as a result of the link between social security benefits and net wages. The increase in disposable income boosts consumption. The increase in labour costs weakens the competitiveness of Dutch exporters and the ensuing negative effect on exports dominates the positive effect of consumption on GDP. After a few years consumption is also negatively affected because disposable income diminishes through higher labour income taxes necessary to prevent a decline of the EMU balance. Moreover, lower employment decreases disposable income. Investments start falling more severely than other expenditures as a result of the decrease in the utilization rate. In the long run, as the standard utilization rate is reached, investments improve somewhat.

It takes about 10 years before a new equilibrium is attained after the wage rate impulse. Exports ultimately fall by 0.5% and GDP by 0.4% whereas the unemployment rate rises by 0.4%. Real net national income shows a somewhat smaller decline than GDP due to an improvement in the terms of trade.

Table 4.2 Effects of a permanent increase in wage rates by 1%, balanced budget

	Year 5	Year 10	Year 20	Year 50
	changes in %			
Prices				
Wage rate enterprises	1.4	1.1	0.9	0.8
Contractual wage rate market sector	1.2	0.9	0.9	0.7
Price private consumption	0.4	0.5	0.5	0.4
Price exports of goods excluding energy	0.4	0.5	0.4	0.3
Price production market sector	0.7	0.8	0.8	0.6
Real labour costs market sector	0.7	0.2	0.1	0.2
Volumes				
Private consumption	0.1	− 0.2	− 0.2	− 0.1
Investments excluding dwellings	− 1.1	− 0.9	− 0.5	− 0.4
Exports of goods excluding energy	− 0.5	− 0.6	− 0.7	− 0.5
Imports of goods	− 0.2	− 0.3	− 0.2	− 0.2
Gross domestic product	− 0.3	− 0.5	− 0.5	− 0.4
Real net national income	− 0.2	− 0.3	− 0.2	− 0.1
Production market sector	− 0.5	− 0.6	− 0.6	− 0.5
Labour productivity market sector	0.1	0.0	0.1	0.1
Employment enterprises (fte)	− 0.5	− 0.6	− 0.6	− 0.5
Labour				
Total employment (persons)	− 0.4	− 0.5	− 0.5	− 0.4
Total labour supply (persons)	− 0.1	− 0.1	− 0.1	− 0.1
Ratios				
Unemployment rate (%)	0.4	0.5	0.4	0.4
Labour income share market sector	0.5	0.1	− 0.0	0.1
Current account (% GDP)	− 0.0	0.0	− 0.0	− 0.0
Tax burden (% GDP)	0.1	0.1	0.1	0.1
of which Direct taxes households (% GDP)	0.2	0.2	0.1	0.1
of which Indirect taxes (% GDP)	− 0.0	− 0.0	− 0.0	− 0.0
Social security premiums (% GDP)	0.2	0.1	0.1	0.1
EMU balance (% GDP)	0.0	0.0	0.0	0.0

Figure 4.2 Effects of a permanent increase in wage rates by 1%, by sector, balanced budget



4.2.2 Sectoral results

Figure 4.2 presents the results for production and employment by sectors. The decrease in exports and investments exceeds the decline of consumption as higher real wages have a positive effect on the demand of households which partially compensates for the effect of lower employment. Compared to manufacturing industry and agriculture, the growth of services depends more on the development of consumption and therefore the slowdown in services is smaller.

For three sectors, agriculture, manufacturing industry and tertiary services the negative effect on employment is larger than the effect on production. The higher costs lower profits resulting in exit of firms. In the medical and social services sector (see Section 2.1.2) it is assumed that the number of firms is fixed, so there is no effect of entry or exit of firms. This mitigates the decline of employment in this sector.

4.3 An increase in labour supply of 1%

The impulse is implemented as an increase of 1% in structural labour supply.

4.3.1 Macro results

The extra job seekers initially enter the unemployment pool. The new job seekers are assumed to be entitled to unemployment benefits, which increases disposable income of households but also the labour income tax rate to prevent a fall of the EMU balance.

The main adjustment mechanism is through wages. Since wages show a lagged response to unemployment, it takes about ten years before the increased labour supply is fully absorbed in labour demand (see Figure 4.3). The mechanisms that restore labour market equilibrium are the same as those discussed in the wage rate simulation in Section 4.2. Lower wages bring about lower prices, higher profit margins and a more competitive position on foreign markets. Exports rise and imports fall. The increased demand for domestically produced goods and services boosts investments, which raises exports further.

Initially consumption is slightly lower on the transition path, as the fall in wages dominates the increase in employment. Effectively, households suffer from the deterioration in the terms of trade. The extra production that results from the expansion of labour supply cannot be sold on foreign markets without accepting a lower export price. As import prices do not fall, households do not profit proportionally from the reduction in production costs. The terms of trade loss therefore reduces the purchasing power of households. However, in the long run the effect on consumption turns out somewhat positive due to higher employment and slightly lower labour income taxes as the tax base broadens.

Table 4.3 Effects of an increase in labour supply of 1%, balanced budget

	Year 5	Year 10	Year 20	Year 50
	changes in %			
Prices				
Wage rate enterprises	− 2.2	− 1.8	− 1.3	− 1.1
Contractual wage rate market sector	− 2.1	− 1.6	− 1.3	− 1.0
Price private consumption	− 0.7	− 0.6	− 0.8	− 0.5
Price exports of goods excluding energy	− 0.5	− 0.7	− 0.7	− 0.4
Price production market sector	− 1.0	− 1.1	− 1.2	− 0.9
Real labour costs market sector	− 1.2	− 0.6	− 0.1	− 0.2
Volumes				
Private consumption	− 0.4	0.2	0.3	0.2
Investments excluding dwellings	1.2	1.6	0.8	0.5
Exports of goods excluding energy	0.5	0.8	1.0	0.7
Imports of goods	− 0.1	0.4	0.4	0.3
Gross domestic product	0.3	0.7	0.8	0.5
Real net national income	0.0	0.4	0.3	0.2
Production market sector	0.4	0.9	0.9	0.6
Labour productivity market sector	− 0.1	− 0.1	− 0.1	− 0.1
Employment enterprises (fte)	0.4	0.9	0.9	0.7
Labour				
Total employment (persons)	0.4	0.8	0.8	0.6
Total labour supply (persons)	0.8	0.8	0.8	0.6
Ratios				
Unemployment rate (%)	0.4	0.1	0.0	0.0
Labour income share market sector	− 0.9	− 0.5	0.0	− 0.1
Current account (% GDP)	0.1	− 0.0	0.0	0.1
Tax burden (% GDP)	− 0.1	− 0.1	− 0.1	− 0.1
of which Direct taxes households (% GDP)	− 0.2	− 0.2	− 0.1	− 0.1
of which Indirect taxes (% GDP)	0.0	0.0	0.0	0.0
Social security premiums (% GDP)	− 0.1	− 0.1	− 0.1	− 0.1
EMU balance (% GDP)	0.0	0.0	0.0	0.0

4.3.2 Sectoral results

Figure 4.4 shows the effects on production and employment by sector. The more exposed sectors agriculture and manufacturing industry profit the most from the Dutch cost advantage of lower wages. Since the improvement of competitiveness particularly benefits exports this result is no surprise. The rise in production is accompanied by an increase of employment. Due to entry of new firms as a consequence of the growth of welfare and the lowering of costs, the effect on employment is even more positive than the increase of production. However, this applies not to medical and social services where no possibilities for entry of firms exist.

Figure 4.3 Absorption labour supply of 1%

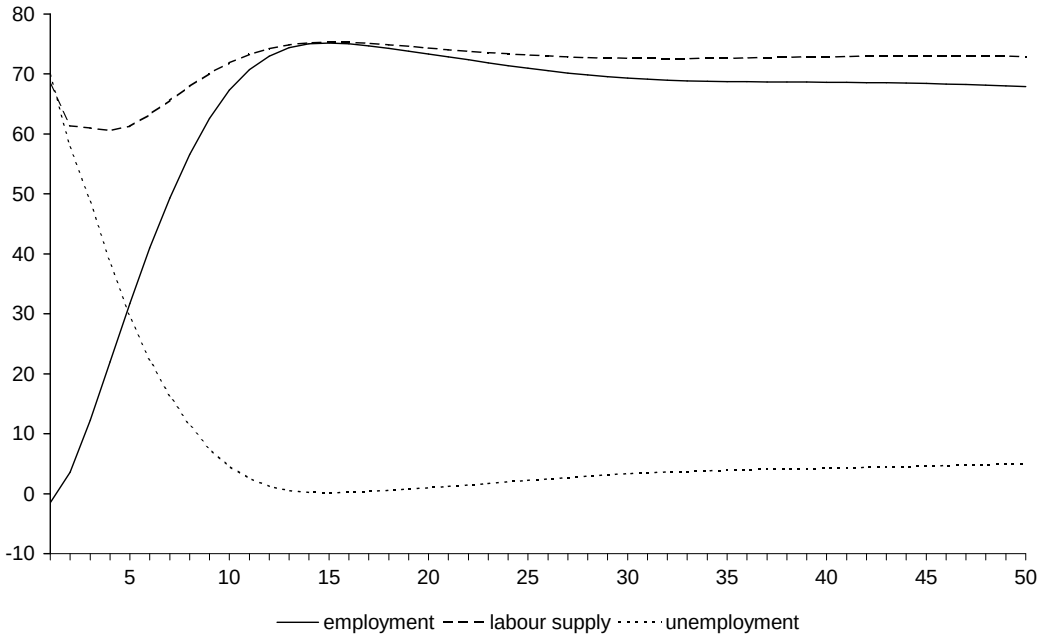
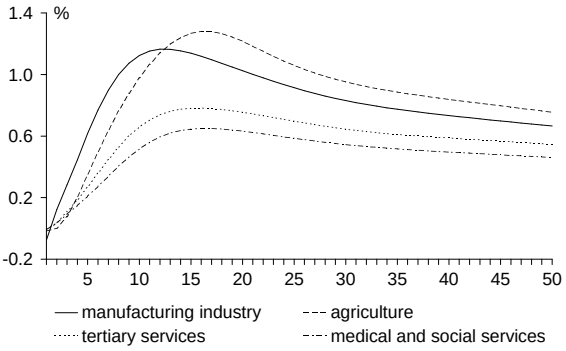
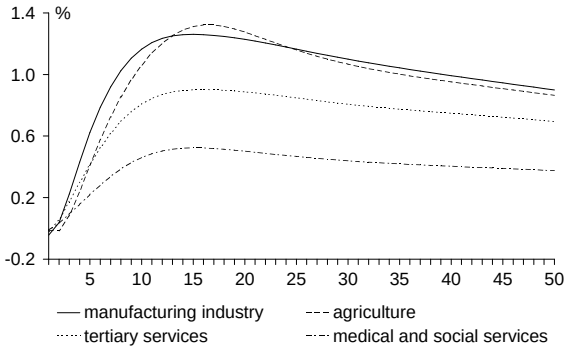


Figure 4.4 Effects of an increase in labour supply of 1%, by sector, balanced budget

Production by sector



Employment by sector



4.4 An increase in energy tax rates by 1% GDP

The impulse is modelled as a permanent increase in the tax rates of gas and electricity for households and firms.

4.4.1 Macro results

To keep the EMU balance unchanged, the increase in energy taxes on gas and electricity is compensated by a decline in wage and income taxes. Due to the lower taxes on wages, the gross wage rate can decrease. The use of energy is more expensive as a result of the higher tax rates. In the production structure, energy is assumed to be complementary to equipment. As a consequence of lower labour costs and the complementarity between energy and equipment the production process will be more labour-intensive and less capital- (and energy-) intensive. The lower capital-intensity will decrease labour productivity.

The effects on the unemployment rate are small. The rise of the energy taxes is accompanied by lower taxes on wages, and as a result the tax wedge is almost unchanged. The equilibrium rate of unemployment is almost the same as in the baseline.

GDP is lower in this simulation because of the decrease in labour productivity, while employment is almost unchanged. This decrease of GDP can also be explained by comparing the base of the energy tax to that of the tax on wages. Since the base of the energy tax is relatively small, it can be expected that the distortionary effects of this tax are larger when the same sum of money must be collected.

Table 4.4 Effects of an increase in energy tax rates by 1% GDP, balanced budget

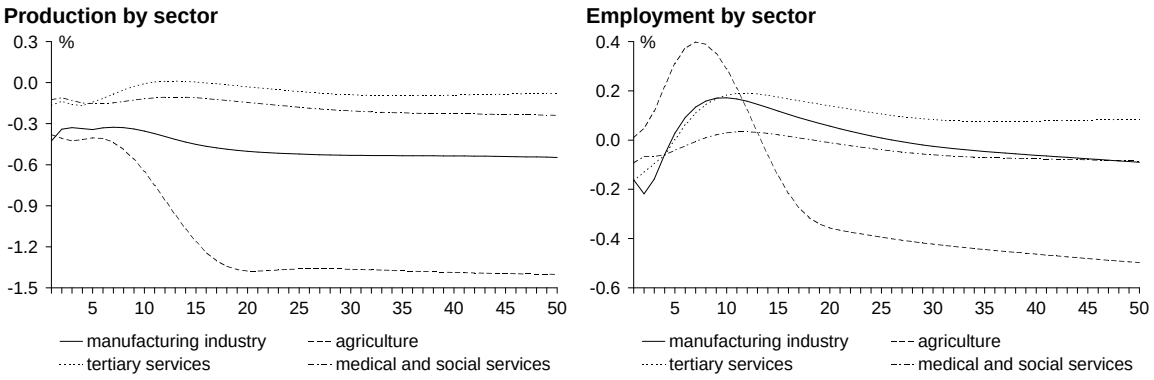
	Year 5	Year 10	Year 20	Year 50
	changes in %			
Prices				
Wage rate enterprises	− 1.8	− 1.5	− 1.3	− 1.2
Contractual wage rate market sector	− 1.7	− 1.3	− 1.2	− 1.2
Price private consumption	0.6	0.9	0.7	0.7
Price exports of goods excluding energy	0.0	0.2	0.3	0.3
Price production market sector	− 1.2	− 0.9	− 0.8	− 0.7
Real labour costs market sector	− 0.6	− 0.6	− 0.4	− 0.5
Volumes				
Private consumption	− 0.5	− 0.2	− 0.2	− 0.3
Investments excluding dwellings	− 1.4	− 0.7	− 0.7	− 0.6
Exports of goods excluding energy	− 0.2	− 0.4	− 0.5	− 0.6
Imports of goods	− 0.6	− 0.3	− 0.3	− 0.3
Gross domestic product	− 0.3	− 0.2	− 0.2	− 0.2
Real net national income	− 0.4	− 0.2	− 0.2	− 0.3
Production market sector	− 0.4	− 0.2	− 0.2	− 0.3
Labour productivity market sector	− 0.3	− 0.3	− 0.3	− 0.3
Employment enterprises (fte)	− 0.1	0.1	0.1	0.0
Labour				
Total employment (persons)	− 0.1	0.1	0.1	− 0.0
Total labour supply (persons)	− 0.0	0.0	0.0	− 0.0
Ratios				
Unemployment rate (%)	0.0	− 0.1	− 0.0	− 0.0
Labour income share market sector	− 0.2	− 0.2	− 0.0	− 0.1
Current account (% GDP)	0.2	0.1	0.1	0.1
Tax burden (% GDP)	− 0.1	− 0.1	− 0.1	− 0.1
of which Direct taxes households (% GDP)	− 1.1	− 1.1	− 1.0	− 0.8
of which Indirect taxes (% GDP)	1.0	1.0	0.9	0.8
Social security premiums (% GDP)	− 0.1	− 0.2	− 0.1	− 0.1
EMU balance (% GDP)	0.0	0.0	0.0	0.0

4.4.2 Sectoral results

Figure 4.5 presents the effects on production and employment by sector. Export prices rise because the exposed sector is confronted with an, in balance, increase in costs as the rise in energy costs exceeds the decline in wage costs for this relatively energy-intensive and labour-extensive sector. In the energy-extensive and labour-intensive sheltered sector costs decline. For the economy as a whole costs change only marginally.

Manufacturing industries and particularly agriculture are confronted with a rise in costs as energy costs exceeds the decrease in wage costs. Consequently production declines in these sectors. For tertiary services and medical services costs decline but the deterioration of competitiveness of Dutch producers also affects services through a negative development of intermediate deliveries and moreover sales of the health sector are directly linked to the growth rate of macro production.

Figure 4.5 Effects of an increase in energy tax rates by 1% GDP, by sector, balanced budget



4.5 An increase in value added tax rates by 1% GDP

The impulse is implemented as a permanent increase in the value added tax of households and the non-deductible value added tax of firms.

4.5.1 Macro results

A rise in the rate of indirect taxes is compensated by a decrease in wage and income taxes to prevent a higher EMU balance. The shift from wage taxation towards indirect taxes decreases the wedge because the tax base of wage and income taxes is larger than for indirect taxes and a small part of the indirect taxes is paid by the government itself. In the short run real labour costs increase as wages depend for 70% on the consumption price and this price is raised by the indirect tax rise. Therefore, employment declines.

The lower wedge decreases (real) labour costs in the long run because finally it is the production price and not the consumption price that matters. As a result wages and production price decrease, unemployment is somewhat lower and the GDP effect is slightly negative. As expected the long run effects of the shift in taxes remain small.

If the rise in indirect tax rates is not accompanied by a decrease in wage and income taxes the results will be negative. The price cut will deteriorate the competitiveness of Dutch producers and production and employment will decline.

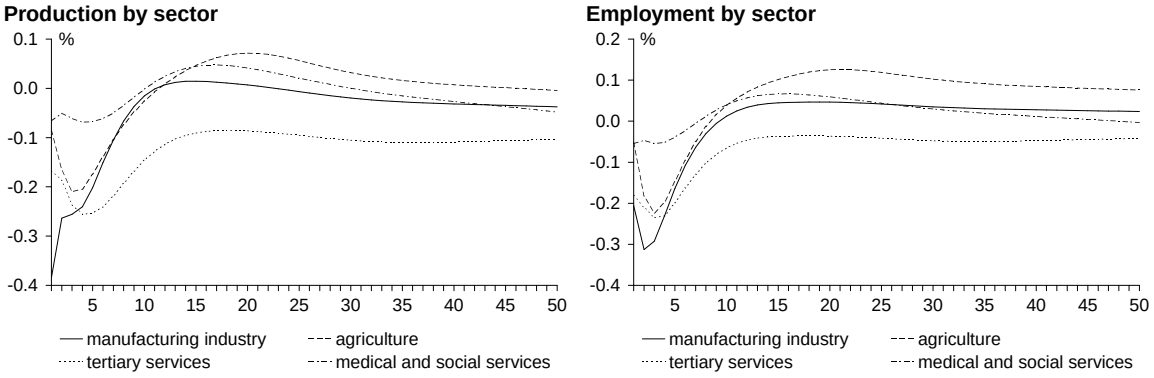
Table 4.5 Effects of an increase in value added tax rates by 1% GDP, balanced budget

	Year 5	Year 10	Year 20	Year 50
	changes in %			
Prices				
Wage rate enterprises	− 0.6	− 0.5	− 0.4	− 0.4
Contractual wage rate market sector	− 0.7	− 0.5	− 0.4	− 0.5
Price private consumption	1.3	1.5	1.4	1.4
Price exports of goods excluding energy	0.0	0.0	− 0.0	0.0
Price production market sector	− 0.3	− 0.1	− 0.3	− 0.3
Real labour costs market sector	− 0.3	− 0.3	− 0.1	− 0.1
Volumes				
Private consumption	− 0.4	− 0.1	0.0	0.0
Investments excluding dwellings	− 0.5	0.0	− 0.1	− 0.2
Exports of goods excluding energy	− 0.1	− 0.0	0.0	− 0.0
Imports of goods	− 0.4	− 0.1	− 0.1	− 0.1
Gross domestic product	− 0.2	− 0.1	− 0.0	− 0.0
Real net national income	− 0.2	− 0.0	− 0.0	− 0.1
Production market sector	− 0.3	− 0.1	− 0.0	− 0.1
Labour productivity market sector	− 0.1	− 0.1	− 0.0	− 0.1
Employment enterprises (fte)	− 0.2	− 0.0	0.0	− 0.0
Labour				
Total employment (persons)	− 0.2	− 0.0	0.0	0.0
Total labour supply (persons)	− 0.0	0.0	0.0	− 0.0
Ratios				
Unemployment rate (%)	0.1	0.0	− 0.0	− 0.0
Labour income share market sector	− 0.2	− 0.2	− 0.0	− 0.0
Current account (% GDP)	0.1	0.0	0.0	− 0.0
Tax burden (% GDP)	− 0.1	− 0.2	− 0.2	− 0.1
of which Direct taxes households (% GDP)	− 1.0	− 1.0	− 1.0	− 1.0
of which Indirect taxes (% GDP)	0.9	0.9	0.9	0.9
Social security premiums (% GDP)	− 0.0	− 0.0	− 0.0	− 0.0
EMU balance (% GDP)	0.0	0.0	0.0	0.0

4.5.2 Sectoral results

Figure 4.6 presents the effects on production and employment by sector. Since on the macro level production is hardly affected by the shift in taxes, it will be no surprise that in the long run the results for the sectors are small and lie between − 0.1% and 0.1%.

Figure 4.6 Effects of an increase in value added tax rates by 1% GDP, by sector, balanced budget



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