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Employment Impacts of Energy Conservation Schemes in the Residential Sector

Calculation of direct and indirect employment effects using a dedicated input/output simulation approach

A contribution to the SAVE Employment project

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Abstract
In this report, the relationship between investments in energy efficiency and employment is investigated. The employment effects of several energy conservation schemes implemented in the residential sector are determined by means of a dedicated input/output simulation approach. The employment effects of energy conservation schemes were determined for France, Germany, The Netherlands, Spain and the United Kingdom. Within the time frame of the project, it was not feasible to perform a comparable analysis for Greece, Ireland and Austria. For Finland, the employment effects of energy auditing schemes were investigated by means of a macro economic simulation model.

The main driving force behind the positive employment effect of investment in energy efficiency in the residential sector is the fact that the energy sector has a rather low labour intensity. The resulting shift of expenditures from the energy sector to other sectors with higher labour intensity leads to increased employment. The main mechanisms that determine the net shift in employment resulting from investments in energy conservation are:

1. The employment effect related to the initial investment in energy efficiency.
2. The energy saving effect. Due to the lower energy bill, a shift in expenditure pattern will occur from the labour extensive energy sector towards sectors with higher labour intensity, thus inducing a net positive effect on employment.
3. The effects of money transfers between sectors. For example, when the investment is subsidised by the government, money is transferred from the governmental sector to the residential sector.
4. Changes in the total government budget as a result of changes in total tax revenue and expenditures on unemployment benefits.

Different financing methods for the investment in energy efficiency are analysed. The initial investment can be financed from the general household consumption budget, by means of a loan, using a subsidy or using private savings. The following input parameters were varied, to investigate the sensitivity of the results: taxes and surcharges, type of energy saving, the rate of improvement of labour productivity, energy prices and household composition on total employment was investigated.

The main finding of this study is that investment in energy efficiency in the residential sector has a positive effect on total employment. However the employment effects of the programmes are generally small compared to the size of the investment. Therefore, environmental benefits should remain the main argument for energy efficiency programmes with job creation as a desirable side effect. The profitability of the investment, the type of investment and the financing method are the most important factors that determine the success of the energy conservation scheme.

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SUMMARY

Introduction
In the Save Employment project the possible impact of energy conservation policy instruments on employment has been studied. By means of case studies, detailed qualitative and quantitative information on the energy and direct employment impacts of a specific conservation instrument are provided. The output of the case studies is transferred to input for country specific input/output based models. In this report, the results of the analysis of the employment effects of case studies by means of dedicated input/output models are presented.

This simulation approach does include both an input/output table and consumer functions expressing the spending behaviour and commodity preferences of households. Input/output models consist of sets of matrices that represent the flows of delivery of goods and services by sector in an economy. In addition to an overview of intermediate deliveries between production sectors, it also depicts deliveries to so-called ‘final demand’ sectors. These final demand sectors are those sectors that do not use the delivered goods and services for further processing inside the economy (country) depicted. It concerns exports, investments (by companies and government) and consumer expenditures. The input/output system can also be used to show the requirements for production. In that case next to the intermediate deliveries not the final deliveries but the other inputs are added, standard it concerns labour costs, imports and banking services. Such systems can also be extended with sub-systems of physical input requirements like energy carriers per sector, man-years labour per sector, etc. Such extensions enable to calculate the impact on energy use or employment of a certain amount of production value in a sector.

By means of this approach, the indirect and induced employment effects of energy conservation schemes targeted at the residential sector have been quantified and analysed. The employment effects of energy conservation schemes were determined for France, Germany, The Netherlands, Spain and the United Kingdom. Due to problems with respect to data requirements, it was not feasible to perform a comparable analysis for Greece, Ireland and Austria. For Finland, the employment effects of energy auditing schemes were investigated by means of a macro economic simulation model.

Employment effects
The main driving force behind the positive employment effect of investment in energy efficiency in the residential sector is the fact that the energy sector is rather labour extensive. It is expected that due to the liberalisation of the energy market, the labour productivity of the energy sector will increase even more rapidly than for other sectors. So, a shift of expenditures from the energy sector to other sectors leads to an increase of employment. An investment by households in energy conservation will lead to a decrease in expenditures on energy (a reduction of the energy bill). The amount of money saved can now be used for other purposes, e.g. the purchase of appliances or services. As a result, a shift in the expenditure pattern of the households is observed from the energy sector towards other sectors with higher labour intensity. This is the general mechanism that explains why the investments related to the reduction of the energy bill, the so-called ‘energy saving effect’ will lead to an increase in employment.

Different mechanisms can be identified that determine the net shift in employment resulting from investments in energy conservation. The main mechanisms are:
- The employment effect related to the initial investment in energy efficiency. This effect occurs in the base year only. Whether the initial investment leads to a positive of negative employment effects depends on the financing method and country specific characteristics such as the expenditure pattern of the consumption budget and the labour intensity of industrial sectors.

- The energy saving effect. Due to the lower energy bill, a shift in expenditure pattern will occur from the labour extensive energy sector towards sectors with higher labour intensity, thus inducing a positive effect on employment.
- The effects of money transfers between sectors. For example, when the investment is subsidised by the government, money is transferred from the governmental sector to the residential sector. The net effect of this mechanism depends on the assumption made with respect to what the government would have done with the money used for the subsidy otherwise.
- The effects of changes in tax revenue. Since the expenditures on energy are reduced, the tax revenue (e.g. VAT) associated with energy consumption is also lowered. This results in a decrease in the governmental budget. However, this effect is compensated by the increase in tax revenue associated with expenditures on other goods and services (rebound effect). This effect may become of increasing importance in case a difference in VAT is being made between purchases of goods (high VAT) and services (low VAT). This distinction in height of taxes can be considered as a measure to stimulate expenditures on labour intensive services rather than on labour extensive goods.
- Total governmental expenditure on unemployment benefits. A decrease in unemployment leads to a decrease in total governmental expenditures on unemployment benefits. The decrease in governmental expenditures can now be used otherwise. If for example the revenue of the decrease in unemployment benefits is returned to the residential sector, total household expenditures are increased, thus increasing total employment related to household expenditures.

Financing investments on energy conservation
Investments in energy saving in the residential sector can be financed by different financing methods. In practice, investments in energy conservation might be financed by a combination of these options. The financing methods considered in this study are:
- financing from the general consumption budget,
- financing by means of a subsidy,
- financing by means of a loan,
- financing by means of private savings.

By means of a fictional though representative reference conservation scheme, the employment effects of the different financing methods are determined. Under the assumption that the subsidy is granted by the government from the general governmental budget, it is concluded that financing investments in energy conservation is more beneficial to employment when the investment is financed from the general consumption budget compared to financing by means of a subsidy. The grant induces a net transfer of money from the governmental sector to the residential sector, thus increasing total household expenditures and decreasing total governmental expenditures. Since the average labour intensity related to governmental expenditures exceeds the average labour intensity related to household expenditures, the transfer of money from the government to the residential sector has a negative effect on employment. The employment effects related to financing investments in energy conservation by means of a loan and private savings could only be assessed partially, since the investment behaviour of the banking sector was not modelled dynamically. However, investment in energy efficient equipment is generally considered to have a positive macro-economic effect. Therefore, it is expected that investments in energy conservation by means of a loan will have slightly higher positive employment effect in comparison to financing energy conservation from the general consumption budget.

By means of a sensitivity analysis, the robustness of the outcome of the modelling is investigated. Therefore, the effect of varying of taxes and surcharges, the type of energy saving, improvement of labour productivity, development of energy prices and the household composition on total employment was investigated.

Employment effects induced by the case studies

For France, large positive employment effects are found over the lifetime of the energy conservation option for the Income Tax Incentive scheme (71,000 labour years). The employment effect of the Environmental Building scheme amounts to 82 labour years and the employment effect of the Energy Management programme amounts to 190 years. However, when a comparison between the total investment and the total employment generated by the programme, it appears that labour effectiveness of the Energy Management is more than twice as high compared to the other programmes.

For Germany, the employment impact of the Thermal Insulation programme is positive for the period up to 2010 (40,100 labour years), but only slightly positive over the lifetime of the option (3,800 labour years). The Ordinance on Heating Systems shows positive employment impacts up to 2010 (19,600 labour years). The CO_2 abatement programme shows a negative employment effect of 1,100. This is particularly due to the strong negative impact of the government budget shift.

For The Netherlands, two energy conservation schemes have been considered. The EPN scheme on standards for new dwelling results in a net increase of total employment by 1,000 labour years. It should be noted that the total investments exceed the total monetary savings by about 35%. So, from a strict economic point of view, this programme can be considered as not cost effective. Despite the lack of economic profitability, the programme induces positive employment effects. The condensing boiler programme induces a total cumulative employment effect of 3,800 labour years over the period 1995-2010. Additional calculations show that the employment effect induced by a decrease in governmental expenditure on unemployment benefits may increase the total employment effect by about 13%.

For Spain, the DSM programme has been analysed. The total cumulative employment effect amounted to about 3,350 labour years over the period up to 2010. However, if the same amount of money were invested in the construction sector instead of the electrical equipment sector, total cumulative employment would rise to about 4,950 labour years, assuming that the total monetary savings are comparable. In a scenario with constant electricity prices, instead of decreasing as in the base line case, total cumulative employment increases from 3,350 labour years to 4,200 labour years.

For the UK, five case studies have been analysed. The HEES programme induces a net increase in employment of 3,800 labour years. Since the programme is subsidised for 100% by the government, the employment impact per pound invested is rather low. If it were financed from the general expenditure budget, a net increase in cumulative employment of about 23,000 labour years is found. The SoP programme results in a cumulative employment impact of 12,250 labour years over the period 1995-2010. Although the HEES programme and the SoP programme are virtually identical, the investment in the SoP programme is financed by the residential sector itself. Moreover, the profitability of the SoP programme is higher in comparison to the HEES programme. This explains the larger positive employment effects per pound invested of the SoP programme. Despite a lack of economic profitability, the Heatwise programme has small positive cumulative employment effects (42 labour years). The main reason for the existence of a net positive employment effect is the fact that the main part of the investment is spent on services, which is rather labour intensive compared to e.g. the construction sector or the electrical equipment sector. The programme on New Building Regulations is for almost 100% financed by the household sector. The total cumulative employment effects amount to 7,100 labour years. The Fridgesavers programme can be considered as a small though profitable programme. Despite that, the investment is financed by the government for about 78%, since the programme especially aims at low income households. The total cumulative employment effects amount to 270 labour years.

For Finland, the macro economic effects of investments on energy efficiency are investigated by means of the FMS-model, a macro economic simulation model of the Finnish economy. Both the investments in energy conservation in the public sector as well as in the industrial sector resulted in an increase in GDP as well as employment. Total investments on energy auditing programmes amount to 23.8 MECU per year. As a result, total employment in 2010 increases by about 780 labour years and total primary energy use decreases by 2,400 TJ.

Conclusions and recommendations

Based on the outcome of this study, it is concluded that investment in energy efficiency in the residential sector induces a positive effect on total employment. However the employment effects of the programmes remain in general small compared to the investment size. Therefore, the main argument for energy efficiency programmes should remain environmental benefits with job creation as a desirable side effect. The profitability of the investment, as well as the type of investment and financing method are the most important factors that determine the success of the energy conservation scheme. An increase in profitability of the investment leads to higher employment effects. Granting of a subsidy on the investment by the government leads to a decrease in employment if a corresponding reduction in general government expenditures is assumed. However, for specific programmes these grants are unavoidable since these programs aim specifically at low-income households.

In future research, more attention should be paid to the monetary flows between sectors and to intertemporal flows. In the approach taken in this study, the behaviour of the government and the service sector (e.g. banks) is modelled statically. As a result, some ‘worst case’ assumptions had to be made in order to be able to estimate the employment effects induced by shift in governmental expenditures. Moreover, the effects of excise taxes and surcharges should be studied in more detail, since it is expected that their effect on employment will become of more importance in future.

1. INTRODUCTION

Investing in energy efficiency can save money. There are many other possible benefits, in addition to this basic reason for making such investments. Energy efficiency increases can contribute to the central aims of energy policy such as improved competitiveness, security of energy supply and environmental protection. Such investment can have also positive impacts on the labour market. The generation of employment, particularly in relatively unskilled occupations, is of increasing importance within the EU.

The aim of energy conservation is not to achieve employment. However, employment generation is a desirable effect, and this may vary by type and by scale of the investment. Policy makers do not, at the present time, have adequate data about the employment effects of investment in energy efficiency. The information available is often in an aggregate form for use at the national or international level.

In the Save Employment project the possible impact of energy conservation policy instruments on employment has been studied. Case studies provide detailed qualitative and quantitative information on the energy and direct employment impacts of a specific conservation instrument. The output of the case studies is transferred to input for country specific input/output based models. This dedicated input/output simulation approach does include both an input/output table and consumer functions expressing the spending behaviour and commodity preferences of households. By means of this approach, the indirect and induced employment effects of energy conservation schemes targeted at the residential sector have been quantified and analysed.

Within the project, the following complementary tasks are identified:
1. Case studies-*micro level*-detailed information for selected policy programmes and instruments, impact assessment of incremental energy and direct employment effects in qualitative and quantitative terms, and a provisional instrument effectiveness rating.
2. Consumption- I/O models-*meso level*-detailed assessment of direct and induced impacts of programmes and instruments for the *residential* sector, contribution to provisional instrument effectiveness rating.
3. General Equilibrium model (GEM-E3)-*macro level*-assessment of packages of instruments, package selection based on the provisional rating carried out in other tasks and implying an initial impulse to the national economy of at least 0.1% of GDP.

This report deals with the second task. Separate reports are published on the case studies and the analysis by means of the GEM-E3-model. The Netherlands Energy Research Foundation (ECN), The Netherlands, served as task leader of the second task. The Association for the Conservation of Energy (ACE), United Kingdom, was in charge of the overall project co-ordination.

For The Netherlands, Germany, France and Finland, dedicated input/output based model already existed. These models were updated and extended with employment modules in order to simulate the development of employment. For Spain and the UK, comparable models have been designed especially for the purpose of this project. Due to problems with respect to data requirements, it appeared not to be feasible to develop similar models for Greece, Ireland and Austria.

The outline of the report is as follows. First, the general methodology used in this project is described (Chapter 2). Next, the approach to determine the employment effects is worked out (Chapter 3). In this Chapter, the different financing options are described as well as the reference and intervention scenario. Some simplified examples are given in order to demonstrate the effects on employment of the different mechanisms involved. A description of the country specific models used in the analysis is given in Chapter 4. In Chapter 5 the different financing methods for energy conservation is addressed. By means of a fictional reference conservation scheme, the impacts on employment are analysed. The financing methods considered are financing energy conservation from the general consumption budget, financing energy conservation from a loan, financing energy conservation from grants and financing energy conservation from private savings.

The employment impacts are broken down into several explanatory effects such as the initial investment, grants, surcharges and monetary savings as a result from a reduction of the energy bill. In Chapter 6, the employment effects resulting from energy conservation schemes in the residential sector are reported for France, Germany, The Netherlands, Spain and the UK. For Finland, the macro-economic effects of an energy auditing scheme targeted at the industrial sector are given. The analysis includes a brief description of the case studies as well as the development of employment and unemployment. The results of the sensitivity analysis are given in Chapter 7. The sensitivity analysis constitutes of an analysis of the effects of employment from a variety of taxes and surcharges, the type of energy saving, improvement of labour productivity, development of energy prices and the household composition. In Chapter 8, the results of the model simulations are discussed. Based on these findings, conclusions are drawn with respect to the possible opportunities to improve the effectiveness of energy conservation schemes and recommendations for future research are formulated.

2. GENERAL METHODOLOGY

Within the project 'SAVE Employment' several approaches have been used to determine the employment effects of energy efficiency investments (see Figure 2.1). The following description focuses on one of these approaches, namely the use of lifestyle-oriented energy-economy-environment (LO-E^3) models. These models have originally been developed for investigating the future development of energy consumption and related emissions (cf. Weber et al., 1996a; Weber et al., 1996b; Perrels et al., 1996; Pellekaan et al., 1996). Within the present project they have been extended to cope also with employment effects.

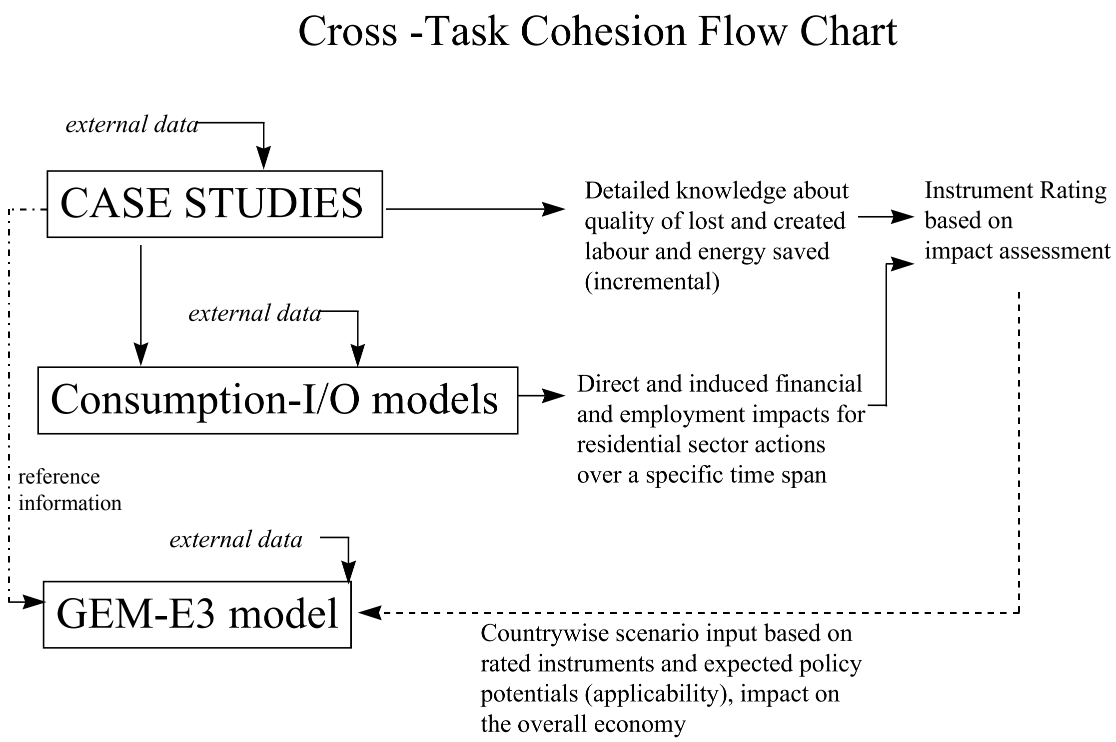


Figure 2.1 *Approaches used and their interconnections*

The lifestyle-oriented energy-economy-environment models consist of two major parts:
- A detailed model of household behaviour.
- An Input/output model.

Within the project, as indicated in Figure 2.1, the LO-E^3-models hold a somewhat intermediate role between the case studies, which provide rather detailed information on a limited scope of employment effects (in particular direct employment effects), and the General Equilibrium Model, which is able to cope also with various indirect effects but only at a rather aggregated level.

In the following first the modelling philosophy (Section 2.1) and then the two major model components (Sections 2.2 and 2.3) are briefly sketched. In Chapter 3, the use of the models within the SAVE employment project is described.

2.1 Modelling approach

Starting point for the development of the lifestyle-oriented energy-economy-environment models has been the observation, that private consumption accounts directly or indirectly for the major part of energy use in a country – and the same holds also for employment. In the past the impact of technical and economic factors on household behaviour had been investigated repeatedly, yet the role of socio-demographic and lifestyle factors had so far not been accounted for in detail. This has therefore been the major aim of the model development. Thereby the focus has been on the determination of detailed empirical relationships based on micro data sources, especially household surveys from the national Statistical offices. Throughout the household types listed in Table 2.1 have been distinguished to account for the differences in household consumption patterns resulting from different lifestyles[1].

Table 2.1 *Household types considered*

Household type	Number of adults	Number of children	Age of reference person
Young singles	1	0	below 35 years
Young couples	2	0	below 35 years
Young one-parent families	1	1 or more	below 35 years
Young families	2	1 or more	below 35 years
Middle-aged singles	1	0	from 35 to below 60 years
Middle-aged couples	2	0	from 35 to below 60 years
Middle-aged one-parent families	1	1 or more	from 35 to below 60 years
Middle-aged families	2	1 or more	from 35 to below 60 years
Elderly singles	1	0	60 years and more
Elderly couples	2	0	60 years and more
Others[2]	2 or more	any	any

A distinctive feature of the lifestyle-oriented energy-economy-environment models is that they are based on a concept of limited rationality and especially limited anticipation (cf. Weber, 1999a; Weber, 1999b). This contrasts in particular with general equilibrium models, which in general assume perfectly rational agents in order to obtain market equilibria in prices and quantities on all markets. LO-E[3] models on the contrary in their current formulation do not account for market equilibria on all markets, especially the income and the investment loop so far are not closed. What can be regarded as a drawback from the viewpoint of conventional economic modelling offers the advantage that empirical relationships may be modelled in much more detail. Furthermore the model formulation is more transparent and hence more accessible to non-experts in an interdisciplinary and/or policy discourse.

Two fundamental differences exist between an input/output based model and a general equilibrium model (Konijn, 1994). First, the input/output model does not include a price mechanism. By the assumption of fixed input/output coefficients, all interdependencies between prices and quantities of commodities have been dropped. In the input/output framework, prices and quantities are determined independently. In a classic I/O-model, a price change of a certain commodity does not influence the demand, nor the supply, for that commodity. However, in the dedicated I/O-models used in this study, the dynamics of consumption are incorporated in the model by means of a set of expenditure functions. Since the supply by industries is determined only by demand, the input/output approach can be characterised as demand-driven. Secondly, the input/output approach does not necessarily describe an equilibrium situation.

1 The importance of household composition for lifestyles is underpinned by (Konietzka, 1995).

2 This household type comprises households with more than two generations (enlarged families) as well as one-parent families and families with a reference person older than 60. For The Netherlands these households have been reattributed to other household types, therefore the household type 'others' is empty.

Final demand usually contains an item called ‘stock changes’, so that one cannot tell whether demand and supply have actually met during that specific period. An input/output based modelling approach provides a reliable and consistent set of data, which can be used to analyse the economy.

Another important result in neo-classical economics is that in a perfect competitive world, in an equilibrium situation, no excess profits can be made. In an input/output table, the differences between revenues and costs per industry are taken to be the profits of the industry. Thus, either the economy is not a perfect market or the market is not in equilibrium. Both assumptions are likely to be true. However, for a general equilibrium model, market equilibrium and perfect market conditions are basic starting points and unemployment is considered as a market imperfection which is supposed not to exist. It can be included in the modelling framework as shown by the neo-classical synthesis, yet then the results are quite dependent on the specific formulation chosen.

2.2 The household behaviour model

The calculation of the total energy and employment effects of household consumption is based on descriptions of the consumer behaviour and the production structure. This section deals with consumer behaviour. Since many aspects of consumer behaviour are energy relevant, detailed models, combining techno-economic approaches with lifestyle concepts, are required. In particular in view of the projection of future energy use a distinction should be made between:
- Appliance, car and dwelling stock and their related direct energy use.
- Expenditures for other goods.

For the present project, where the impact of energy efficiency programs on stocks and energy use is determined in separate case studies, the detailed treatment of the first aspect is not that necessary. However an integrated treatment, as realised in particular in the German model (cf. Weber, 1999a) is clearly preferable. It is in general supposed that households have an implicit or explicit notion of hierarchy in their budget (Hagenaars et al., 1988; Deaton et al., 1980). This assumption is therefore also applied here to the estimation of expenditure functions, resulting in a multi-stage budgeting concept. The fully integrated approach applied for Germany is illustrated by means of Figure 2.2.

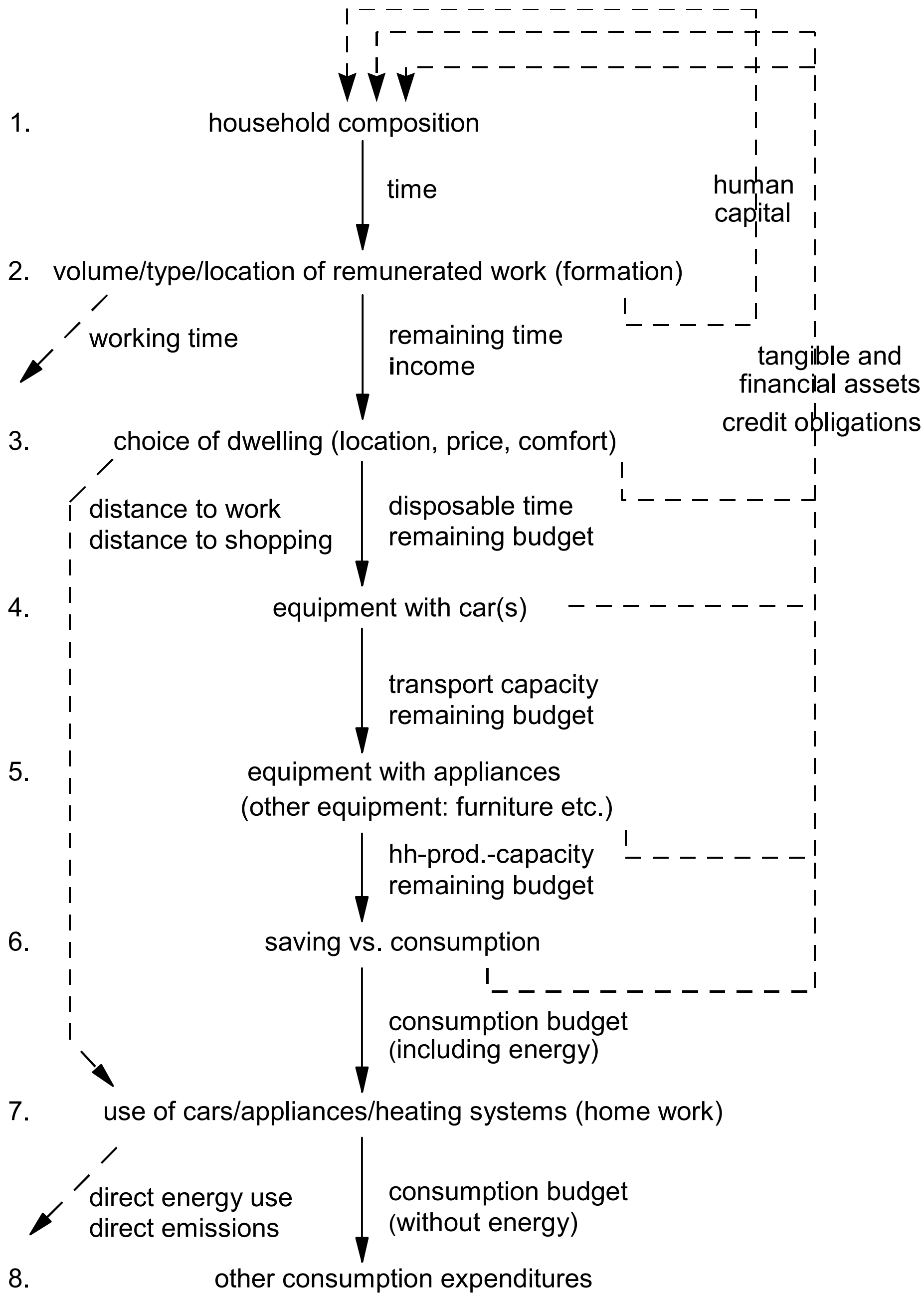


Figure 2.2 *Integrated hierarchical model for the analysis of environmentally relevant household decisions, especially in the field of energy use and air-borne emissions of the German E^3-life model*

In the other countries not exactly the same approach has been applied, yet for all countries the following broad expenditure categories have been distinguished:
- food
- clothes
- home
- leisure
- transport
- health.

Given the allocated budget shares for these main groups, more detailed decisions have to be made on how to spend the budget meant e. g. for food to different sub-categories. In general a total of 16 subcategories has been distinguished with some national specificities due to restrictions in data availability.

In the expenditure functions that were estimated, one of the explanatory variables is an ‘income’ variable. It can be questioned which income measure will be used, viz. gross income, net income or total expenditures. Since in expenditure functions, budget shares are considered, with a budget share denoting the share of consumption of a good or group of goods relative to total expenditures, it is desirable to include total expenditures as explanatory variable. However, as part of scenario preparation a growth path of net income has been defined. This means that within the model system of which the sets of expenditure functions are a part, net income is an endogenous variable. Yet, households may still decide not to spend their entire net income, and indeed in most cases they save as well. Therefore the difference between net income and total expenditures, called (free) savings, has to be defined and assessed. As a consequence, prior to the estimations of expenditure functions, a savings function is estimated.

All expenditure and saving functions have been estimated for the case of The Netherlands, Germany and France using micro data from the national statistical offices. In a first step the relations between budget shares for different categories of goods and household characteristics like income, household size (number of members), age of head of family and education level have been analysed using cross section data. For Spain, the United Kingdom and Finland a slightly different approach has been taken, see also Sections 4.4, 4.5 and 4.6.

In a second step based on these estimation results in connection with time series for the explanatory variables, ‘residual’ time series have been constructed, from which influences of household characteristics are thus subtracted. These residual series have then been (re)estimated by using time series data on prices and a trend variable if necessary. A description of the complete estimation procedure is found in (Pellekaan et al., 1996). Since evolving consumption patterns are a focal point of the lifestyle-oriented models it has been taken into account that each household type defined in Table 2.1 has specific consumption behaviour. So, estimations are carried out for each household type, as far as sufficient data are available. However with respect to time series estimation for the 16 subgroups of goods, data limitations only allowed to consider a restricted number of groups.

2.3 The Input/output model

In order to determine the overall energetic impact of household behaviour, not only the direct energy use of households, but also the energy consumption occurring in the production both of energy carriers and other goods delivered to households have to be investigated. This requires an investigation of the production processes and their interconnections. Such an investigation is a fortiori necessary if the employment impact of consumption decisions is to be analysed. In this section, the methodological aspects of this ‘back-tracing’ of a given consumption vector through the production system are discussed.

For determining the employment impact of the production of given consumption items an Input/output model can be used. In Figure 2.3 the Input/output tables necessary for the determination of total energy requirements or total employment effects for a given final demand of households are represented. These are additional to the first and second quadrant of standard Input/output tables, i. e. the matrix of intersectoral flows X and the matrix of deliveries to final demand Y also so-called fifth and sixth quadrants, which contain the energy consumption (matrices S^x and S^y), pollutant emissions (matrices W^x and W^y) or employment by staff categories (matrix G^x) of each sector in the economy respectively for each component of final demand.

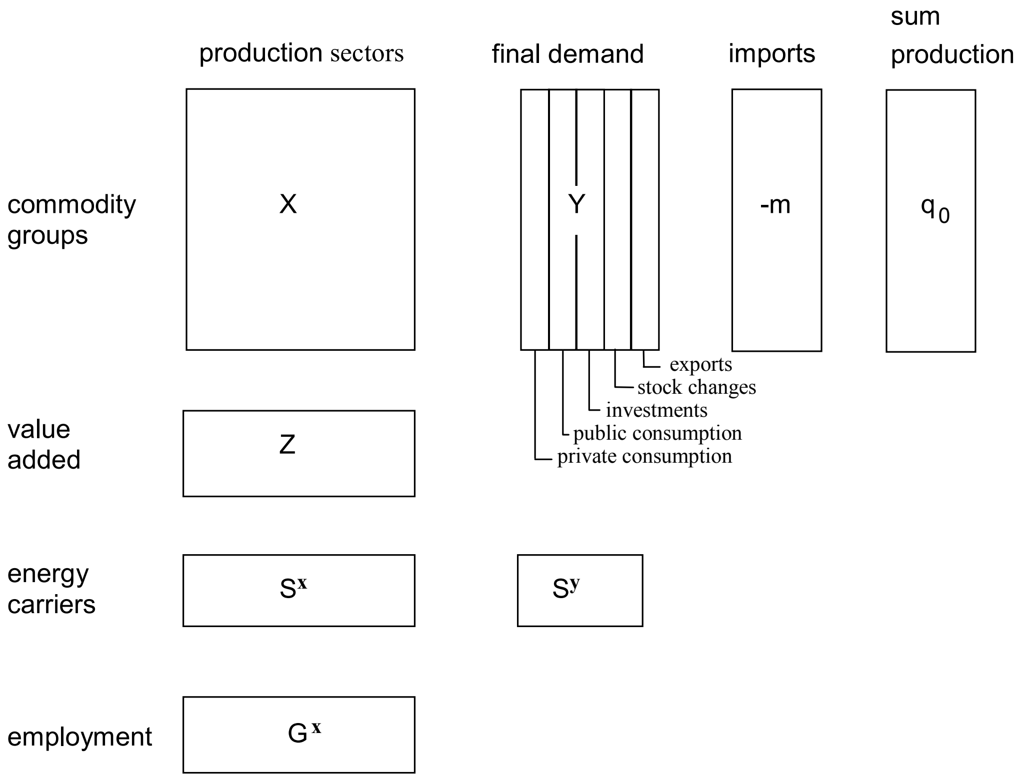


Figure 2.3 *Structure of Input/output tables used*

From X together with the vector of sectoral production values q_0 the Input-coefficient matrix A may be deduced via:

$$A = X < q_0 >^{-1} \qquad (1)$$

Then the total production requirements q for the production of a given final demand y may be determined using the static open Leontief-model which can be written in general terms as:

$$q = Aq + y \qquad (2)$$

Therefrom one obtains

$$q = Cy \quad \text{with the Leontief - Inverse } C = (I - A)^{-1} \qquad (3)$$

In a closed economy without imports the production requirements q are equal to the national production values q_0 if the final demand vector y equals the total final demand. In an open economy this is not always valid, but depends on the type of Input/output tables used. If imported goods are treated similar to domestic deliveries, i. e. are also included in the matrices X and Y, then the Input coefficient matrix A represents the so-called technical coefficients, that is the total production requirements per unit of output. The Leontief-Inverse C and the production vector q in turn then include total cumulated production requirements-be it domestic or abroad. These are then determined under the implicit assumption that the foreign production structures are similar to the domestic ones.

Another possibility is that only domestic (national or EU-wide) deliveries are included in the matrices X and Y. In this case the production values obtained through Equation (3) correspondingly only include domestic production, i. e. at a national or EU-wide level.

From the total production requirements *q* by using the employment-input coefficient matrix *Fx*:

$$F^x = G^x < q_0 >^{-1} \qquad (4)$$

The total employment effects *CEE* for the given final demand *y* can be deduced via:

$$CEE = F^x\, q = F^x\, C\, y \qquad (5)$$

As stated for the production values *q* also the cumulated employment effects *CEE* can be determined at a worldwide, EU or national level.

In order to connect household expenditures with emissions and energy requirements in the production sectors, the expenditures by expenditure categories as derived in Section 2.2 have to be redistributed according to the sectors of the Input/output system used. Therefore a connection matrix has been derived based on tables provided by the national statistical offices.

It could be argued that the increase in final demand does not directly create actual jobs, since the increase in final demand could be fulfilled by improving the labour productivity. However, an increase in labour productivity implies that the profitability of the production sector increases. This has a positive effect on the economy and will increase employment. If the increase in final demand can not be fulfilled by increasing the labour productivity, people have to be hired and (temporal) jobs are created. An increase in final demand could also mean that less people lose their jobs, since the employment effect calculated is the difference between the reference scenario and the energy conservation case. In this study, a linear relationship between final demand and labour is assumed.

3. THE APPROACH TO DETERMINING EMPLOYMENT EFFECTS

With the model sketched in Chapter 2, different employment effects of energy efficiency measures may be determined. Given the emphasis LO-E[3] models put on the consumption side of the economy, they are particularly suited to treat energy saving options for consumers. They are less suited for dealing with the production sectors and they will consequently not be used to analyse energy efficiency measures in this field.

In this Chapter, the different causes behind the changes in employment are discussed first. Next, the reference scenario and the intervention scenarios are described. After that, the different methods for financing an investment in energy saving are outlined. Based on these mechanisms, some illustrations are given to demonstrate the relationship between employment, investment and savings. Finally, the different elements of the sensitivity analysis are described.

3.1 Analysis of changes in employment

For energy efficiency measures for households in particular, the following effects can be computed by means of the lifestyle-oriented energy-economy-environment models (cf. Weber 1998):

- *Direct purchase effects*
  The purchase of energy-efficient devices induces directly employment in the sector manufacturing the device[3].
- *Indirect purchase effects*
  The purchase of energy-efficient devices leads also to an increase of the demand from manufacturers of the energy efficient devices for input of goods from other sectors (e. g. steel), inducing thereby in these sectors additional employment.
- *Decrease in energy consumption*
  The reduced demand for energy caused by the energy-efficient device also induces losses in employment in the energy supply sectors and the sectors delivering to those[4].
- *Household budget effect*
  The extra money spent on energy efficient devices resp. the money saved on the energy bill modifies the budget available to the household. This leads to changes in the remaining consumption pattern (or in the savings) of the household which has direct and indirect employment effects. Part of the extra money is likely to be spent on energy consuming activities, e.g. appliances. This rebound effect is taken into account.
- *Government budget effect*
  If the purchase of energy efficient devices is induced through some governmental program[5] (and not through preference changes of consumers), this commonly also involves some kind of governmental expenses. These may also lead to modifications in the remaining government budget with employment effects as a consequence.

[3] In the short term this might be overtime work for existing staff instead of additional jobs. However this effect is not accounted for by the input/output model which assumes a linear relationship between work input and production output.
[4] Note that this effect occurs over the lifetime of the energy-efficient device, whereas the previous ones are at the moment of purchase.
[5] The same applies mutatis mutandis to programs of other actors such as energy utilities.

There exist further, more indirect effects such as rebound and price effects that potentially may also affect employment (see Weber, 1998). Yet, the importance of these more indirect effects is not always evident. Moreover, if these effects can be treated at all, then mostly at a rather high level of aggregation (cf. the CGE models) and then a considerable number of interesting details, e. g. the type of jobs created and the sectors concerned is neglected.

In order to compute the aforementioned effects listed above, a comparison of two scenarios needs to be made:
- A reference scenario, which describes some kind of business-as-usual scenario without policy intervention.
- A policy intervention scenario, accounting for the specific measure to be investigated.

In the following, first the basic assumptions of the reference scenario are described in Section 3.2. Then in Section 3.3 it is explained how the intervention scenarios are constructed from the outcomes of the case studies. Section 3.4 deals with the important aspect how the financing of the energy efficiency investment is accounted for. In Section 3.5 an illustration is given of the relationship between investments, budget re-allocation and employment. Finally in Section 3.6 the methodology for sensitivity analysis to assess the robustness of results is discussed.

3.2 Reference scenario

The reference scenario should reflect a plausible development of energy use and employment in the case that no specific measures to enhance energy efficiency are taken. Given the European context of the project it seems advisable to choose as reference a scenario already in use at the EU level. Therefore the baseline case given in (Capros, 1997) is taken as starting point. The major developments taken from this study are summarised in Table 3.1. In particular GDP and energy price developments relevance. For some countries, more recent prognoses provided by the national government are available. Any deviations from the scenario described in (Capros, 1997) are given in the description of the scenario inputs given in Chapter 6.

Table 3.1 *Development of energy prices and GDP according to (Capros, 1997) [% p.a.]*

	1990-1995	1995-2000	2000-2010
Oil price	-6.4	-0.2	3.1
Gas import price	-2.4	2.9	3.4
GDP growth			
Finland	-0.7	3.2	2.2
France	0.9	2.2	2.2
Germany	1.6	2.5	2.4
The Netherlands	1.8	2.9	2.6
Spain	1.5	3.1	2.9
United Kingdom	1.3	2.9	2.6

The development of labour productivity is taken from national sources such as (Prognos, 1993) for Germany. For the purpose of the lifestyle-oriented models it is split up into two parts: the development of labour productivity per time unit and the development of average labour time. For the latter corresponding to (Weber et al., 1996a), a diminution of 0.5% per year is assumed, due in particular to an increased share of part time jobs.

The linkage between these macro-economic developments and the household income and employment is realised through a socio-economic module within the LO-E^3 models.

3.3 Intervention scenarios – from case studies to model input

The aim of the study is to quantify the (direct and) indirect employment effects of energy efficiency programs. The focus is on energy efficiency programs that have been realised in the past years and that have been evaluated by means of case studies within the project. These case studies have delivered the information summarised in Table 3.2 (Wade et al., 1999). For the intervention scenarios in particular the following issues are important:

- *Energy savings*
  These indicate the reduction of energy use and corresponding expenditures over the lifetime of the equipment in the intervention scenario compared to the reference scenario.
- *Investment costs*
  These are expenditures in the base year that have to be financed in one way or another (cf. Section 3.4).
- *Sectors concerned by the investment*
  This yields the distribution of the investment sum over the economic sectors in order to determine employment effects.

Table 3.2 *Case study results and their use in the model runs*

Case study result	Use for model run
- Equipment, installation, consultancy and management cost	Modification of consumer budget in base year
- Operation and Maintenance costs	Annual modifications of consumer budget
- Administration costs and governmental expenditures	Modification of government budget
- Direct employment covered	Is compared to model output
- Energy saved (by energy carrier)	Annual modification of energy bill
- CO_2 saved	-
- Repartition of costs over economic sectors	Used for the Input/output model

It has to be noted that the energy savings and the investment occur at different points in time. To cope with this issue it has been decided to analyse only the effects of investments induced by the energy efficiency program in a base year. As base year the year 1995 is chosen, since all data are available for this year. If an energy efficiency program has been lasting for several years, the investment effects have been collapsed into the base year 1995 in order to facilitate calculations. Since inflation has been low in the middle of the nineties and prices of energy equipment has even had tendency to fall, the error committed through this procedure should be small. If an energy efficiency program has permanent effects on investments (such as a new standard) it has been decided already for the case studies to analyse only the effects of the investments in the past years.

Besides the base year 1995 the employment effects of the energy efficiency programs are also evaluated for the years 2000 and 2010. The first has been chosen to provide an assessment for the close future whereas the latter describes a point in time that corresponds to at least half of the lifetime of the equipment installed. In principle it would also be possible to extend the scenario projections beyond this date, however then uncertainties become much larger and the effect of the energy efficiency programs much more difficult to identify. For an approximation of the overall employment effect of the investment, one has to distinguish between:

- Effects in the base year.
- Continuous effects over the lifetime.

The direct and indirect purchase effects clearly fall into the first category, whereas the energy saving effects belong to the latter. Budget effects can fall in both categories, depending on how the investment is financed. This will be discussed in the following section.

3.4 Financing methods – closing the household budget

In the following, a short explanation is given how the financial flows associated with investments by households in energy saving devices are treated in the chosen approach. Basically, an energy saving option can be financed in four different ways:

1. Paying for it from the general consumption budget.
2. Using a loan; the loan can be provided e.g. by the government or a bank. When a loan is used, the interest rate and pay back time of the loan has to be known.
3. Subsidies; subsidies can for example be provided by the government. It is likely that not the total additional investment is subsidised, so in practice, one of the other financing options must be applied.
4. Paying for it from savings.

It is likely that in most cases, a combination of these financing methods is used, for example, part of the investment is subsidised and part of the investment is paid from by the general budget and part by savings. The effect of using different ways of financing on employment is investigated by performing a sensitivity analysis (cf. Section 3.6). It is likely that there will be a relationship between the height of the investment and the financing method. If the investment is rather small, one is able to afford it from general budget. If the investment is a bit larger, some money from savings has to be used. If the investment is rather large, it is likely to be financed from a loan.

It should be clear that when talking about the investment, always the *additional* investment is meant, so the difference between the investment in the energy efficient option and the reference option. In estimating the expenditures per expenditure category (e.g. food, home, leisure, medical care…) using a set of expenditure functions, it is assumed that the expenditures on the reference technology are incorporated. So, only the budget shift due to the additional investment has been addressed.

Base line scenario

In the base line scenario, so without the additional investment in energy saving, the total consumption C_b is divided over the distinguished expenditure categories E_x, e.g. food, housing, clothes, energy, medication etc., using a set of expenditure functions, see Section 2.2 and Figure 3.1. This is done for the base year, 1995, as well as for the modelling years 2000 and 2010. The expenditures per category are fed into the I/O-table using a 'connection' matrix (cf. Section 2.3). In the base line scenario, the sum over the expenditure categories equals the total consumption budget ($\Sigma E_n = C_b$).

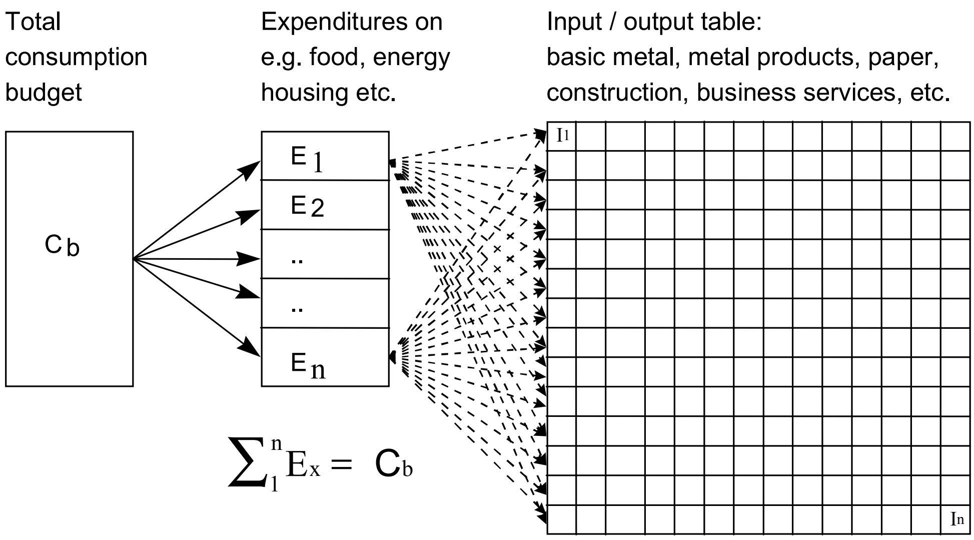


Figure 3.1 *Base line scenario*

Option 1 Financing from general consumption budget

When the (additional) investment *I* on energy saving, e.g. a condensing boiler, is financed from the general consumption budget, the total consumption budget is lowered by *I*, see Figure 3.2. However, since the option saves energy, the energy bill is lowered by *S*, and therefore the consumption budget is increased by *S*. Therefore, the new consumption budget C'_b is equal to C_b-I + S. Next, the consumption budget C'_b is distributed over the expenditure categories E_x. However, the expenditure on energy E'_{energy} now has to be corrected for the monetary savings *S* due to the lower energy bill. Next, the additional investment *I* has to be allocated to one or several of the production sectors of the I/O-table, see Figure 3.2. This re-allocation depends on the type of energy saving options. For example, if a high efficient refrigerator is purchased, the initial investment has to be allocated to the sector 'electro-mechanical equipment'. So, in fact, the monetary savings as well as the initial investments are re-allocated. Note that the additional investment *I* is done in the base year only (a one time investment). Therefore, *I* = 0 in 2000 and 2010.

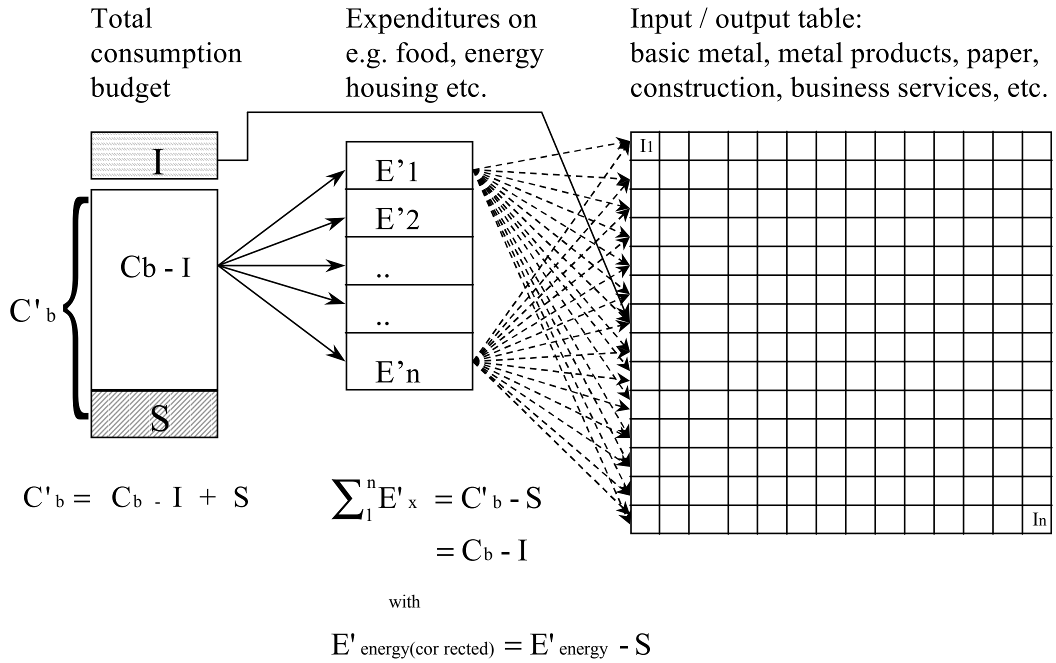
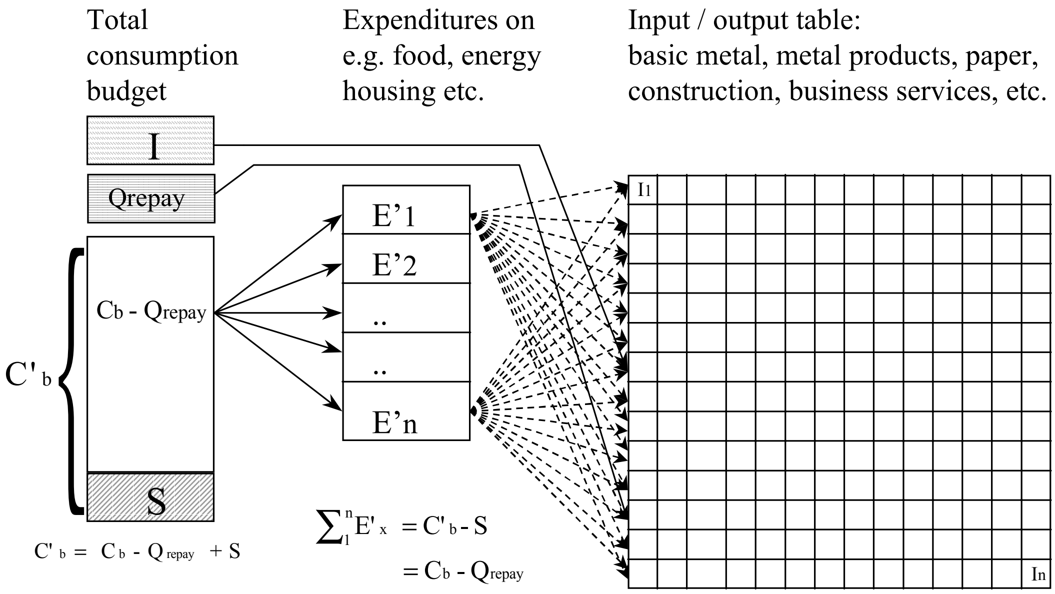


Figure 3.2 *Financing energy conservation from general consumption budget*

Option 2 Financing energy conservation with a loan

When the additional investment is financed with a loan, the total consumption budget in the base year is increased by the amount of money borrowed. It is assumed that the amount of money borrowed equals the additional investment *I*. The money from the loan can not be allocated freely over the expenditure functions, since it is used for the purchase of the energy saving options (see also 'financing option 1').



$$\sum_1^n E'_x = C'_b - S = C_b - Q_{repay}$$

with

$$E'_{energy(corrected)} = E'_{energy} - S$$

Figure 3.3 *Financing energy conservation using a loan*

A certain amount of money, Q_{repay}, consisting of interest and pay back of the additional investment, has to be paid on a yearly basis over the lifetime of the energy saving option. It is assumed that the economic lifetime and the real lifetime are equal. The consumption budget is increased due to monetary savings *S* from the lower energy bill but lowered due to the repayment of the loan. Therefore, the new consumption budget C'_b is equal to C_b-Q_{repay} + *S* (where C_b is the total consumption budget in the base line scenario), see Figure 3.3. Next, the consumption budget C'_b is distributed over the expenditure categories E_x. However, the expenditure on energy E'_{energy} now has to be corrected for the monetary savings *S* due to the lower energy bill. Therefore, the total expenditure budget is reduced with the amount of money that has to be paid for the loan ($\Sigma E_n = C_b - Q_{repay}$). As in the other financing options, the (additional) investment *I* is zero for all modelling years except the base year.

Option 3 Financing energy conservation with a subsidy

When the additional investment is (partly) financed with a subsidy *G*, the consumption budget C_b is increased by the monetary savings *S* from energy savings and decreased by the net investment *I'*. So, the new consumption budget C'_b is equal to C_b + *S*-*I'*, see Figure 3.4. The total investment *I* does not change. However, the net investment by the household *I'* is lowered by *G* and therefore *I* = *I'* + *G*.

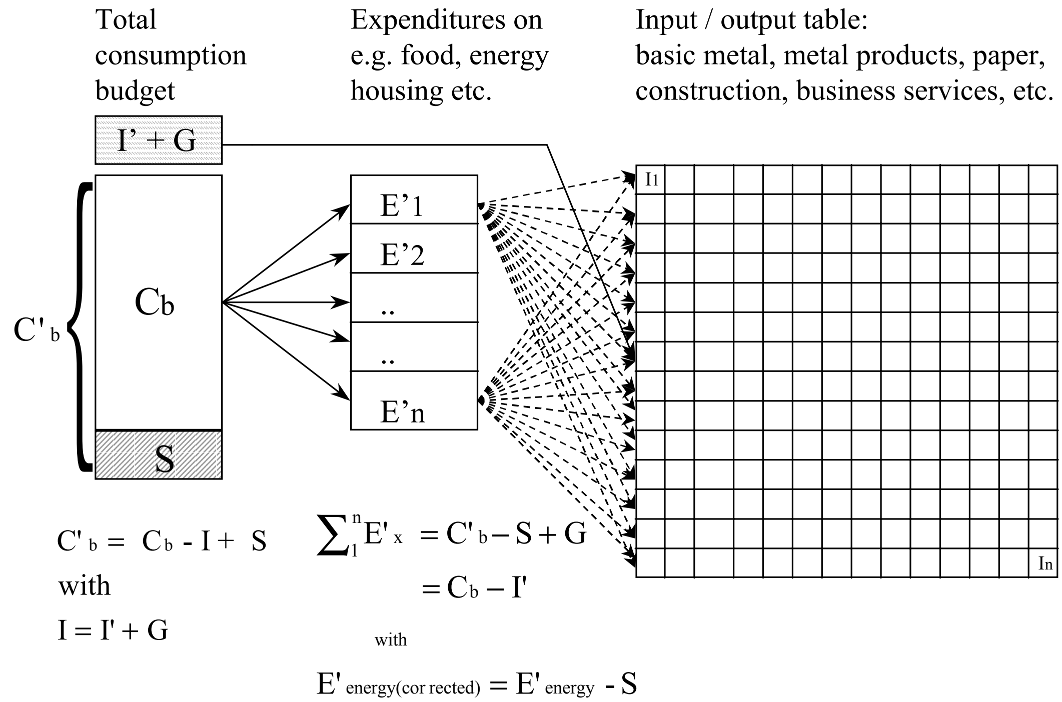


Figure 3.4 *Financing energy conservation by a subsidy*

Using a subsidy, the total expenditures within the household sector increase due to the fact that money (the subsidy) is transferred from e.g. the government to the household sector. Therefore, the total expenditures from the government have to be corrected for the additional amount of money that is transferred from the government to the household sector. The decrease in governmental expenditures will lead to a decrease in employment. Either the investment part of the governmental expenditures, which is part of the final demand for investment in national accounts, is cut correspondingly. Or, and this is the reference option retained here for most countries, the current governmental expenditures (government consumption in national accounts) is reduced proportionally.

Option 4 Financing energy conservation from savings

The fourth option that is considered in financing the additional investment is by paying it from money that was saved by the households in previous years and was put on the bank. This means that the consumption budget increases by the monetary savings from energy conservation, see Figure 3.5. Therefore, the new consumption budget C'_b is increased by S. However, in order to refill the total amount of private savings to a level equal to the base case, a yearly amount Q_{loss} of money has to put on the bank account. So, $C'_b = C_b - Q_{loss} + S$. Next, the new consumption budget C'_b is distributed over the expenditure categories E_x by means of a set of expenditure functions. The totale expenditures on energy are corrected for the amount of money saved due to the lower energy bill, and therefore $\Sigma E_x = C_b - Q_{loss}$.

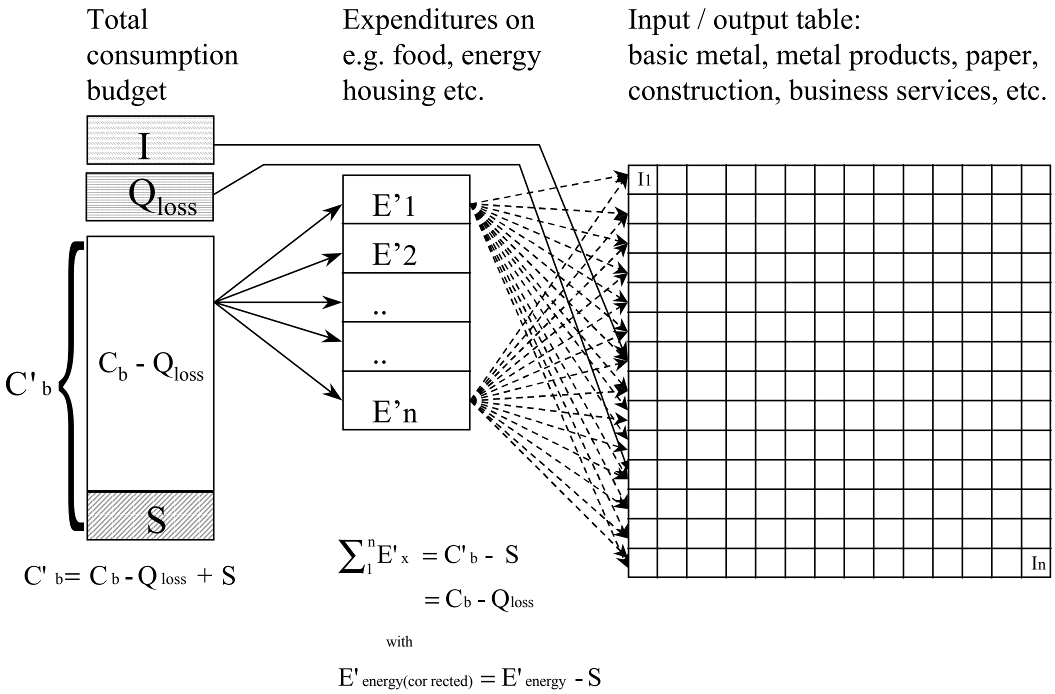


Figure 3.5 *Financing energy conservation from savings*

The main difference with the subsidy case is that the money is not from the government but from the bank. Since the amount of money in the bank is lowered with the additional investment *I*, the households will lose some money, Q_{loss}, in future years due to the fact that they lose the annuity (interest payments and capital pay-back) that could be otherwise obtained from the money spent on the additional investment *I*. This decrease in revenue obtained from capital depends on the interest rate on savings but otherwise it is similar to the pay-back obligations in the case of a loan.

It is likely that in practice the investment in energy conservation is done by choosing a combination of options. This is not empirically determined in the case studies but the effect of different assumptions have been be studied through sensitivity analysis.

3.5 Examples

In this paragraph, some simplified examples are given in order to illustrate the different mechanisms that act on employment in a more visual way. Changes in energy prices and improvement of labour productivity are taken into account in de the model calculations but are not treated in these examples. Three examples will be elaborated. The first example is a re-allocation of money from the general consumption budget (option 1, Section 3.4). The second and third example deal with financing energy conservation by a loan (see option 2, Section 3.4).

In the first example, the initial investment is re-allocated from the general consumption budget at t = T_0 (option 1, Section 3.4). This re-allocation of the general budget could lead to an increase I_0 or decrease I_o' of total employment, depending on the labour intensity of manufacturing of the energy saving option, see Figure 3.6.

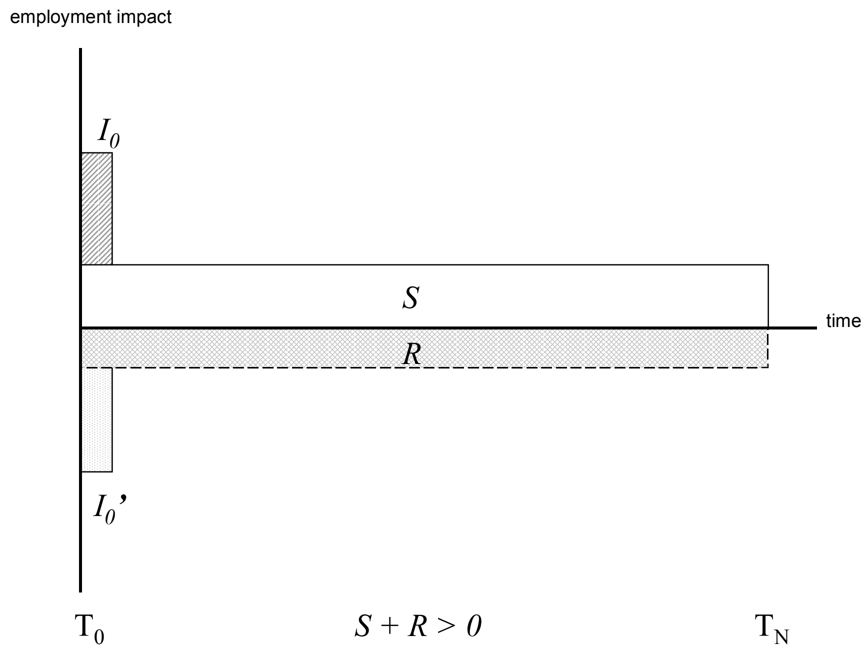


Figure 3.6 *Employment impact as a result of a re-allocation of the general budget*

The impact on employment of the initial investment occurs only at the year the option is installed. Since less energy is used, the energy bill is lowered and more money can be spend on other goods and services. This effect lasts over the lifetime of the option. Due to this effect, total employment is increased by a factor S, see Figure 3.6. However, since less energy is consumed, this will (eventually) lead to a decrease in employment R in the energy production sector. This effect also lasts over the lifetime of the option. Since the energy production sector is rather labour extensive compared to other industrial sectors, the shift of expenditures from this sector to other industrial sectors leads to a net increase of total employment, meaning S + R > 0.

By financing energy conservation from a loan, the effect of the initial investment on employment is always positive, since the total budget of the households is increased by the amount of money that is borrowed. However, the loan cannot be spent freely, since it is used for payment of the initial investment of the energy saving option. The increase in employment is represented by I_0 in Figure 3.7. The impact on employment of the initial investment occurs only in the year the option is installed.

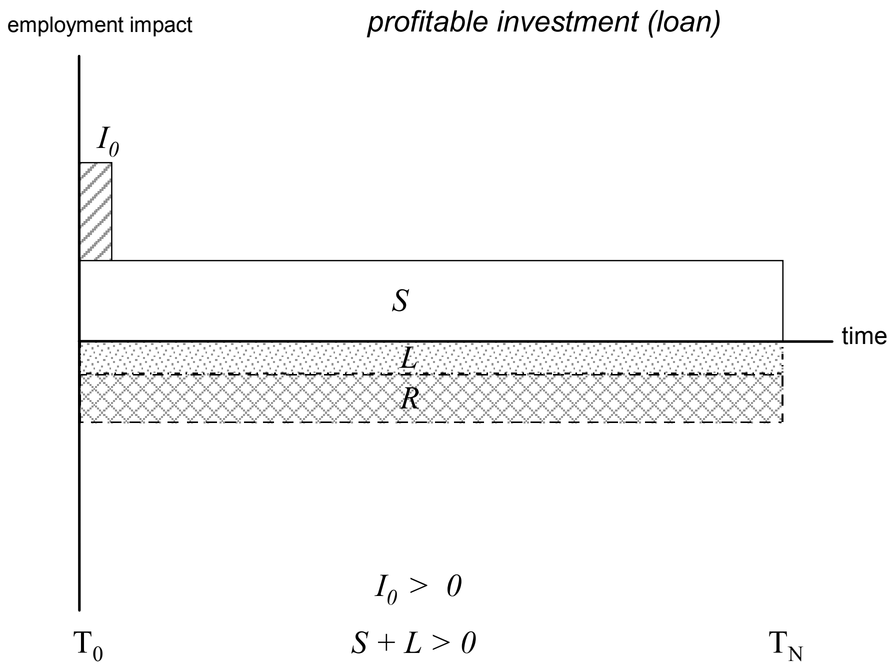


Figure 3.7 *Employment impact in case of a profitable investment*

As in the first example, less energy is consumed and therefore the energy bill is lower and more money can be spent on other goods and services. This effect lasts over the lifetime of the option. This leads to an increase in total employment with a factor S, see Figure 3.7. However, since less energy is consumed, this will (eventually) lead to a decrease in employment R in the energy production sector. This effect also lasts over the lifetime of the option. Both the effects of the reduction in expenditures on energy (effect S) as well as the effect of a decrease in energy production (effect R) are identical to the effects as described in the first example. However, since the loan has to be repaid, the total consumption budget is reduced by the amount of money that has to be paid back to the bank. The pay back consists of interest and a repayment. The impact on employment, R, always has a negative impact on total employment that is related to consumer expenditures, due to the decrease of the total consumption budget. It is assumed that the pay back lasts over the lifetime of the energy saving option. In case of a profitable energy saving option, the amount of money that has to be paid back to the bank is less than money saved due the lowering of the energy bill. This means that $S + L > 0$. Whether the impact on total employment is positive depends on the contribution of the increase in employment related to the initial investment I_0 and decrease in employment R due to the decrease in total energy consumption. However, on forehand, it is not clear whether or not the increase in employment related to I_0 will be able to counterbalance the decrease in employment R.

When the same way of financing the energy saving option is used, but the pay back of the loan exceeds the monetary savings due to the lower energy bill, the investment can be regarded as non-profitable. With respect to employment, this means that $(S + L) < 0$, see also Figure 3.8. It is likely that this will lead to a net decrease in total employment, since the net employment effect is given by $I_0 + S + L + R$ with $I_0 > 0$ and $(S + L) < 0$ and $R < 0$. Therefore, the employment effect of the initial investment I_0 has to counterbalance the negative effects of the budget shift $(S + L)$ and the reduction in energy consumption R.

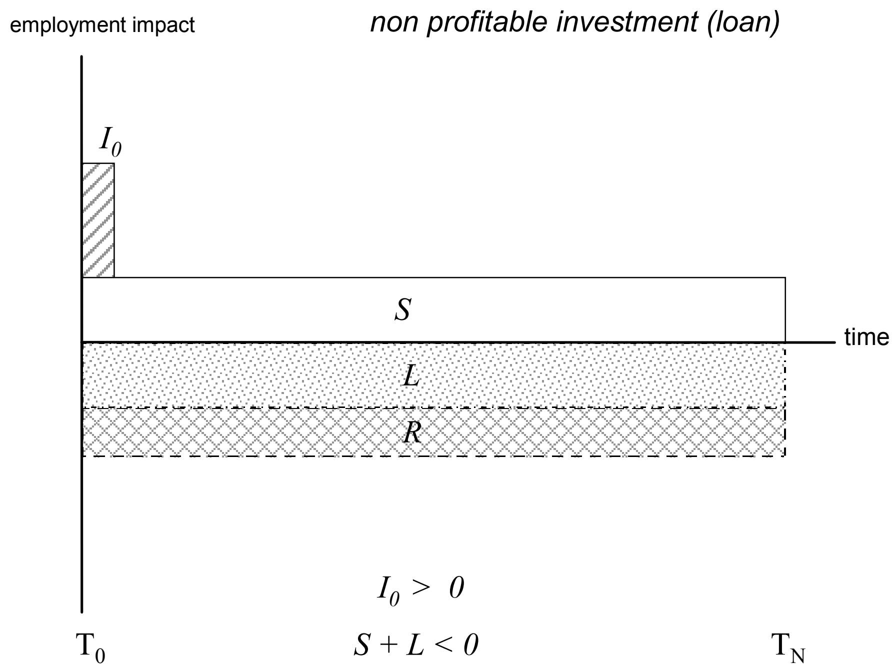


Figure 3.8 *Employment impact in case of a non profitable investment*

3.6 Sensitivity analysis

The employment effects of energy efficiency investments depend on several factors whose impact on employment might be difficult to derive from specific case studies. These factors are:
- different ways of financing energy conservation,
- the distribution of investments over household types,
- the future energy prices,
- the type of energy saving option,
- the effects of energy related taxes and surcharges,
- improvement of labour productivity.

In order to cope with these uncertainties a sensitivity analysis has been carried out, see Chapter 7. For particular case studies the uncertain parameters are varied and the impact on the employment effects is observed. The distribution of investments over household types is varied for a German case study on the new insulation standard for buildings. The impact of future energy prices, labour productivity, taxation and different financing options are studied for a hypothetical though representative policy scheme.

4. COUNTRY SPECIFIC MODELS

To estimate the impacts of energy conservation schemes on employment, country specific models are used. By using country specific models, differences in consumer behaviour and preferences and other specific characteristics such as the structure of the production sector and development of labour intensity are dealt with. In this Chapter, a short description is given of the main characteristics of the models used to determine the impact of energy conservation schemes on employment.

4.1 The E^{3}life model for Germany

The lifestyle-oriented energy, economy, emission model E^{3}life has been conceived to implement the results of empirical investigations of household behaviour, production structure and employment effects in a scenario-based framework (cf. Weber et al., 1996a; Weber et al., 1996b; Weber, 1999a). These are supplemented by additional information on socio-economic as well as technological developments in the future. Throughout households are differentiated according to the eleven household types mentioned in Table 2.1. In Figure 4.1 the different modules of the E^{3}life model corresponding to the general methodology described in Sections 2.1 to 2.3 are outlined together with their interconnections.

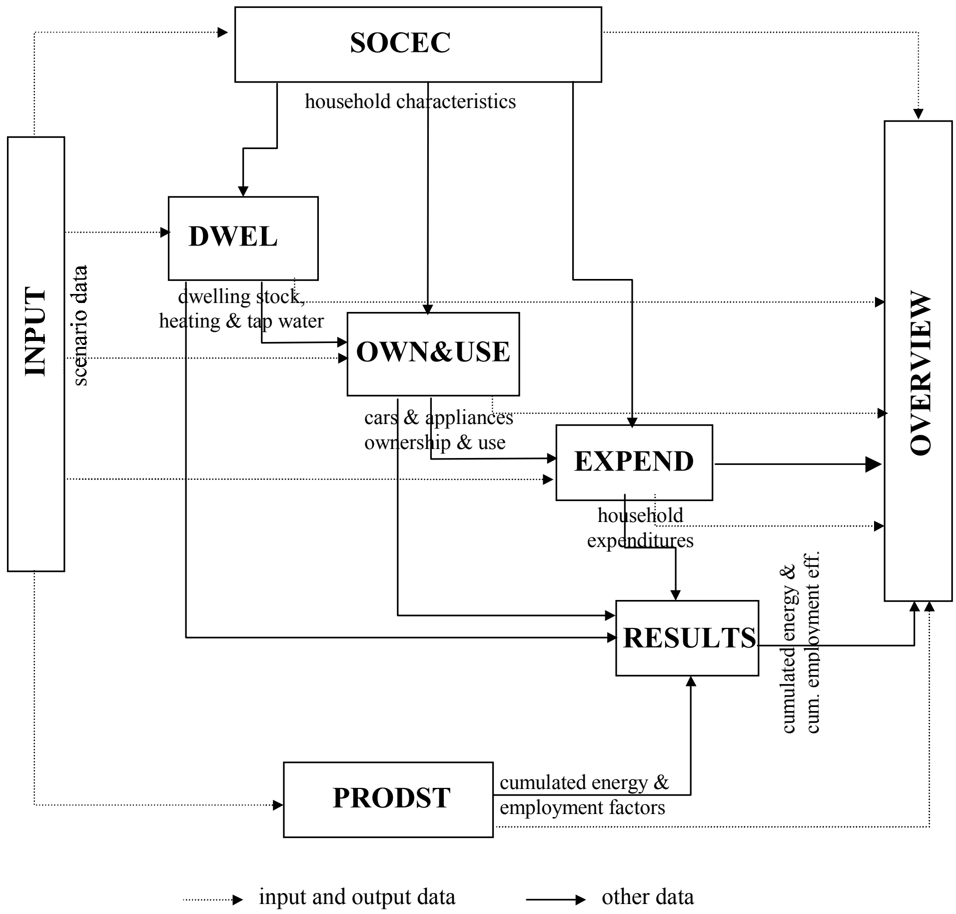


Figure 4.1 *Modules and interconnections in the E^{3}life model*

The names and functions of the different modules are described in Table 4.1. Of course-as indicated in Table 4.1- these modules closely correspond to the model parts shown in Figure 2.2. Only household equipment and energy use have been distinguished by type of energy use. To each type of energy use-space and tap water heating, appliance energy consumption and motor fuel consumption-a separate module is devoted, which covers both the corresponding equipment and its utilisation.

For the SAVE Employment project the model has been extended to cover also employment effects and the Input/output tables have been updated using the latest available year being 1993. The base year for the scenario calculations has been shifted to 1995, assuming that the structural changes in production structure between 1993 and 1995 can be neglected.

Table 4.1 *Main components of the lifestyle-oriented simulation model E^3life*

Module name	Function	Corresponding level in hierarchical model (cp. Fig. 2.1)
INPUT	Contains scenario specific input data	-
SOCEC	Determines household characteristics from scenario settings	1, 2
DWEL	Determines dwelling stock and direct energy for space heating and hot tap water	3, 7
OWN&USE	Computes car and appliances stock, motor fuel consumption and electricity use for appliances	4, 5, 6, 7
EXPEND	Computes expenditures by consumption category and household type	8
PRODST	Contains Input/output system with energy, emission and employment coefficients	-
RESULTS	Computes energy, emissions and employment by household type and totals	-
OVERVIEW	Overview of scenario results	-

The modules are implemented as Excel-spreadsheets. By means of some control routines (macros) a comfortable and automated scenario evaluation is made possible.

4.2 The E^3life model for France

For France an E^3life model similar to the German one has been used. However due to restrictions in data availability some simplifications had to be made. Furthermore the French model corresponds to the first version of the E^3life model as developed in the project *Consumers' Lifestyles and Pollutant Emissions* (Weber et al., 1996a; Weber et al., 1996b). The modifications made for the German model in further work (Weber, 1999a) have not been transferred to the French model. Yet within the SAVE employment project the following work has been performed: an extension to cover also employment effects, an update of the database and the use of 1995 as base year.

As in the German case, two main parts of the model can be distinguished: modelling of the household behaviour on the one side and modelling of the production structure on the other.

For the *household behaviour* dwelling size and car ownership are modelled as pre-eminent investment decisions. Also the corresponding energy uses are looked at in detail. Since micro data on appliance ownership have not been available no detailed modelling has been made for this equipment. Household expenditures are again distinguished by categories. Both socio-demographic and price effects are accounted for.

For the *production structure,* as in the German case, a mixed monetary-energetic Input/output model is used. The sectoral disaggregation is however lower, given that energy consumption data is only available for a reduced set of sectors.

4.3 The Dutch ELSA model

In co-operation with IER (Stuttgart, Germany) and C3ED (Versailles, France), ECN has carried out a project to analyse and illustrate the influence of changes in consumption patterns on energy use and emissions (Perrels et al., 1996; Pellekaan et al., 1996). The influence of household size, income and other socio-demographic factors on the consumption structure of households was analysed. As part of this project, the ELSA model (Energy and Lifestyle Simulation Approach) has been developed for The Netherlands. The approach is basically identical to the method outlined in Section 2.1 to 2.3. The model is described in more detail in (Pellekaan et al., 1996) and (Perrels et al., 1996).

The main components of the ELSA model are a set of expenditure functions coupled to an input/output system. By means of econometric methods and large household surveys a set of expenditure functions has been estimated. The expenditure functions were estimated for ten different household types and consist of two layers. One 'upper' layer of six main expenditure categories and a more disaggregate layer of sixteen categories. Furthermore, the saving share was estimated. Explanatory variables are household income, number of household members, age of head, education level and relative prices.

Household expenditures are disaggregeated in expenditures on energy carriers (electricity, natural gas, district heat, and motor fuels – the so-called direct energy use) and other expenditures. The direct energy use is determined by means of simulation of ownership rates of appliances and cars and also involves household characteristics. The non-energy expenditures are repartitioned over the production system by means of an input/output system. The input/output system takes care that the energy contribution to each sector is accumulated until a total indirect energy claim can be established. Once energy consumption by energy carrier and by sector has been calculated, the emission consequences can be simulated. In Figure 4.2 a schematic overview of the ELSA model is given.

The starting point of the ELSA model is the specification of economic growth expressed as increases of value added by main sector (manufacturing, services, etc.). The growth rates are prespecified exogenously in scenarios. The value added is transferred to households by means of income from labour, distributed profit and social security. Employment and income consequences are derived from economic growth, labour productivity, labour time arrangements. Next, at a micro level, the household income, the amount of (free) savings and expenditure patterns are established.

The expenditures at the macro level of the whole economy constitute the consumption vector of the input/output system. From there, the money flows are traced back into the productive system. Additionally imported goods are added. The production system of countries of origin is assumed to be the same as the Dutch system. Finally, the consumer expenditures are adding up per sector of origin and the so-called consumption by origin is obtained.

The linkage of consumption of households to an input/output system implies that the production effects of the demand of consumers can be shown. It also means that the emissions attributed to household consumption can be decomposed by sector of emissions. The model produces simulations about the economy – notably the income distribution and private consumption expenditures, the dwelling stock and natural gas consumption, the appliance stock and electricity consumption, the car stock and the use of motor fuels, the indirect energy requirement of production and transport for non-energy consumer goods. In addition, the resulting emissions of CO_2, NO_x, CO and VOC are calculated. For the purpose of this project, the model is extended with an employment module. In this way, the total direct and indirect effects of investments in energy conservation on employment can be calculated. With respect to the type of employment, a distinction is made between employees and self-employed, sex (male, female), age (15 – 24, 24 – 44 and 45 – 64 years of age) and education level (elementary education, primary education, higher education and college/university), see Table D.1 to Table D.4 of Annex D. The labour coefficients for sex, age, and education level were obtained from 1997 values (CBS, 1998a), the labour coefficients for employees and self-employed were obtained from 1995 statistics (CBS, 1997). Moreover, the input/output table was updated from 1990 to 1995 values.

Apart from the studies that were mentioned before, the ELSA model was used recently in two studies that focussed on the relationship between lifestyle and domestic appliances (Jeeninga, 1998a; Perrels, 1998; Jeeninga, 1998b).

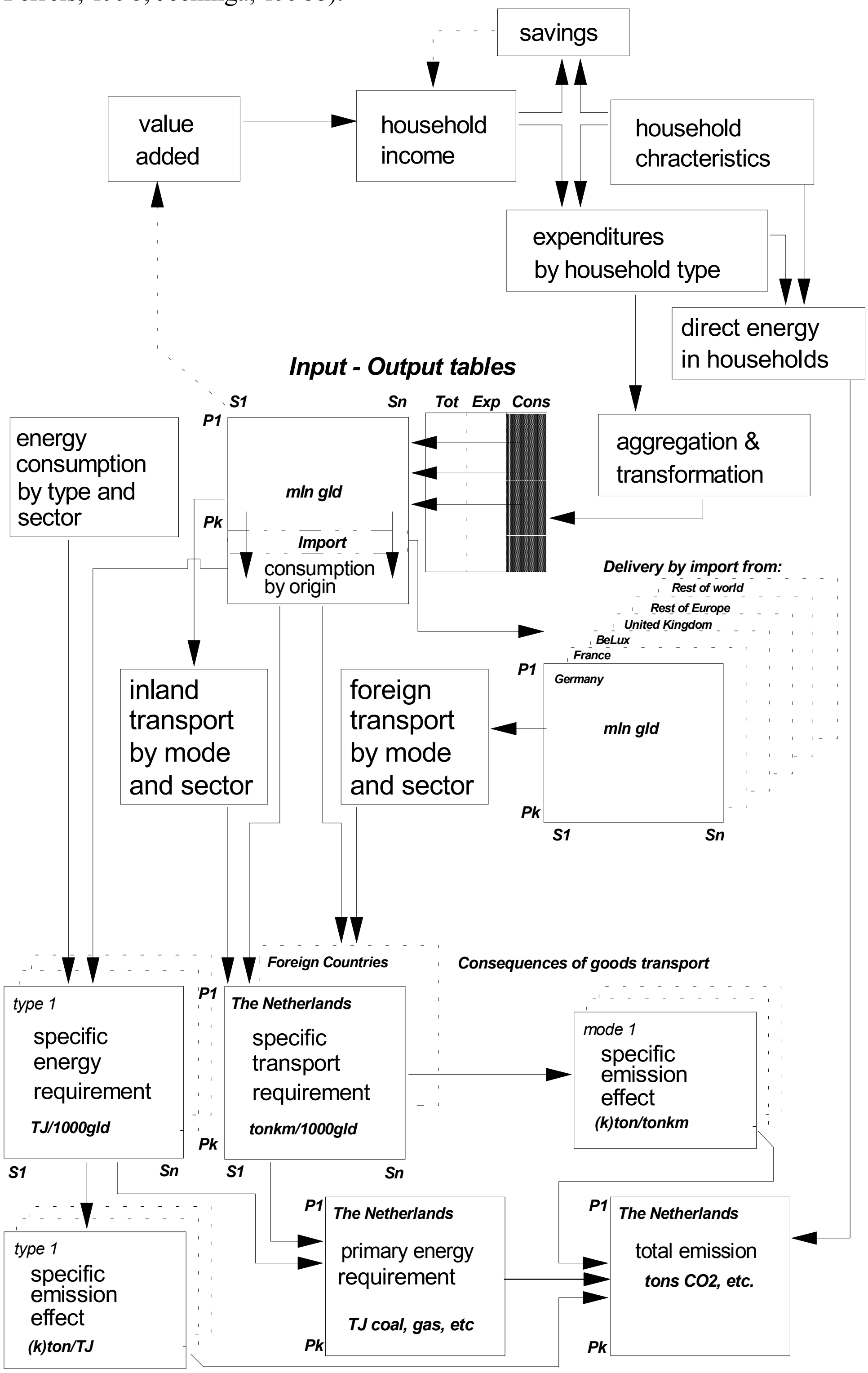


Figure 4.2 *Schematic overview of the ELSA model*

4.4 The modelling approach for Spain

The input/output model drawn up for Spain has some different characteristics from the corresponding models for The Netherlands, Germany and France. From the two large sub-models who can be distinguished within the LO-E^3 models (the model referring to consumers' behaviour and the input/output model) it is the consumers' behaviour model for Spain which has certain differences in comparison with those described in general in Section 2.2.

Households' surveys in Spain offer information on energy consumption in households classified according to the characteristics of the households themselves (size, age of head of family, etc.). However, the National Institute of Statistics has not undertaken the task of applying the information gathered directly from interviews in order to estimate consumption functions, and, in short, the elasticity of energy consumption to these variables. For this reason, the Spanish model does not provide estimated consumption functions with cross section data for each expenditure category and for the different household types in Table 2.1.

The absence of estimated consumption functions taken from cross section data has meant that consumption functions have had to be approximated with time series. This work, called *Simple Econometric Characterization of Consumption Functions,* undertaken by the Autonomous University of Madrid for this project, is included in Annex A of this report.

The objective of the work was to determine the elasticities of each of the ten categories of final consumption to income, the own price, and the price of other substitute goods. This was done by regarding the extent to which a price increase of goods causes reduction in consumption, and shifts towards the consumption of other alternative goods. The explanatory variable of income is calculated from the sum of the 42 expenditure categories included in National Accounts, aggregated to 10, which is the number of estimated consumption functions, and expressed in terms per capita. All the estimated equations follow the basic formula of a simple model of lineal regression as given below:

$$\ln\left(E_{i,t}\right) = {}_{0,i} + {}_{1,i} \times \ln\left(I(t)\right) + \sum_{x=\text{food}}^{x=\text{miscellaneous}} {}_{x,i} \times \ln(p_x(t))$$

with:

$E_{i,t}$ = total inland private consumption on expenditure category *i* at year *t*
$\beta_{x,i}$ = coefficients expenditure functions for expenditure category *i*
i = expenditure category, *i* = food, clothing, gross rent, fuel and power, furniture, medical products, medical care, transport, recreation and miscellaneous
t = time, *t*
$I(t)$ = income per capita at year *t*
$p_x(t)$ = price index of good *x* at year *t*

The parameters ß obtained for each explanatory variable in each of the expenditure equations are given in Table A.2 of Annex A.

Linking expenditure and employment

The integration of the model of consumer behaviour in the input/output model is achieved through $q = (I - A)^{-1} \cdot y$ where *y* is the final demand vector, see Section 2.3. Changes in final income available for consumption resulting from actions analysed in the case studies[6], lead to changes in the volume of consumption in each category of goods (*y* vector rows).

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[6] Either a reduction in budget available for other consumption apart from energy equipment, an increase in budget as a result of energy saving achieved or of receiving subsidies for launching such actions, or a combination of both (see Chapter 3, in particular, Section 3.3 and 3.4).

This new consumption will require new production from each of the sectors given in the input/output table. New production data can be obtained by applying the implicit production structure from the Leontief inverse matrix.

The last input/output table published for the Spanish economy is from 1993 (INE, 1993a). The sectoral division of 56 branches of activity is aggregated later to 25 categories, see Table A.3 of Annex A. Employment statistics in Spain enable sectoral information to be calculated for the total employed population, classified by sex, and by part-time and full time parameters. The employment coefficients are calculated from 1995 employment statistics and will enable a calculation to be made of net job creation resulting from new production figures by sector. In 1997, the total part-time employed population stood at 8%, which is a relatively low percentage in comparison with other neighbouring countries. On the other hand, the difference between temporary and long-term employment is of greater interest: in 1997, 33.5% of the total employed population in Spain held contracts for a specific length of time. However, only total and sex-classified employment coefficients will be used for the purpose of the input/output model.

4.5 The input/output model for the United Kingdom

Saving and expenditure functions for the UK are estimated for 7 different expenditure categories. The functions are linear in accordance with the methodology outlined by ECN (Pellekaan et al., 1996), with the exception of the income term in the expenditure equations which is represented by the logarithm of the total expenditure. The functions for the UK differ from the outline methodology in that they are estimated on the basis of national accounting data rather than cross section data. This means that relatively long time series of data can be used to estimate both income and price elasticities simultaneously, which increases the quality of the estimates. In addition, the task of linking these functions with national input output tables is more straightforward. However, a distinction in expenditure behaviour between different types of households cannot be made, since this is only possible using cross section data.

Income, expenditure and savings
Using national accounts data has allowed consistency in establishing the relationship between household income before tax, household disposable income, saving and expenditure. Household final consumption is defined as household disposable income minus saving minus consumption expenditure of non profit institutions serving households. Following the approach of Pellekaan (Pellekaan et al., 1996), saving is determined as a function of net income. This leaves expenditure as a residual item once saving is determined. Saving is estimated as a function of income and time.

Categories of household consumption
Seven categories of expenditure have been adopted. These are food, housing, clothing, transport and other, as outlined by the ECN methodology, and in addition, energy and services. Energy and services have been separated out since in the case of energy the nature of the products are technically significantly different from those of any other group and in the case of services, an ever rising proportion of expenditure is devoted to the items in this category.

Analysis of consumption by category
Although in principle, factors like household composition, age of head of household, size of families, and so on have important effects on consumption, empirical attempts to estimate these effects using detailed budget surveys have not been entirely successful. This is due partly to the nature of budget surveys in that they are not panels of data but come from successive resamples on each occasion.

Thus the households included in each subcategory are different for each survey which adds to the variance of the estimates. In addition, at least for the UK, expenditure is recorded not for an entire year but for some shorter period e.g. two weeks, and this again introduces variability between diary entries over the entire sample. Improvements in sampling technique also complicate the process of combining data from surveys from different periods. Hence the UK study focuses on time series estimation of expenditure functions. These use data on a consistent basis, and enable us to spot any changes in trends, which may not be apparent from survey data. The downside is that time series complications such as the presence of autogressive processes can affect the interpretation of the results.

The expenditure equations are estimates in which expenditure on category i, E_i, is estimated as a linear function of income, own price, prices of other expenditure categories, seasonal effects and time. The development and main characteristics of the expenditure functions are described in more detail in Annex B of this report.

I/O table and labour coefficients.
The basic I/O table contains 123 sectors. For practical reasons, this table is condensed to 23 sectors, see Table B.1 of Annex B. Labour coefficients are determined using the National Accounts. The types of employment are distinguished are male full time, male part time, all male, female full time, female part time and all female, see also Table B.1.

4.6 The FMS model for Finland

In Finland the FMS model is used for the evaluation of the macroeconomic effects of the energy efficiency investment programs. The FMS model system (FMS = the Finnish long-term Model System) is a multisector, econometric simulation model of the Finnish economy (Mäenpää, 1996). It has bee developed in the University of Oulu and is used in the Thule Institute at present.

The LO-E^3 models are focused on the energy consumption of households whereas the FMS is more oriented to the questions of the energy use of industries. This is important, because the main case studies of Finland comprise energy efficiency investments in manufacturing, private services and the public sector.

The FMS model system consists of two main parts: the core model and the satellite models. The core model describes the general dependencies of the functioning of the economy in a logically compact way. Yet it is rather detailed: production in the economy is divided into 31 industries, household consumption covers 19 commodity groups, investments 5 investment goods and foreign trade 32 commodity categories. The income distribution system of the economy's five institutional sectors comprises 17 income, outlay and finance categories. Classifications are shown in Table C. 1 of Annex C. The main structure of FMS is shown in Figure 4.3. The contents of each section of the model system are described briefly below.

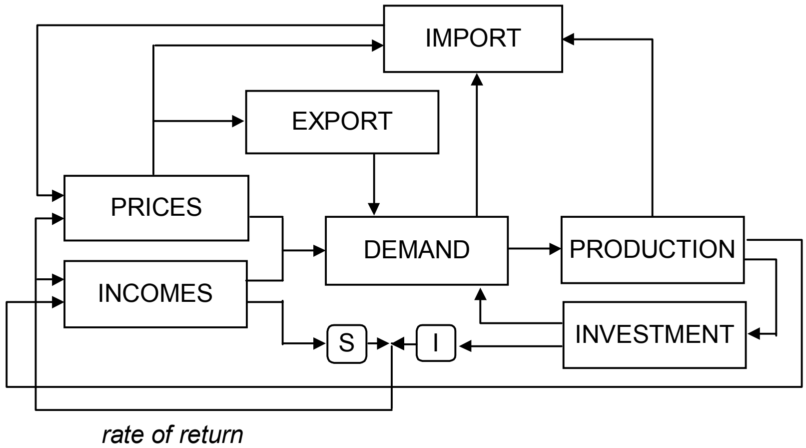

Figure 4.3 *Basic feedback loops of the FMS core model*

- *Production*. Industrial sectors are linked together by an input/output model. The output from each sector can be calculated from the demand for final products and the use of intermediate outputs. A vintage model links the growth of production and the demand for investments and labour through the dynamics of technical change.
- *Income*. Income from production factors is channelled into the institutional sectors. After the redistribution of income, disposable income for each sector is calculated and allocated to consumption and saving. The growth in the volume of public consumption is determined exogenously and then some tax changes are made-typically in the household income tax-so as to balance the public budget.
- *Prices*. Producers' prices are derived for each industrial sector and from these the purchasers' prices of consumption and investment goods are determined. The price section does not contain independent parameters, rather it is an exact dual of the structures contained within the flows of goods for production and financial flows in the income section.
- *Demand*. Household demand for consumption goods is derived using a linear expenditure system with habit formation extension. The total expenditure of households on consumption goods is given by the income section whilst prices of different groups of consumption goods come from the price section. Government expenditures on intermediate products, the goods content of investments and goods exports are all added to final product demand.
- *Foreign trade*. The exports and imports of each industrial sector are combined with the model system. Exports are mainly calculated from assumptions on growth in the volume of international demand for different product groups coupled with the level of Finnish price competitiveness.
- *Equilibrium*. Total savings S and the value of investments I have to be equal in the economy. An iterative algorithm in the model searches for the rate of return on investments that leads to equilibrium in the financial markets. As the model system is internally consistent, financial market equilibrium automatically leads to equilibrium in the external balance of exchange.

As it is typical of equilibrium models in general, in the FMS model the changes of relative prices are important, but the general level of inflation does not, however, affect the real flows of the economy. In the FMS the industry wide nominal wage rates work as a common denominator of prices. Inflation can be introduced to the model system simply by exogenously assuming some convenient rate of change for the nominal wage rates.

The core model is in itself a self-sufficient portrayal of the Finnish economy. The model has been moreover expanded by adding satellite models for the environment and natural resources: *Energy, Forest, Metal, Natural resources, Transport, Emissions* and *Welfare* – each of which describes a particular part of the core model in more detail. The core and the satellite models are interacting so that demand in the satellite models is obtained from the monetary flows of the core model and the changes in the monetary parameters of the core model are derived from structural changes in the physical flows of the satellite models.

The energy satellite model classifies energy into 19 final energy types, which rise to 21 primary energy sources when electricity and heat are converted into primary energy. The final demand for energy comes from the outputs of each industrial sector in the core model using energy input coefficients. Energy input coefficients can be reduced by conserving energy. Engineering data has been collected on the options and costs of energy conservation for each industrial sector and different types of energy. The behavioural rule is as follows. Energy conservation occurs whenever the purchase price of energy exceeds the price of conserved energy. The purchase price of energy can be increased via energy and environmental taxes and the price of conserved energy can be reduced using investment subsidies. The production of electricity and heat is classified by power station type.

The energy efficiency case studies can be linked into the FMS model as follows. The basic data of the case studies for feeding the FMS are: planning and general execution costs (including e.g. auditing), ordinary investment costs, grants from the public sector and resulting energy savings in energy units.

The basic data of a case is fed to the FMS generally as exogenous changes in the parameters and additions of the flows of the model mainly as follows. Planning and general execution costs are added to the input coefficients of industries from the other business services industry. Ordinary investment costs are added to the capital coefficients of the industries. Grants are added to the 'Other' current transfers from the General government to the Enterprises. The energy savings are deduced from the energy coefficients of the industries in the energy satellite, which are inside the model fed further to the corresponding changes in the related monetary input coefficients of the core model.

The main effects can be qualitatively characterised as follows. Reduced energy consumption (mainly electricity and district heat) reduces energy production and thus investments in heavy industry and also lowers the imports of the primary energy sources. On the other hand diminished energy consumption reduces the production costs of the industries which reduce the producers' prices of the industries. The increased planning and general execution costs increase the demand of services but also raise the production costs and thus the producers' prices. The ordinary investments increase the demand of the investment goods producing industries but in the same time raise the capital costs of industries and thus producers' prices. The grants partly offset additional costs of the energy efficiency investments making industries but these outlays of the general government are to be balanced by higher taxes.

The macro-economic net effects are affected by the following additional considerations. The change in the producers' prices of the investing industries depends on the relation of the investment-related costs and the energy cost reduction. If the producers' prices are reduced, the competitiveness of the industries in the foreign trade is improved and thus exports will increase and the share of competitive imports will diminish. The quantity of the domestic demand will also increase. If those industries produce household consumption goods, the purchasing power of the households will rise, too, and their real consumption will increase. There is also a structural effect in the economy: the relatively light, labour intensive industries such as business services and investment goods industries are substituted for relatively heavy energy producing industries. This structural change will probably increase the general level of employment in the economy.

5. FINANCING OF ENERGY CONSERVATION SCHEMES

In this chapter, the effect of different methods that can be applied to finance the investment in energy conservation is investigated. These financing methods are described in more detail in Section 3.4. Four different financing methods are considered: (1) financing energy saving from the general consumption budget, (2) financing the energy saving by means of a governmental grant, (3) financing energy saving by means of a loan, and (4) financing energy saving from private savings. First, the base line scenario is described briefly. After that, the employment effect due to investment in energy saving is analysed for the financing options considered.

Subsequently, the effect of scenario parameters on the model results is determined. First, the effect of taxes and surcharges of energy carriers on employment is dealt with. Next, the effect of the type of energy saving option, the effect of improvement in labour productivity and the effect of energy prices are analysed. Finally, the effect of differences in household characteristics is investigated.

The analysis of the impact of the different financing methods and the sensitivity analysis is performed using the model that has been developed for Spain, see also Section 4.4 and Section 6.4. Of all models available at ECN, this model is regarded to be the most transparent one. Since the expenditure functions of the Spanish model are based on a time series analysis instead of a cross section analysis as used for the Dutch ELSA model, the quality of the fit is higher in calculations where differences in household characteristics are not taken into account. However, as differences in household characteristics can not be taken into account, that part of the sensitivity analysis is performed using the E^3-Life model for Germany. Although the models used for the sensitivity analysis are country specific, it is expected that the results are also applicable to other countries. In the analysis, the focus is on the effects of the different mechanisms behind the employment shift rather than on the quantitative impact. Between countries, the quantitative effects may vary, but the mechanisms that describe the relationship between energy conservation and employment are regarded to be comparable.

The impact of changes in tax revenue on employment induced by the implementation of an energy conservation scheme are not treated in this Chapter, since the outcome of the analysis is for the greater part determined by the country specific structure of the tax system. As far as possible, this topic is treated in a general sense (Section 7.1). A country specific analysis is made for The Netherlands, see Section 6.3.4. Moreover, the use of taxes and surcharges as a tool to enhance the cost effectiveness of an energy conservation scheme is discussed in Section 8.4.

5.1 Base line scenario

The development of energy prices is given in Table 5.1. The development of energy prices is based on a scenario provided by the Spanish Ministry of Economics and not taken from (Capros, 1997) as described in Section 3.2. This scenario is worked out by IDAE, since the Spanish Ministry of Economics, as well as (Capros, 1997) do not provide development of energy prices by energy carriers. The value-added tax (VAT) is the same for all energy carriers and amounts to 16%. No additional surcharges are applied.

Table 5.1 *Development of energy prices in the base line scenario*

	[Euro/toe]				As index			
	1995	2000	2005	2010	1995	2000	2005	2010
Coal	254	231	233	235	1.00	0.91	0.92	0.93
Heating oil	273	347	410	453	1.00	1.27	1.50	1.66
Gas	453	407	449	472	1.00	0.90	0.99	1.04
LPG	440	389	447	470	1.00	0.88	1.02	1.07
Electricity	1741	1430	1408	1333	1.00	0.82	0.81	0.77
Biomass	197	197	197	197	1.00	1.00	1.00	1.00

The average improvement of labour productivity amounts to 1.9% per year over the period 1995 to 2010, see Table 5.2. It is that assumed that the improvement of labour productivity is highest in the manufacturing industry and utilities (2.9% per year). The lowest value for improvement of labour productivity is found for the non-commercial services.

Table 5.2 *Yearly improvement of labour productivity per main sector (Pellekaan, 1996) [%]*

	1995-2000	2000-2005	2005-2010
Primary sector	1.6	1.6	1.6
Manufacturing industry & Utilities	2.9	2.9	2.9
Building industry	1.4	1.4	1.4
Wholesale, retail, repair, catering	1.6	1.6	1.6
Transport & Communications	2.2	2.2	2.2
Commercial Services	2.3	2.3	2.3
Non-commercial services	1.2	1.2	1.2
Average over all sectors	1.9		

To be able to assess the employment effects of a energy saving policy scheme, a reference energy saving option has to be defined, see Table 5.3. Total investment of the energy saving scheme is assumed to be 100 MEuro in 1995. This corresponds to an average investment of 8.1 Euro per household. Due to the policy scheme, a reduction of total electricity consumption of 250 GWh per year is obtained. Due to the saving of electricity, the energy bill is reduced by about 3.0 Euro per household in the base year. A rough indication of the profitability of the investment is obtained by dividing the initial investment by the profits due to the lower energy bill. The thus obtained ‘pay back time’ of the policy scheme amounts to 2.7 years. It is assumed that the money from initial investment is flows to the construction sector[7], see also Section 3.4. The energy saving option is assumed to have a lifetime of 15 years.

Table 5.3 *Total investment and energy saving of the reference policy scheme*

	National level		Per household	
Initial investment	100 [MEuro]		8.1 [Euro]	
Electricity saving	250 [GWh/year]		20.2 [kWh/year]	
Euro per household	*1995*	*2000*	*2005*	*2010*
Average lowering of the energy bill	3.03	2.33	2.17	1.98

[7] At the ‘demand side’ of the I/O-matrix, see for example Figure 3.2.

5.2 Financing of energy saving options

5.2.1 Financing energy saving from the general consumption budget

The investment in energy savings can be paid from the general consumption budget, see option one in Section 3.4. This means that households take money from their general consumption budget. Therefore, the money related to this investment can not be spent on other commodities. This financing method is also applicable to the case that the investment is financed by the government using a surcharge on for example energy, on condition that the administration costs can be neglected and the total revenues from the surcharges are equal to the total investment[8]. Under these conditions, money is transferred from the residential sector to the governmental sector and again returned to the residential sector. Since no money stays behind in the governmental sector, the total expenditures in the residential sector remains constant.

In Table 5.4, the employment impact of financing the policy scheme from the general consumption budget is given. The cumulative employment effect over the lifetime of the energy saving option amounts to 13,000 labour years.

Table 5.4 *Employment effects in case the policy scheme is financed from the general consumption budget*

Labour years [× 1000]	1995	2000	2005	2010	1995-2010
Employment effect initial investment[1]	0.397	-	-	-	
Employment effect energy saving[1]	1.162	0.853	0.759	0.645	
Employment effect grants	-	-	-	-	
Cumulative employment effect					12.979

[1] Accounting for the compensating shift in the household expenditure budget.

In the analysis of the employment effect of the policy scheme, different factors are distinguished, see also Section 3.1. Due to the re-allocation of the household budget, the employment increases by almost 400 labour years. This effect occurs in the base year only. The effect of the change in expenditure pattern due to the lower energy bill amounts to 1160 labour years in 1995 and decreases to 650 labour years in 2010. This effect occurs yearly and lasts over the lifetime of the energy saving option. The decrease in the ‘energy saving effect’ is due to two factors: (1) the improvement of labour productivity and (2) the decrease of the electricity prices.

5.2.2 Financing energy saving from a loan

The investment in energy savings can be paid for from a loan, see option two in Section 3.4. The bank will lend the money needed for the additional investment to the households. This means that no money is taken from the general consumption budget. However, yearly a certain amount of money has to be paid off. It is assumed that the investment is paid off over the lifetime of the energy saving option (15 years). The interest rate for the loan amounts to 6% per year. The yearly repayment of the total investment of 8.1 Euro per household amounts to 0.83 Euro over a period of 15 years. Due to the interest on the loan, over 1.5 times of the investment is paid off by the households. Therefore, over the lifetime of the energy saving option, there is a net transfer from money from the residential sector to the service sector.

In Table 5.5, the employment impact of financing the policy scheme by a loan is given. The cumulative employment effect over the lifetime of energy saving option amounts to 11,500 labour years.

[8] This holds if the energy demand is price inelastic so that the so-called dead weight losses can be neglected. Indeed, empirical studies in general support the hypothesis that residential energy demand is price inelastic at given equipment.

Table 5.5 *Employment effects in case the policy scheme is financed by a loan*

Labour years [× 1000]	1995	2000	2005	2010	1995-2010
Employment effect initial investment	4.709	-	-	-	
Employment effect repayment loan	-0.451	-0.403	-0.367	-0.334	
Employment effect energy saving	1.162	0.853	0.759	0.645	
Employment effect granting of the loan	p.m.	p.m.	p.m.	p.m.	
Employment effect reception loan	p.m.	p.m.	p.m.	p.m.	
Cumulative employment effect					11.474

Due to the initial investment, the employment increases by about 4700 labour years in 1995. This effect occurs in the base year only. The employment effect in the base year is higher than in the case of financing from the general consumption budget, since the budget in the base year is increased by the loan. So, the total residential expenditure budget is increased. The loan has to be paid off by the households over the lifetime of the energy saving option. This leads to a decrease in employment related to residential expenditures and therefore these values have a negative sign. The decrease in employment due to the pay off of the loan amounts to 450 labour years in 1995 and 330 labour years in 2010. The employment effect due to the lower energy bill (the 'energy saving effect') amounts to 1160 labour years in 1995 decreasing to 650 labour years in 2010. This is comparable to the effect found for the case of financing from the general budget, see Section 5.2.1.

Over the lifetime of the energy conservation option, there is a net transfer of money from the consumers to the banks (total pay back of the loan equals about 1.5 times the initial investment). The banks will use these gains again for other purposes. It must be noted that the financial behaviour of the service sector, like banks or other finance companies is not modelled dynamically. Therefore, the short and long term employment effect of the granting and reception of the loan can not be assessed without further study. As a result, the employment effect calculated can be considered as a lower limit.

In general terms, a comparison can be made between financing energy conservation from the general consumption budget or by means of a loan (Van Leeuwen, 1999). If new or additional demand for a good or service occurs, the existing consumption pattern is changed. Not only the specific mix of goods and services demanded would change, but also the pattern or inputs that lies at the basis of this consumption. A crucial assumption now is that the input mix (including value added and links to employment) for producing the original basket of goods and services differs from the newly added goods and services. If not, the change in consumption pattern will have no effect in the input-output model outcomes.

First of all additional demand for certain consumption goods or services can be financed by lowering consumption of other goods. This is a so-called budget neutral shift in the consumption pattern, at least in the first iteration round of the model. The second option is financing the additional demand by borrowing. In this case an intertemporal shift in consumption occurs; consumption in the current period is financed by additional future returns or at the expense of future consumption. Next both cases are reviewed in somewhat more detail.

In case the investment in energy conservation is financed by means of a budged neutral shift within the existing consumption pattern, the total amount of money spend for consumption of new or additional goods and services crowds out (part) of the original consumption. Crucial in this case is the difference between the input shares of the two baskets of goods before and after the change in consumption. Depending on the difference in efficiency (for example measured as value added generated at given inputs before and after the change in the consumption pattern) and employment per unit the input-output model calculates which of the two consumption basket is 'optimal' in both the first and higher order effects. What is to be considered optimal, depends crucially on the point of view of the user of the model. Optimal can be an economically better solution or a more environmental friendly consumption pattern, etc. Generally speaking the macro-economic effects-changes in GDP, (un)employment rates, etc.-of the kind of shifts in consumption pattern as considered here are usually rather small. Very large shifts in the consumption pattern, needed to really make a difference, are not very likely either. Though, on a more disaggregated level the effects can be of some importance.

In case the additional consumption is financed by means of a loan, next to the shift in consumption pattern, the total consumption in the given period changes (increases at least in the first iteration round) and the situation on the financial markets are likely to change. Therefore, more effects also on the macro-level, can be expected. Crucial in this case is whether the additional consumption can be considered as pure consumption or more as an investment. In the first case the consumption is merely shifted backward from the future to the current period. More consumption now will mean less consumption later. Since the input-output model does not take into account intertemporal effects and does not include a proper financial market the model outcomes are likely to overvalue the current situation at the expense of the future.

The second option-increase in consumption of a more investment type good like for example consumption in more energy efficient equipment – is generally considered to have a positive macro-economic effect. Not so much in the first year(s), but especially on the medium and long term. Still a warning for over optimism is needed. Again crowding out is likely to occur; not so much in consumption, but in investments. Borrowing will push up the interest rate, make investing more expensive and therefore will tend to lower the demand for investments. Despite this effect the outcome of this case is more likely to be positive.

5.2.3 Financing energy saving from grants

In this variant, it is assumed that 10% of the total investment is financed by a subsidy provided by the government. The remaining investment is paid for from the general consumption budget, see also Section 5.2.1. Due to this subsidy, money is transferred from the governmental sector to the residential sector. This effect occurs in the base year only. The transfer of money leads to an increase in employment related to expenditures in the residential sector and a decrease of employment related to the expenditures in the governmental sector, assuming that no additional surcharges are introduced to compensate for the, temporary, reduction in governmental expenditures.

In Table 5.6, the employment impact of financing the policy scheme from grants is given. The cumulative employment effect over the lifetime of energy saving option amounts to 12,750 labour years.

Table 5.6 *Employment effects in case the policy scheme is partly financed by a subsidy*

Labour years [× 1000]	1995	2000	2005	2010	1995-2010
Employment effect initial investment	1.259	-	-	-	
Employment effect energy saving	1.162	0.853	0.759	0.645	
Employment effect grants	-1.110	-	-	-	
Cumulative employment effect					12.731

Due to the re-allocation of the household budget and the subsidy, the employment increases by 1,260 labour years in 1995. This effect occurs in the base year only. The effect of the change in expenditure pattern due to the lower energy bill amounts to 1,160 labour years in 1995 and decreases to 650 labour years in 2010. This effect occurs yearly and lasts over the lifetime of the energy saving option and is comparable to the impact calculated in case the option is financed from the general budget (the base case). Due to the transfer of the grants from the governmental sector to the residential sector, the employment decreases by 1,110 labour years in 1995. This effect occurs in the base year only.

5.2.4 Financing energy saving from private savings

Instead of financing the energy saving option from the general consumption budget, the option could also be paid for by means of a cash withdrawal of savings deposited at the bank. This means that money is transferred from the service sector (the bank) to the residential sector. However, since the households have spent their money on the energy saving option, the amount of interest yearly obtained from their savings decreases. It is assumed that the interest provided by the bank on savings amounts to 3% per year. The initial investment of 8.09 Euro corresponds to a yearly loss of interest of 0.24 Euro. Moreover, it is assumed that within the lifetime of the energy saving option, the households refill their savings account. The amount of money that yearly has to be deposited at the bank amounts to 0.60 Euro per year.

Table 5.7 *Employment effects in case the policy scheme is financed by private savings*

Labour years [× 1000]	1995	2000	2005	2010
Employment effect initial investment	4.709	-	-	-
Employment effect loss of interest	-0.131	-0.118	-0.107	-0.097
Employment effect refill of savings	-0.292	-0.261	-0.237	-0.216
Employment effect energy saving	1.162	0.853	0.759	0.645
Employment effect cash withdrawal	p.m.	p.m.	p.m.	p.m.

The effect of the energy saving is comparable to the 'financing from the general consumption budget'. The employment effect of the initial investment is identical to the effect found for financing the investment by means of a loan, since in both cases the initial investment is provided for by a transfer of money from the service sector to the residential sector.

It must be noted that the financial behaviour of the service sector, like banks or other finance companies is not modelled dynamically. Therefore, the short and long term employment effect of the cash withdrawal can not be assessed without further study. Therefore, the full cumulative employment effect is not reported. The cumulative employment effect without considering the employment effects of the cash withdrawal amounts to 11,830 labour years.

6. DIRECT AND INDIRECT EMPLOYMENT EFFECTS RELATED TO ENERGY CONSERVATION SCHEMES IMPLEMENTED IN THE RESIDENTIAL SECTOR

In this Chapter, the direct and indirect employment effects related to the energy conservation schemes as described by means of case studies are reported (Wade1999). Model calculations have been performed for Finland, France, Germany, The Netherlands, Spain and the United Kingdom. For Austria, Greece and Ireland, this analysis could not be made, since the development of an I/O-based expenditure model was not feasible within the time frame of the project. The results are obtained according to the methodology as described in Chapter 2, and the country specific models described in Chapter 4. In contrast to the analysis of the financing methods and the sensitivity analysis described in Chapter 5, real data obtained from case studies are used instead of a fictional reference conservation scheme. The case studies considered in the analysis are all implemented in the residential sector. Energy conservation schemes implemented in the tertiary sector or the industrial sector can not be analysed by means of an I/O-based expenditure model. Since for Finland a macro-economic model was available, it was possible to study the employment and macro-economic effects of an energy auditing scheme at the industrial sector. Besides an analysis of the employment impacts of the energy conservation schemes, an overview of the development of employment and unemployment is given. For The Netherlands, the employment effects of a decrease in governmental expenditures on unemployment benefits are investigated as well.

6.1 Employment effects of energy conservation schemes in France

For France three energy efficiency programs could be analysed by means of the E^3life model described in Section 4.2. These are:

- Income tax incentives for energy savings in existing dwellings (see Section 6.1.3),
- Environmental buildings for the education sector (see Section 6.1.4),
- Regional energy conservation/energy management programme in the region Nord-Pas de Calais (Section 6.1.5).

Data on these case studies were provided by Outrequin (1998) together with basic Input/output and employment data[9]. Before these case studies and the corresponding modelling results are discussed in detail, an overview of the employment situation in France is given in Section 6.1.1 and the general model input is described in Section 6.1.2.

6.1.1 Employment and unemployment in France

Since 1970 the labour force in France increased from 20.9 million to 22.7 million in 1998 (INSEE 1999). Especially the number of employed women raised considerably, with the activity rate passing from 38.2% in 1970 to 47.6% in 1998. In the same period the activity rate for men passed from 74.3% to 62.0%, reflecting earlier retirement, increased longevity and raise in unemployment. The development of the unemployment rate is depicted in Figure 6.1. After a small decline in the second half of the eighties unemployment rose by more than 3 points between 1990 and 1994 and since then decreased only slightly. Unemployment of women has always been about 4 points higher than for men. Also young people and less qualified persons are more concerned by unemployment than the average, see Table 6.1.

[9] For the other three case studies carried out for France, either sufficient data were not available (*EU labelling on cold appliances)*, or they did not focus on the final demand sectors households and government (*DSM in the industrial sector, DSM in rural areas*).

Table 6.1 *Unemployment rates in France by age class and by social category, January 1999*

By age category	[%]	By social category	[%]
15 – 24 years	25.9	Managers, superior intellectual professions	4.6
25 – 49 years	10.7	Intermediate professions	7.0
50 years and more	7.7	Employees	14.8
		Workers	15.3

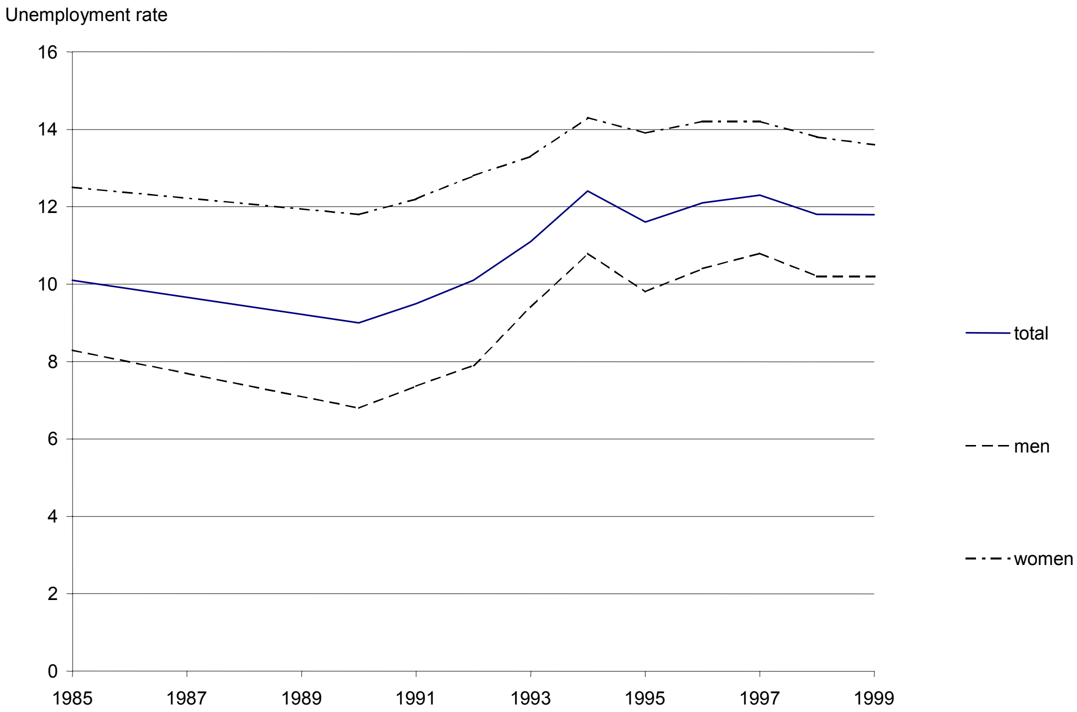

Figure 6.1 *Development of the unemployment rate in France in the period 1985-1999 (Source: EuroSTAT, using the definition of the ILO)*

6.1.2 General model input

The employment impact of the French energy efficiency programmes is evaluated against a Business as usual scenario. The main parameters entering this scenario are summarised in Table 6.2. These parameters are also valid for the intervention scenarios including the energy efficiency programmes. So the only difference between the intervention and the reference case lies in the energy efficiency programmes. The reference case corresponds as far as possible to the baseline scenario retained in Capros et al. (1997). The price developments reflect the development of international oil and gas prices as depicted in Capros et al. (1997) as well as a moderate decline in electricity prices for private customers due to liberalisation. For France no additional carbon or energy tax has been assumed.

Table 6.2 *Basic data, baseline scenario for France*

[% p.a.]	1995-2000	2000-2010
GDP Growth	+2.4	+2.3
Growth number of households	+0.7	+0.7
Labour productivity growth	+2.5	+2.5

[Ects/kWh]	1995	2000	2010
Electricity price households	11.1	10.5	10.3
Natural gas price households	3.3	3.3	3.4
Fuel oil price households	3.6	3.5	4.5

6.1.3 Income tax incentives for energy savings in existing housing

France has conducted since 1974 a programme of tax incentives in favour of energy saving investments for residential space heating. The application conditions of the programme have been varying over time as well as the tax benefit obtained. Since 1993 a tax reduction equal to 25% of the expenditure is received. Thereby only expenditures below a certain ceiling, currently 40.000 FF for a couple without children, are retained. Besides energy efficiency investments also other building renovation measures are subsidised under the scheme. The public aid for energy saving works has been on average 223 MEuro per year in the period 1995 to 1997, inducing investments of 1850 MEuro per year (Table 6.3 and Outrequin, 1998).

For the model runs, the subsidies of the years 1995 to 1997 have been collapsed into the calculation year 1995, to obtain a sufficient impact to be visible in the aggregated perspective of the Input/output model. The energy savings obtained are estimated at 40,193 TJ per year for the investments of 1995 to 1997. These are distributed as indicated in Table 6.3 on the different energy carriers.

Table 6.3 *Basic data, French income tax incentives 1995–1997*

Expenditure total	5551 [MEuro]	Average lifetime	20 [years]
Subsidies given	668 [MEuro]	Corresponding energy saving	40.2 [PJ/year]

Distribution by type	[%]	Distribution by energy carrier	[%]
Heating system	50	Natural gas	33
Building	25	Electricity	30
Installation	8	Oil	20
VAT	17	District heating	5
		Other (coal, wood)	1

The simulation results are summarised in Table 6.4. The tax incentive scheme turns out to have an overall positive employment effect of about 71,400 labour years over the lifetime of the installations (23 years). This effect is due to a positive gross employment effect of the initial investment and a positive effect of the budget shift resulting from energy efficiency investment and energy savings. The energy savings in themselves contribute a negative employment effect, as do shifts in government expenditures. The largest proportion of employment is created for workers, the category most touched by unemployment (see Table 6.1).

Table 6.4 *Model results, French income tax incentives 1995-1997*

Employment [years × 1000]	1995	2000	2010
Gross employment effect initial investment	83.2	0.0	0.0
Gross employment effect decrease in energy consumption	-4.6	-4.2	-3.5
Compensating employment effect household budget shift	4.6	3.9	3.7
Compensating employment effect government budget shift	-13.6	0.0	0.70
Total employment effect	69.6	-0.3	0.3
		1995-2018	
Cumulative employment effect		71.4	
of which: full time employed		58.3	
part time employed		13.1	
self-employed		8.2	
managers, higher intellectual professions		4.5	
intermediate professions		8.6	
employees		19.1	
workers		31.0	

6.1.4 Environmental buildings for the education sector

The next French case study analysis the concept of eco-buildings as supported by the 'Plan Construction and Architecture' which is subordinated to the Ministry of Housing. Here a pilot project has been selected for evaluation, an environmentally friendly school building, the secondary school Maximilien-Perret in Alforville in the region Ile-de-France (Paris and surroundings). For this school building energy savings have been evaluated at 770 MWh per year compared to a conventional building with additional costs for energy management of 0.089 MEuro.

For the model runs the project size has been amplified by assuming that 10 similar schools are built. The corresponding input data are summarised in Table 6.5. Thereby it is assumed that the funding of the investment is done from the investment budget of the government with corresponding cuts in other investments. For the calculation of the financial benefits of energy savings 15% lower energy prices than for households are assumed. These benefits are then used for other government investments.

Table 6.5 *Basic data, French environmental buildings*

Expenditure total	7.1 [MEuro]	Average lifetime	25 [years]
		Corresponding energy saving	27.7 [TJ per year]
Distribution by type	[%]	Distribution by energy carrier	[%]
Building system management	61	Natural gas	38
		Electricity	14
Other actions	22	Oil	33
VAT	17	District heating	10
		Other (coal, wood)	5

The simulation results are indicated in Table 6.4. The scheme has an overall positive employment effect of about 82 labour years over the lifetime of the installations. Especially the government expenditure induced through the energy savings is much more employment intensive than the corresponding energy use, leading to a positive employment effect. Besides workers particularly self-employed and intermediate professions are benefiting from the new jobs created.

Table 6.6 *Model results, French environmental buildings*

Employment [years]		1995	2000	2010
Gross employment effect initial investment		13.2	0.0	0.0
Gross employment effect decrease in energy consumption		-2.2	-2.0	-1.7
Compensating employment effect household budget shift		0.0	0.0	0.0
Compensating employment effect government budget shift		-12.0	5.4	4.9
Total employment effect		-1.1	3.3	3.2
			1995-2020	
Cumulative employment effect			81.7	
of which:	full time employed		75.5	
	part time employed		6.3	
	self-employed		11.2	
	managers, higher intellectual professions		6.8	
	intermediate professions		11.6	
	employees		8.7	
	workers		43.4	

6.1.5 Regional energy conservation/energy management programme in the region Nord-Pas de Calais

A further case study for France addresses a regional initiative for energy conservation and energy management. Actions were undertaken by the Region Nord-Pas de Calais associated with ADEME since 1984 to reduce energy consumption. The period 1994-1998 has been investigated in more detail. In this period within a pluri-annual agreement a joint policy intervention around the topics of energy management, waste management and air quality was carried out. Broad sectors such as municipalities and industry were targeted by the program, but the majority of works in the energy field concerned the installation of new heating equipment or thermal insulation in municipal buildings. The total energy savings are evaluated at 79 GJ per year for a total investment of 6.6 MEuro.

The corresponding input data are summarised in Table 6.7. Part of the expenditures are financed by grants from the regional council, the remainder are mostly municipal expenditures (the fact, that about 15% of the financing came from industry is neglected, since it may not be treated within the model). These expenditures are in the model taken from the investment budget of the government leading to the reduction of other investments. Again for the calculation of the financial benefits of energy savings 15% lower energy prices than for households are assumed. These benefits are then used for new government investments.

Table 6.7 *Basic data, French regional programme for energy conservation*

Expenditure total	6.6 [Meuro]	Average lifetime	20 years
		Corresponding energy saving	79.3 [TJ/year]
Distribution by type	[%]	Distribution by energy carrier	[%]
Electric equipment	9	Natural gas	38
Mechanical industry	88	Electricity	14
VAT	3	Oil	48

Table 6.8 shows the outcomes of the simulations. Again an overall positive employment effect is found for the scheme, summing up to 191 labour years over the lifetime of the installations. More than half of the new jobs are for workers, but less then 10% for part-time employed.

Table 6.8 *Model results, French regional programme for energy conservation*

Employment [years]		1995	2000	2010
Gross employment effect initial investment		125.4	0.0	0.0
Gross employment effect decrease in energy consumption		-6.7	-6.1	-5.0
Compensating employment effect household budget shift		0.0	0.0	0.0
Compensating employment effect government budget shift		-115.8	15.3	13.9
Total employment effect		2.9	9.2	8.9
			1995-2015	
Cumulative employment effect			190.6	
of which:	full time employed		175.6	
	part time employed		15.0	
	self-employed		22.9	
	managers, higher intellectual professions		18.7	
	intermediate professions		31.1	
	employees		20.1	
	workers		97.9	

6.2 Employment effects of energy conservation schemes in Germany

Three energy efficiency programmes have been investigated for Germany by means of the German E^3life model, see also Section 4.1. They all concern various aspects of space heating:

- the ordinance on thermal insulation of buildings (see Section6.2.3),
- the ordinance on heating systems (see Section 6.2.4),
- the CO_2 reduction programme of the KfW (see Section6.2.5).

The direct employment effects as well as economic and energy data of these programmes have been investigated by Karl (1998) who has also provided sectoral employment data. Based on these input data in the following an assessment of the direct and indirect employment effects of the programmes is carried out. But first overviews on the employment situation in Germany and the general model input data are given in Section 6.2.1.

6.2.1 Employment and unemployment in Germany

The labour force in West Germany increased between 1970 and 1998 from 26.4 million to 29.3 million (Statistisches Bundesamt, 1998). Whereas the number of employed men remained stable, the number of employed women rose by more than 20%. Together with the former GDR now the number of employed persons attains 35.9 million of which 43% are women. The development of the unemployment rate is given in Figure 6.2. Unemployment rose in the first half of the eighties and again between 1991 and 1997, attaining now a rate of 12.3% of the active population (without self-employed). Unemployment of women is about 2 points higher than for men. A particular high unemployment rate is found among foreigners (20.3%), whereas young people are in Germany on average less touched by unemployment with a rate of 11.8% for the age class below 25 years.

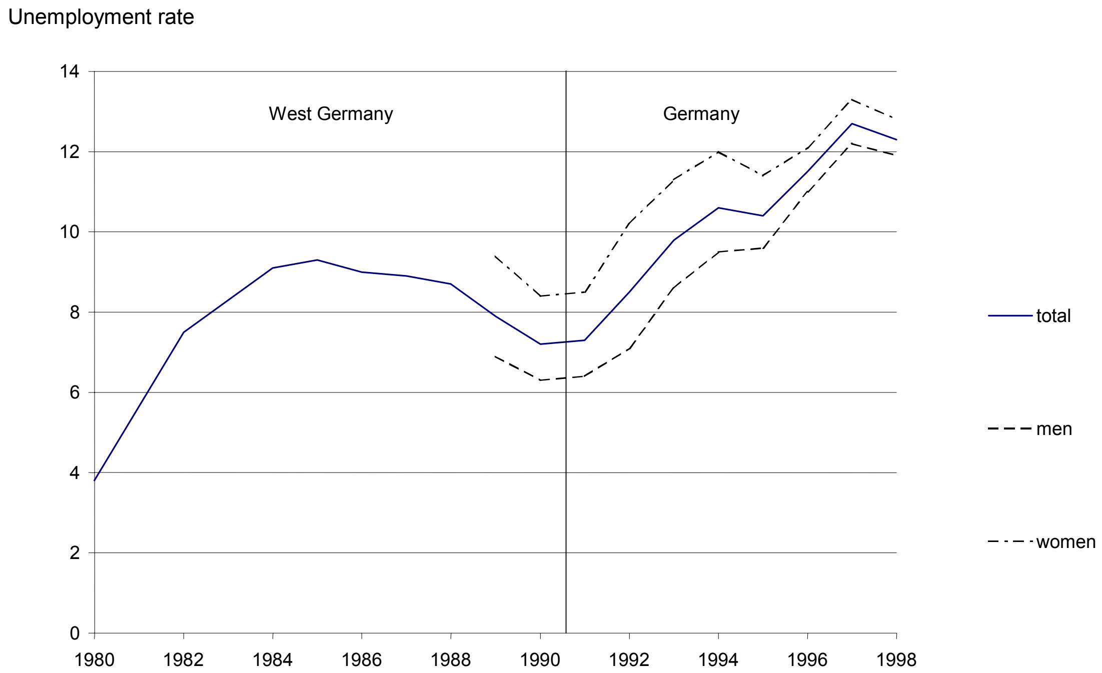

Figure 6.2 *Unemployment rate in Germany 1985 to 1999 (Source: Bundesanstalt für Arbeit, national definition)*

6.2.2 General model input

The German energy efficiency programmes are compared with a Business as usual scenario. Table 6.9 gives an overview on the main parameters entering this scenario. These parameters are also valid for the intervention scenarios including the energy efficiency programmes. The only difference between the intervention and the reference case is therefore in the energy efficiency programmes. The energy prices for households are influenced by the international prices described by Capros et al. (1997) but additionally the new German energy tax has been accounted for, which was enacted in April 1999.

Table 6.9 *Basic data, baseline scenario for Germany*

[% p. a.]	1995-2000		2000-2010
GDP Growth	+2.5		+2.4
Growth number of households	+0.5		+0.1
Labour productivity growth	+2.4		+2.4
[Ects/kWh]	1995	2000	2010
Electricity price households	11.6	12.1	11.8
Natural gas price households	2.7	3.0	3.3
Fuel oil price households	2.3	2.5	2.8

6.2.3 Ordinance on thermal insulation of buildings (Wärmeschutzverordnung 1995)

The Thermal Insulation Ordinance, which took effect in January 1995, has tightened the thermal requirements for new buildings in Germany. Compared to previous standards the heating energy requirements have been reduced by about 30%. According to studies for the Federal Government costs are expected to increase by 2% to 3% due to higher thermal requirements, see also Table 6.10. Current experiences show that the additional costs are decreasing after some years.

With about 650,000 new buildings constructed in the period 1995 to 1997 this leads to additional expenditures of about 5340 MEuro. The corresponding energy savings are around 20 PJ per year, mostly of natural gas, since this energy carrier predominates in the new construction segment. As in previous cases these figures are collapsed for the model runs in the year 1995.

Table 6.10 *Basic data, Thermal insulation ordinance in Germany*

Expenditure total	5340 [Meuro]	Average lifetime	30 years
		Corresponding energy saving	20 [PJ per year]
Distribution by type	[%]	Distribution by energy carrier	[%]
Buildings & equipment	87	Natural gas	70
VAT	13	Oil	26
		Coal	4

The model results concerning employment are shown in Table 6.11. According to these calculations the thermal insulation ordinance has a small positive impact (3,800 person years) on employment over the lifetime of the installations. For the period up to 2010 the employment impact is with about 40,100 person years more important. The category of employed which gets most advantage from the programme are the workers. This is the only group for whom the employment effect remains positive even if the whole lifetime is considered. A major reason for the small overall employment effect is that the energy efficiency investments induced by the thermal insulation ordinance are not cost effective under the currently low energy prices. These prices are now lower than in the middle of the nineties when the ordinance was enacted and expected to be cost-effective.

Table 6.11 *Model results, Thermal insulation ordinance in Germany*

Employment [years × 1000]		1995	2000	2010
Gross employment effect initial investment		99.1	0.0	0.0
Gross employment effect decrease in energy consumption		-1.5	-1.4	-1.1
Compensating employment effect household budget shift		-3.2	-2.7	-2.0
Compensating employment effect government budget shift		0.0	0.0	0.0
Total employment effect		94.4	-4.1	-3.1
		1995-2010		Lifetime
Cumulative employment effect		40.1		3.8
of which:	full time employed	41.1		9.0
	part time employed	-1.0		-5.1
	self-employed	0.2		-3.7
	helping family members	-0.4		-1.0
	officials	-0.4		-2.1
	employees	12.9		-2.5
	workers	25.5		12.2
	trainees	2.4		0.9

The initial investment is financed by means of a loan that is paid back over the lifetime of the option. The employment impact in the base year is rather high, since the total expenditures from the residential sector are increased through the loan. In the other modelling years, the loan is repaid, which induces a decrease in the total residential expenditures. The thermal insulation ordinance is a non-profitable investment. Total cumulative investment amounts to 5340 MEuro and the total cumulative energy saving is worth about 3330 MEuro. The repayment of the loan exceeds the profits resulting from a decreased energy bill. As a result, a negative employment effect is found for the compensating effect from the shift in household budget, since the (yearly) repayment of the loan exceeds the profits resulting from a lower energy bill.

The overall employment impact of this measure is rather small compared to the investment volume and employment reasons seem not to be a good argument to justify further tightening of insulation standards. They nevertheless may be very useful from an environmental point of view.

6.2.4 Ordinance on heating systems (Heizanlagenverordnung)

The heating systems ordinance has been renewed in 1994 to limit flue gas losses and increase efficiency of gas- and oil-fired boilers for space and water heating. It takes up also substantial parts of the EU directive No. 92/42 concerning the efficiency of gas- and oil-burning water heaters. Important new regulations compared to the previous ordinance include:

- Retrofit with thermostat valves is mandatory also in small buildings.
- Condensing boilers are allowed to be installed without preliminary calculation of thermal needs.
- From 1998 on only low temperature boilers and condensing boilers are allowed to be installed, except for particular cases.

The additional investment requirements for these measures are estimated at 3390 MEuro (see Table 6.12) for the period 1995 to 1997, leading to annual energy savings of 16 PJ.

Table 6.12 *Basic data, Heating system ordinance in Germany*

Total investment	3390 [Meuro]	Average lifetime	20 years
Maintenance expenditure	25 [MEuro p.a.]	Corresponding energy saving	16 [PJ/year]
Distribution by type	[%]	Distribution by energy carrier	[%]
Heating systems & building equipment	68	Natural gas	70
Installation	19	Oil	30
VAT	13		

Corresponding employment effects are given in Table 6.13. The gross employment effect of the initial investment is about 65,400 additional employment years. However due to energy savings and shifts in the other expenditures the net effect in the period 1995 to 2010 is only about one third and during the lifetime a net creation of about 17,400 employment years is obtained. Here exclusively full time jobs are created, even some part time jobs – presumably in the service sectors are dropped. The socio-professional category who gains most from the energy efficiency programme is again workers. Employees and trainees also benefit from the programme, but to a far lower extent.

Table 6.13 *Model results, Heating system ordinance in Germany*

Employment [years × 1000]		1995	2000	2010
Gross employment effect initial investment & maintenance		65.4	0.4	0.3
Gross employment effect decrease in energy consumption		-1.2	-1.1	-0.8
Compensating employment effect household budget shift		-2.9	-2.5	-1.9
Compensating employment effect government budget shift		0.0	0.0	0.0
Total employment effect		61.4	-3.1	-2.3
		1995-2010		Lifetime
Cumulative employment effect		19.6		17.4
of which:	full time employed	21.7		19.8
	part time employed	-2.1		-2.4
	self-employed	-0.8		-1.1
	helping family members	-0.6		-0.6
	officials	-0.8		-1.0
	employees	4.1		3.1
	workers	16.2		15.6
	trainees	1.4		1.3

Again, the initial investment is financed by means of a loan that is paid back over the lifetime of the option. As a result, the employment impact in the base year is rather high, since the total expenditures from the residential sector are increased in the base year. In the other modelling years, the loan is repaid, which induces a decrease in the total household expenditures. The Heating system ordinance is a non-profitable investment. Total cumulative investment amounts to 3390 MEuro, additionally 1000 MEuro supplementary maintenance expenditures occur and the total cumulative energy saving is worth about 2620 MEuro. As a result, a negative employment effect is found for the compensating effect from the shift in household budget.

6.2.5 CO_2 abatement programme of the KfW

The state-owned bank Kreditanstalt für Wiederaufbau (KfW) has launched in 1996 a programme of reduced interest loans for CO_2 abatement measures in the building stock. Different measures, such as insulation, heating system renovation, installation of double-pane windows, may be financed with these loans. The federal government provides each year 107 million Euro to finance the scheme. In 1996 investments in 111,000 dwellings were subsidised with a total loan volume of 1,3 billion Euro. Of these 815 MEuro were financed by low interest loans. In 1997 and 1998 interest in these loans somewhat decreased, but still 989 MEuro were invested in 1997. However most of the investments are, according to Karl (1998), replacement investments and only 285 MEuro can be considered as additional investment induced by the programme. About two third of the investments relate to the building shell the remaining third is used for heating system modernisation.

Table 6.14 *Basic data, KfW CO_2 abatement programme in Germany*

Additional investment	440 [MEuro]	Lifetime for calculation	30 years
Maintenance expenditure	2.4 [MEuro/year]	Corresponding energy saving	1.39 [PJ/year]
Distribution by type	[%]	Distribution by energy carrier	[%]
Consultancy, management	10	Natural gas	56
Equipment	29	Oil	35
Installation	39	Coal	9
Maintenance	9		
VAT	13		

These investments lead to the employment effects summarised in Table 6.15. The cumulative effect is for this programme negative, both for the period 1995 to 2010 and for the lifetime of the investments. This is particularly due to the strong negative impact of the government budget shift. Here it is assumed that when financing the loans, the government decides to restrict other government investments (mainly in infrastructure and buildings). These are however rather labour intensive. Sensitivity calculations show however that under the alternative assumption that the KfW loans are financed out of the current government expenditures, the negative labour market impacts are even somewhat more important. But as for the previous programmes it has to be noted that under the given assumptions the investments are not profitable for the households and that this favours also negative employment effects.

Table 6.15 *Model results, KfW CO_2-abatement programme in Germany*

Employment [years × 1000]		1995	2000	2010
Gross employment effect initial investment		8.4	0.0	0.0
Gross employment effect decrease in energy consumption		-0.1	-0.1	-0.1
Compensating employment effect household budget shift		-0.3	-0.3	-0.2
Compensating employment effect government budget shift		-4.4	0.0	0.0
Total employment effect		3.6	-0.3	-0.3
		1995-2010		Lifetime
Cumulative employment effect		-1.1		-4.2
of which:	full time employed	-0.7		-3.3
	part time employed	-0.5		-0.9
	self-employed	-0.3		-0.6
	helping family members	-0.1		-0.2
	officials	-0.2		-0.3
	employees	-0.9		-2.3
	workers	0.4		-0.6
	trainees	0.0		-0.1

Since the initial investment is financed by means of a loan, the employment impact in the base year is rather high, since money is transferred from the government to the residential sector. Therefore, the total expenditures from the residential sector increases and total governmental expenditures decrease by the same amount. In the other modelling years, the loan is repaid, which induces a decrease in the total household expenditures.

On a national level, the KFW CO_2 abatement programme is a non-profitable investment. Total cumulative investment amounts to 440 MEuro and also additional maintenance expenditures of 72 MEuro are incurred. The total cumulative energy saving is worth about 230 MEuro. As a result, a negative employment effect is found for the compensating effect from the shift in household budget.

6.3 Employment effects of energy conservation schemes in The Netherlands

In this section, the employment effects of two case studies performed for The Netherlands are presented. The two case studies considered are a subsidy programme on the condensing boiler and the EPN scheme, an introduction of new building standards for new dwellings. First, an overview of the development of employment, unemployment and vacancies in The Netherlands is given. Next, a summary of the case studies considered is given. After that, the model input and the base line scenario are described and the total employment effects related to the energy conservation schemes are reported and analysed. Finally, the induced employment effect due to the decrease in governmental expenditures on unemployment benefits is investigated.

6.3.1 Development of employment, unemployment and vacancies

The total labour force in The Netherlands has increased from about 4.1 million persons in 1960 to 6.8 million persons in 1997, see Figure 6.3. Labour force is defined as persons with an age between 15 – 64 years working at least 12 hours per week. Within the period 1977 – 1997, the total labour force increased with 39%. However, the male labour force increased with only 15%, but the female labour force increased with 103%.

Figure 6.3 *Development of total labour force and employed labour force in The Netherlands (CBS, 1999a; CBS, 1999b)*

The total unemployed labour force increased from 34,000 in 1969 to a maximum of 547,000 persons in 1994 and amounted to 349,000 persons in 1998. In 1998, 57% of the unemployed labour force is female. Within the period 1980 – 1998, the total unemployed labour force increased with 80%, the total unemployed male labour force increased with about 60% and the total unemployed female labour force increased with 100%. The number of registered persons looking for work is lower than the unemployed labour force, since not all people looking for a job are registered at the job centre.

In 1998, the total registered employment amounted to 287,000, of which 46% is female (note that 57% of the unemployed labour force in 1998 is female). The decreasing trend in unemployment seems to continue. In May 1999, the number of registered persons looking for work amounted to 236,000[10]. This is the lowest value since June 1980 (CBS, 1999c).

In 1971, total unemployed labour force amounted to 0.9% of the total labour force, see Figure 6.4. In 1980, the total unemployed labour force, the unemployed male labour force and the unemployed female labour force amounted to respectively 3.8%, 2.6% and 6.7%. In 1983, the maximum percentage of total unemployed labour force (10.2%) and unemployed male labour force (9.1%) was reached. However, maximum unemployment rate with respect to the female labour force was reached in 1987 (13.1%). In 1997, the unemployment rate amounts to 6.4%, 4,6% and 9.1% for respectively total labour force, male labour force and female labour force.

[10] The number of registered persons looking for work is the average value over the month mentioned, the previous month and the next month. A correction for seasonal influences is applied.

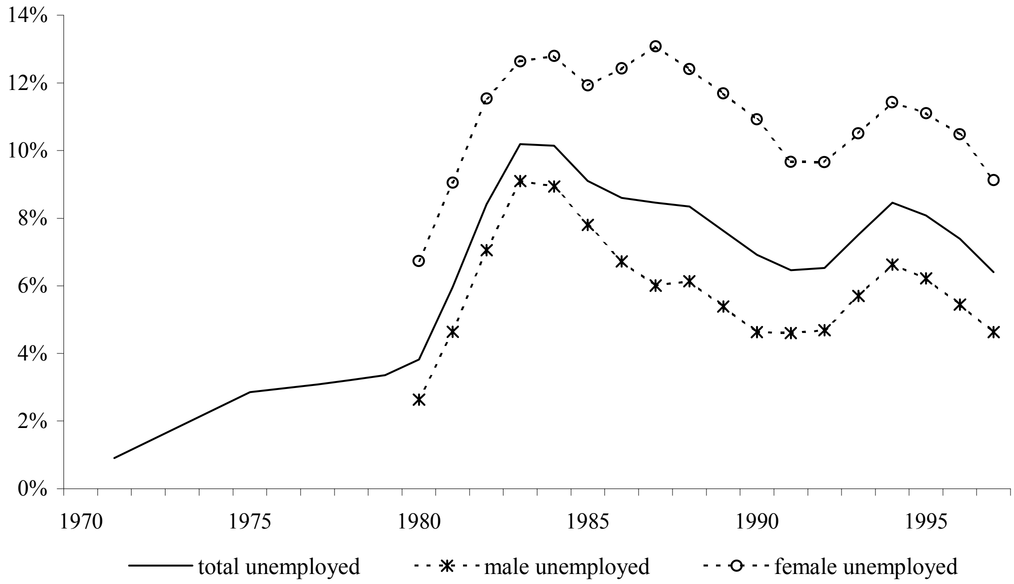

Figure 6.4 *Development of unemployed labour force as percentage of total labour force (CBS, 1999a; CBS, 1999b)*

In 1999, 48% of all persons unemployed for over one year is over 55 of age. In 1998, 2.8% of all male workers and 4.7% of all female workers over 55 became unemployed. This is four times as high as for young workers. About 28% of the registered persons looking for work is aged over 55, and 6% of the workers are aged over 55.

In Figure 6.5, the number of vacancies by education level is given. In 1970, total amount of vacancies was 164,000. About 60% of these vacancies were on the primary education level. In 1982, a minimum of 24,000 vacancies was found. The share of vacancies on primary education level decreased from 21% in 1968 to 2% in 1993. The share of vacancies on college/university education level increased from 1% in 1968 to 20% in 1993 with a maximum of 25% in 1983. In the period 1994 to 1998, the total number of vacancies rose rapidly from 41,000 in 1994 to 125,700 in 1998.

Mid-1999, the number of vacancies rose to 146,000. Of this, 12,000 vacancies are at the government. Approximately 75,000 vacancies were unfulfilled for more than three months. The number of workers changing jobs increased to a new maximum of 204,000 persons in the spring of 1999 (CBS, 1999c).

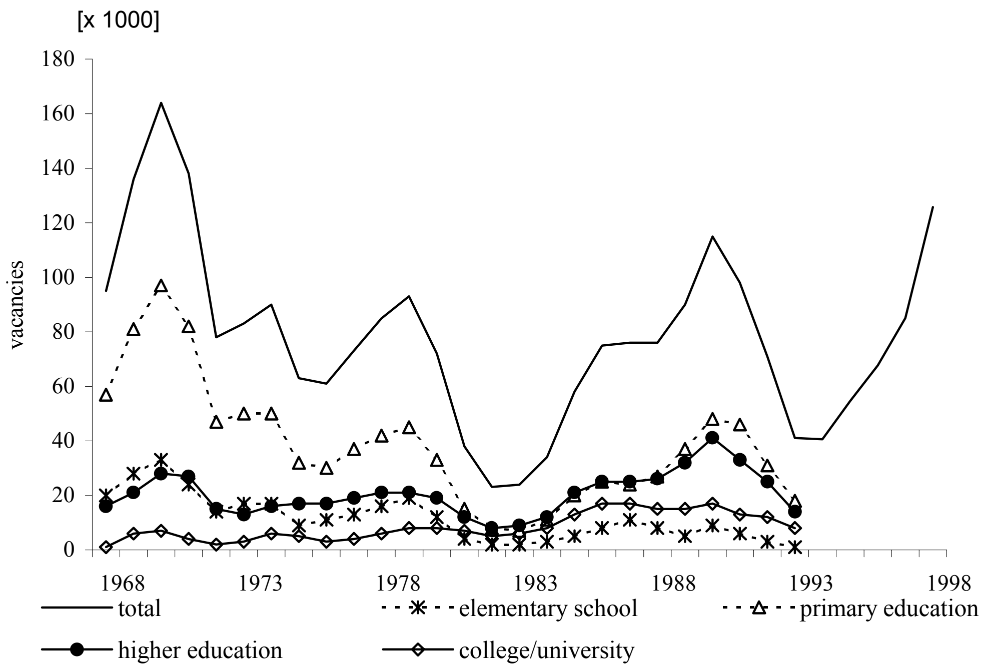

Figure 6.5 *Number of vacancies per education level in The Netherlands (CBS, 1999a; CBS, 1999b)*

The ratio between unemployed labour force and the number of vacancies amounted to 0.3 in 1969, see Figure 6.6. When this ratio is below 1, this means that the amount of vacancies is higher than the unemployed labour force. After 1974, the ratio between labour force and the number of vacancies exceeded 1. In the period 1979 to 1983, the ratio increased rapidly from 1.8 in 1979 to over 20 in 1983. In 1990, the ratio decreased again to 3.6. A second maximum of 13.5 occurred in 1994. In 1998, the ratio between the total unemployed labour force and the total number of vacancies amounted to 2.8.

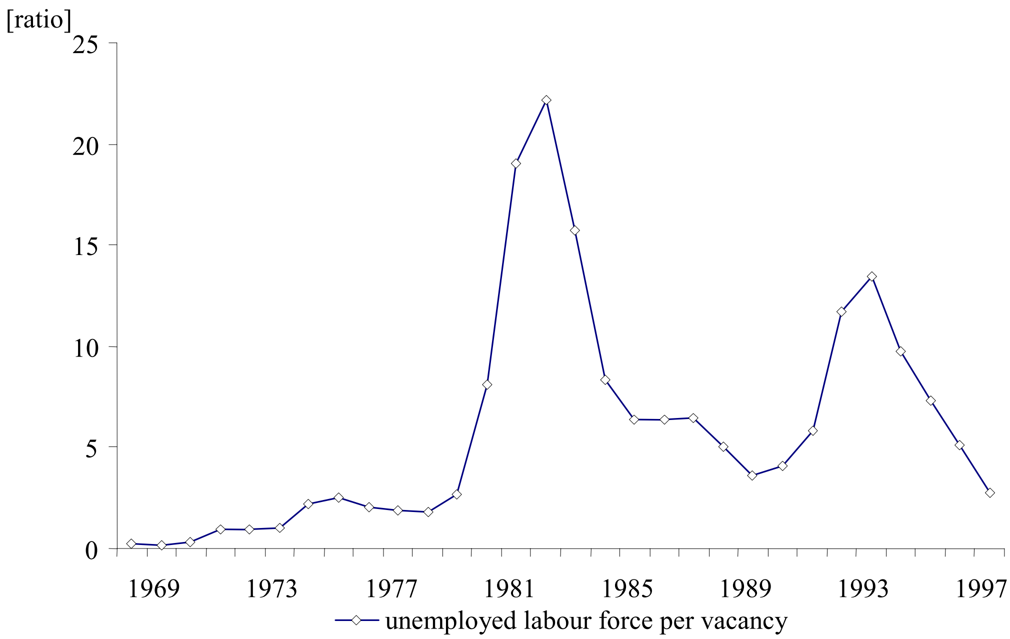

Figure 6.6 *Ratio between the total number of vacancies and total unemployed labour force*

In Table 6.16, the registered unemployment per education level is given. When the unemployment per education level is compared with the number of vacancies per education level, it appears that in 1990 the number of unemployed persons per vacancy is the highest for the education level ‘elementary school’. For the other education levels, this ratio is about a factor of three to four lower, see also Table 6.16.

Table 6.16 *Comparison between registered unemployment and vacancies by education level*

	Total	Elementary school	Primary education	Higher education	College and university
Registered unemployment [× 1000]					
1990	358	108 (30%)	104 (29%)	90 (25%)	55 (15%)
1996	440	104 (24%)	117 (27%)	147 (33%)	71 (16%)
1997	375	88 (24%)	106 (28%)	121 (32%)	60 (16%)
Vacancies [× 1000]					
1990	115	9 (8%)	48 (42%)	41 (36%)	17 (15%)
Ratio 1990	3.3	9.8	2.2	2.9	3.5

In 1997, 38% of the labour years is related to female workers, see Table 6.17. Sectors with a low share (< 10% of labour years) of female labour are quarrying, oil industry, basic metal, the transportation industry and construction and building materials. Sectors with a high rate of female labour (over 50%) are health and veterinary services, textile and other services (excl. business services and government). The largest relative share of young people (age class 15 –24) is employed at the catering and lodging. High shares of middle aged employees are found at the chemical and oil industry. The share of elderly employees (age class 45 – 64) varies less between sectors. High shares are found for the electricity and natural gas sector, lowest share is found for the oil industry. A high share of elementary education level is found for the chemical industry (end products) and other industry. A high share of primary education level is found at the transportation industry. For the higher education level, high shares are found for quarrying and textile and leather industry. Highest rates of college and university education level are found at the government and business services and retail.

Table 6.17 *Share of labour force (full time equivalents) by function, sex, age class and education level in 1997 (CBS, 1997; CBS, 1998a) [%]*

	Employees	Self-employed		
Function	88	12		
	Male	Female		
Sex	62	38		
	age 15-24	age 25-44	age 45-64	
Age class	12	59	29	
	Elementary education	Primary education	Higher education	College + university
Education level	7	21	46	26

Recently, The Netherlands Bureau for Economic Policy Analysis (CPB) investigated the rise and fall in employment and unemployment over the period 1966-1995 (CPB, 1999). The equilibrium unemployment is determined by three factors: tax rates, replacement rate[11] and real interest rate. The analysis shows that the rise of unemployment in the seventies can be attributed to increasing tax rate and replacement rate. High unemployment rates in the eighties are explained by rising capital costs, despite a decrease in replacement rate. Currently, the actual unemployment rate is almost identical to the equilibrium unemployment rate.

[11] The rate between the net income of an unemployed person and the net income of an employed person.

Therefore, no additional decrease in unemployment can be expected as a result of current economic state. According to (CPB, 1999), a further decrease in unemployment can only be obtained as a result of governmental policy schemes (a reduction in the financial burden, or a lowering of the replacement rate) or a further decrease of the actual interest rate.

6.3.2 Case studies

For The Netherlands, three quite recent policy schemes for energy conservation have been studied to assess the quality and the size of their employment impacts. The first case is the subsidy for high efficient condensing boilers (HR-boilers), granted from 1991 to 1996 in the context of the Environmental Action Plan (MAP). The second case is on Energy Management Systems in the industrial sector, for which subsidy has been granted between 1991 and 1994 as part of the subsidy program TIEB, Tenders Industrial Energy Conservation. Since this case study focuses on energy conservation in the industrial sector and not on the residential sector, it is not analysed in this report. The third case study performed is the introduction of the Energy Performance Standard EPN, a regulation introduced towards the end of 1995, that imposes requirements on the energy performance of new dwellings. An extensive description of these case studies is given in (Dougle et al., 1999).

The condensing boiler programme

Total investments related to the condensing boiler programme amount to 260 million Euro, see Table 6.18. About half of the additional investment is spent on installation, the other half on equipment. Due to the expected increase in prices of natural gas, the total monetary saving increases by 60%.

Table 6.18 *Investments, grants and savings for the condensing boiler programme (Dougle, 1999)*

[MEuro]	1995	2000	2010
Private investments	259.5	0.0	0.0
- installation	127.1	0.0	0.0
- equipment	132.3	0.0	0.0
Grants	10.2	0.0	0.0
Maintenance	3.6	3.6	3.6
Saving natural gas	2858.0	2858.0	2858.0
Total monetary savings	20.2	30.5	32.4

In the case study, it was assumed that 1 hour of additional service per year is needed for a condensing boiler compared to the reference technology. This leads to a yearly expenditure loss of 17.9 million Euro. This would imply that in the base year, the maintenance costs are equal to 90% of the total monetary savings. For the other modelling years, the maintenance costs would exceed 50% of the total monetary savings, therefore reducing the yearly net profits for the consumer considerably. Since the value for expenditures related to maintenance presented in the case study seems rather unrealistic, further inquiries have been made. It appeared that the difference between a service contract for a condensing boiler and the reference boiler is at maximum 25 Dutch guilders per year per boiler (about 11.3 Euro) (Kropman, 1999). This is about a factor of 5 lower compared to the values given in the case study. In (Feenstra, 1999), the difference in price between a closed boiler for space heating and an open system amounts to 1 guilder per month[12].

[12] It is assumed that the reference boiler is an open system. This is a rather conservative estimate, since part of the non-condensing boilers (boilers without a subsidy) also use a closed system.

In the remainder of the analysis, a modified value for the maintenance costs will be used, since the price difference in service contracts between the condensing boiler and the reference boiler is a more reliable estimate of the additional maintenance costs compared to the method used in the case study. It is assumed that the additional maintenance costs amount to 25 guilders per boiler per year (a conservative estimate).

Apart from the grants awarded by the government, additional subsidies of 28,4 million Euro were granted by the utilities. This subsidy is financed by the MAP-levy on energy prices for households. Therefore, the net transfer of money between sectors is zero, since the levy is returned again to the residential sector as a subsidy.

The accumulated monetary savings exceed the total private investments by 41%. Total accumulated savings over the lifetime of the condensing boiler amount to 440 million Euro. The total accumulated investments amount to 314 million Euro (subsidy excluded), of which 54 million Euro is due to additional maintenance. Without the modification of the maintenance costs, total expenditure amounted to 530 million Euro of which 270 million Euro was used for additional maintenance.

The EPN scheme

By means of the methodology described in the EPN standards, a reference energy consumption is calculated for new dwellings. The energy functions covered by the EPN methodology are space heating, hot water production, lighting and ventilation (including air conditioning). The main objective for implementing a new methodology that sets demands on the energy performance of new dwellings was to optimise the cost effectiveness of building related energy saving options, rather than energy conservation.

Total investments related to the EPN scheme amount to 75 million Euro, see Table 6.19. About 10% of the additional investment is spent on installation, 34% on equipment such as energy efficient window panes, cavity wall insulation and condensing boilers, and 57% is spent on consultancy. Grants provided are due to an increase in rental subsidy, since the increase in total construction costs result in a slightly higher rent of rented houses. The additional maintenance costs are due to the increase in maintenance needed for the condensing boiler, see also the scheme on the condensing boiler.

Table 6.19 *Investments, grants and savings for the EPN scheme (Dougle, 1999)*

		1995	2000	2010
Private investments	[MEuro]	75.420	0	0
- installation	[MEuro]	7.185	0	0
- equipment	[MEuro]	25.334	0	0
- consultancy	[MEuro]	42.901	0	0
Grants	[MEuro]	0.027	0.027	0.027
Maintenance	[MEuro]	0.278	0.278	0.278
Saving electricity	[TJ]	23	23	23
Saving natural gas	[TJ]	246	246	246
Saving electricity	[MEuro]	0.7	0.9	0.9
Saving natural gas	[MEuro]	1.7	2.6	2.8
Total monetary savings	[MEuro]	2.5	3.5	3.6

As for the scheme on the condensing boiler, maintenance costs as reported in the case study are likely to be overestimated and have therefore been adapted. According to the case study, 24504 new dwellings were equipped with a condensing boiler. The resulting additional maintenance costs amount to 0.28 million Euro per year.

Total accumulated savings over the period 1995-2010 amount to 51 million Euro. The total accumulated investments amount to 80 million Euro (subsidy excluded), of which 4.2 million Euro is due to additional maintenance. Therefore, it can be concluded that the EPN programme is not cost effective, since total expenditures exceed total monetary savings by 36%. Without the modification of the maintenance costs, total additional maintenance costs rise from 4.2 million Euro to 20 million Euro.

6.3.3 Scenario parameters and model input

In this section, a brief description of the scenario parameters of the base line scenario is given. The growth of private consumption, total population as well as the development of the Consumer Price Index (CPI) are obtained from (Capros, 1997), see Table 6.20. In Table 6.21, the development of total private consumption and population is given.

Table 6.20 *Growth of private consumption, population and CPI according to (Capros, 1997)*

[%]	1995-2000	2000-2005	2005-2010
Growth of private consumption	2.32	2.39	2.33
Growth of population	0.73	0.45	0.35
Growth of CPI	1.98	1.90	1.82

Table 6.21 *Development of private consumption and population (CBS, 1998)*

		1995	2000	2010
Private consumption	[million Dutch guilders]	376760	422540	533544
Population total	[million]	15.42	16.00	16.65
Number of households	[million]	6.516	7.094	7.990
Family size	[pers./hh.]	2.37	2.25	2.08

The total disposable income per household rises from 58,000 Dutch guilders to 60,000 guilders in 2000 to 67800 guilders in 2010, see Table 6.22. This corresponds to a yearly increase by 0.6% in the period 1995 – 2010 and an increase by 1.2% per year in the period 2000 – 2010. The lowest consumption budget is found for one-parent families younger than 36 years of age (51% below average). The highest consumption budget is found for couples aged of 36 – 60 years of age (23% above average). Due to the rise in labour participation, the consumption budget rises faster than the average value. On the other hand, the consumption budget of the elderly people (over 65) rises less rapidly than the average consumption budget, since these categories do not profit from the increase in wages and labour participation.

Table 6.22 *Development of total average budget for consumption per household type*

	1995	2000	2010
Singles <36	36150	36748	46232
Singles 36-65	40999	41615	52266
Singles >65	47712	46246	51507
Couples <36	60502	58544	73563
Couples 36-65	71741	75230	87736
Couples >65	56535	55597	59910
Families <36	63062	65888	76316
Families 36-65	71636	79398	83666
One parent families <36	28593	27912	29196
One parent families 36-65	42144	42573	51319
Average	58297	60117	67998

The decomposition of the total population in different household types is given in Table 6.23. The share of one-person households is expected to increase from 31% in 1995 to 38% in 2010. The share of two parent families decreases from 33% in 1995 to 29% in 2010 and the share of one parent families decreases from 5% in 1980 to 4% in 2010. The share of the population that is over 65 years of age increases from 17.5% in 1995 to 21% in 2010.

Table 6.23 *Development of number of households per household type (CBS, 1998)*

	1995	2000	2010	1995	2000	2010
Single <36	669	801	1037	10.3%	11.3%	13.0%
Single 36-65	689	786	963	10.6%	11.1%	12.0%
Single >65	690	826	1070	10.6%	11.6%	13.4%
Couple <36	613	620	629	9.4%	8.7%	7.9%
Couple 36-65	924	997	1047	14.2%	14.1%	13.1%
Couple >65	450	514	579	6.9%	7.2%	7.2%
Family <36	546	535	542	8.4%	7.5%	6.8%
Family 36-65	1610	1689	1806	24.7%	23.8%	22.6%
One parent family <36	65	65	63	1.0%	0.9%	0.8%
One parent family 36-65	261	261	254	4.0%	3.7%	3.2%
Total	6516	7094	7990	100%	100%	100%

In The Netherlands, the consumption of energy in the residential sector concerns two major energy carriers: natural gas and electricity. About 92% of all houses are connected to the natural gas grid, practically all houses are connected to the electricity grid. The initial natural gas price, without surcharges and VAT, is presumed to rise from 0.39 Dutch guilders[13] per m^3 in 1995 to 0.46 guilders per m^3 in 2010, see Table 6.24. In 1995, a surcharge of 1.8% per m^3 had to be paid within the framework of the MAP-levy. The revenues of the MAP-levy were returned by the utilities to the households as subsidies on energy investments. From 2000 on, the MAP-levy is cancelled. In the period 2000-2010, two other surcharges are applied. The WBM-levy is an environmental tax on energy use. For natural gas, the WBM-levy amounts to 0.026 cents/m^3. Recently, the REB-levy was introduced. In the period 2000-2010, the REB-levy amounts to 0.189 cents/m^3. A total consumption of 800 m^3 of natural gas is exempted from the REB-levy. The revenue of the REB is supposed to be returned to the households. The VAT amounts 17.5%. The natural gas price for end-users increases from 0.49 guilders per m^3 in 1995 to 0.79 guilders per m^3 in 2010, an increase of 60%.

The initial electricity price rises only moderately from 0.190 guilders per kWh in 1995 to 0.194 guilders/kWh in 2000 and 2010. The slower increase of the electricity prices is due to the expected effects of the liberalisation of the energy market. In 1995, the surcharges consist of a 1.8% MAP-levy. In 2000 and 2010, a REB-levy of 0.058 guilders per kWh is applied. A total consumption of 800 kWh is exempted from the REB-levy. The electricity price for end-users increases from 0.26 guilders per kWh in 1995 to 0.30 guilders per kWh in 2010, an increase of 15%.

[13] One Dutch guilder equals 2.20 Euro.

Table 6.24 *Development of energy prices (CPB, 1997; Capros, 1997)*

		1995	2000	2010
Natural gas, initial	[Dutch guilders/m^3]	0.39	0.42	0.46
- surcharges (ex VAT)	[Dutch guilders/m^3]	0.03	0.21	0.21
- VAT	[Dutch guilders/m^3]	0.07	0.11	0.12
Natural gas including VAT and surcharges	[Dutch guilders/m^3]	0.49	0.74	0.79
Electricity, initial	[Dutch guilders/kWh]	0.190	0.194	0.194
- surcharges (ex VAT)	[Dutch guilders/kWh]	0.029	0.058	0.058
- VAT	[Dutch guilders/kWh]	0.033	0.034	0.034
Electricity including VAT and surcharges	[Dutch guilders/kWh]	0.257	0.296	0.296

In Table 6.25, the improvement of labour productivity is given for the aggregate industrial sectors. The highest rate of improvement is found in the manufacturing industry and utilities. The lowest value is obtained for the non-commercial services.

Table 6.25 *Improvement of labour productivity [% per year] (Pellekaan, 1996; CPB, 1996)*

	1995-2010
Primary sector	2,00
Manufacturing industry & Utilities	3,60
Building industry	1,75
Wholesale, retail, repair, catering	2,00
Transport & Communication	2,75
Commercial services	2,30
Non-commercial services	1,50

6.3.4 Calculated employment effects of the condensing boiler programme

In this section, the calculated direct and indirect employment effects of the condensing boiler programme are given. It is assumed that the additional investment is financed from the general consumption budget, see also Section 3.4. Moreover, a comparison is made between the calculated employment effects and the direct employment effects as reported in the case study.

In Table 6.26, the increment in employment related to private and governmental expenditures is given for the condensing boiler programme. The cumulative employment effect amounts to 3,800 labour years. As a result of the grants, the employment related to private expenditures increases by about 130 labour years in the base year. However, since the governmental budget is reduced, the total employment related to governmental expenditures decreases by 200 labour years in the base year. Therefore, the net effect of the grants is negative (a decrease of employment of 70 labour years).

Table 6.26 *Increment of employment related to private and governmental expenditure for the condensing boiler programme*

Labour years [× 1000]	Private expenditure			Governmental expenditure		
	1995	2000	2010	1995	2000	2010
Grants	0.131	-	-	-0.200	-	-
Investment	1.049	-	-	-	-	-
Maintenance	0.015	0.014	0.013	-	-	-
Energy	0.119	0.188	0.183	-	-	-
VAT - investment	-	-	-	0.384	-	-
VAT - energy consumption	-	-	-	-0.025	-0.024	-0.023
		1995-2000				
Cumulative employment effect		3.837				

Due to the shift in the general consumption budget, see also Section 3.1, total employment increases by over 1,000 labour years in the base year. This effect occurs in the base year only and is related to private expenditures solely. The employment effect of the additional maintenance needed lasts over the lifetime of the option and amounts to about 15 labour years per year. Due to the reduction on the energy bill, households are able to spend more money on other commodities and services. The reduction of energy consumption leads to a decrease in employment in the industrial sectors related to electricity production. However, this effect is compensated by the expenditures on other commodities and services. The net effect of the energy saving amounts to 120 labour years in the base year and increases to about 180 labour years in 2000 and 2010. The energy saving effect lasts over the lifetime of the option and is solely related to employment from private expenditures. The cumulative energy saving effect amounts to 2,600 labour years over the period 1995 – 2010.

As a result of different VAT levels between goods and services, two employment effects occur. Due to a shift in the general consumption budget induced by the payment of the initial investment, the total VAT revenue decreases by about 57 million guilders, see Table 6.27. However, tax revenue related to the initial investment amounts to 100 million guilders. So, in the base year, there is a net increase in VAT revenue of about 40 million guilders resulting from the investment in energy saving. This can be explained by the fact that the VAT level related to the investment is higher than the average VAT level of the total consumption budget, see Table D.5 of Annex D. There is a net transfer of money spent on goods and services with low VAT level to goods and services with a high VAT level. As a result of this increase in tax revenue, the employment related to governmental expenditures increases by over 380 labour years in the base year.

Table 6.27 *Changes in governmental tax revenue from VAT for the condensing boiler programme*

[Million guilders]	1995	2000	2010
VAT - investment	100.1	0	0
VAT - budget shift	-56.8	0	0
VAT - energy	-7.8	-11.8	-12.5
VAT - rebound	4.9	8.8	9.5

Since less energy is consumed, total VAT revenue related to energy consumption decreases, see Table 6.27. However, the money saved due to a lower energy bill is now spent on other goods and services. The net effect of this shift in expenditure pattern amounts to a decrease in VAT revenue of about 3 million guilders per year.

This effect occurs over the lifetime of the energy saving option. As a result, total employment decreases by about 25 labour years per year over the lifetime of the option. The cumulative effect is a decrease in employment of about 360 labour years. For the condensing boiler programme, it is concluded that the net effect of changes in total tax revenue is only very small but slightly positive (27 labour years over the period 1995-2010).

The effect of tax revenue of excise taxes, for example on motor fuels, alcohol and tobacco and energy, is not analysed. This issue does not raise methodological obstacles, but could not be tackled within the time frame of this project.

Employment changes by sector

As a result of the condensing boiler programme, total employment increases by 3,200 labour years in the base year in the construction sector, see Table 6.28. As a result in the shift in the consumption budget in the base year (re-allocation of expenditures in order to finance the energy saving option), the employment decreases in most other sectors, especially in government sector and other services.

In the other modelling years, a decrease in employment is found for production and distribution of natural gas and water and related (supplying) sectors such as quarrying and electrical industry. The sector 'other services' appears to be the most sensitive to changes in expenditure budget.

Table 6.28 *Shift in total employment by sector as a result of the condensing boiler programme*

Labour years [× 1000]	1995	2000	2010
Agriculture and fishing	-0.120	0.011	0.010
Quarrying (including oil and gas)	-0.006	-0.004	-0.004
Food	-0.062	0.005	0.003
Textile and leather	-0.246	0.023	0.021
Paper	-0.044	0.005	0.004
Oil industry	-0.003	0.000	0.000
Chemicals (basics)	-0.024	0.003	0.003
Chemicals (end products)	0.016	0.000	0.000
Basic metal	0.116	0.002	0.002
Metal products	0.012	0.000	0.000
Electrical industry	-0.035	-0.061	-0.056
Transportation industry	-0.001	0.000	0.000
Other industry	0.197	0.009	0.008
Electricity, natural gas and water (prod. and distr.)	-0.047	-0.046	-0.041
Construction and building materials	3.241	0.048	0.045
Trade and repair	0.031	0.004	0.004
Catering and lodging	-0.217	0.024	0.026
Transport and communication services	-0.147	0.015	0.015
Financial institutions	-0.124	0.015	0.015
Exploitation of real estate	-0.035	0.004	0.005
Business services and rental of moveable property	-0.013	0.019	0.019
Health and veterinary services	-0.081	0.009	0.006
Other services (excl. business services, government)	-0.583	0.063	0.061
Government	-0.353	0.028	0.028
Sum	1.473	0.178	0.173

Employment effects by type of worker

As a result of the condensing boiler programme, both the number of employees and the number of self-employed rise, but the programme is more beneficial with respect to self-employed persons. This holds for the base year as well as for the other modelling years. The share of female workers related to the condensing boiler programme is below average in the base year due to the shift in expenditures from government to the construction sector and sectors related to the construction sector. However, in the other modelling years, the share of female workers is slightly over average. The net effect on female labour is positive (about 600 labour years). For all age classes of workers, a net increase of labour is found. However, the program is more beneficial for workers of age class 15 - 24 years. As a result, the share of the age class 25 – 44 as well as the share of the age class 45 - 64 decreases slightly. The condensing boiler programme has a positive effect on employment for workers with a low education level (elementary and primary education). This effect especially occurs in the base year, but is still present in the other modelling years. The programme has a negative effect on employment for highly educated workers (college and university education level). In summary, the condensing boiler programme is especially beneficial for (male) self-employed persons, people aged between 15 and 24, and workers with an elementary and primary education level. Nevertheless, the net effect on female labour is positive as well.

Comparison between model calculations and the case study

According to the case study (see Dougle, 1999), about 350 temporary jobs are created as a result of work related to the instalment of the condensing boiler. Moreover, about 180 jobs are created over the lifetime of the option due to the additional maintenance required. In the model calculations, the net effect of the initial investment amounts to 1,050 labour years, of which 3,200 labour years are found in the construction sector, see also Table 6.28. In the case study, only the direct employment effects are assessed and therefore the total employment effects in the case study are likely to be underestimated.

According to the model calculations, about 15 labour years per year are related to the additional maintenance. However, without the modification of the model input with respect for maintenance, the additional labour would amount to about 75 labour years. The sector specific labour coefficients used in the modelling are based on average process conditions. This means that besides labour also goods/materials are used in the industrial process. The additional maintenance refers to an action in which only labour is involved (no spare parts are used in the (additional) maintenance of the condensing boiler). The labour coefficients refer to average sector conditions in which labour as well as goods/materials are used, the case study refers to an action in which only labour is used. It is concluded that the employment effect found for maintenance is likely to be underestimated by a factor two in the model calculations, due to the absence of use of spare parts in the maintenance process. If this effect is taken into account, the employment related to additional maintenance as calculated by the model is consistent with the values reported in the case study.

6.3.5 Calculated employment effects of the EPN scheme

In this section, the calculated direct and indirect employment effects of the EPN scheme are given. For modelling reasons, it is assumed that the additional investment is financed from the general consumption budget, see also Section 3.4. In practice, a large share of the households will finance the additional investment by means of a mortgage. However, it is expected that the differences in financing method will not change the outcome of the modelling results considerably, see also Section 5.2.2. In addition, a comparison is made between the calculated employment effects and the direct employment effects as reported in the case study.

In Table 6.29, the increment in employment related to private and governmental expenditures is given for the EPN scheme. The cumulative employment effect amounts to 1,000 labour years, which is remarkable when the profitability of the scheme is considered. The grants involved are only minimal due to a small increase of rental subsidies. The effect on labour related to governmental expenditures is only marginal and amounts to 1 labour year in the base year and is even smaller in the other modelling years. The effect of the grants on employment related to private expenditures is negligible.

Due to the shift in the general consumption budget, see also Section 3.1, total employment increases by 485 labour years in the base year. This effect occurs in the base year only and is related to private expenditures solely. The employment effect of the additional maintenance needed lasts over the lifetime of the option and amounts to about 1 labour year per year. The net effect of the energy saving amounts to 15 labour years in the base year and increases to about 21 labour years in 2000 and 2010. The energy savings effect lasts over the lifetime of the option and is solely related to employment from private expenditures. The cumulative energy saving effect amounts to 300 labour years over the period 1995-2000.

Table 6.29 *Increment of employment related to private and governmental expenditure for the EPN scheme*

Labour years [× 1000]	Private expenditure			Governmental expenditure		
	1995	2000	2010	1995	2000	2010
Grants	0.000	0.000	0.000	-0.001	-0.000	-0.000
Investment	0.485	-	-	-	-	-
Maintenance	0.001	0.001	0.001	-	-	-
Energy	0.015	0.021	0.021	-	-	-
VAT - investment	-	-	-	0.258	-	-
VAT - energy saving	-	-	-	-0.003	-0.002	-0.002
		1995-2000				
Cumulative employment effect		1.022				

As a result of different VAT levels between goods and services, two employment effects occur. The VAT levels per expenditure category are given in Table D.5 of Annex D. Due to a shift in the general consumption budget induced by the payment of the initial investment, the total VAT revenue decreases by about 17 million guilders, see Table 6.30. However, the VAT related to the investment in energy conservation amounts to 29 million, so there is a net increase in tax revenue in the base year. As a result of this increase in tax revenue, the employment related to governmental expenditures increases by 260 labour years in the base year.

Table 6.30 *Changes in governmental tax revenue from VAT for the EPN scheme*

[Million guilders]	1995	2000	2010
VAT - investment	29.1	0	0
VAT - budget shift	-17.2	0	0
VAT - energy	-1.0	-1.3	-1.4
VAT - rebound	0.6	1.0	1.1

Since less energy is consumed, total VAT revenue related to energy consumption also decreases, see again Table 6.30. However, the money saved due to a lower energy bill is now spent on other goods and services. The net effect of this shift in expenditure pattern amounts to a decrease in VAT revenue of about 0.3 million guilders per year. This effect occurs over the lifetime of the energy saving option. As a result, total employment decreases by about 3 labour years per year over the lifetime of the option (cumulative 37 labour years). It should be noted that only the employment effects due to changes in tax revenue related to VAT is studied. Within the timeframe of the project, it was not feasible to analyse the effects of excise taxes on for example alcohol and tobacco, motor fuels and energy. The net effect of changes in total VAT revenue for the EPN scheme is larger than for the condensing boiler programme. The cumulative employment effect amounts to 220 labour years over the period 1995 – 2010. This can be explained for the greater part by the low economic profitability of the EPN scheme. The amount of energy saved per guilder invested is much lower for the EPN scheme and therefore the change in VAT revenue resulting from energy conservation is lower.

Employment changes by sector

As a result of the EPN scheme, total employment increases in the construction sector by almost 400 labour years in the base year and by 770 labour years in the business services sector, see Table 6.31. As a result in the shift in the consumption budget in the base year, the employment decreases in most other sectors, especially in 'other services'. Due to the net increase in VAT revenue, the employment effect in the governmental sector is positive in the base year. In the other modelling years, again a decrease in employment is found for production and distribution of natural gas and water and related (supplying) sectors such as quarrying, electrical industry. The sector other services appears to be the most sensitive to changes in expenditure budget.

Table 6.31 *Shift in total employment by sector as a result of the EPN scheme*

Labour years [× 1000]	1995	2000	2010
Agriculture and fishing	-0.038	0.001	0.001
Quarrying (including oil and gas)	-0.001	-0.000	-0.000
Food	-0.019	0.001	0.000
Textile and leather	-0.078	0.003	0.003
Paper	0.002	0.001	0.000
Oil industry	-0.001	0.000	0.000
Chemicals (basics)	-0.009	0.000	0.000
Chemicals (end products)	0.002	0.000	0.000
Basic metal	0.011	0.000	0.000
Metal products	0.000	0.000	0.000
Electrical industry	-0.004	-0.007	-0.006
Transportation industry	0.000	0.000	0.000
Other industry	0.014	0.001	0.001
Electricity, natural gas and water (prod. and distr.)	-0.007	-0.005	-0.005
Construction and building materials	0.398	0.004	0.004
Trade and repair	0.008	0.000	0.000
Catering and lodging	-0.059	0.003	0.003
Transport and communication services	-0.040	0.002	0.002
Financial institutions	-0.037	0.002	0.002
Exploitation of real estate	-0.010	0.001	0.001
Business services and rental of moveable property	0.772	0.002	0.002
Health and veterinary services	-0.024	0.001	0.001
Other services (excl. business services, government)	-0.169	0.008	0.007
Government	0.044	0.003	0.003
Sum	0.756	0.020	0.019

Employment effects by type of worker

As a result of the EPN scheme, both the amount of employees as well as the self-employed rise. In the base year, the scheme is relatively more beneficial to employees, in the other years more to the self-employed. The effect on female employment is positive in the base year as well as in the other modelling years. In the base year, the programme is more beneficial for male workers, in the other modelling years the programme is more beneficial for female workers. As a result of the programme, for all age categories an increase in employment is found. However, the programme is more beneficial to workers of age class 15 - 24 years, especially in the period after the base year. The share of the age class 25 - 44 increases slightly in the base year. The change in the other modelling years is minimal. The share workers of age class 45 - 64 decreases, especially after the base year. The EPN scheme has a positive effect on employment for workers with a low education level (elementary and primary education). This effect is of equal size for all modelling years. The programme has a negative effect on employment share for highly educated workers (both higher education level and college and university education level), although in absolute terms, there is still an increase in the amount of highly educated persons employed. In summary, the EPN scheme is especially beneficial for people aged between 15 and 24, and workers on with an elementary and primary education level. For all categories, the employment expressed in absolute terms, increases. However, highly educated persons and people aged over 45 profit less from this increase, and therefore the share of these groups decreases.

Comparison between model calculations and the case study
According to the case study (see Dougle, 1999), about 100 jobs are created. Most of these are in the installation and additional maintenance of the condensing boiler by skilled and semi-skilled blue-collar workers. In the model calculations, the net effect of the initial investment amounts to 750 labour years, of which 400 labour years are found in the construction sector and 770 in the business services (architects), see also Table 6.31. In the case study, only the direct employment effects related to maintenance are assessed. Therefore the total employment effects in the case study are likely to be underestimated. According to the model calculations, about 1 labour year is related to the additional maintenance, see Table 6.29. Without the modification of the model input with respect for maintenance, the additional labour would amount to about 5 labour years (yearly). The difference between the direct employment effect reported in the case study and the total employment effect calculated amounts to a factor 10. Since in the case study only a small part of the total employment effect is quantified, it is concluded that the results of the case study and the model calculations are not inconsistent.

6.3.6 Employment effects of decreasing expenditures on unemployment benefits

Both the condensing boiler programme as well as the EPN scheme have a positive effect on employment. As a result of the increase in employment, the total governmental expenditures on unemployment benefits will decrease. It is assumed that the average labour productivity is not changed due to this (small) increase in governmental expenditures and the associated labour force. For the condensing boiler programme, the increase in employment in the base year amounts to 1,473 labour years in 1995, see also Table 6.28. Assuming a governmental expenditure of 1800 guilders per month per labour year per unemployed person (820 Euro per month per labour year), the total decrease in the governmental expenditures on unemployed benefits amounts to 31.8 million guilders (14.4 million Euro) for the condensing boiler programme, see Table 6.32. In 2000 and 2010, the decrease in governmental expenditures amounts to 1.7 million Euro, assuming that the height of the unemployment benefits does not change[14].

Next, it is assumed that the total governmental budget remains constant[15]. Therefore, the unemployment benefits are returned to the residential sector, e.g. by means of a lowering of income taxes. The resulting increase in total household expenditures induces a positive effect on employment (first order) of about 215 labour years in 1995 and about 20 labour years in 2000 and 2010. However, due to the increase of employment, again, the total governmental expenditures on unemployment benefits are lowered (the second order effect).

The total induced employment effect related to the decrease in governmental expenditures on unemployment benefits amounts to 250 labour years in 1995 and about 25 labour years in 2000 and 2010. The cumulative effect of the induced employment amounts to 500 labour years for the condensing boiler programme and 140 labour years for the EPN scheme. This is about 13% of the total cumulative employment effect.

[14] At constant prices (1995 prices)
[15] The effect of additional VAT-revenue from the expenditure related to the decrease of total unemployment benefits is not taken into account.

Table 6.32 *Decrease in governmental expenditures on unemployment benefits and induced employment*

Condensing boiler programme		1995	2000	2010
Increase of employment	[1000 labour years]	1.473	0.178	0.173
Decrease of governmental expenditures on unemployment benefits (first order effect)	[MEuro]	14.4	1.74	1.70
Induced employment (first order effect) unemployment benefits	[1000 labour years]	0.185	0.020	0.017
Total induced employment unemployment benefits	[1000 labour years]	0.211	0.023	0.019
			1995-2010	
Cumulative induced employment unemployment benefits	[1000 labour years]		0.500	
EPN scheme		1995	2000	2010
Increase of employment	[1000 labour years]	0.756	0.020	0.019
Decrease of governmental expenditures on unemployment benefits (first order effect)	[MEuro]	7.4	0.19	0.19
Induced employment (first order effect) unemployment benefits	[1000 labour years]	0.095	0.002	0.002
Total induced employment unemployment benefits	[1000 labour years]	0.108	0.003	0.002
			1995-2010	
Cumulative induced employment unemployment benefits	[1000 labour years]		0.141	

In order to investigate the effect of the height of the unemployment benefits on the total induced employment, the height of the monthly payment is varied. When the unemployment benefits are lowered from 1800 guilders per month to 1500 guilders per month (680 Euro/month), the total induced effect amounts to 11% of the total cumulative employment effect. When the unemployment benefits are increased to 2100 guilders per month (950 Euro/month), the total induced effect resulting from the decrease in unemployment benefits amounts to 16% of the total cumulative employment. It should be noted that the induced effects reported are only valid under the assumption that the avoided unemployment benefits are returned to the residential sector.

6.4 Employment effects of energy conservation schemes in Spain

In this section, the results for the Spanish case study are presented. First, an overview of the development of unemployment and activity rate is given. Next, the scenario parameters as well as a brief description of the case study are given. Finally, the results of the model calculations are analysed.

The effects of shifts in governmental expenditures due to changes in tax revenues are left out of the analysis. Due to the decrease in consumption of energy, total tax revenues (e.g. VAT) related to energy consumption will decrease. This also results in a decrease in the total governmental expenditure budget. However, a rebound effect occurs, since the money saved due to the lower energy bill is now spent on other goods and services. The tax revenue associated with these expenditures increases. In case no difference in tax level (e.g. VAT) exists between different goods and services, the rebound effect will compensate the decrease in tax revenue resulting from energy saving. However, it is recommended to study the effects of employment impacts related to changes in revenue of (excise) taxes more extensively in future.

6.4.1 Development of employment and unemployment

Although the problem of unemployment is a central concern in the economic and social politics of all European countries, the high rates of unemployment in Spain, reduced level of activity of the female population, and the inflexibility of wages which came to light particularly in the first half of the nineties, all make Spain's situation differ from that of its fellow European countries.

The activity rate in Spain for the age range 16 to 64 years was 62.6% in 1998, but the difference between male and female activity for the same age range was 76.7% and 48.7% respectively. The unemployment rate also affects these two groups differently, with 13.8% for men and 26.6% for women aged between 16 and 64 years, with a joint average of approximately 18.8%.

Table 6.33 shows the evolution of the principal variables that have characterised the labour market in Spain during the nineties. As it can be seen, last year there was a reactivation of employment, which brought the unemployment down below 20%, but it is still far from the 10% average of the EU.

Table 6.33 *Development of unemployment and activity rate (INE 1998)*

	Activity Rate [%][16]	Unemployment Rate [% of working population]	Employment [% annual variation]
1990	49.4	16.3	2.6
1991	49.1	16.3	0.2
1992	48.9	18.4	-1.9
1993	49.0	22.7	-4.3
1994	49.0	24.2	-0.9
1995	49.0	22.9	2.7
1996	49.6	22.2	2.9
1997	49.8	20.8	3.0
1998	50.0	18.8	3.4

Another characteristic which makes the Spanish labour market different, is the duality between long-term and temporary workers, which has occurred as a result of the restructuring intended to make the market more flexible, and which led to a wide range of temporary contractual figures. In 1998, workers with temporary contracts accounted for 33% of the total working population.

In Figure 6.7, the development of total employed and unemployed labour force is given. The total labour force increases by about 0.94% per year over the period 1977 – 1999. Over 80% of this increase is explained by the increase in female labour force.

[16] The activity rate in this table refers to the total population over 16 years of age.

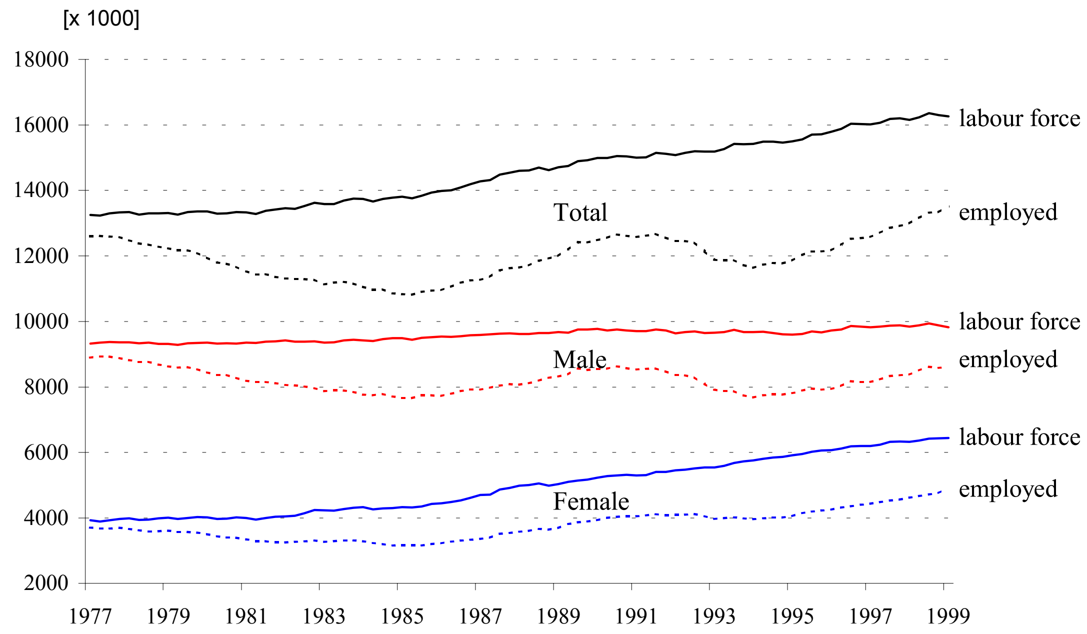

Figure 6.7 *Development of employed and unemployed labour force in Spain (INE, 1993; INE, 1999)*

In Figure 6.8, the development of unemployment is given. Especially in the mid-nineties, female unemployment reached high levels. Currently, the female unemployment exceeds the male unemployment rate by about a factor of two.

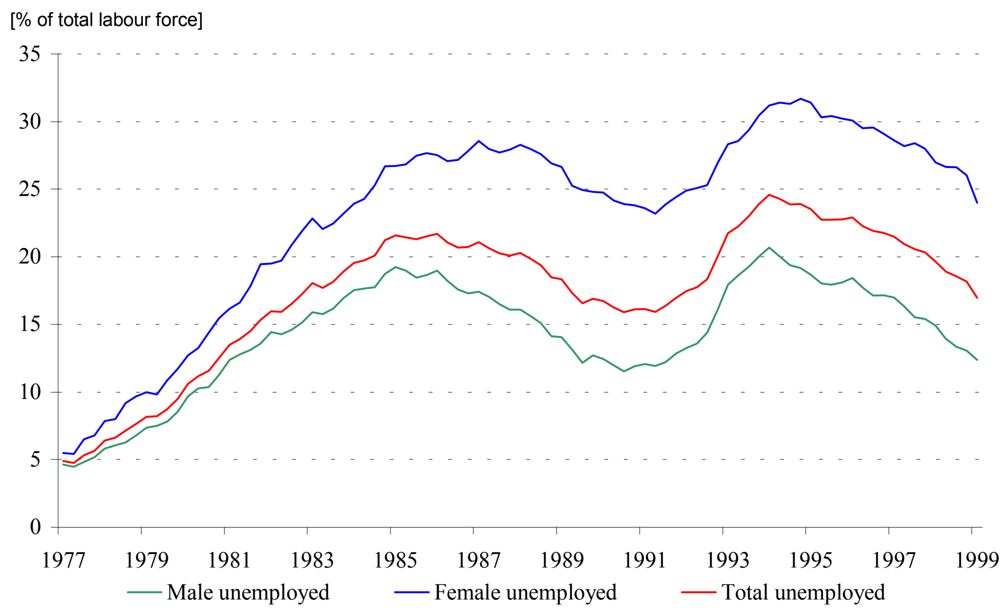

Figure 6.8 *Development of male, female and total unemployment in Spain (INE, 1993; INE, 1999)*

Unemployment in the European Union in general, and in Spain in particular, is a big problem. This makes studies to evaluate the impact on employment of certain government actions, which are aimed at achieving other objectives more important. In this case, the objective of the governmental programmes is to reduce energy consumption.

6.4.2 Case studies

An input/output model, which complements case analysis and the development of a general macro-economic model, has been designed for Spain to evaluate the direct and indirect impact on employment of programmes and actions regarding domestic energy efficiency launched in the last few years, see also Section 4.4. In this way, the results of the input/output model presented here, complete the results of the six cases studied on employment created directly through the investments in energy efficiency.

The six cases studied for Spain were as follows:

- Third Party Financing (TPF) in both industrial and tertiary sectors.
- Subsidies offered through the Energy Conservation and Efficiency Programme (ECEP) which was also offered to industry and to services, and was also analysed separately and differentially in each case.
- Demand Side Management Programmes (DSM) in residential, industrial and tertiary sectors.

Of all the above cases, only the implications of the latter, the Demand Side Management Programmes (DSM), designed for households, can be studied using the input/output modelling approach as described in Chapter 2 and Section 4.4.

The actions included in the Demand Side Management Programmes (DSM), launched by IDAE, were effected directly or indirectly by the utilities[17]. The object of such actions was to intervene in the market to change the shape and size of the load curve by introducing more efficient technologies, leading to energy savings, environmental benefits and reduced energy costs.

Within the framework of the DSM programme, four programmes were introduced in the domestic sector in 1995 with the object of promoting:

1. The substitution of incandescent light bulbs with low consumption compact electronic light bulbs.
2. The purchase of efficient refrigerators through incentives of discounts given directly to the consumer when purchasing a refrigerator with an energy efficiency label of class A, B or C.
3. The substitution of direct electric heating with nocturnal heat accumulation systems.
4. The substitution of direct electric heating for domestic clients who wished to purchase air conditioning equipment using direct incentives in the purchase of heat pumps.

In 1997, 8 programmes were launched. Four of these had the same objectives as those launched in 1995, and the other four had the objective of promoting the installation of equipment to manage electricity consumption and auditing.

6.4.3 Direct employment induced by the DSM programme

The study on the direct impact on employment of the different demand side management programmes launched in these two years was effected on a basis of the results of the questionnaires (and if the questionnaires were not returned, a telephone poll was held) sent to representatives of the utilities, manufacturing and distributing companies of equipment, and business associations. Three sources of employment were analysed for the purpose of the study: employment created in the utilities which managed the programme (approximately 100 jobs in the two years), employment created in companies which produce and distribute the equipment in question

[17] The Ministry of Industry and Energy is in charge of establishing the amount of money to allocate to DSM programmes by means of the tariff system and the system to compensate the commercialisation costs of electric distributors. The utilities execute the programmes approved by the Ministry of Industry and Energy. In a strict sense, the grants involved in these programmes are financed by the electricity consumers. The utilities are in charge of the implementation of the programmes. The administration costs related to the management of the DSM programmes are therefore made by the utilities. The utilities are compensated for the total costs associated to DSM actions if the objectives of the programmes, which are set up by the Ministry of Industry and Energy, have been achieved. This financial compensation is again financed by the electricity consumers.

(frequently imported, but mainly from other EU countries) and employment created in companies which manufacture the components required in the production process of the equipment which are the object of the subsidy (this type of employment was partially evaluated in the initial approach in the case study, from employment coefficients deducted from the input/output table of the Spanish economy[18]).

Identifying direct employment created by the programme, either in Government Departments, utilities or IDAE itself, and new jobs created in companies who manufacture this equipment, was the main objective of the case study. No significant increases were reported as a result of this programme in the workforces of companies who manufacture this equipment. Some jobs in the areas of component assembly, marketing, logistics and distribution may be attributed to the programme, although the figures obtained from the questionnaires sent to the companies are of reduced validity and reliability. Despite this, companies did, however, provide a qualitative valuation of the success of the programmes, with regard to their effects on energy saving and on employment and on the activation of sales of these products, and of their possible drawbacks, and this has been of great use for IDAE. The evaluation of the volume of indirect employment created in companies which supply the components for the manufacture of efficient appliances, is the object of the input/output model which was designed.

6.4.4 Scenario parameters and model input

The principal data obtained from the DSM-case study are given in Table 6.34.

Table 6.34 *Basic data obtained from the DSM-case study*

[MEuro]	1995	2000	2005	2010
Grants awarded	12.6	-	-	-
Administration costs	7.4	-	-	-
Private expenditure (incl. VAT)	66.0	-	-	-
Net investments households (incl. VAT)	53.4	-	-	-
Monetary savings DSM, yearly	14.4	11.8	11.6	11.0

These data from the case study provide the principal inputs for the input/output model as described in Section 4.4.. The subsidies-grants-give the total sum of incentives awarded to consumers in their purchase of efficient equipment. The private consumption shows the total expenditure of families when they purchased these goods. Savings, in monetary terms, are those made from the reduction of electricity consumption during the useful life of the equipment. The reduction of the national budget is due to the reduction in taxes which are levied for the consumption of energy, and which are no longer received as a result of the reduction in this consumption.

Programmes considered in the DSM case study were financed through the general expenditure budget. This implies that the total family income available for consumption is reduced by the sum set aside for the investment in the new and more efficient equipment, minus the subsidy or incentive received from the government. However, due to the investment in energy efficiency, the energy bill is lowered. This amount of money can now be spent on other commodities and services (see also Section 3.4 regarding the different financing methods of the saving and efficiency programmes for households).

[18] This effect could only be evaluated in the case of the DOMOLUZ Programme, designed to substitute conventional lights with low consumption ones, as it was only possible to identify the sectors which supply the components and their country of origin (whether national or imported), through the distribution and manufacturing companies.

The prices of the different goods and services consumed by families are considered as exogenous variables with regard to the estimated consumption functions. Forecasts of (relative) prices are obtained through linear extrapolation of historical data (with the exception of prices of goods included in the fuel and power category, which are obtained directly from the forecasts of the evolution of energy consumption and prices per sources). In this way, the consumption in each of the goods and services categories in the scenario of reference as well as in the intervention scenario are estimated. In this case, the intervention scenario constitutes of a Demand Side Management programme where family income is modified by investments made in energy efficiency, subsidies received, and savings made during the useful life of the equipment purchased.

The development of energy prices is given in Table 6.35.

Table 6.35 *Development of energy prices*

	[Pesetas/toe]				Index			
Prices (1995)	1995	2000	2005	2010	1995	2000	2005	2010
Coal	42274	38408	38794	39183	1.00	0.91	0.92	0.93
Heating oil	45439	57794	68289	75447	1.00	1.27	1.50	1.66
Gas	75300	67719	74767	78581	1.00	0.90	0.99	1.04
LPG	73204	64772	74303	78173	1.00	0.88	1.02	1.07
Electricity	289693	237855	234308	221869	1.00	0.82	0.81	0.77
Biomass	32754	32754	32754	32754	1.00	1.00	1.00	1.00

The price index of fuel and power is based on the development of the energy prices as well as the share of the different energy carriers in total consumption.

The hypotheses made in both scenarios on the evolution of private consumption (household expenditure) and population are given in Table 6.36. The improvement in labour productivity is given in Table 6.37.

Table 6.36 *Growth of private consumption, population and consumer price index (IDAE 1999; INE, 1995)*

Annual growth [%]	1995-2000	2000-2005	2005-2010
Total Private Consumption	3.09	2.53	2.29
Consumer price index	2.20	2.00	2.00
Total Population	0.13	0.11	0.05

Table 6.37 *Development of improvement of labour productivity*

Productivity Improvement per year [%]	1995-2010
Primary Sector	1.6
Manufacturing Industries & Utilities	2.9
Building Industry	1.4
Wholesale, Retail, Repair, Catering	1.6
Transport & Communications	2.2
Commercial Services	2.3
Non-commercial Services	1.2

6.4.5 Calculated employment effects of the DSM-scheme

In accordance with the methodology, which has been described in Chapter 2, the increases in the demand or consumption of the different categories of goods and services lead to increased production in the sectors, which produce or supply such goods and services, and sectors, which supply the former. However, the increase in the final demand in the different productive sectors is not just the result of an increase in the final consumption of households due to increased income received as a result of savings from the investment, and, to the contrary, in the first year (1995) as a result of the net investment made[19]. At the same time, there is a reduction in income for Government Departments suffered from the destination of the expense in other productive sectors. This reduction in Government income is a result, first, of awarding the subsidy itself (which is destined in full to the purchase of the equipment, and which, therefore, is also localised in full in the 'Electrical Products' sector) and, second, of the reduction in household energy consumption, which leads to reduced tax collections.

The increase in production required in each productive sector to cover the extra, or rather, variations in the demand which occurs when the programme is launched, causes increased volume of employment through the application of the coefficients which are calculated from the input/output tables (see Annex A).

The consideration of constant employment coefficients implies the assumption of the existence of a linear relation between production and employment, and, therefore, of the absence of improvements in productivity. Although the coefficients do not remain constant in the period of prediction (Table 6.37 illustrates the hypothesis for productivity gains per sector studied), the coefficients remain invariable, since it is assumed that the production structure of the economy is not altered by the energy conservation scheme. Therefore, changes in production volume which occur in the latter scenario automatically lead to changes in employment volume, in accordance with the relation calculated from the tables, without consideration of possible economies of scale.

The results obtained are shown in Table 6.38.

Table 6.38 *Effects of the Demand Management Programmes 1995-1997 on employment*

Labour years [× 1000]	1995	2000	2005	2010	1995-2010
Employment effect initial investment	-0.794	-	-	-	
Employment effect energy saving	0.446	0.328	0.292	0.248	
Employment effect grants	-0.698	-	-	-	
Cumulative employment effect					3.344

It is found that there is an initial negative effect in the base year from the investment made due to the shift in general consumption budget, see also Section 3.1. This is because the investment is localised in a sector with a reduced labour intensity (the Electrical Products sector), and as a result of this investment there is a reduction in demand in other sectors which have generally more labour intensive activity.

The effect of energy saving on employment is positive. In this case, energy savings achieved during the useful life of the goods purchased lead to increased income and consumption of other goods (apart from electrical products), and related production requires a greater employment volume per product unit. In this way, the transfer of demand from energy sectors (with extensive work) to other sectors, causes an increase in employment in net terms (i.e., considering the effect of the possible loss of employment occurring in the energy sectors caused by a reduction in electricity demand).

The effect of the grants, the third effect in which total job creation has been broken down, is negative in all simulations considered. This effect is the result of the reduction in state budget caused by granting the subsidy in the residential sector. The subsidy received by households is destined in full to the purchase of the electrical appliance, and, as mentioned earlier, this is localised in a sector with rather low labour intensity. This leads to a reduction in employment associated with governmental expenditures.

[19] Defined as the difference between the price of the new equipment, minus the incentives or subsidies received from the Government.

In Table 6.39, the shift in total employment per sector is given. As a result of the implementation of the DSM programme, the total employment in the base year decreases by about 1000 labour years. The largest decrease in employment is found for the governmental sector and the sector recovery. Since the initial investment is located in the sector ‘electrical products’, total employment in this sector increases by over 1000 labour years in the base year. Supplying sectors such as ‘non metallic products’ and ‘machinery’ also show as small increase in employment in the base year. In the other modelling years, a decrease in employment is found for the energy sector and sectors supplying to the energy sector. A large increase is found for the sector ‘recovery’. This sector appears to be the most sensitive to changes in household expenditure pattern.

Table 6.39 *Shift in total employment as a result of the DSM programme*

Labour years [× 1000]	1995	2000	2005	2010
Agriculture	-0.120	0.029	0.025	0.020
Energy	-0.144	-0.080	-0.072	-0.062
Iron and steel	0.022	0.000	0.000	0.000
Non metallic products	0.001	0.001	0.001	0.001
Chemical products	-0.011	0.005	0.005	0.004
Metallic products	0.019	0.004	0.003	0.002
Machinery	0.005	-0.001	-0.001	-0.001
Electrical products	1.067	0.004	0.003	0.002
Transport means	-0.019	0.004	0.004	0.003
Food	-0.058	0.013	0.011	0.008
Textiles	-0.060	0.014	0.011	0.008
Paper	-0.013	0.004	0.004	0.003
Rubber	0.009	0.002	0.002	0.001
Other manufacturing	-0.012	0.003	0.003	0.002
Building and construction	-0.033	0.005	0.005	0.004
Recovery etc.	-0.441	0.134	0.121	0.105
Lodging	-0.268	0.070	0.063	0.054
Transport	-0.078	0.022	0.020	0.017
Communication	-0.031	0.008	0.007	0.006
Credit and insurance	-0.006	0.003	0.003	0.002
Market services	-0.040	0.011	0.009	0.008
Research	-0.160	0.009	0.008	0.007
Health	-0.192	0.019	0.019	0.018
Other services	-0.178	0.043	0.039	0.033
Government	-0.301	0.000	0.000	0.000
Total	-1.045	0.328	0.292	0.248

In Table 6.40, the shift in employed induced by the DSM programme is given for male and female workers. As a result of the initial investment, total employment decreases for both male and female workers in the base year. As a result of the budget shift resulting from energy saving, male as well as female employment increase in all modelling years. The cumulative effect of the DSM programme for male workers amounts to about 2,000 labour years over the period 1995 – 2010.

The increase of female workers is lower (1,350 labour years). About 62% of all workers in the base line scenario are male. The employment increase resulting from the DSM-scheme consists of 59% male workers and 41% female workers, so the DSM programme is slightly more beneficial for female workers.

Table 6.40 *Employment effect of the DSM programme on male and female workers*

Labour years [× 1000]	1995	2000	2005	2010	1995-2010
Male workers					
initial investment	-0.616	-	-	-	-0.616
energy saving effect	0.243	0.177	0.156	0.131	2.601
total male workers	-0.373	0.177	0.156	0.131	1.985
Female workers					
initial investment	-0.875	-	-	-	-0.875
energy saving effect	0.203	0.151	0.136	0.117	2.234
total female workers	-0.672	0.151	0.136	0.117	1.359

The employment changes resulting from the initial investment are more beneficial for male workers, since the share of male workers in the sector 'electrical products' amounts to 82%. However, the shift in expenditure pattern as a result of the conservation of energy is more beneficial for female workers, since the average share of male workers related to the energy saving effect amounts to 54%. This can be explained by the shift in expenditures on energy (average share of male workers amounts to 85%) to other goods and services (with a lower share of male workers).

Application of grants

In case a subsidy is granted from the general governmental budget, a decrease in employment related to governmental expenditures occurs, since the government is not able to spend the money now used as a grant for other purposes. In this case, the application of a subsidy induces a net transfer of money from the governmental sector to the residential sector. However, sometimes a surcharge is used as a stimulus to change the expenditure pattern. In order to avoid detrimental economic effects, the profits of the surcharge are returned to the target group who paid the levy. One way of returning the money is the granting of a subsidy, i.e. on energy efficiency. In this case, the grants are financed by the target sector itself, and, if administration costs and dead weight losses are not considered, there is no net transfer of money between sectors. Subsequently, the granting of this type of subsidy does not affect the total governmental budget and therefore the employment related to governmental expenditures is not affected.

In order to investigate the sensitiveness of the DSM programme to the application and type of subsidy granted, calculations are performed under the hypothesis that the granting of a subsidy does not result in a net shift of money between the residential and other sectors (i.e. the governmental sector, banks). So, in this case, the application of a grant does not result in a decrease in the governmental budget. Therefore, the employment related to governmental expenditures is not affected. The results of this analysis are given in Table 6.41.

Table 6.41 *Effects of the Demand Side Management Programmes 1995-1997 on employment under the hypothesis that the granting of a subsidy induces no net transfer of money between sectors*

Labour years [× 1000]	1995	2000	2005	2010	1995-2010
Employment effect initial investment	-1.336	-	-	-	
Employment effect energy saving	0.446	0.328	0.292	0.248	
Employment effect grants	0.000	-	-	-	
Cumulative employment effect					3.499

In comparison to the base case, see Table 6.38, the total cumulative employment effect is only slightly higher (3500 labour years vs. 3350 labour years). Since there is no net transfer of money from the governmental sector to the residential sector, a larger negative employment effect is found as a result of the financing of the initial investment. However, the employment effect of the grants is zero, since there is no net transfer of money between sectors.

Type of energy saving
An alternative simulation made under the hypothesis that the investment is made in the building sector (construction sector) instead of the sector related to electrical equipment, leads to an initial positive result due to the more intensive nature of work in this activity. This is due to differences in labour intensity between sectors, and the distribution of the consumption by origin related to the investment over the different industrial sectors, see also 7.2. The labour intensity amounts to 0.09 employees per million pesetas produced in the Electrical Products sector, in comparison with 0.21 employees per million pesetas in the building sector. Results of this second simulation are given in Table 6.42.

Table 6.42 *Effects of the Demand Side Management Programmes 1995-1997 on employment (under the hypothesis that investments are localised in the building sector)*

Labour years [× 1000]	1995	2000	2005	2010	1995-2010
Employment effect initial investment	0.804	-	-	-	
Employment effect energy saving	0.446	0.328	0.292	0.248	
Employment effect grants	-0.698	-	-	-	
Cumulative employment effect					4.941

In the alternative simulation, the total cumulative employment increases from about 3,350 labour years to about 4,900 labour years, due to the change in employment related to the initial investment.

Energy prices
The effect on employment if electricity prices are maintained at a 1995 level can be seen in Table 6.43.

Table 6.43 *Effects of the Demand Management Programmes 1995-1997 on employment (under the hypothesis that electricity prices remain constant)*

Labour years [× 1000]	1995	2000	2005	2010	1995-2010
Employment effect initial investment	-0.794	0.000	0.000	0.000	
Employment effect energy saving	0.446	0.400	0.361	0.324	
Employment effect grants	-0.698	0.000	0.000	0.000	
Cumulative employment effect					4.224

In this simulation, energy prices are maintained at high levels in both the base case without the energy conservation scheme as well as this variant with the energy conservation scheme. Higher electricity prices lead to a greater saving, in monetary terms, in comparison with the reference scenario, and, therefore, to a greater spending capacity on the part of households in other goods and services. High energy prices increase the cost-effectiveness of the energy conservation scheme. Compared to the reference energy conservation scheme, see Table 6.38, total cumulative employment increases from about 3,350 labour years to about 4,200 labour years.

6.5 Employment effects of energy conservation schemes in the United Kingdom

In this section, the employment effects of five case studies performed for the UK is discussed. The case studies considered in the analysis all aim at energy conservation in the residential sector. First, an overview of the development of employment, unemployment and vacancies in the UK is given. Next, a summary of the case studies considered is given. After that, the model input and the base line scenario are described and the total employment effects related to the energy conservation schemes are reported and analysed.

The effects of shifts in governmental expenditures due to changes in tax revenues are left out of the analysis. Due to the decrease in consumption of energy, total tax revenues (e.g. VAT) related to energy consumption will decrease. This also results in a decrease in the total governmental expenditure budget. However, a rebound effect occurs, since the money saved due to the lower energy bill is now spent on other goods and services. The tax revenue associated with these expenditures increases. In case no difference in tax level (e.g. VAT) exists between different goods and services, the rebound effect will compensate the decrease in tax revenue resulting from energy saving. In the UK, low VAT levels are applied for domestic fuels, government grants for energy efficiency measures, books and food. It is recommended to study the effects of employment effects related to changes in revenue of (excise) taxes more extensively in the future.

6.5.1 Development of employment, unemployment and vacancies

Unemployment levels

In 1997 there was a steady growth in the labour market at an historically high level. Employment has been rising at between 20,000 and 40,000 jobs per month, whilst unemployment has fallen at between 15,000 and 35,000 per month. The annual earnings growth is steady at 4.5%.

The seasonally adjusted unemployment figures for Great Britain fell to 2 million in the summer of 1997. The claimants in the UK in November were 1.44 million, which is its lowest level since August 1980. The unemployment rate (as a percentage of the workforce) was 7.1% in the summer of 1997, the lowest since spring 1990. The percentage of claimants was 5.1% in November 1997, the lowest since July 1980.

The number of employed people in the UK was 26.6 million in the summer of 1997, a rise of over 400,000 from the same time the year before. Manufacturing industries accounted for almost 4 million of the total number of jobs, whilst the energy and water supply industries accounted for 217,300. Manual labour continues to rise, but at a lower level than for non-manual labour (1.4% compared to 2.3%).

The economic activity rate for those over the age of 16 was 63.0% in the summer of 1997. This represents a rise of 0.2% since the summer of 1996. However, the proportion of men of working age in employment fell by 0.2% to 84.8% over the year between Summer 1996 and Summer 1997, whilst the female proportion rose by 0.5% to 72.2%. In 1996, men worked an average of 44 hours per week, whilst woman worked an average of 31 hours, showing the greater participation of woman in part-time work. The average for both sexes was 38 hours. The ages for which the economic activity rate is currently highest for women is 35-49, in which 77% are active, for men the highest rate is found in 25-34 range at 94%.

Unemployment in the UK was 7.0% in 1996, compared to an EU average in that year of 10.7%. The level in the UK is lower than in Spain, Ireland, Finland, France, Sweden, Belgium and Germany, but higher than in The Netherlands, Denmark, Austria, Luxembourg and Portugal.

The effect of the recession in the UK in the early 1990s can be seen in Table 6.44. The economic recovery in the last few years has seen a rapid drop in the level of unemployment, down to a level currently lower than the EU average.

Table 6.44 *GDP index vs. the unemployment rate in the UK (AAS, 1997)*

	GDP index UK	Unemployment UK
1990	100.0	
1991	98.0	
1992	97.5	10.1
1993	99.5	10.2
1994	103.8	9.6
1995	106.7	8.7
1996	109.2	8.2
1997	113.7 (3rd quarter)	7.6-7.0 (Jan-Oct)

Particular issues of unemployment in the UK

Youth unemployment is a significant problem-particularly amongst males. The average unemployment rate for men aged 16-19 was 18.1% in summer of 1997 and 15.0% for women of that age, compared to the national average of 7.0%. Ethnic groups also have particular unemployment problems in the UK. The average white unemployment for 16-24 years olds is 14.4%, compared to 30% for ethnic groups, of which blacks are the highest at 36%. Unemployment for black females is lower than for black males, but for other ethnic groups, this trend is reversed.

There is still a skill shortage in the UK population, with 19% of working age people having no qualifications at all. 20% have higher education qualifications, 12% have A' levels, 14% have 5 or more GCSEs[20], 10% have trade apprenticeships, 17% have NVQ[21] level 1 or above and 8% have other qualifications. Skill shortages exist in the construction and installation industry with many companies having difficulties filling vacancies (INSTA, 1998).

Regional unemployment is also a problem. In the NorthEast, 10.6% of the total workforce is claiming benefits; in Merseyside the figure is 13.1%; and in Northern Ireland, 10.9%. Male unemployment in these regions is particularly high in Merseyside, the percentage of claimants in this group is 18.8%, and in the North East, 15.3%. At the other end of the scale, the SouthEast has only 5.4% on benefits and the eastern region, 6.1%.

There is a particular problem in the UK with long term unemployment, particularly amongst the young. The figure for the long term unemployed (i.e. more than one year) is now 690,000-785,000 lower than the peak in Spring 1984, but 59,000 higher than the start of the most recent upward trend which started in Spring 1991. There is a also a problem, particularly amongst young males, of having few skills and often having never worked in their lives. As seen from the table below, the problem is mainly for men, almost 50% of these claimants being out of work for more than 6 months.

Table 6.45 *Duration of unemployment claim (AAS 1997) [%]*

Duration of claim	All	Male	Female
Less than 4 weeks	15	14	18.3
4-26 weeks	38.2	36.3	44.3
26-52 weeks	15.9	16.2	14.8
More than 52 weeks	30.9	33.6	22.6

Welfare to Work and New Deal

With these specific problems in mind, the new Government has created a Welfare to Work strategy, which includes new help for lone parents and disabled people. Employment Zones have also been created to tackle regional unemployment and a fundamental review of the relationship between the tax and benefits system has begun.

[20] General Certificate of Secondary Education.
[21] National Vocational Qualification.

New Deal is one element of the Government's wider Welfare to Work strategy and deals with young unemployed people. Its aims are defined as:

- Give the young unemployed a greater chance to take control of their lives, recognising that work is the foundation for independence and a sense of self-worth.
- Utilise their talents and energy and equip them with the skills to compete for future jobs.
- Contribute to the regeneration of local communities, not just through the move from welfare to work and the provision of training, but directly through environmental and voluntary work by young people on New Deal.
- Focus resources to help people move from welfare to work , and so to assure those working and paying taxes that their contributions are being used creatively to tackle one of the biggest problems in society.

There are four options on New Deal:

- a job with an employer who is subsidised,
- work with a voluntary sector organisation,
- full time education or training,
- work with the Environment Task Force (ETF).

The first and last options are of most significance to this study. The ETF will offer up to six months work on tasks designed to improve the environment. This will include at least one day per week, or equivalent, working for an approved qualification. The subsidised job in the first option may also include schemes designed to train people to fit installations and carry out such programmes.

Energy efficiency programmes and employment

Thus the connection between environmental aims (in particular energy efficiency schemes) and employment problems has already been made politically. There is currently much enthusiasm on employment effects from energy efficiency programmes, and some analysis has already been carried out on programmes that have taken place. The issue is still very much an emerging one and many different methods and estimates have been made of the effects of such programmes, but there is certainly an interest, which can be drawn on for the purposes of this study.

6.5.2 Case studies

For the UK, seven case studies were studied. Reflecting the focus of work nationally, the majority of these are focused on the fuel poor sector. The housing stock in the UK is generally older and less energy efficient than in most EU countries, particularly in Northern Europe. So the majority of work done is aimed at those who cannot afford to heat their homes to a level at which to avoid ill health (generally taken as 16˚C in the main living area).

The first of these is the Home Energy Efficiency Scheme (HEES) which is the largest government grant scheme for low-income households. Standards of Performance (SoP) is a second scheme, again aimed mainly at low-income households and is run by the electricity utilities and financed by a levy on all domestic (and small business) consumers (the case study only covers insulation measures installed under the programme).

A second part of the SoP scheme – the Fridgesavers programme – is included as a separate case study. This is a subsidy programme for replacing old refrigerators in low-income families. An example of an intermediate labour market – Heatwise – is also included. This had employment creation as its main aim, using energy efficiency measures to achieve this. Finally, the UK building regulations are included.

For several of these programmes, the employment effects had already been analysed to some extent. For Heatwise, this is because employment creation is the main aim of the programme, and for HEES it was originally an aim (although this was removed at a later date). ACE had previously analysed the employment effects of the SoP programme for the Energy Saving Trust in the UK (ACE 1996).

The case studies looked at the programmes already analysed in more detail and to fit the methodology of this study and also analysed the employment effects of the remaining case studies. In most cases, good data were obtainable and these are reported in (Wade et al., 1999).

6.5.3 Scenario parameters and model input

In the following tables, the scenario parameters and the model input are given. Part of the scenario parameters is already described in Section 3.2. The number of households in the UK is expected to increase from about 24.3 million in 1995 to 25.6 million in 2010, see Table 6.46. Since the average number of persons decreases from 2.41 in 1995 to 2.33 in 2010, the total number of households rises more rapidly than the number of inhabitants.

Table 6.46 *Development of the number of inhabitants and the number of households in the UK (Capros, 1997) [× 1000]*

	1995	2000	2005	2010
Number of inhabitants	58597	59008	59452	59750
Number of households	24337	24879	25318	25637

In Table 6.47 and Table 6.48, the development of energy prices and the total energy consumption is given. In the UK, a high and a low tariff is used for electricity. The average electricity price is obtained by taking the weighed average using the prognoses of the development of energy consumption per energy carrier.

Table 6.47 *Development of energy prices (Energy Paper, 1995)*

		1995	2000	2005	2010
Electricity, average	[pounds/kWh]	0.0692	0.0597	0.0621	0.0658
- VAT + NFFO	‘	0.0055	0.0048	0.0050	0.0053
Natural gas	[pounds/kWh]	0.0159	0.0144	0.0137	0.0142
- VAT	‘	0.0008	0.0007	0.0007	0.0007
Solid fuel	[pounds/kWh]	0.0186	0.0192	0.0196	0.0220
- VAT	‘	0.0009	0.0010	0.0010	0.0011
Petroleum	[pounds/kWh]	0.0155	0.0155	0.0155	0.0155
- VAT	‘	0.0008	0.0008	0.0008	0.0008

The average electricity price and the price of natural gas are assumed to decrease by respectively 5% and 10% over the period 1995-2010. The price of solid fuel increases and price of petroleum remains constant. The VAT on energy in the UK amounts to 5%. For electricity, an additional tax, the so-called NFFO-tax, of 3% is applied. No other taxes or surcharges on energy carriers are applied in the UK.

The total consumption of solid fuel is assumed to decrease rapidly from 46.9 TWh in 1995 to 17.6 TWh in 2010, see Table 6.48. Total consumption of petroleum decreases even more. The most part of the rise in the natural gas consumption can be explained by the decrease of consumption of solid fuel and petroleum. The total electricity consumption is expected to increase, since the increase in efficiency of domestic appliances is not able to compensate for the increase in consumption related to increasing penetration rates and changes in hours of usage.

Table 6.48 *Development of total energy consumption (Energy Paper, 1995)*

[TWh]	1995	2000	2005	2010
Solid Fuel	46.9	35.2	26.4	17.6
Petroleum	32.2	17.6	8.8	8.8
Natural gas	348.9	372.3	392.8	404.6
Electricity (economy rate)	19.9	20.5	21.7	21.7
Electricity (standard rate)	79.7	82.1	86.8	86.8

In Table 6.49, the investments, grants and administration costs are given. The net investments by the households are obtained by subtracting the grants from the total private investments.

Table 6.49 *Total private investments, net investments, grants and administration costs for the energy conservation schemes considered (1995)*

[Million pounds]	Grants	Administration Costs	Private Investments	Net Investments
HEES	334.5	29.4	334.5	0.0
SoP	0	28.0	102.0	102.0
HeatWise	2.3	2.4	2.3	0.0
Building Regs	0.1	0.0	62.0	61.9
Fridgesavers	4.4	0.7	5.6	1.3

The HEES programme is by far the largest programme. In the HEES programme, the net investment, private investments minus grants, is zero, meaning the investment is paid solely by the government. For most programmes considered in the analysis, the larger part of the investment is paid for by a subsidy. As explained before, this is due to the fact that energy conservation is only one of the motives to execute the programme.

The employment effects are also determined by the type of conservation option, see Section 7.2. So, it is of importance in which sector the money invested in energy saving is allocated. In Table 6.50, the allocation of the initial investment on energy saving is given for the different programmes.

Table 6.50 *Allocation of the initial investment on energy saving*

	Sector
HEES	100% construction
SoP	100% construction
HeatWise	32% construction, 68% services
Building Regs	100% construction
Fridgesavers	100% metal and metal products

The investments of the HEES programme, the SoP programme and the Building Regs programme are allocated to the construction sector, since the money is spent on measures that aim to reduce the building related energy consumption (e.g. cavity wall insulation, loft insulation, double glazing etc.).
In the Heatwise programme, about 30% of the investment is spent on dwelling insulation and about 70% on training and work experience. The investments of the Fridgesavers programme are allocated to the sector 'metal and metal products', since the money is spent on efficient freezers.

The amount of energy saved for the programmes considered is given in Table 6.51 and Table 6.52. The total amount of energy saved is highest for the HEES programme. However, this does not mean that it is the most cost effective programme, since total investments in the HEES programme exceed the total investments in the other programmes by far, see again Table 6.49. The total monetary savings of the energy conservation scheme are determined by multiplying the energy prices by the amount of energy saved. By comparing the monetary savings to the total investment, an indication of the profitability of the programme is obtained.

Table 6.51 *Yearly amount of energy saved for the HEES programme, the SOP programme, the Building Regs programme and the FridgeSavers programme*

[GWh/yr]	Electricity	Natural gas	Solid fuel	Petroleum	Total
HEES	1085	0	0	0	1085
SoP	580	0	0	0	580
Building Regs	173	581	61	52	867
Fridgesavers	23	0	0	0	23

Table 6.52 *Yearly amount of energy saved for the Heatwise programme*

[GWh/yr]	1995	2000	2005	2010
Electricity saved	2.85	0.38	0.38	0.13
Natural gas saved	9.56	1.27	1.27	0.45
Solid fuel saved	1.00	0.13	0.13	0.03
Oil saved	0.86	0.11	0.11	0.05
Total	14.27	1.89	1.89	0.66

In Table 6.53, a comparison is made between the total investment and the cumulative energy savings. Moreover, the share of grants provided by the government in the total investment is given. From an economic point of view, the Heatwise programme can be considered as the least profitable conservation scheme. The total investments exceed the total cumulative savings by a factor of 1.6. The Heatwise programme is financed for 100% by the government. It should be noted that in the comparison between investments and profits, the interest on capital is not considered. So, this ratio is only a first order indication of the profitability of an energy conservation scheme.

Table 6.53 *Comparison between total investments and total energy saving*

	Total investments [million pounds]	Share of grants [%]	Cumulative savings [million pounds]	Ratio between investments and savings
HEES	335	100	1027	0.33
SoP	102	0	549	0.19
HeatWise	2.4	100	1,4	1.65
Building Regs	62	0.2	319	0.19
Fridgesavers	1.3	78	22	0.26

For the HEES programme, the total amount of investments is about one third of the total monetary savings. Again, this programme is financed for 100% by the government. For the SoP programme, the total monetary savings exceed the total investments by a factor of five. The most cost-effective programme is the Building Regulations programme. The total amount of money saved exceeds the total investments by about a factor of 5.5.

6.5.4 Calculated employment effects of the energy conservation schemes

The Home Energy Efficiency Scheme (HEES)

In the HEES program, total private investments are counterbalanced by a governmental subsidy of equal size. So, the net income change for households is zero, see Table 6.49. This means that money is transferred from the government to the residential sector.

The model calculations show a cumulative employment effect of over 3,800 labour years. The initial investment induces an increase in employment of about 16,600 labour years. This effect is quite large, since the granting of a subsidy means that the total expenditure budget increases. Due to the lowering of the energy bill, households are able to spend more money on other commodities and services. This creates a positive employment effect of 2,100 labour years in 1995. The effect lasts over the lifetime of the energy saving option. This so called 'energy saving effect' slowly decreases from about 2,100 labour years in 1995 to 1,180 labour years in 2010 due to the decrease in energy prices and the improvement in labour productivity. The cumulative employment effect of the energy saving amounts to 22,000 labour years.

Table 6.54 *Employment effects related to changes in private and governmental expenditure for the HEES programme*

Labour years [× 1000]	1995	2000	2005	2010	1995-2010
Employment effect initial investment	16.601	-	-	-	
Employment effect energy saving	2.186	1.489	1.304	.187	
Employment effect grants	-35.186	-	-	-	
Cumulative employment effect					3.815

Since governmental money is transferred from the governmental sector to the residential sector (the grants), a decrease in employment related to governmental expenditures is found. The resulting decrease in employment amounts to about 35,000 labour years. This effect occurs in the base year only. The employment effect of the grants exceeds the employment effect of the initial investment by about a factor of two, since the average labour intensity related to governmental expenditures is more than a factor two higher than the average labour intensity related to investments in the construction sector.

The case study for this programme estimated a direct job increase of around 1,600 in the last year (compared with 16,600 estimated by the model calculations). The figure from the case study is based on a large survey and are actual new jobs. The larger figure found in the modelling exercise accounts for new work whether or not it has created new jobs. This includes all those who avoided losing jobs as a result of the scheme.

If the investment were paid for by the general consumption budget instead of being financed from the governmental budget solely, the programme would have had a positive cumulative employment effect of 23,000 labour years, see Table 6.55. Due to the shift in the general consumption budget necessary to pay for the initial investment, the employment increases by 925 labour years. This is much lower compared to the case in which the investment was paid for by a subsidy. As stated before, the granting of a subsidy means that the household expenditure budget increases. The energy saving effect is identical to the former calculations and not employment effect through grants occur.

Table 6.55 *Employment effects induced by the HEES programme in case the investments are paid from the general consumption budget*

Labour years [× 1000]	1995	2000	2005	2010	1995-2010
Employment effect initial investment	0.925	-	-	-	
Employment effect energy saving	2.186	1.489	1.304	1.187	
Employment effect grants	-	-	-	-	
Cumulative employment effect					23.325

Although this programme is only slightly effective in terms of employment, it must be remembered that the scheme is aimed at low-income households and does not involve a householder contribution. The justification of the scheme can be made purely on the basis that it is alleviating poor housing conditions and the health problems that are associated with it.

Energy Efficiency Standards of Performance (SoP)

In the SoP program, the investments are made purely by the residential sector itself. This is either in the form of a consumer levy on electricity, or a direct contribution to the measures being installed. So no money is transferred between sectors (i.e. from government to residential).

This programme appears to have a positive employment impact. The cumulative effect is a creation of 12,250 labour years, see Table 6.56. Although virtually identical to the HEES programme in terms of the type of works carried out (for the portion of the scheme studied in the case study), the fact that it is funded by private investment means that it has a much more positive employment effect. Secondly, the ration between the total investments and the total monetary savings is much lower for the SoP programme see also Table 6.53. The total employment impact of the SoP programme is three times as high as for the HEES programme, but total investments are only one third. The total cumulative energy saving effect amounts to over 12,000 labour years.

Table 6.56 *Employment effects related to changes in private and governmental expenditure for the SoP programme*

Labour years [× 1000]	1995	2000	2005	2010	1995-2010
Employment effect initial investment	0.282	-	-	-	
Employment effect energy saving	1.169	0.796	0.697	0.635	
Employment effect grants	-	-	-	-	
Cumulative employment effect					12.260

The case study for this programme estimated that a total of 320 direct (i.e. employment effect of the initial investment) jobs were created for the duration of the 4 year period of the scheme. Again, these were mainly based on likely new jobs and the effect of employment retention was ignored so the effect is likely to be underestimated.

As described above, the UK has particular problems in terms of employment for males with low skills and also regional problems. The advantages of programmes like SoP and HEES are not so much the numbers involved, but that they can make use of these under-utilised labour markets.

Heatwise

The total money invested is £ 2.4 million pounds. Again, 100% of the investments are financed by the government. Part of the impulse goes to the construction sector, part of the impulse to the service sector. The Heatwise project is small compared to the other case studies. Moreover, the monetary savings are also quite low. Over the lifetime, they are estimated to be around £ 1.4 million, see also Table 6.53. So, it is a non profitable investment. However, its primary aim is not to invest in energy efficiency, but to use it as a vehicle for giving unemployed people employment opportunities. In this respect it is a success.

Heatwise's cumulative employment impact is estimated to be 42 labour years, see Table 6.57. The main difference between the Heatwise programme and the HEES programme is that about 70% of the total investments is allocated to the service sector and 30% in the construction sector, see Table 6.50. Therefore, the difference between the initial employment effect and the (negative) employment effect related to the grants is much smaller for the Heatwise programme. The employment effect of the initial investment amounts to about 250 labour years. The decrease in employment due to the decrease in governmental expenditures resulting from granting of a subsidy amounts also to about 250 labour years. Since the amount of energy saving decreases rapidly in time, see Table 6.52, the employment related to the lowering of the energy bill also decreases rapidly. The total cumulative energy savings effect amounts to 38 labour years.

Table 6.57 *Employment effects related to changes in private and governmental expenditure for the Heatwise programme*

Labour years [× 1000]	1995	2000	2005	2010	1995-2010
Employment effect initial investment	0.256	-	-	-	
Employment effect energy saving	0.011	0.001	0.001	0.000	
Employment effect grants	-0.252	-	-	-	
Cumulative employment effect					0.042

The net employment effect of the Heatwise programme is quite low. However, as a training programme for unskilled people, the effects on employment are likely to be much larger than the figures show.

Building Regulations

The total investments are 62 million pounds. The money is spent on labour (43%) as well as on materials (57%). Annual energy saving amounts to 3.12 PJ (20% electricity, 67% gas, 6% oil, 7% solid fuel). Total monetary savings over the lifetime of the energy saving option amounts to about 320 million pounds, see Table 6.53. The investment is for almost 100% financed by the households it self. The grants constitute of only 0.2% of the total investments.

The model shows a cumulative effect of 7,100 labour years, see Table 6.58. Compared to, for example, the HEES programme, the employment effect per pound invested is quite large, since the negative employment effect of the grants is quite small. Almost all investment is private investment (i.e. not avoided government expenditure).

Table 6.58 *Employment effects related to changes in private and governmental expenditure for the Building Regulations programme*

Labour years [× 1000]	1995	2000	2005	2010	1995-2010
Employment effect initial investment	0.177	-	-	-	
Employment effect energy saving	0.674	0.476	0.401	0.363	
Employment effect grants	-0.013	-	-	-	
Cumulative employment effect					7.139

The energy saving effect is the main drive behind the employment increase. In the base year, over 650 labour years are created due to expenditure shift resulting from a lower energy bill. This effect lasts over the lifetime of the energy saving options, but slowly decreases to 360 labour years in 2010. The total cumulative energy saving effect amounts to about 7,000 labour years. The employment effect of the initial investment is rather small, since total investments and the resulting budget shift are quite small, see Table 6.49.

Fridgesavers
The Fridgesavers programme is the smallest programme considered in the analysis for the UK. Total net private investments are 1.25 million pounds. The total cumulative employment effect of this energy conservation scheme amounts to 270 labour years, see Table 6.59. As a result of the grant, a negative employment effect of 460 labour years is induced due to the decrease in the governmental expenditure budget. Again, the main driving force behind the net increase in employment is the energy saving effect, although the employment effect of the initial investment is also positive. However, the latter effect only occurs in the base year, whereas the energy saving effect lasts over the lifetime of the energy saving option. The total cumulative energy saving effect amounts to 475 labour years.

Table 6.59 *Employment effects related to changes in private and governmental expenditure for the Fridgesavers programme*

Labour years [× 1000]	1995	2000	2005	2010	1995-2010
Employment effect initial investment	0.257	-	-	-	
Employment effect energy saving	0.046	0.032	0.028	0.025	
Employment effect grants	-0.460	-	-	-	
Cumulative employment effect					0.273

The direct employment effect calculated in the case study was 65 person years over the 2 years studied. This is a factor of 4 less than the 260 jobs calculated as a direct effect of the investment.

6.6 Macro-economic effects of energy efficiency investments in Finland

In the following, the economy-wide effects of energy efficiency investment programs in Finland are studied by using the FMS model. From the case studies of Finland, the energy auditing program has the complete data basis needed in simulations. However, the energy auditing has been divided into three sub-programs: energy auditing in manufacturing industries, in private services and in public sector.

6.6.1 Base line scenario

First, the base line scenario of the Finnish economic development up to the year 2010 has been defined and simulated by using the FMS model (Mäenpää, 1996). The development of the economic structure and energy balance follows mainly the same assumptions as in the background calculations of the Finnish Energy Strategy (MTI, 1997). The main macro-economic characteristics as the yearly percentage growth rates are shown in Table 6.60.

Table 6.60 *Main macro-economic indicators of the base line scenario for Finland 1995-2010 in yearly percentage growth rates*

		Levels		Change/year
		1995	2010	[%]
GDP	[MECU]	87,827	138,305	3.1
Private consumption	[MECU]	44,828	82,821	4.2
Public consumption	[MECU]	18,327	20,995	0.9
Exports	[MECU]	30,574	54,637	3.9
Primary energy consumption	[PJ]	1,192	1,493	1.5
Electricity consumption	[PJ]	249	345	2.2
Employment	[man-years]	2,068	2,181	0.4
Labour productivity	[GDP/my]	42.5	63.4	2.7
Unemployment rate	[%]	17.2	11.4	

The average rate of growth of the GDP is over 3% per year. After the deep depression in the first half of the 1990's, the realised economic growth rate of Finland in the second half has been over 4.5% per year on the average, however. In the base line scenario this means that the growth rate in the period 2000-2010 should be about 2.5% per year. Nevertheless the unemployment rate will stay fairly high till the end year.

6.6.2 Energy efficiency investment programs

The energy efficiency investment programs to be analysed by means of the FMS macro model are sub-programs of the energy auditing realised in the period 1992-1997. The main characteristics of the sub-programs are presented in Table 6.61.

Table 6.61 *The main characteristics of the energy auditing sub-programs 1992- 1997*

		Industry	Private services	Public sector
Costs/year	[kECU]	10,036	5,745	8,074
Subsidies	[kECU]	570	337	464
Direct yearly employment	[man-years]	60	34	48
Cumulated direct energy savings	[TJ]			
District heat		1,514	603	934
Electricity		305	189	141

The audits have mainly been directed to the general energy consumption of buildings. In industry, the most cost effective energy saving opportunities were not considered in the audits, since the main focus of the audits was building related energy use and not energy used within the industrial process. Therefore the main energy consumption kinds concerned are heating, which in Finland is mostly district heat, and the use of electricity. As it can be seen from Table 6.61, the most energy savings are reached in heating.

The FMS model is fed by the data of the sub-programs as follows. The FMS is a long-term equilibrium growth model. It seeks the equilibrium solution for the end year of the period under consideration. For the analysis of subprograms with the FMS model the sub-programs are changed in the following way. First the sub-programs are smoothed so that it is assumed that the investments in each sub-programs are distributed evenly in the 6-year period. Secondly, the timing of the sub programme are moved so that the last investment year is in the end year of the simulation, 2010, and also all the energy savings are accumulated in that year. A brief description of the FMS model is given in Section 4.6 of this report.

The applied method answers the question: What would be the total long-term macro-economic effects of the program, if it were realised in the future? The data of the sub-programs are channelled into the FMS as follows. The costs of the program are divided into the administration, auditing, planning, installation and acquisition costs. The auditing and planning costs are increased input costs of the investing branches from the business services branch. The administration costs are partly costs from the business services but also partly costs of the general government. The installation costs are assumed to be increased labour costs of the investing branches. The acquisition costs are increased investment costs and thus further increased capital costs of the investing branches. The subsidies are channelled from the general government into the investing branches as negative elements of the net indirect taxes. The energy savings are first fed to the energy satellite of the FMS where it transforms these into the changes in the monetary input coefficients from the electricity, gas and water supplying industry. The energy satellite also calculates the needed change in the structure of the heat and power generation and the following change in the consumption of the primary energy.

The simulated effects as differences from the base line scenario in the end year are depicted in Table 6.62.

Table 6.62 *Macro-economic effects of the sub-programs in the end year 2010 as differences from the base line scenario*

	Units	Industry	Private services	Public sector	Total
GDP	[kECU]	78,674	1,160	5,606	85,246
Private consumption	[kECU]	62,630	773	5,219	68,429
Exports	[kECU]	23,003	-387	580	23,003
Employment	[man-years]	679	34	69	781
District heat	[TJ]	-1,434	-601	-936	-2,966
Electricity	[TJ]	-284	-184	-133	-500
Primary energy	[TJ]	-921	-754	-795	-2,428

All the sub-programs have resulted in an increase of GDP. This is also clear on the basis of the high profitability of the investments in the firm-level cost-benefit analysis of the case study. The GDP growth is relatively much more higher in the Industry case as in the other cases also in relation to the scale of the sub-programs. This is because the increased competitiveness of the industries in the foreign trade has a high multiplier effect on the growth of the economy. In the private services the foreign trade has minor importance. On the contrary, in the equilibrium of the financial markets, the increased (energy efficiency) investments in one part of the economy tightens the financial markets elsewhere and thus the energy efficiency investments in the service sector have a slightly negative competitiveness effect on the industry. The public sector investments do not have this kind of displacement effect because in the FMS model the balanced budget principle is applied to the general government and thus the public investments are self-financed. The increased public outlays are financed by increased income taxes on households.

The economy-wide employment effects are in the Industry case many times higher than the direct employment of the investment program. This is because of the increased overall economic growth. The total employment effect of the Private services case remains the same as the direct employment of the sub-program. The sub-program of the Public sector has moderate positive indirect effects.

The total realised economy-wide energy savings due to the investment programs are somewhat smaller than the direct energy savings reached by the program: the increased economic growth causes some rebound effect on the energy consumption.

The effects on the consumption of primary energy have some special phenomena, which are due to the characteristics of Finnish heat and power production. In heating the share of district heat in Finland is high and furthermore most district heat is produced in combined heat and power generating stations which have a high conversion coefficient from primary energy to the produced secondary energy. Unfortunately a lot more heat savings than electricity savings are realised in the energy efficiency investment program. This means that the heat load for the combined production is decreased more than electricity consumption and thus more electricity has to be produced as inefficient conventional condensing power. Thus the energy savings in the primary energy are lower than those in heat and electricity.

The column of the Total effects of Table 6.62 differs a little from the direct sum of the sub-programs. The Total column depicts the effects when all the sub-programs are realised simultaneously. The cross-effects between the sub-programs and non-linearity's in the FMS model are causes of this phenomenon.

For sensitivity testing, if the investment programs were assumed to have no energy efficiency effects, the whole auditing program would result in a drop of 24,000 kECU of the GDP. This drop is slightly more than the costs of the program. This shows that the pure costs – without any benefits – are also costs in the macro level of the economy. On the other hand, the direct energy savings of the program could have been only about one third of the realised savings without causing any negative impact on the GDP.

7. SENSITIVITY ANALYSIS

In this chapter, the effect of varying some main scenario parameters on the modelling results is investigated. The reference case is the energy conservation scheme that is financed from the general consumption budget, see Section 5.2.1.

7.1 Effects of taxes and surcharges on employment

The effects of changes in taxes and surcharges on employment are a topic that is very difficult to treat in a general sense. Current tax systems may differ strongly between countries. Even between goods and services, tax levels may differ. The Netherlands, for example, has low VAT levels for food, rental of houses and medical care. Excise taxes are applied for example to alcohol and tobacco, energy consumption and motor fuels. Moreover, a distinction has to be made between taxes that are meant to create a shift in the consumption pattern solely and which are supposed to be neutral to the total expenditure budget, and taxes of which the revenue leads to an increase in the governmental budget. In the latter case, there is a net transfer of money from the residential sector to the governmental sector. The need to make a distinction in the spending in taxes will even enhance the country specific character of the analysis. As a result of this dependency on country specific characteristics, only the effects of changes in tax levels on the energy saving effect is assessed in this section. However, for countries with equal VAT levels between goods and services, the net change in tax revenue is negligible. For example, the decrease in tax revenue resulting from a decrease in expenditure on energy is compensated by the rebound effect resulting from the spending of the money saved on other goods and services. For The Netherlands, the impact of changes in tax revenue induced by the implementation of an energy conservation scheme has been investigated extensively, see Section 6.3.4.

Part of the revenues of the government are obtained from taxes and surcharges on commodities and services, including energy. This means that total revenues are decreased when less energy is consumed, for example due to the implementation of an energy conservation scheme. In the base line scenario, it is assumed that a VAT of 16% is applied. In order to investigate the effects of taxes and surcharges on employment, total taxes on energy are risen from 16% to 30% both in the base line scenario as well as in the energy conservation case. Tax levels on other goods and services remain unchanged. It should be noted that this means that a different base line scenario is used. The macro economic effects due to this shift in base line scenario can not be assessed be means of the type of model used in this analysis. The main goal of this exercise is to investigate the effectiveness of the reference program in an economy, which is in a different state, see also Section 8.4 of the discussion. Apart from the change in taxes on energy, the energy conservation scheme is identical to the one described in Section 5.1.

In the reference case, the total decrease in tax revenue resulting from the decrease in energy consumption amounts to 5.2 MEuro in 1995. The decrease in tax revenue is compensated by the rebound effect of spending on other goods and services of equal size[22]. In case the VAT on energy is raised from 16% to 30%, the decrease in tax revenue increases to 9.7 MEuro. However, the rebound effect is still equal to 5.2 MEuro, so there is a net decrease in VAT revenue of 4.5 MEuro in the base year. The cumulative net decrease in VAT revenue amounts to 57 MEuro.

The effects on employment are given in Table 7.1. Due to the rise in VAT level, the cumulative employment effect decreases from about 13,000 labour years to about 11,600 labour years, see also Table 5.4. The employment effect of the initial investment remains equal, but the energy saving effect increases by 12% (about 100 labour years). Due to the increase in energy prices,

[22] Under the assumption that VAT levels are identical for all goods and services.

the cost effectiveness of the conservation program increases. The amount of money saved due to the lowering of the energy bill is increases, which amplifies the energy saving effect. However, the decrease in VAT revenue induces a decrease in employment related to governmental expenditure of 250 labour years in the base year. Cumulative, this effect results in a decrease of employment by 2,850 labour years.

Table 7.1 *Employment effects in case of a base line scenario with high VAT on energy*

Labour years [× 1000]	1995	2000	2005	2010	1995-2010
Employment effect initial investment	0.397	-	-	-	
Employment effect energy saving	1.302	0.956	0.851	0.723	
Employment effect grants	-	-	-	-	
Employment effect VAT rise energy	-0.251	-0.192	-0.177	-0.157	
Cumulative employment effect					11.629

If the VAT for all goods and services is raised from 16% to 30%, then the rebound effect also increases and the net effect of the VAT revenue is zero again. In this case, the total cumulative employment rises from 13,000 labour years to 14,500 labour years. This variant has large similarities with the variant in which the prices of energy are raised, see Section 7.4. It is stressed again that a full assessment of the impacts of changes in (excise) taxes on employment can only be made on a country specific basis.

7.2 Effects of the type of energy saving option on employment

With respect to the reference case study as described in Section 5.1, it is assumed that the money related to the energy saving option is invested in the construction sector. In this variant, the employment effect is investigated when the money invested in the energy saving option relates to 'electrical equipment' (e.g. efficient appliances), instead of 'construction' (e.g. insulation of dwellings).

To investigate the relationship between employment and the type of energy saving option, an impulse of 1 Million Euro is given in the construction sector and the sector related to electrical equipment. The total production value related to an impulse of 1 Million Euro amounts to 1.6 million Euro when the impulse is targeted at the construction sector, see Table 7.2. When the impulse is addressed at the electrical equipment sector, the resulting production value amounts to 1.4 million Euro. The resulting labour volume amounts to 47 labour years for the impulse addressed at the construction sector and 23 labour years with respect to the impulse addressed at the industrial sector concerning electrical equipment. The total labour volume resulting from the impulse in the construction sector is about a factor two higher than the labour volume related to the impulse in the electrical equipment sector. About 15% of this surplus in labour volume is related to the difference in sum of production value, and 85% is related to the distribution of the production value over the industrial sectors. The difference in labour intensity of the sector itself accounts for the major part of the variance in labour volume.

Table 7.2 *Production value and labour resulting from an impulse of 1 Million Euro in the construction sector and the electrical equipment sector*

	Production Value [MEuro]		Labour years	
	Construction sector	Electrical equipment	Construction sector	Electrical equipment
Agriculture	0.003	0.002	0.16	0.09
Energy	0.056	0.027	0.37	0.18
Iron and steel	0.034	0.059	0.23	0.40
Non metallic products	0.134	0.009	2.24	0.14
Chemical products	0.024	0.023	0.20	0.19
Metallic products	0.038	0.024	1.07	0.68
Machinery	0.015	0.013	0.29	0.26
Electrical products	0.029	1.105	0.44	16.55
Transport means	0.004	0.002	0.04	0.02
Food	0.004	0.002	0.04	0.03
Textiles	0.019	0.003	0.62	0.11
Paper	0.009	0.008	0.20	0.18
Rubber	0.015	0.019	0.23	0.29
Other manufacturing	0.001	0.001	0.02	0.02
Building and construction	1.009	0.006	35.27	0.21
Recovery etc.	0.044	0.032	1.97	1.43
Lodging	0.014	0.009	0.50	0.32
Transport	0.054	0.016	1.52	0.45
Communication	0.010	0.005	0.28	0.14
Credit and insurance	0.017	0.012	0.28	0.20
Market services	0.087	0.040	0.87	0.40
Research	0.001	0.008	0.08	0.52
Health	0.000	0.000	0.00	0.00
Other services	0.002	0.001	0.15	0.09
Government	0.000	0.000	0.00	0.00
Total	1.623	1.426	47.09	22.88

For the reference energy saving scheme, the employment effects when the energy saving option is related to 'electrical equipment' are given in Table 7.3. Compared to the reference conservation scheme, the cumulative employment decreases from 13,000 labour years to 10,550 labour years, see also Table 5.4. This is due to a decrease of the employment effect related to the initial investment. In this case, the impact from the initial investment even has a negative sign, which means that the average labour intensity related to the total average household expenditures is higher than the labour intensity related to 'electrical equipment'. In other words, the shift of expenditures from the general consumption budget to expenditures on electrical equipment leads to a decrease in total employment. With respect to investments in the construction sector, an increase in employment related to the initial investment is found. This effect may differ between countries, due to the country specific labour intensities per economic sector, although the construction sector is mostly rather labour intensive.

Table 7.3 *Employment effects in case of investment in an energy saving option that is related to 'electrical equipment'*

Labour [years × 1000]	1995	2000	2005	2010	1995-2010
Employment effect initial investment	-2.024	-	-	-	
Employment effect energy saving	1.162	0.853	0.759	0.645	
Employment effect grants	-	-	-	-	
Cumulative employment effect					10.558

7.3 Effects of improvement of labour productivity on employment

In the base line scenario as well as in the reference case it is assumed that the average labour improvement amounts to 1.9% per year in the period 1995-2010, see also Table 5.2. However, improvement of labour productivity differs between sectors.

In Table 7.4, the employment effects are given for the case that there is no improvement in labour productivity. Obviously, this applies to the base line scenario as well as to the variant including the energy conservation scheme. When no improvement in labour productivity is assumed, the cumulative employment effect increases from 13,000 labour years to 14,650 labour years. Compared to the reference case, the employment impact in the base year is not changed. In the other modelling years, the impacts on employment are amplified. This holds for positive employment impacts but might as well as cause negative employment impacts.

Table 7.4 *Employment effects in case no improvement in labour productivity is assumed*

Labour [years × 1000]	1995	2000	2005	2010	1995-2010
Employment effect initial investment	0.397	-	-	-	
Employment effect energy saving	1.162	0.936	0.912	0.847	
Employment effect grants	-	-	-	-	
Cumulative employment effect					14.656

In the reference case, it is assumed that the improvement of labour productivity differs between sectors, see Table 5.2. In order to investigate the effect of sector specific improvements of labour productivity, the improvement of labour productivity is set equal for all sectors. The rate of improvement of labour productivity is set at 1.9% per year, which is equal to the average level of labour productivity improvement in the base case.

In Table 7.5, the employment effects are given for the variant in which the improvement of labour productivity is set equal for all industrial sectors. The cumulative employment effect amounts to 12,870 labour years and is about equal to the value found for the reference case. For, the base year, there is (obviously) no difference between the base case and this variant. For the other modelling years, the positive employment effect of the energy saving effect is slightly lower.

Table 7.5 *Employment effects in case the improvement of labour productivity is equal for all sectors*

Labour [years × 1000]	1995	2000	2005	2010	1995-2010
Employment effect initial investment	0.397	-	-	-	
Employment effect energy saving	1.162	0.848	0.750	0.632	
Employment effect grants	-	-	-	-	
Cumulative employment effect					12.870

Due to the liberalisation of the energy market, it is expected that the average improvement of labour productivity in the energy production and energy distribution sector will increase faster than in other sectors, due to the higher competition between energy suppliers. Estimates of the improvement of labour productivity are largely based on historical developments. It is likely that future increase of labour productivity in the energy production and energy distribution sector will exceed the historical rate of improvement. Therefore, in this study the employment shift due to the energy saving effect can be regarded as a conservative estimate.

7.4 Effects of energy prices on employment

In the base line scenario, it is assumed that the prices of electricity will drop slightly due to the liberalisation of the European electricity market, see Table 5.1. To investigate the effects of higher energy prices on employment, it is assumed that in the period 1995-2010 prices of electricity will increase by 10% in each period of 5 years. In the base case, the electricity prices drop with 23% to 0.11 Euro/kWh in 2010 compared to the 1995 level. In this variant, the electricity price rises from 0.15 Euro/kWh in 1995 to 0.20 Euro/kWh in 2010, an increase of 33%. As in the reference case, the VAT amounts to 16%, no other surcharges are applied.

In Table 7.6, the employment effects are given in case of increasing electricity prices. The cumulative employment effect increases from 13,000 labour years in the reference case to 17,750 in this variant. Employment effects in the base year are identical, since energy prices are equal for 1995. However, for the other modelling years, the profitability of the energy saving option increases due to the higher energy prices, which enhances the energy saving effect.

Table 7.6 *Employment effects in a rise in electricity prices*

Labour [years × 1000]	1995	2000	2005	2010	1995-2010
Employment effect initial investment	0.397	-	-	-	
Employment effect energy saving	1.162	1.146	1.140	1.127	
Employment effect grants	-	-	-	-	
Cumulative employment effect					17.750

7.5 Effects of repartition over households on employment

Not only the financing method, VAT level and prices influence the outcome of the simulations. Also the way the energy investments are distributed over the household types may have an impact on the employment effect, since different household groups will spend the money saved on energy on different commodities. Therefore in the first German case study (thermal insulation ordinance, see Section 6.2.3) alternative assumptions on the distribution of investments over household types have been tested.

The reference alternative (Case A), reported in Section 6.2.3, is that the investments of the household categories are proportional to their share in the total population. Another hypothesis (Case B) is to assume that the investments are proportional to the share in building ownership. Under this hypothesis e.g. young single households would invest less, whereas families would be investing more.

In Table 7.7 the two assumptions are compared. Only the employment effect due to the household budget shift diverges between the two cases and there also the differences are rather limited. For the net employment effect cumulated over the lifetime the relative difference is more important, with alternative B, i. e. investments proportional to the share in building owners, yielding higher net employment effects. However the results should not be over-interpreted, given the small absolute size of these employment effects. So by and large, the way investments are distributed over household types only weakly affects the results.

Table 7.7 *Distribution of investments over household types (German thermal insulation ordinance)*

Labour [years × 1000]	1995 A	1995 B	2010 A	2010 B
Gross employment effect initial investment	99.1	99.1	0.0	0.0
Gross employment effect energy saving	-1.5	-1.5	-1.1	-1.1
Compensating employment effect household budget shift	-3.2	-3.1	-2.0	-2.0
Compensated employment effect government budget shift	0.0	0.0	0.0	0.0
Total employment effect	94.4	94.5	-3.1	-3.0
	Lifetime A		Lifetime B	
Cumulative employment effect	3.8		5.9	
of which: full time employed	9.0		10.7	
part time employed	-5.1		-4.8	
self-employed	-3.7		-3.5	
helping family members	-1.0		-1.0	
officials	-2.1		-2.0	
employees	-2.5		-1.7	
workers	12.2		12.9	
trainees	0.9		1.0	

A: investments proportional to share of household type in population
B: investments proportional to share of household type in building owners

8. DISCUSSION AND CONCLUSIONS

The aim of this study is to determine the employment effects related to investments in energy efficiency. This is done by modelling specific case studies on energy conservation schemes for different countries. All case studies considered in the analysis, except the case study for Finland, deal with energy conservation schemes that aim at the reduction of energy consumption in the residential sector. Since the quantitative outcome of the modelling may vary between countries, the different mechanisms behind the employment shift are more important than the size of the employment shift itself. Therefore, a sensitivity analysis has been conducted by means of which the effects of different financing methods are studied. Moreover, attention was paid to the effects of labour productivity improvement, energy prices and taxes and surcharges on energy and the characteristics of the energy saving option.

8.1 Investment in energy conservation and employment

Different mechanisms can be identified that determine the net shift in employment resulting from investments in energy conservation. The main mechanisms are:

- The employment effect related to the initial investment in energy efficiency. This effect occurs in the base year only. Whether the initial investment leads to a positive of negative employment effects depends on the financing method and country specific characteristics such as the expenditure pattern of the consumption budget and the labour intensity of industrial sectors.

- The energy saving effect. Due to the lower energy bill, a shift in expenditure pattern will occur. This effect lasts over the lifetime of the energy saving option. The size of this effect is determined by the average labour intensity of the energy sector and the average labour intensity of the sectors that benefit from the shift in expenditure budget.

- The effects of money transfers between sectors. For example, when the investment is subsidised by the government, money is transferred from the governmental sector to the residential sector. As a result of these grants, the total expenditure budget of the households is increased, which will result in an increase in employment. However, the employment related to governmental expenditures will decrease, since the governmental budget is decreased by the amount of subsidy granted. The net effect of this mechanism depends on the assumption made with respect to what the government would have done with the money used for the subsidy otherwise. In this project, it is for most cases assumed that the money would have been spent within the governmental sector itself. With respect to employment, this is a 'worst case' approach, since the governmental sector is amongst the sectors with the highest labour intensity.

- The effects of a decrease in tax revenue. Since the expenditures on energy are reduced, the tax revenue (e.g. VAT) associated with energy consumption is also lowered. This results in a decrease in the governmental budget. However, this effect is compensated by the increase in tax revenue associated with expenditures on other goods and services (rebound effect). Especially in the case when no distinction in the height of taxes between commodities and services exists, the net effect on employment of the shift in revenues of taxes is expected to be negligible. However, this effect may become of increasing importance in case a difference in VAT is being made between purchases of goods (high VAT) and services (low VAT). This distinction in height of taxes can be considered as a measure to stimulate expenditures on labour intensive services rather than on labour extensive goods. For example in The Netherlands, the total amount of taxes and surcharges on energy consumption are higher than the

VAT-rate. However, part of the surcharges are returned to the residential sector, e.g. as subsidies on investments in energy efficient appliances. In the United Kingdom, there exists also an additional tax of 3% on electricity consumption (the NFFO-surcharge). Recently, the Ministers of Finance of the European Union have agreed upon lowering the VAT for labour intensive services (Turku, 1999).

For The Netherlands, the effect of the decrease in payments on unemployment benefits associated with the decrease of employment induced by the energy conservation scheme has also been investigated. For The Netherlands, this effect leads to an increase of the total employment effects by about 13%, depending on the height of the unemployment benefit.

The main driving force behind the positive employment effect of investment in energy efficiency in the residential sector is the fact that the energy sector is rather labour extensive. It is expected that due to the liberalisation of the energy market, the labour productivity of the energy sector will increase even more rapidly than for other sectors. So, a shift of expenditures from the energy sector to other sectors leads to an increase of employment. An investment by households in energy conservation will lead to a decrease in expenditures on energy (a reduction of the energy bill). The amount of money saved can now be used for other purposes, e.g. the purchase of appliances or services. As a result, a shift in the expenditure pattern of the households is observed from the energy sector towards other sectors with higher labour intensity. This is the general mechanism that explains why the investments related to the reduction of the energy bill, the so-called 'energy saving effect' will lead to an increase in employment.

The importance of the energy saving mechanisms is also stressed by Geller et al. In (Geller, 1998), the relationship between employment and investment in energy conservation in the USA was studied. Geller et al. conclude that the positive employment and income results are due primarily to the relatively low labour intensity of the energy sector compared to the economy as a whole. The conservation of energy leads to a decrease in expenditures on energy, thus enabling the purchase of non-energy goods, equipment and services. This results in a shift in economic activity away from energy supply industries and towards sectors of the economy which employ more workers per dollar received.

The analysis performed by Geller et al. was conducted using an input/output economic model. By means of this input/output model, the overall employment and income effects from changes in expenditure pattern in particular sectors was estimated. The model accounted for direct (i.e. on-site) effects, indirect (i.e. supplier) effects, and induced (i.e. respending) effects from investments and expenditures on all levels. Only cost effective investments in energy saving were included in the modelling. The additional investments amounted to $46 billion per year during the period 1992 – 2010. Due to these investments in energy efficiency, the energy use per unit of GDP falls 2.4% per year over the period 1990 – 2010. Moreover, the investments lead to more jobs, higher personal income and a marginally higher GDP over the same period. It was estimated that about 293,000 new jobs could be created by 1995, 471,000 by 2000 and 1.1 million jobs by 2010 on a net basis. The rise in personal income reaches 0.5% in 2010, while the increase in GDP is less than 0.1%. Less than 10% of the net jobs are associated with direct investment in efficiency measures, whilst more than 90% are associated with energy bill savings and respending of those savings. The largest increase in jobs is found in the construction, retail trade and services industries. The energy supply sectors employ fewer workers. According to (Geller, 1998), investment in energy efficiency leads to more jobs and higher personal income at the national level, in addition to saving consumers money, reducing energy imports and cutting pollutant emissions associated with energy supply. More jobs can be created and the environment can be protected by adopting policies that enhance energy efficiency.

The main conclusions found by (Geller, 1998) are supported by the results of the analysis of the impacts of investments on energy efficiency in Finland. By means of a multisector econometric simulation model, the macro economic effects of energy audit schemes performed at the industrial sector are determined, see Section 6.6. Both the investments in energy conservation in the public sector as well as in the industrial sector resulted in an increase of GDP and employment. The total energy savings were slightly lower than the energy saving of the efficiency programme solely, due to some rebound effects related to GDP growth.

In (Gameson, 1997), it is concluded that the fear that environmental policies will destroy jobs is largely unfounded. No systematic correlation has been found between environmental policies and competitiveness impact. Environmental-related losses of new and existing jobs are considered to be almost irrelevant in comparison with job losses resulting from corporate decisions and government policies. The empirical experience in the EU over the past twenty years shows that a whole series of measures and policies have made it possible to combine environmental protection with job creation. According to Gameson et al., although the analysis by different macro-economic models is inconclusive on some points, they consistently provide the evidence that the business as usual scenario (without environmental policies) extended to the future is unsustainable.

8.2 Financing of investments in energy conservation

Different financing methods can be applied to finance the initial investment in energy conservation. The investment can be paid for by the general consumption budget, from private savings, by a loan or by means of a subsidy, see also Chapter 5. In case of financing energy conservation from the general consumption budget, a shift in the general expenditure pattern will occur. Whether this shift will lead to a net employment increase depends on the differences in labour intensity between sectors. This may vary between countries. A comparison of the case studies of Spain and the UK show that for the UK, both the investment in 'electrical equipment' as well as in 'construction' will result in an increase in employment. For Spain however, only the budget reallocation associated with an investment in 'construction' will lead to a net employment increase for the initial investment. The shift in expenditure budget that involves an investment in 'electrical equipment' leads to a net decrease of employment.

In case a subsidy is granted, money is transferred from the governmental sector to the residential sector. This leads to an increase in total expenditures by the residential sector and a comparable decrease in total expenditures in the governmental sector. The net employment effect is now determined by the difference in average labour coefficients related to total governmental expenditures and total expenditures from the residential sector. By means of a set of expenditure functions connected to an input/output table, the average labour coefficient related to expenditures and expenditure shifts from the residential sector can be determined quite accurately. Since the shift in expenditure pattern of the government is not modelled dynamically, an assumption has to be made with respect to the question of what would have happened with the money if the government had not used it as a grant. In this analysis, it is for most cases assumed that the money would have stayed within the governmental sector. This can be regarded as a conservative estimate, since the governmental sector is, in comparison to other sectors, rather labour intensive. Under this assumption, the granting of a subsidy on the initial investment by the government is likely to result in a net decrease in total employment.

The analysis of case studies for the UK shows that the effect of grants can be quite significant. They may determine the outcome of the analysis for the greater part. Part of the energy conservation schemes for the UK focus specifically on low-income households. Therefore, the total investment is subsidised for 100% by the government. For the HEES programme, this leads to an increase in employment of about 4,000 labour years over the period 1995 – 2010. However, if the initial investment had been financed from the general expenditure budget, the net employment would have increased by 23,000 labour years over the same period. The shift of money from the government results in an increase of employment related to residential expenditures of 16,500 labour years and a decrease in employment related to governmental expenditures of 35,000 labour years. For this programme, the total cumulative employment effect induced by the shift in expenditure due to lower energy costs amounts to 22,000 labour years. From an economic point of view, the HEES programme could be considered as a cost ineffective programme. However, it should be stressed that despite a lack of profitability there are other reasons, such as social welfare and environment that justify the implementation of an energy conservation scheme.

Investments in energy conservation can also be financed by means of a loan. This means that a net transfer of money occurs from future years to the base year. However, since interest has to be pain on the loan, over the lifetime of the option (loan) there will be a transfer of money out of the residential sector to the service sector (banks). This transfer of money out of the residential sector leads to a decrease in employment related to household expenditures. The banks will invest this money again, which will lead to an increase in employment. It is expected that the employment generated by the re-allocation of the repayment of the loan exceed the employment loss related to the decrease of the total household expenditures. The employment impacts resulting from financing an investment by means of private savings could only be assessed partially. The financial behaviour of the service sector, such as banks or other finance companies is not modelled dynamically. Therefore, the short and long term employment effect of the cash withdrawal can not be assessed without further study. The outcome mainly depends on the assumption whether or not cash withdrawal leads to an increase of economic growth or not.

8.3 Employment effects in the case studies

Within the overall project, case studies of actual energy conservation schemes have been conducted. Part of these case studies aim at conservation of energy in the residential sector. The direct and indirect employment effects induced by these conservation schemes are assessed in this study. In, total 14 case studies were analysed (three for France, three for Germany, two for The Netherlands, one for Spain and five for the UK), see Chapter 6. Almost all case studies show positive employment effects. Only the CO_2 abatement programme for Germany has negative employment impacts as a result of a shift in governmental expenditure pattern.

The main conclusion that can be drawn from the comparison between the case studies, is that for all case studies considered, the so-called ‘energy saving effect’ leads to an increase in employment. The net employment impact depends mainly on two factors: (1) the financing method, and (2) the type of energy saving option. As explained in the sections above, the granting of a subsidy results in a decrease of the net employment effect induced by the energy conservation programme. Whether or not the net cumulative employment effect is positive or not depends on the magnitude of the energy saving effect and the type of energy conservation scheme.

8.4 Profitability of the energy conservation scheme and employment impacts

An increase in profitability of the energy conservation scheme enhances the probability that the net employment effect of the energy conservation scheme is positive. Basically, two employment effects can be distinguished: (1) the employment effect related to the initial investment in the base year and (2) the employment effect related to the energy saving. The employment effect related to the initial investment can be either positive or negative. The sign and magnitude of this effect depends on the energy conservation option and the financing method, see Section 0 and 7. The change in employment related to the decrease in energy consumption (the ‘energy saving effect’) has a positive sign for all countries considered. This can be explained by the fact that the average labour intensity for the energy production and distribution sector is lower than the average value of the other industrial sectors. So, a shift of expenditures from the supply sectors to other sectors will lead to an increase of total employment. The net effect of the energy conservation scheme is positive in case the (positive) employment effect related to the energy saving exceeds the employment effect related to the initial investment in case that the initial employment effect is negative. It should be noted that the employment effect related to the initial investment can also be positive.

What happens when the profitability of the energy conservation scheme increases? The profitability could be enhanced by increasing the profits from energy saving, for example due to higher energy prices or an increase in the amount of energy saved, or by reducing the total investments. If the profits from energy saving increase, the employment effect related to the energy saving effect will also increase. Therefore, the probability that the energy saving effect is able to compensate any negative employment effects (if existing) related to the initial investment increases. In case that the profitability of the energy conservation scheme is enhanced by reducing the total initial investments, any existing negative employment effect will be lowered subsequently. This also enhances the probability that the energy saving effect is able to compensate possible negative employment effects related to the initial investment.

What options does the government have to enhance the profitability of the energy conservation scheme? As stated before, this could be done by either decreasing the investment or increasing the profits from energy savings. By providing a subsidy on the total investments, the profitability of the investment increases for the households. However, on a national level, the profitability is not changed. The sensitivity analysis shows that providing a subsidy by the government may have detrimental effects on total employment, since the governmental money spent on grants can't be used otherwise, see also Section 5.2.3. Therefore, provision of a subsidy as a measure is considered not to be a solution to enhance the profitability (on a national level) of an energy conservation scheme. However, other reasons may justify the providing of a subsidy.

Another option to enhance the profitability of the energy conservation scheme is to increase the profits from energy saving, for example by increasing the energy prices. This could be either a tax of which the revenue is returned to the households (e.g. by means of a lowering of income tax) or a tax of which the revenue is used by the government for general purposes (e.g. an increase of the VAT). By means of the dedicated input/output based simulation models used in this study, the employment effects of an energy conservation scheme can be determined by comparison to a base line scenario. In the sensitivity analysis in Section 7, the effects of changes in energy prices and taxes on energy (VAT) are investigated. For The Netherlands, the employment shifts resulting from a change in tax revenue are investigated in more detail (Section 6.3.4). The introduction of an additional tax or an increase in energy prices means that the base line scenario is altered. By means of model calculations, the employment effects compared to the new base line scenario can be assessed. However, the macro-economic effects resulting from the shift in the base line scenario cannot be addressed with the type of models used in this study. The sensitivity analysis shows that in a base line scenario with a higher VAT solely on energy, employment effects of a reference energy conservation scheme are lower compared to the reference base line scenario (Section 7.1). Due to the decrease in VAT revenue, the employment related to governmental expenditure decreases. When a base line scenario with higher energy prices is used, the employment impacts increase, see Section 7.4, since the cost effectiveness of the programme is enhanced. However, it is likely that the macro-economic effects introduced by the shift in base line scenario, e.g. as a result of a new tax system, will dominate the overall employment effects, see for example (MinFin, 1998). This topic is beyond the scope of this study and further research is recommended.

8.5 Summary of findings and recommendations for future research

This study provides empirical evidence that investments in energy efficiency in the residential sector are beneficial for the environment as well as for employment. By means of a dedicated input/output approach the employment impacts resulting from investments in energy conservation have been determined. The main driving force behind the increase in employment is the fact that the average labour intensity of the energy sector is lower compared to other sectors. Therefore, a shift in expenditures from the energy sector to other sectors leads to a net increase of employment. However the employment effects of the programmes remain in general small compared to the investment size. Therefore, the main argument for energy efficiency programmes should remain environmental benefits with job creation as a desirable side effect.

The profitability of the investment, as well as the type of investment and financing method are the most important factors that determine the success of the energy conservation scheme. An increase in profitability of the investment leads to higher employment effects. Granting of a subsidy on the investment by the government leads to a decrease in employment if a corresponding reduction in general government expenditures is assumed. However, for specific programmes these grants are unavoidable since these programs aim specifically at low-income households. Depending on the distribution of the labour intensity between sectors, an investment in for example dwelling insulation (the construction sector) might lead to higher employment effects in comparison to a comparable investment on efficient appliances (electrical products). However, this may vary between countries.

In future research, more attention should be paid to the monetary flows within the governmental sector and to intertemporal flows. In the approach taken in this study, the behaviour of the government is modelled statically. As a result, some 'worst case' assumptions had to be made in order to be able to estimate the employment effects induced by shift in governmental expenditures. Moreover, the effects of excise taxes and surcharges should be studied in more detail, since it is expected that their effect on employment will become of more importance in future. For The Netherlands, a new tax system will be introduced as of 2001 (MinFin, 1999). This system intends to enhance employment and to create a shift from environmental harmful consumption to more environmental friendly consumption. By means of the dedicated input/output simulation approach used for this study, the employment effects of energy conservation programmes resulting from this change in tax system can be determined quite accurately.

ANNEX A MODEL CHARACTERISTICS AND INPUTS FOR SPAIN

Table A.1 *Expenditure categories*

Category nr.	Expenditure category
1	Food, beverages and tobacco
2	Clothing and footwear
3.1	Gross rent and water charges
3.2	Fuel and power
4	Furniture, furnishings and household.
5.1	Medical and pharmaceutical products
5.2	Medical care and health expenses except 5.1
6	Transport and communication
7	Recreation, entertainment, education.
8	Miscellaneous goods and services

Table A.2 *Coefficients β for the expenditure functions*

	Constant	Income	Expenditure categories									
Category nr.	β_0	β_1	1	2	3.1	3.2	4	5.1	5.2	6	7	8
1	9.39	0.50	-0.43	0.00	0.06	0.00	0.03	0.00	0.00	0.07	0.04	0.11
2	5.65	0.62	0.03	0.00	0.02	0.00	0.01	0.01	0.00	0.02	0.01	0.03
3.1	7.11	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.2	-4.96	1.31	0.13	0.05	0.06	-0.40	0.04	0.02	0.01	0.09	0.04	0.14
4	-2.96	1.35	0.00	0.00	0.06	0.00	-0.40	0.00	0.00	0.07	0.00	0.11
5.1	-13.75	1.99	0.00	0.00	0.30	0.00	0.16	-1.47	0.00	0.34	0.16	0.53
5.2	-10.64	1.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	-4.75	1.47	0.29	0.11	0.00	0.00	0.10	0.08	0.00	-0.95	0.10	0.32
7	-4.82	1.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	2.90	0.76	0.59	0.22	0.00	0.00	0.19	0.17	0.00	0.00	0.00	-0.64

Table A.3 *Industrial sectors and labour coefficients for Spain*

			Labour coefficients 1995 [1000 employees/million pesetas]		
	Industrial sectors	Code	Total	Male	Female
1	Agriculture	010	0,00029	0,00021	0,00008
2	Energy	031 - 110	0,00004	0,00003	0,00000
3	Iron and steel	134 + 137	0,00004	0,00003	0,00000
4	Non metallic products	151 - 157	0,00010	0,00009	0,00001
5	Chemical products	170	0,00005	0,00004	0,00001
6	Metallic products	190	0,00017	0,00016	0,00002
7	Machinery	210	0,00012	0,00011	0,00001
8	Electrical products	230 + 250	0,00009	0,00007	0,00002
9	Transport means	270 + 290	0,00007	0,00007	0,00001
10	Food	310 - 390	0,00007	0,00005	0,00002
11	Textiles	410-450	0,00020	0,00012	0,00008
12	Paper	471 + 473	0,00013	0,00010	0,00003
13	Rubber	490	0,00009	0,00007	0,00002
14	Other manufacturing	510	0,00015	0,00013	0,00002
15	Building and construction	530	0,00021	0,00020	0,00001
16	Recovery etc.	550 + 570	0,00027	0,00016	0,00011
17	Lodging	590	0,00021	0,00012	0,00008
18	Transport	611 - 650	0,00017	0,00016	0,00001
19	Communication	670	0,00017	0,00012	0,00005
20	Credit and insurance	690	0,00010	0,00007	0,00003
21	Market services	710 + 730	0,00006	0,00004	0,00002
22	Research	750 + 850	0,00041	0,00016	0,00025
23	Health	770 + 890	0,00023	0,00007	0,00016
24	Other services	790 + 930	0,00045	0,00017	0,00028
25	Government	810	0,00025	0,00015	0,00010

A SIMPLE ECONOMETRIC CHARACTERIZATION OF CONSUMPTION FUNCTIONS

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A.I INITIAL OBJECTIVES AND WORK STAGES

The goal pursued by setting up an input-output-type model is the determination of the elasticities of each of the categories of final consumption with respect to income, the own price of the good or service consumed and the price of other alternative goods, if these exist.

This goal implies the prior construction of a complete time-series database of sufficient breadth to allow subsequent quantitative analysis. This database would therefore include aggregate consumption-related information and a breakdown of it into a broad series of specific categories.

The second, and main stage, consisted of estimating the elasticities of each of the categories after first defining the methodological strategy to apply in general.

Once the data obtained had been revised, the final stage involved the choice of those data deemed most appropriate for the purposes of the investigation. Where necessary the initial estimate was revised in order to improve certain aspects.

Each of these stages is described in this document. An annex containing additional information of interest is also included.

A.II DATABASE: DATA GATHERING AND DESCRIPTION

(The database is included as an Excel file called 'DatosC.xls'.)

The linked database is in the format of an Excel file called 'DatosC.xls' A description of this file is given in the annex. Technical details: The data in this database has been gathered from the information held by the National Accounts Department at the National Statistical Institute (Contabilidad Nacional del Instituto Nacional de Estadística).

- The information available from the National Statistics Institute (INE) did not allow linked series of data to be obtained directly on a single base year for the whole of the period 1980 to 1996. The problem was that after the change in the basis by the INE from 1980 to 1986 no official link was made between the consumption figures for 42 of the spending functions even in current value terms. There are therefore two different databases both in current-price and constant-price terms: one between 1980 and 1985 in base 80 and the other from 1986 to 1996 in base 86. The only official point at which they are linked seems to be a single series 80-85 on the 1986 basis which is only available for the 8 main spending categories (to one digit). It was therefore necessary to establish this link.
- By assuming the data on the 1986-basis was correct and taking in it in conjunction with the aggregate series mentioned above for the period 1980-1985 it was possible to generate the rest of the information previously unavailable on the 1986-basis, i.e. the two or three digit entries in both current- and constant-price terms. To do so the one-digit aggregates were taken and shared out between the totals for all two/three digit categories according to their share of these same aggregates in the former 80-basis, both for current and constant prices.
- The limitations and disadvantages of this linking procedure, which is one of several which could be used, are plain to see. In our opinion, it might have been better to respect the rates of growth in constant-price terms and use deflators relating to the former basis (1980) and subsequently obtain the magnitude in current value terms. Nevertheless, the people in charge at the National Statistical Institute who were consulted advised this procedure as, according to them, the growth figures for the series on the earlier basis (i.e. in short, the information) was '*not at all reliable.'* In truth it must be stated that the time series obtained for the consumption categories between 1980 and 1985 is not completely consistent with that in the 80-basis series, although this is no guarantee that the information finally obtained is correct.
- Considerable care needs to be taken in using this information and we recommend that the link point 1985-1986 be considered a turning point in the structure of the information. This would explain, without ruling out other possible causes, the appearance of dummy impulse or scale variables in the regressions used to estimate elasticities.

A.III.A Goal

As stated at the start of this report, the goal sought was to evaluate how the volume of consumption of each of the goods or services in the INE's CNAE classification responds to three basic variables: income, own price and price of other goods.

A.III.B Initial information

Although a foretaste has been given elsewhere in this document, the description of the information used is as follows:

- As data for the volume of consumption for each category the constant 1986-basis series was taken. This series was obtained as described above.
- The data used for income was domestic consumer spending, obtained as the total of the 42 previous categories. This explicitly implies equalling income and consumption, i.e. assuming that increases in income are wholly converted into consumption without the mediation of savings. Nevertheless, given that the elasticities of consumption with respect to income have been calculated individually, there is nothing inherent in the system meaning this always has to be accepted when all elasticities are made to operate simultaneously.
- For the sake of convenience, the implicit deflators derived from the previous INE magnitudes have been used for prices.

Although initially the possibility of including other supporting variables was considered, such as employment, unemployment, deterministic temporal trends, rates of interest, etc. in the end an effort was made to maintain the homogeneity of the procedure, and their use was forgone in all but one category (6.1. Personal transport equipment) in which the long term interest rate served as a substitute for price. Similarly, as has already been explained in the section on the link with the basic consumption series, it was necessary in some cases to include a dummy impulse or step variable from 1986 onwards.

A.III.C Functional Form

Each of the estimated equations follows the basic formulation of a simple linear regression model:

$$\mathit{Consumption} = \beta_0 + \beta_1 \times \mathit{Income} + \beta_2 \times \times \mathit{Own\ Price} + \beta_3 \times \mathit{Other\ Prices}$$

The equations have been estimated using data in logarithms. This makes it possible to interpret each parameter, approximately, as an elasticity. In effect in the model we have:

$$\mathrm{y}^* = \beta_0 + \beta_1 \cdot x_1^* + \beta_2 \cdot x_2^*$$

where:

$$y^* = \log y$$
$$x_i^* = \log x_i$$

so:

$$\beta_1 = \frac{\partial y^*}{\partial x_1^*} = \frac{\partial \log y}{\partial \log x_1} = \frac{\Delta y / y}{\Delta x_1 / x_1}$$

Each regression has been estimated individually using ordinary least squares with data for 1980-1996 for the 8 main categories and for 1980-1994 for the 42 two- or three-digit categories.

A.III.D Alternative Prices[23]

Given the nature of the 42-category national accounts classification, determining the substitutability for each category is conceptually difficult. As the description of each category shows, almost all of them include indispensable goods or services, which it would be difficult to do with out, let alone replace with others. It could be said that each of the categories defines a specific area of consumption, which does not intersect any other, at least directly. Nor is this intellectual exercise simple within the same group: look, for example, at the case of foods, the most specific group (three digits) and try to substitute or complement the utility given by any of them with any other.

Nevertheless, despite this conceptual difficulty, one cannot help thinking, for example, that an increase in price of a good can free income by means of a decrease in the volume of its consumption greater than the increase in its price. In this case, this income would be destined to 'alternative' consumption which, probably would not replace the utility of the good of which less was consumed, but would make it possible to define a technical 'substitutability' which could undoubtedly influence the data available.

In order to study this substitutability between the different categories no attempt was made at a 'conceptual' analysis, i.e. to define what goods could logically be substituted for by others. Instead a quantitative analysis of these relationships was performed on paper. Thus, for each consumption category 9 regression analyses were initially carried out, with own prices and income, changing in each case the replacement goods deflator:

- One regression analysis in which the Total Consumption deflator excluding from the same the category of consumption analysed was taken as a deflator for substitute goods (*somewhat like the price of the rest of the goods and services*).
- One analysis in which the deflator for the group to which the excluded good from the consumption category being analysed belongs, is considered as a deflator for substitute goods (*somewhat like the price of the goods and services 'similar' to that analysed*).
- Seven regression analyses, in which the deflators for the total of each of the *remaining* groups are taken to be deflators for substitute goods *(somewhat like the price of the goods and services other than that analysed*).

This crossed analysis was even performed relating each category with every other category, giving rise to a total 2600 regression analyses. The results of this 'pool' were analysed with Dbase and Clipper programs and it was decided that the homogeneity of the results obtained for categories belonging to the same group would allow a more aggregate analysis (9 regressions per category) without excessive loss of detail.

Each of these 9 regressions for each consumption category was studied and corrected individually with special attention being paid to the mistakes made, the individual and combined significance of the variables entered, the appropriateness of the sign expected for each variable and the existence of structural changes.

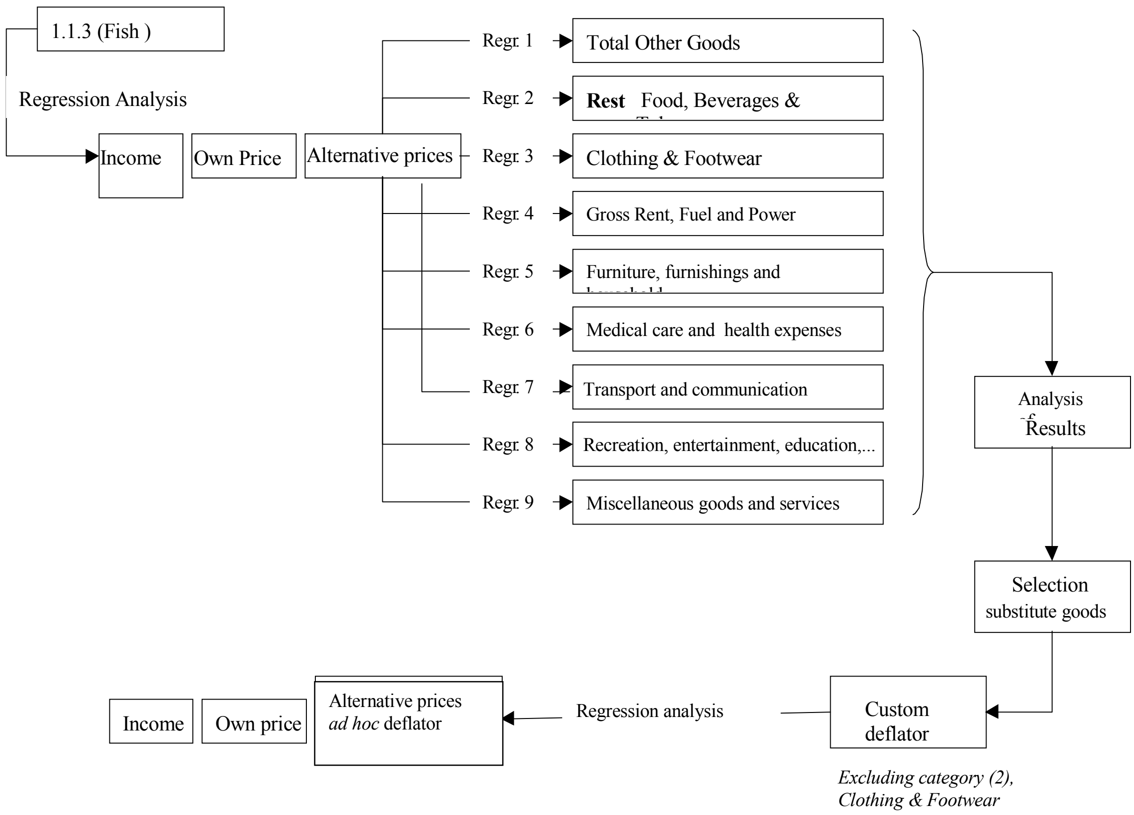
In this way, for each of the 42 categories it was possible to observe whether the elasticities of income, own price and alternative prices, remained homogeneous when the 'substitute' category was varied or not. It was decided, in accordance with these partial regressions, which goods or services would be considered substitute of each category. Moreover, in some cases, there has been no hesitation in describing as inelastic consumption with respect to income or own price.

[23] Although we are talking here generically about alternative prices, our analysis has only centred upon substitutability and not complementarity. Independently of the conceptual difficulty, which is even greater than in the case of substitutability, if that were possible, none of the results of the regressions were negative in sign (an indication of complementarity) in the alternative price of goods parameters.

Finally, having decided which goods or services were shown to be 'substitutes' for each consumption function, a deflator for substitute goods was custom-made for each category. This included only those goods or services which had been selected beforehand. The intention was to use this *ad hoc* deflator for substitute goods to produce a single regression which would make it possible to summarise in a single parameter all the information on crossed elasticities contained in the 9 previous regressions.

The result is therefore a first average estimate of the elasticities based on what was considered valid for the 9 main regressions and a second estimate based on the use of a single deflator.

As an example, the schematic diagram below shows the procedure used in the analysis of category 1.1.3 (Fish):



A.III.E Presentation of Preliminary Results

The results obtained for all the categories analysed –in all cases according to the scheme described above– may be found in the Excel file called 'ResultadosC.xls', which is described, in the annex to this document.

A.IV SELECTION OF RESULTS. REVISION OF BASIC ESTIMATE

A.IV.A Goal

On the basis of the preliminary results obtained and given the need of the main study, it was decided to consider only the results obtained for the main groups, i.e. the 8 basic consumption categories.

The elasticities obtained were taken as a starting point, considering the *ad hoc* deflators defined in the methodological scheme. Given these results the decision was made to revise the estimates initially obtained for these 8 groups in order to make them more complete and make room for a greater number of effects than those initially estimated. In the case of some groups, initially united in the same category, it was decided to consider a number of subgroups separately and make individual estimates for them. The final results obtained are given below:

A.IV.B Final Description of Regressions

The results are given in this section divided into the basic groups used in the final analysis. The definitive series were generated from the information provided in the database by means of simple summation of the groups included in, or excluded from, each category.

GROUP 001

(Food, beverages and tobacco)

For this group an estimate was used with the *ad hoc* deflators initially obtained. This *ad hoc* deflator was constructed for this group excluding categories 2 (*Clothing and footwear*) and 5 (*Medical care and health expenses*). The final results obtained are as follows:

Sample: 1980 1996
Included observations: 17

Variable	Coefficien	Std. Error	t-Statistic	Prob.
C	9.385793	0.456028	20.58162	0.0000
LOG(D001)	-0.430101	0.045598	-9.432378	0.0000
LOG(KCPI/N)	0.503765	0.037739	13.34850	0.0000
LOG(D001REX25)	0.306378	0.046717	6.558141	0.0000

R-squared	0.971344	Mean dependent var	15.54636
Adjusted R-squared	0.964731	S.D. dependent var	0.033432
S.E. of regression	0.006279	Akaike info criterion	-9.938883
Sum squared resid	0.000512	Schwarz criterion	-9.742833
Log likelihood	64.35855	F-statistic	146.8844
Durbin-Watson stat	2.318308	Prob(F-statistic)	0.000000

The variable D001REX25 is the *ad hoc* deflator constructed taking into account the price of all the categories of goods excluded from 2 and 5 (*together, of course, with the one analysed*).

GROUP 002
(Clothing and footwear)

In this group the solution adopted was to use the *ad hoc* deflator formed by all the groups except the category under analysis itself (i.e. group 2) (*D002R- this deflator is calculated from the ratio of current to constant prices of the sum of all the consumption categories except 002*).

The parameters finally arrived at appear below in the regression analysis.

Sample: 1980 1996
Included observations: 17

Variable	Coefficien	Std. Error	t-Statistic	Prob.
C	5.653721	2.669362	2.118005	0.0526
LOG((KCPI/N))	0.618568	0.222132	2.784685	0.0146
LOG(D002R)	0.129366	0.068570	1.886629	0.0801

R-squared	0.910813	Mean dependent var	14.50571
Adjusted R-squared	0.898072	S.D. dependent var	0.121434
S.E. of regression	0.038769	Akaike info criterion	-6.341472
Sum squared resid	0.021043	Schwarz criterion	-6.194434
Log likelihood	32.78056	F-statistic	71.48662
Durbin-Watson stat	0.386653	Prob(F-statistic)	0.000000

GROUP 003
(Gross rent, fuel and power)

Given the disparities between the result obtained for the two subgroups (3.1. and 3.2) in this case the solution adopted was to separate them into two groups: gross rent and water charges, on the one hand, and fuel and power on the other. The regressions finally obtained for each are shown below:

Group 031

In this case no elasticity has been detected with respect to own price or the price of substitute goods. This consumption function is expressed exclusively in relation to income and a dummy step variable with a value of 1 from 1986 inclusive and 0 before that period.

Sample(adjusted): 1980 1994
Included observations: 15 after adjusting endpoints

Variable	Coefficien	Std. Error	t-Statistic	Prob.
C	7.114738	0.923499	7.704108	0.0000
LOG((KCPI/N))	0.578021	0.069925	8.266264	0.0000
F86C	-0.082677	0.014680	-5.632007	0.0001

R-squared	0.864889	Mean dependent var	14.76154
Adjusted R-squared	0.842370	S.D. dependent var	0.035715
S.E. of regression	0.014180	Akaike info criterion	-8.335023
Sum squared resid	0.002413	Schwarz criterion	-8.193413
Log likelihood	44.22860	F-statistic	38.40781
Durbin-Watson stat	1.230019	Prob(F-statistic)	0.000006

Group 032

In this case, which has special implications for energy products, elasticity was detected between the three basic variables: own price, substitute price and income.

As in the case of group 002 an *ad hoc* deflator was put forward which excluded all categories except 032 itself, i.e. variable D0032R (*note that this deflator therefore includes the goods included in category 031, that is to say, it does not exclude the whole of group 3, just group 032).* The reason for proposing this type of deflator rather than any other as an *ad hoc* deflator is that no smaller group was found that gave a better deflation than this generic group.

Sample(adjusted): 1980 1994
Included observations: 15 after adjusting endpoints

Variable	Coefficien	Std. Error	t-Statistic	Prob.
C	-4.961409	1.768144	-2.805998	0.0171
LOG(D032)	-0.403808	0.048739	-8.285171	0.0000
LOG((KCPI/N))	1.309355	0.141467	9.255545	0.0000
LOG(D032R)	0.578708	0.064184	9.016426	0.0000

R-squared	0.996298	Mean dependent var	13.23205
Adjusted R-squared	0.995288	S.D. dependent var	0.263530
S.E. of regression	0.018089	Akaike info criterion	-7.801692
Sum squared resid	0.003599	Schwarz criterion	-7.612879
Log likelihood	41.22862	F-statistic	986.7662
Durbin-Watson stat	2.317106	Prob(F-statistic)	0.000000

GROUP 004

(Furniture, furnishings and household ...)

In this group elasticities have been estimated with respect to the three fundamental variables: income, own price and substitute prices. As an *ad hoc* deflator the price of the rest of the other goods distinct from group 4 analysed has been used, excluding an important set of consumption functions: category 1 *(Food, beverages and tobacco)*, category 2 *(Clothing and footwear)*, category 5 *(Medical care and health expenses)* and category 7 *(Recreation, entertainment, education,...)*. In short, it may be concluded that the substitute prices are those in groups 3 and 6. The results of the regression are shown below:

Sample: 1980 1996
Included observations: 17

Variable	Coefficien	Std. Error	t-Statistic	Prob.
C	-2.963492	0.771289	-3.842257	0.0020
LOG(D004)	-0.399590	0.084962	-4.703157	0.0004
LOG((KCPI/N))	1.348906	0.062565	21.55997	0.0000
LOG(D004REX1257)	0.243957	0.080935	3.014224	0.0100

R-squared	0.994505	Mean dependent var	14.31792
Adjusted R-squared	0.993237	S.D. dependent var	0.120908
S.E. of regression	0.009943	Akaike info criterion	-9.019454
Sum squared resid	0.001285	Schwarz criterion	-8.823404
Log likelihood	56.54340	F-statistic	784.3028
Durbin-Watson stat	1.326165	Prob(F-statistic)	0.000000

GROUP 005
(Medical care and health expenses)

In this case the decision was taken, as in the case of group 003, to divide the aggregate into two new groups: group 051, comprising medicines only, and the rest of group 005, comprising categories from 052 to 055, which we shall call 005X51 (as it contains group 5 except category 051).

Group 051

For this group, apart from the elasticities estimated for own price and income, an *ad hoc* deflator was detected comprising the price of all the goods excluded from categories 1 *(Food, beverages and tobacco)* and 2 *(Clothing and footwear)* and also excluding, obviously, the category analysed.

The results obtained from the regression are shown below:

Sample(adjusted): 1980 1994
Included observations: 15 after adjusting endpoints

Variable	Coefficien	Std. Error	t-Statistic	Prob.
C	-13.74934	4.505654	-3.051575	0.0110
LOG(D051)	-1.465180	0.186976	-7.836192	0.0000
LOG((KCPI/N))	1.991057	0.360945	5.516241	0.0002
LOG(D005REX12)	1.480560	0.225278	6.572136	0.0000

R-squared	0.991597	Mean dependent var	12.97394
Adjusted R-squared	0.989305	S.D. dependent var	0.389980
S.E. of regression	0.040330	Akaike info criterion	-6.198147
Sum squared resid	0.017891	Schwarz criterion	-6.009333
Log likelihood	29.20202	F-statistic	432.6859
Durbin-Watson stat	2.527296	Prob(F-statistic)	0.000000

Group 005X51

In the case of this new group, in which subgroup 051 is excluded from the previous group 5, own price is not significant in any of the cases and the effect of the price of other goods has a negative sign. Apart from a specific conceptual interpretation justifying the revision of the system used for all other goods in this case, we chose to take only income as an explanatory variable. The regression is shown below:

Sample(adjusted): 1980 1994
Included observations: 15 after adjusting endpoints

Variable	Coefficien	Std. Error	t-Statistic	Prob.
C	-10.63561	1.969026	-5.401456	0.0001
LOG((KCPI/N))	1.776995	0.147875	12.01689	0.0000

R-squared	0.917411	Mean dependent var	13.02525
Adjusted R-squared	0.911058	S.D. dependent var	0.197506
S.E. of regression	0.058903	Akaike info criterion	-5.540171
Sum squared resid	0.045104	Schwarz criterion	-5.445765
Log likelihood	22.26721	F-statistic	144.4056
Durbin-Watson stat	0.596842	Prob(F-statistic)	0.000000

GROUP 006

(Transport and communication)

For this category elasticities were estimated with respect to own price and income. With respect to prices of substitute goods an *ad hoc* deflator was used from which category 3 *(Gross rent, fuel and power)* was excluded.

The results of the final regression are shown below:

Sample: 1980 1996
Included observations: 17

Variable	Coefficien	Std. Error	t-Statistic	Prob.
C	-4.749070	1.419695	-3.345135	0.0053
LOG(D006)	-0.951698	0.126625	-7.515907	0.0000
LOG((KCPI/N))	1.469538	0.117781	12.47692	0.0000
LOG(D006REX3)	0.999615	0.123789	8.075137	0.0000

R-squared	0.991971	Mean dependent var	15.02786
Adjusted R-squared	0.990118	S.D. dependent var	0.207663
S.E. of regression	0.020643	Akaike info criterion	-7.558435
Sum squared resid	0.005540	Schwarz criterion	-7.362385
Log likelihood	44.12475	F-statistic	535.3930
Durbin-Watson stat	1.783952	Prob(F-statistic)	0.000000

GROUP 007

(Recreation, entertainment, education,...)

In the case of group 7 elasticity was only detected with respect to total income. As an atypical point was detected in 1983 it was decided to add a dummy impulse variable for this year. The final regression is as follows:

Sample: 1980 1996
Included observations: 17

Variable	Coefficien	Std. Error	t-Statistic	Prob.
C	-4.824570	0.606111	-7.959877	0.0000
LOG((KCPI/N))	1.433954	0.045423	31.56860	0.0000
F83	0.045840	0.021313	2.150757	0.0494

R-squared	0.986981	Mean dependent var	14.29929
Adjusted R-squared	0.985121	S.D. dependent var	0.161136
S.E. of regression	0.019655	Akaike info criterion	-7.700023
Sum squared resid	0.005409	Schwarz criterion	-7.552985
Log likelihood	44.32824	F-statistic	530.6629
Durbin-Watson stat	1.151247	Prob(F-statistic)	0.000000

GROUP 008
(Miscellaneous goods and services)

In the case of this group elasticity was estimated with respect to own price, income and substitute prices. An *ad hoc* deflator was included for substitute prices from which the following categories were excluded: 3 *(Gross rent, fuel and power),* 6 *(Transport and communication)* and 7 *(Recreation, entertainment, education,...).*

The final results are shown below:

Sample: 1980 1996
Included observations: 17

Variable	Coefficien	Std. Error	t-Statistic	Prob.
C	2.900051	0.978888	2.962597	0.0110
LOG(D008)	-0.642561	0.103479	-6.209578	0.0000
LOG((KCPI/N))	0.759530	0.075664	10.03817	0.0000
LOG(D008REX367)	1.174470	0.118068	9.947367	0.0000

R-squared	0.997709	Mean dependent var	15.46114
Adjusted R-squared	0.997180	S.D. dependent var	0.211775
S.E. of regression	0.011245	Akaike info criterion	-8.773294
Sum squared resid	0.001644	Schwarz criterion	-8.577243
Log likelihood	54.45104	F-statistic	1887.178
Durbin-Watson stat	1.566597	Prob(F-statistic)	0.000000

A.V EXAMINATION OF CONGRUENCE FOR INCOME ELASTICITY

In the calculation of elasticity for each of the consumption categories with respect to income total consumption has been used as an explanatory variable, as this is the total income applied to consumption. This eliminates possible distortions in the simple phenomenon which we wish to specify (i.e. variations in consumption of a good as available income varies) which may be caused by various saving behaviours.

This assumption implies a certain mathematical relationship, which has necessarily to be fulfilled: the summation of the elasticities of each consumer good multiplied by the proportion which each accounts for in total consumption must be equal to unity. This ensures that the elasticities obtained give rise to the historical value of consumption produced each year. That is to say, by means of this restriction we ensure that the apparent elasticity between total income (specified as total consumption) is equal to unity.

$$\sum_{J=1}^{9} \varepsilon_j \frac{C_j}{C_{total}} = 1$$

The table below shows the congruence calculation performed:

	(A) Income elasticity	Range Variation	(B) [%]	(A × B) [% total consumption]
K001	0.504	± 0.08	24.0	0.12
K002	0.619	± 0.44	8.4	0.05
K031 (1)	0.578	± 0.14	11.2	0.06
K032 (2)	1.309	± 0.28	2.4	0.03
K004	1.349	± 0.13	7.0	0.09
K051	1.991	± 0.07	1.9	0.04
K005X51 (3)	1.777	± 0.30	2.0	0.03
K006	1.470	± 0.24	14.2	0.21
K007	1.434	± 0.09	6.8	0.10
K008	0.760	± 0.15	21.9	0.17
Total	1 (4)	± 0.00 (4)	100.0	0.91

(1) The disparity between the components of group three has made it necessary to separate them out rather than consider them in aggregate. The data available for two-digit disaggregation is only available from 1980 to 1994. This elasticity has therefore been estimated with two observations fewer than in the other cases.
(2) Ditto.
(3) Group five has been modelled as two subgroups: one containing component 5.1 alone and the other comprising the rest of the group.
(4) As a result of the theoretical restriction alluded to above, the theoretical elasticity must be one and its variance zero.

As can be seen in the table, the value obtained for the total elasticity and for the weighted sum of the components is 0.91, with a range of variation from 0.74 to 1.07, which means that the results are fully congruent, with a confidence level of 95%.

The range of variation has been obtained from the estimated value of the dispersion of the coefficients (elasticities) in each regression.

ANNEX A.I

Description of the Excel data file 'Datos.xls'

The file 'Datos.xls' contains the 1986-basis linked data series for Inland Private Consumption from the National Accounts. These data series cover 42 categories (divided into 8 main branches) for the period 1980 to 1996 in both current and constant prices.

- In the sheet entitled 'Series' in the Excel file the series (categories) appear in the rows and the years in the columns. Total Inland Private Consumption appears as a sum in the last row of the tables. The 42 categories are grouped into 8 main branches *(shown in bold).*
- Column A includes a description of each of the categories. The data are shown in constant terms in columns B and R. In columns T to AJ the data are shown in current terms. As can be seen, information is available up to 1996 for the 8 main categories. For the rest of the series data are only available for years up to 1994.
- The deflators subsequently used have been obtained, without variations, from this basic information, although they do not appear generated in the Excel file.

Description of the file of results 'ResultadosC.xls'

The file 'ResultadosC.xls' contains the estimated elasticities for the 42 consumption categories according to the procedural or detailed scheme in the relevant section of this document.

- Column A: Description of the consumption function
- Columns (1) to (6): Average results after 'purging' of the 9 regressions carried out for each of the 42 consumption categories according to the logical scheme mentioned above. By 'purging' here we mean that only the regressions considered valid and homogeneous have been used to calculate average parameters and typical deviations.
  1. Average elasticity with respect to own price derived from the validated, purged and selected content of the 9 initial basic regressions.
  2. Typical average deviation from the elasticity parameter for own price given in the first column.
  3. Average elasticity with respect to income derived from the validated, purged and selected content of the 9 initial basic regressions.
  4. Typical average deviation from the elasticity parameter for income given in column (3).
  5. Average elasticity with respect to prices of substitute goods derived from the validated, purged and selected content of the 9 initial basic regressions.
  6. Typical average deviation from the elasticity parameter for prices of substitute goods given in column (5).

- Columns (7) to (12): Results of single regression with *ad hoc* deflator carried out when possible for each of the 42 consumption categories according to the logical structure commented on above.
  7. Elasticity with respect to own price derived from the single regression performed with the *ad hoc* deflator prepared for the price of substitute goods.
  8. Typical deviation of the parameter described above.
  9. Elasticity with respect to income derived from the single regression performed with the *ad hoc* deflator prepared for the price of substitute goods.
  10. Typical deviation of the parameter described above.
  11. Elasticity with respect to price of substitute goods derived from the single regression performed with the *ad hoc* deflator prepared for the price of substitute goods.
  12. (12) Typical deviation of the parameter described above.

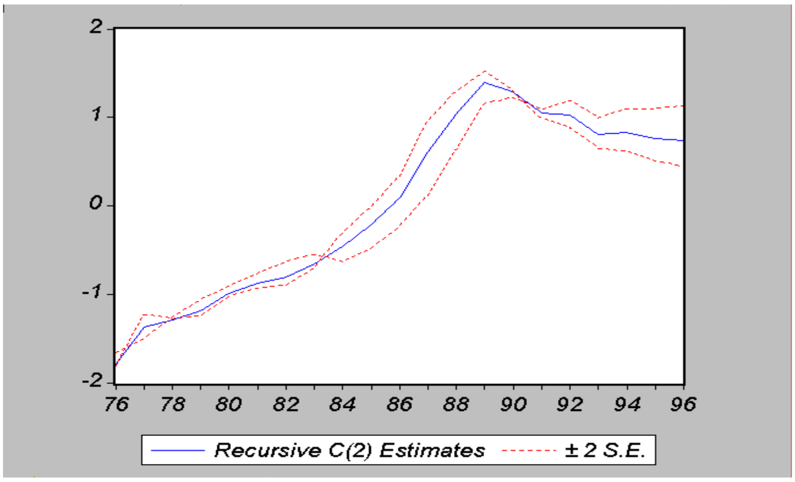
Estimated Total Income Elasticity-Consumption

In order to calculate the simple elasticity income – consumption the national accounts data series from 1970 to 1996 have been taken for Inland Private Consumption at constant prices 1986-basis (CPI86) and Family Disposable Income in 1986-basis (YDH86).

The simple regression CONSUMO[24] = f(C, RENTA[25]) of these two variables in logarithms offers an approximation to the value of the elasticity.

As is usual when estimating an elasticity of this type, problems arise as a result of the instability of the coefficient: it is difficult to find a constant elasticity for a period as broad as 1970 to 1996.

If a recursive estimate of the elasticity coefficient is carried out, i.e. if years are added successively to the regression starting out from a minimum sample 1970-1973, it can be seen that the parameter clearly increases. In other words, the elasticity coefficient is not constant around an average reference value. The graph below shows the development of elasticity revealed by recursive estimation.



It is clear that the parameter changes as the sample size is increased and it only stabilises around the second half of the 1980s. *(In any event, care should be taken to avoid interpreting the fact that the parameter fluctuates between 2 and -2 as the parameter represented in the test is standardised).* Obviously these changes are produced symmetrically in the independent term.

On the basis of this variability of the parameter classic tests for structural change have been performed. These have shown 1986 to be the most appropriate year for the change. (*The changeover point cannot be seen on the graph as these are recursive estimates, implying that if the parameter changes sharply in 1986 the change would not be detected until a few more years in which the new structure had been operative were added, and so for example in 1988 or 1989 using a sample from 1970-87 the change would not be detected as there would be only two years with the new structure against 16 with the old one).*

The technical recommendation is therefore to use two different estimates:
- One estimate from 1970-1985 in which the value of income-consumption elasticity would take a value close to unity. More precisely, the value of this elasticity would be 0.99 and that of the marginal trend (independent term) almost zero: -0.005.
- An estimate for 1986-1996 in which the value of income consumption elasticity would take a value close to unity. More precisely, the value of this elasticity would be 0.83 and that of the marginal trend (independent term) very much greater than unity: 1.705.

[24] Consumption/spending.
[25] Income.

ANNEX A.II

General technical comment
A short technical summary will be given here in addition to the basic statistics accompanying each regression in the final report.

By way of an overall technical valuation, it may be said that the regressions are generally affected by moderate serial autocorrelation and multicolinearity problems.

The presence of multicolinearity between the exogenous variables should not be a surprise when looking at the results given the simplicity of the theoretical model applied to each regression. It could almost be said that if there were not considerable multicolinearity, important correlations between endogenous and exogenous variables would not have been found as all the information is drawn from the same initial database, and this comprised only a limited amount of information. In effect, the data available come down to no more than two series per consumption category, one in constant prices, the other in current prices from which the implicit deflator is obtained. The need to use the same specification for all cases in order to guarantee the homogeneity of the model and at the same time, the difficulty of introducing additional exogenous variables for which it would be difficult to give a subsequent prediction, reduces the raw material to the limit, making any other outcome technically impossible.

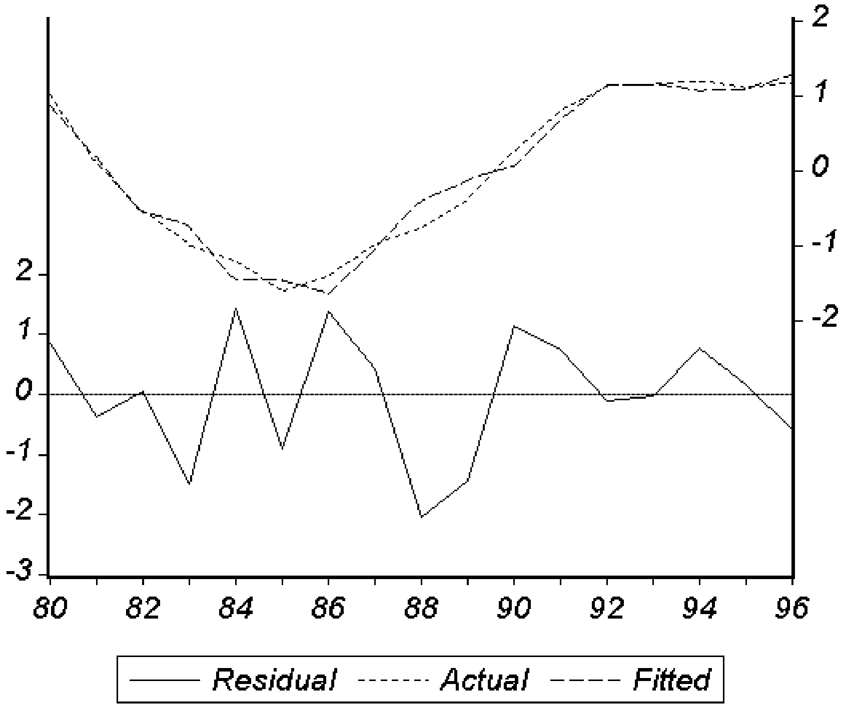
The existence of signs of serial autocorrelation together with the presence of high determination coefficients clearly suggest that spurious relationships are being estimated. Indeed, the use of step variables (corrected by the logarithms, but in short, in steps) makes it easy to find high correlations, incurring various types of technical problem, including autocorrelation. Nevertheless, it would be naïve to suppose that from the initial information it would be possible to estimate with a high degree of precision true causal relationships. In the consumption of each category other variables which have nothing to do with own price, income or the price of other categories also have an influence. Nevertheless, we do not think that the objective is to look for causality but to establish a battery of correlations between very basic variables (correlations shown to exist by the high values of the correlation coefficients) and which may be used to simulate the impact of movements of key variables. That is to say, it is about estimating elasticities not multivariate causality models.

In any case it is recommendable to use the results of these estimates with the due reservations inherent in any process of econometric estimation and inference.

GROUP 001
(Food, beverages and tobacco)

Technical note: Good trend-curve fit. Average percentage error in absolute terms very low (0.45%). Significant absence of serial autocorrelation. High level of multicolinearity between the exogenous variables included in the specification, particularly between the two deflators included.

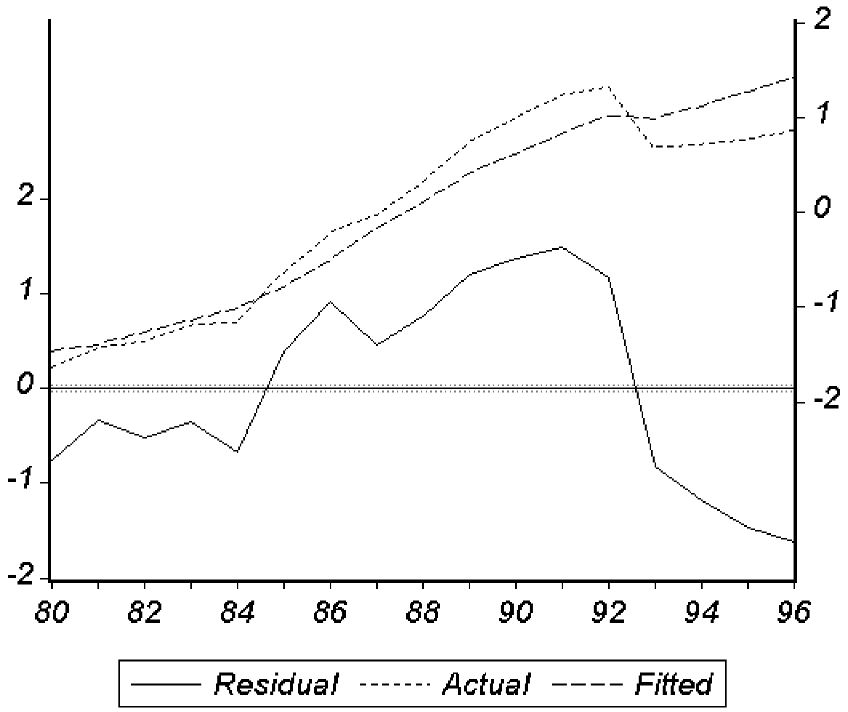
Graph fit



Adjusted R2	D.W. Contrast	Annual % Average Absolute Error	Average Quadratic Error	Average Absolute Error
0.965	2.32	0.45	30467	25024

GROUP 002
(Clothing and footwear)

Technical note: Slow reaction trend-curve fit limited to trend change in 1993. Average percentage error fairly high in absolute terms (3.2%). Possible existence of first order positive serial autocorrelation. High multicolinearity between exogenous variables included; of around 0.92 simple correlation.

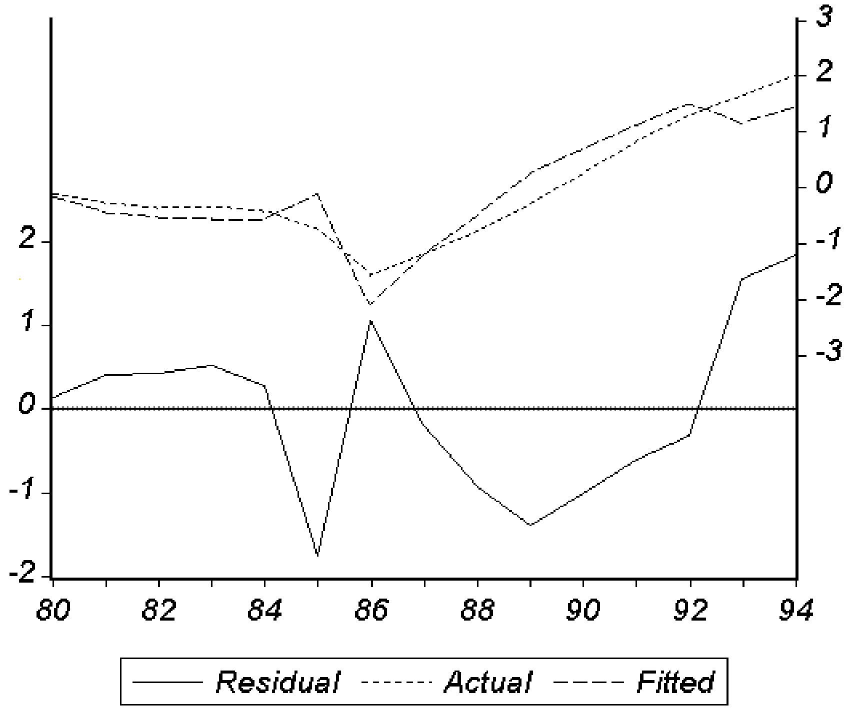


Adjusted R2	D.W. Contrast	Annual % Average Absolute Error	Average Quadratic Error	Average Absolute Error
0.898	0.39	3.20	76014	66926

GROUP 003
(Gross rent, fuel and power)

Group 031

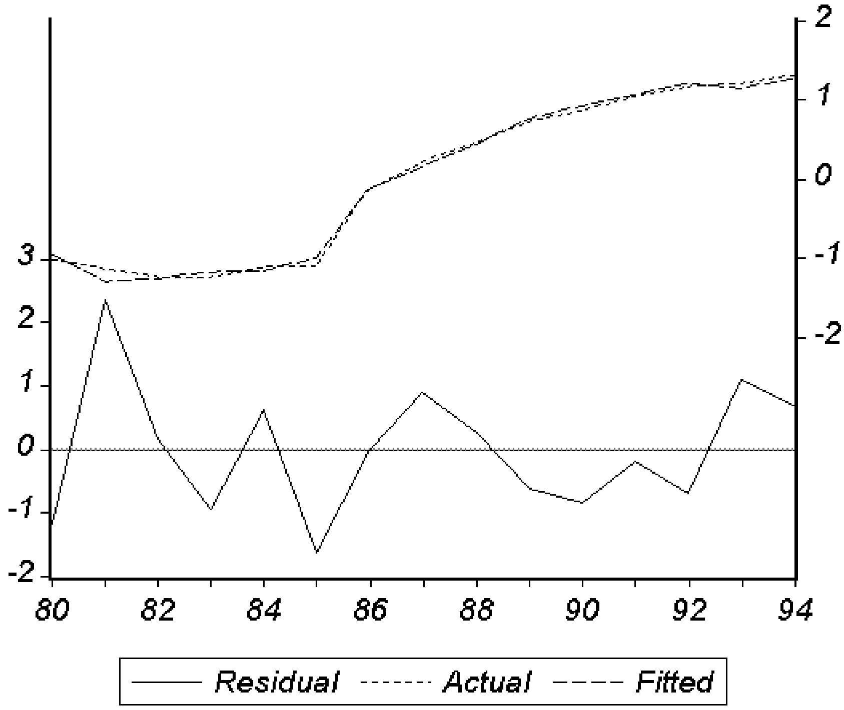
Technical note: Slow reaction trend-curve fit limited on account of sharp change in trend in 1985 and 1986. Average percentage error terms fairly high in absolute (3.2%). Possible existence of positive first order serial autocorrelation. Multicolinearity high between exogenous variables included; of around 0.92 of simple correlation.



Adjusted R2	D.W. Contrast	Annual % Average Absolute Error	Average Quadratic Error	Average Absolute Error
0.842	1.23	1.05	33150	27222

Group 032

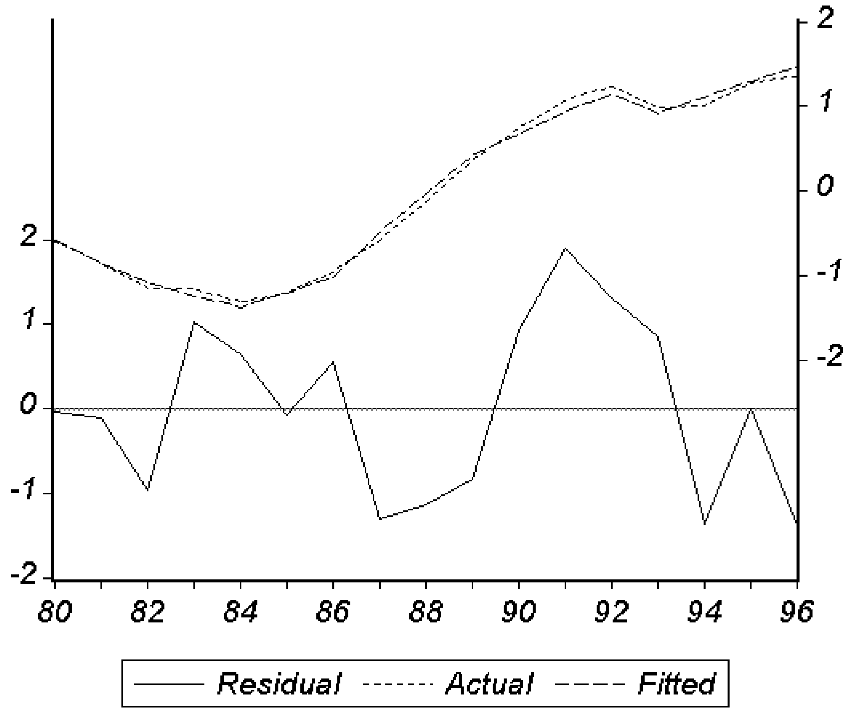
Technical note: Excellent trend-curve fit. Average percentage error in absolute terms very low (1.25%). Absence of serial autocorrelation according to the 5% Durbin Watson limit. Multicolinearity between the exogenous variables included slight, possibly of importance between deflator D032R and income measure.



Adjusted R2	D.W. Contrast	Annual % Average Absolute Error	Average Quadratic Error	Average Absolute Error
0.995	2.32	1.25	7950	6791

GROUP 004
(Furniture, furnishings and household...)

Technical note: Excellent trend-curve fit. Average percentage error in absolute terms very low (0.74%). Slight indication of first-order positive serial autocorrelation. Clear signs of multicolinearity between all the exogenous variables included.

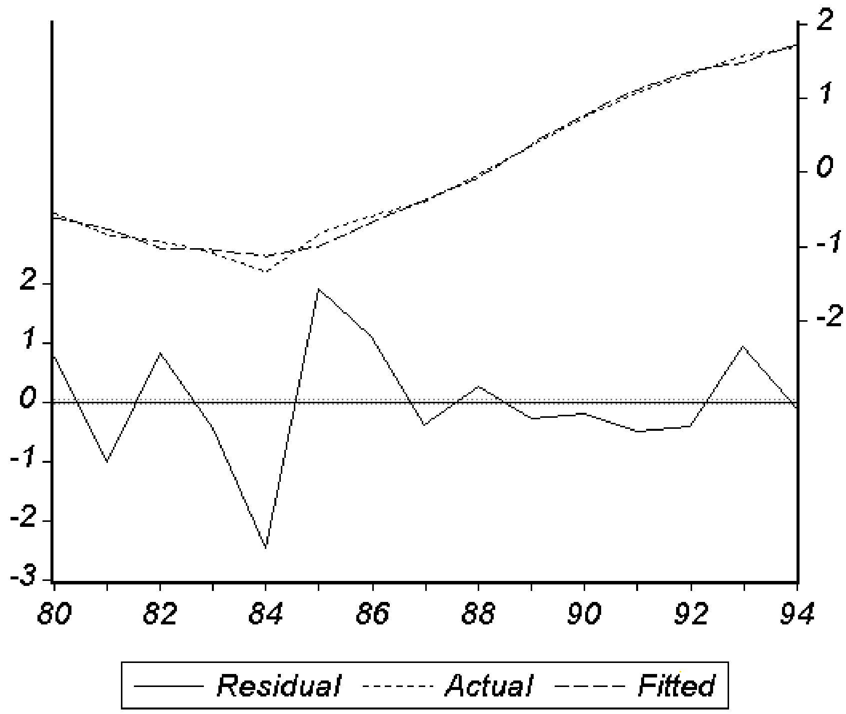


Adjusted R2	D.W. Contrast	Annual % Average Absolute Error	Average Quadratic Error	Average Absolute Error
0.993	1.33	0.74	15299	12633

GROUP 005
(Medical care and health expenses)

Group 051

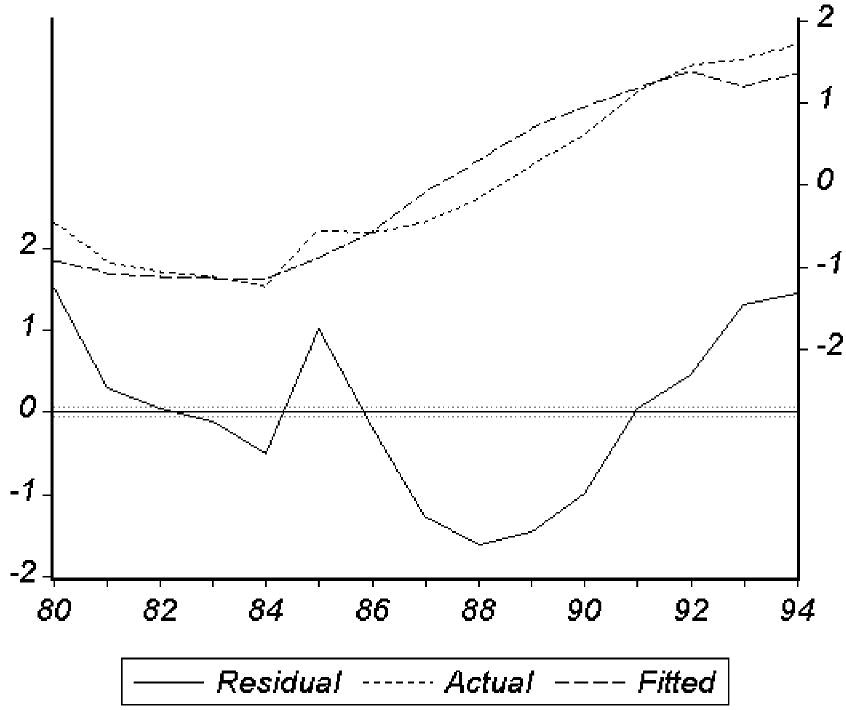
Technical note: Excellent trend-curve fit. Average percentage error in absolute terms very low (2.66%). No indication of serial autocorrelation. Clear signs of multicolinearity between the deflators used.



Adjusted R2	D.W. Contrast	Annual % Average Absolute Error	Average Quadratic Error	Average Absolute Error
0.989	2.53	2.66	12381	10325

Group 005X51

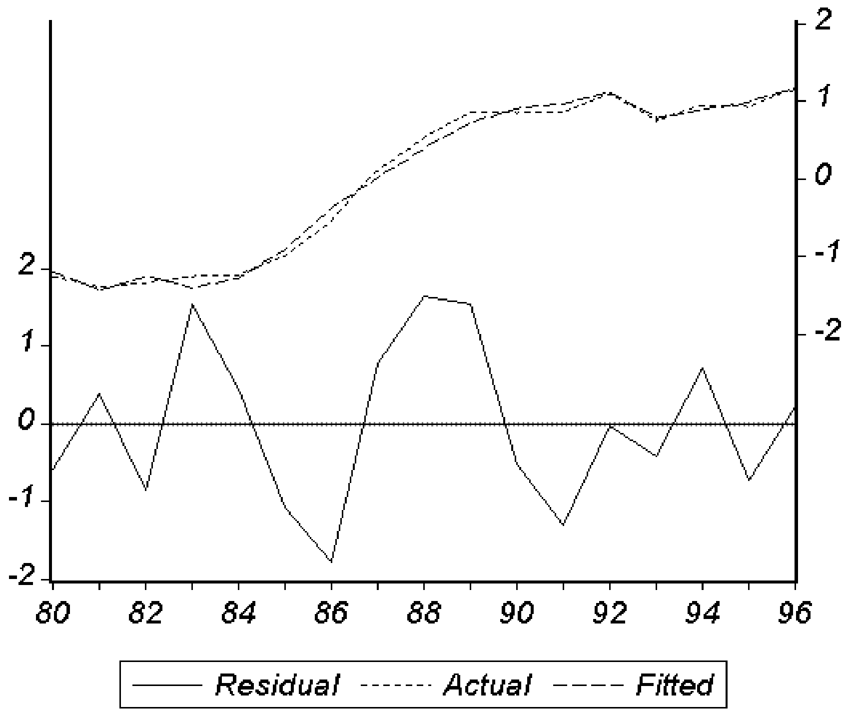
Technical note: Acceptable trend-curve fit apart from fairly considerable type II errors in 1984 and 85. Average percentage error in absolute terms good (4.47%). Signs of positive serial autocorrelation. Multicolinearity between the variables used.



Adjusted R2	D.W. Contrast	Annual % Average Absolute Error	Average Quadratic Error	Average Absolute Error
0.911	0.60	4.47	26968	21490

GROUP 006
(Transport and communication)

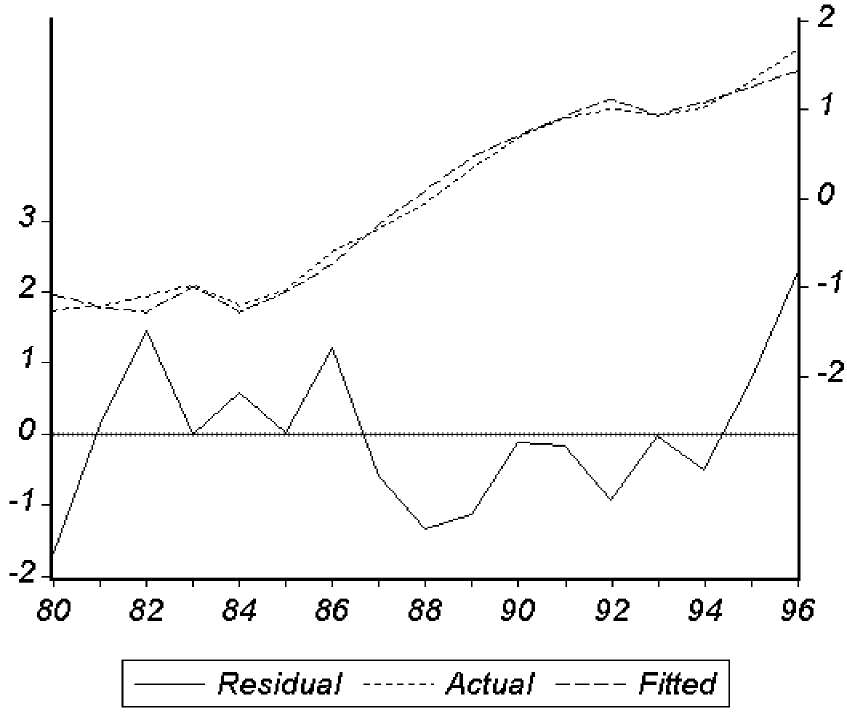
Technical note: Good trend-curve fit. Average percentage error in absolute terms very good (1.54%). Absence to 5% of serial positive autocorrelation. Signs of multicolinearity between the variables used.



Adjusted R2	D.W. Contrast	Annual % Average Absolute Error	Average Quadratic Error	Average Absolute Error
0.990	1.78	1.54	61457	51926

GROUP 007
(Recreation, entertainment, education,...)

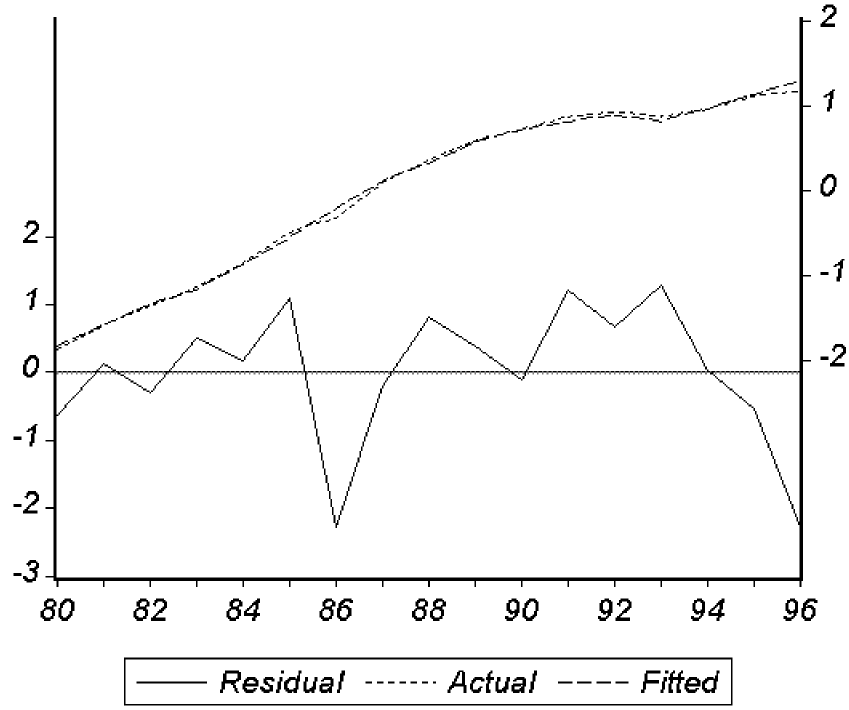
Technical note: Good trend-curve fit. Average percentage error in absolute terms very good (1.35%). Slight first order positive serial autocorrelation. Absence of any sign of multicolinearity between the variables used.



Adjusted R2	D.W. Contrast	Annual % Average Absolute Error	Average Quadratic Error	Average Absolute Error
0.985	1.15	1.35	30744	22480

GROUP 008
(Miscellaneous goods and services)

Technical note: Very good trend-curve fit. Average percentage error in absolute terms very good (0.73%). Slight first order positive serial autocorrelation. Signs of multicolinearity between the exogenous variables used.



Adjusted R2	D.W. Contrast	Annual % Average Absolute Error	Average Quadratic Error	Average Absolute Error
0.995	2.32	1.25	7950	6791

DESCRIPTION OF GROUPS USED

Group 1	FOOD, BEVERAGES AND TOBACCO
1.1	Food
1.1.1.	Bread and cereals
1.1.2	Meat
1.1.3	Fish
1.1.4	Milk, cheese and eggs
1.1.5	Oils and fats
1.1.6	Fruits and vegetables
1.1.7	Potatoes and other tubers
1.1.8	Sugar
1.1.9	Coffee, tea and cocoa
1.1.10	Other foods
1.2	Non-alcoholic beverages
1.3	Alcoholic beverages
1.4	Tobacco
Group 2	CLOTHING AND FOOTWEAR
2.1	Clothing
2.2	Footwear
Group 3	GROSS RENT, FUEL AND POWER
3.1	Gross rent and water charges
3.2	Fuel and power
Group 4	FURNITURE, FURNISHINGS AND HOUSEHOLD...
4.1	Furniture, fixtures, carpets,...
4.2	Household textiles
4.3	Heating and cooking appliances
4.4	Glassware, tableware,...
4.5	Household operation
4.6	Domestic services
Group 5	MEDICAL CARE AND HEALTH EXPENSES
5.1	Medical and pharmaceutical products
5.2	Therapeutic appliances and equipment
5.3	Services of physicians, nurses and...
5.4	Hospital care and the like
5.5	Service charges on accident and health
Group 6	TRANSPORT AND COMMUNICATION
6.1	Personal transport equipment
6.2	Operation of personal transport equipment
6.3	Purchased transport
6.4	Communication
Group 7	RECREATION, ENTERTAINMENT, EDUCATION,...
7.1	Equipment and accessories, incl. Repairs
7.2	Entertainment, recreational and cultural services
7.3	Books, newspapers and magazines
7.4	Education
Group 8	MISCELLANEOUS GOODS AND SERVICES
8.1	Personal care and effects
8.2	Goods n.e.c.
8.3	Expenditure in restaurants, cafes and hotels
8.4	Packaged tours
8.5	Financial services n.e.c.
8.6	Services n.e.c.

ANNEX B MODEL CHARACTERISTICS AND INPUTS FOR THE UK

Table B.1 *Industrial sectors distinguished in the I/O table and corresponding labour coefficients for the UK.*

	Sector	ISIC code (1992)	Labour coefficients (1996) Male full time	Male part time	Female full time	Female part time
1	Agriculture; forestry and fishing	1, 2, 5	0.00614	0.00125	0.00124	0.00102
2	Extraction-oil and gas	11, 12	0.00087	0.00001	0.00015	0.00002
3	Other mining and quarrying	10, 13, 14	0.00194	0.00001	0.00025	0.00003
4	Solid and nuclear fuels; oil refining	23	0.00095	0.00000	0.00016	0.00002
5	Chemicals, man-made fibres	24	0.00573	0.00006	0.00219	0.00032
6	Other non-metallic minerals	25, 26	0.00936	0.00014	0.00248	0.00052
7	Metals and metal products	27 – 33	0.03863	0.00048	0.00910	0.00164
8	Transport equipment	34, 35	0.01106	0.00009	0.00129	0.00016
9	Food, beverages, tobacco	15,16	0.00895	0.00033	0.00374	0.00156
10	Textile and leather products	17, 18, 19	0.00502	0.00019	0.00578	0.00105
11	Pulp, paper printing and publishing	21, 22	0.00926	0.00035	0.00469	0.00125
12	Other manufacturing	20, 36, 37	0.00649	0.00020	0.00196	0.00058
13	Energy and water	40, 41	0.00363	0.00003	0.00093	0.00019
14	Construction	45	0.02237	0.00035	0.00299	0.00112
15	Motor vehicles sales and repairs	50	0.01320	0.00080	0.00268	0.00126
16	Wholesale trade	51	0.02121	0.00143	0.00671	0.00259
17	Retail trade	52	0.01541	0.00818	0.01710	0.03482
18	Hotels and restaurants	55	0.00791	0.00621	0.00942	0.01942
19	All transport	60 – 63	0.02035	0.00103	0.00583	0.00162
20	Post and telecommunications	64	0.01028	0.00092	0.00248	0.00110
21	Financial intermediation	65, 66, 67	0.01408	0.00034	0.01393	0.00415
22	Real estate, renting, business activities	70, 71	0.00606	0.00072	0.00408	0.00223
23	Services	72 →	0.09177	0.01960	0.09942	0.09560

B EXPENDITURE FUNCTIONS FOR THE UK

David Hawdon, University of Surrey, November 1998

Abstract

Using quarterly time series data of income and expenditure, I estimate saving and expenditure functions for the UK for seven different expenditure categories. The functions are linear in accordance with the methodology of earlier work on this project, with the exception of the income term in the expenditure equations, which is represented by the logarithm of total expenditure. It would have been interesting to compare various forms of the expenditure function but this was not possible within the time frame of the project. The results are mixed-relatively good statistical fits for the expenditure equations with sensible coefficients, but not for the saving equation. It is found that coefficients vary over time as might well be expected but that sometimes the longer period may provide more reliable estimates than the subperiods because it contains more variance for particular series. Finally, an attempt is made to relate the expenditure results with input output structures. A simple way is provided for splitting the expenditures into 123 input output product components of final demand. These can be used directly in economy wide analysis.

B.1 Introduction

This paper presents estimates of expenditure functions for the UK as far as possible in line with the methodology of ECN as described in Pellekaan and Perrels(1996)[1]. The major differences are that functions are estimated on the basis of national accounting data rather than cross section data. The advantage of this approach is that relatively long time series of data can be used to estimate both income and price elasticities simultaneously. For forecasting purposes, such estimates may be superior to those based on panels of cross section data. Secondly, because the basis is the national accounts it is a relatively straightforward task to link estimated expenditure functions with national input output tables. The main limitation of the present approach is that it is impossible to estimate separate functions for different household types, which might be useful for more detailed policy analysis.

B.2 Income, expenditure and savings.

Use of national accounts data presents the opportunity to achieve consistency in establishing the relationship between household income before tax (GI), household disposable income (NI), saving (H) and expenditure. Household disposable income is GI minus taxes and subsidies (T). Until the most recent revision of the national accounts, it was possible to estimate the level of saving as a balancing item between household disposable income and expenditure on goods and services. However, the adopted new European System of Accounts (ESA 95)[2] separates household expenditure into two categories-consumption expenditure of households (E) and consumption expenditure of non profit institutions serving households (NPISH). These are largely educational institutions receiving their income in the form of grants and bequests. Their expenditure should be netted out of the data since they have large discretion in the types of goods they purchase and so may behave in a different manner to households themselves.

To summarise, the relationship between household income before tax and household disposable income is

$$NI = GI - T$$

Household final consumption expenditure is

E = NI-H-NPISH

E is the part of household disposable income allocated to consumption and will be used as the income variable in the subsequent investigation.

Following the two stage approach of Pellekaan, saving is determined as a function of net income. This leaves expenditure as a residual item once saving is determined. In order to ensure this adding up property, saving will be estimated as a share of income (or as the savings ratio),

H = f(household disposable income, time)

Then, given scenarios of household disposable income, E and NPISH in total can be found by subtracting H from household disposable income.

B.3 Categories of household consumption

The second level of decision making relates to the purchasing of major consumption items like food, housing, transport etc. I have retained five of the categories adopted by the Pellekaan study-food, clothing, household, transport and other. However, in addition I have separated out expenditure on energy and on services since in the case of energy the nature of the products are technically significantly different from those of any other group and in the case of services, an ever rising proportion of expenditure is devoted to the items in this category.

The following table gives a breakdown of the consumption categories adopted

Level 2 Consumption Categories	*Data obtained from Consumer Trends* [3]
Food (FDT)	Food Drink Tobacco
Housing (House)	Rent (including imputed rent) Water & sewage
Clothing (Cloth)	Clothing Footwear
Energy (Energy)	Electricity Gas Coal Other fuels
Transport (Trans)	Vehicles Petrol and engine oil Motor vehicle running costs Travel & communications
Services (Serve)	Financial services Other services
Other (Other)	Other durables Other goods

B.4 Analysis of Consumption by Category

Although in principle, factors like household composition, age of head of household, sizes of families, and so on have important effects on consumption, empirical attempts to estimate these effects using detailed budget surveys have not been entirely successful. Usually the goodness of fit to the data is poor, and the empirical estimates are not robust between samples. This is due partly to the nature of budget surveys in that they are not panels of data but come from successive resamples on each occasion. Thus the households included in each subcategory are different for each survey which adds to the variance of the estimates. In addition at least for the UK, expenditure is recorded not for an entire year but for some shorter period e.g. two weeks, and this again introduces variability between diary entries over the entire sample. Improvements in sampling technique also complicate the process of combining data from surveys from different periods.

Hence this study focuses on time series estimation of expenditure functions. These use data on a consistent basis, and enable us to spot any changes in trends, which may not be apparent from survey data. The downside is that time series complications such as the presence of autoregressive processes can affect the interpretation of the results. What this means is that the information has to be used with care, however good (or bad) the estimates appear in themselves.

Expenditure equations are estimates in which expenditure on category, Ei, is estimated as a linear function of income (in this case measured by total consumer's expenditure), own price, prices of other expenditure categories, seasonal effects and time.

The case for measuring for measuring consumption on a per head or on a per household basis is a strong one. Such data focuses on the decision maker, rather than the industry aggregates. Results can be compared with the predictions of economic theory if so desired. We have followed convention in placing all expenditures and income data onto a per household basis. This enables us to make some allowance for changing sizes of households and growth in population The alternative of estimating the aggregative functions, and then dividing through by numbers of households was rejected because of the substantial changes which have occurred in the series which would otherwise be ignored.

B.5 Results

Characteristics of the data

Table 1 illustrates the rise in real incomes and expenditures between the early part of the period (1963Q1 to 1979Q4) and the later part (1980Q1 to 1998Q2). This indicates the care, which should be undertaken before using the results from any one historic period in forecasting ahead.

Table B.2 *Descriptive statistics for data on income, households, expenditure and savings-per household basis, UK*

Variable	Mean	Std. Dev	Max	Min	Mean	Mean
		(1963Q1-1998Q2)			*('63Q1-'79Q4)*	*('80Q1-'98Q2)*
Gross disposable income	16014.80	2942.72	22523.20	11614.40	13533.60	18295.20
Savings	730.68	527.88	1925.88	-422.92	491.52	950.44
NPISH5H*	373.23	147.20	684.52	173.74	254.52	482.32
Consumers expenditure	14933.20	2541.44	21250.40	10648.00	12830.00	16866.00
Population	56.50	1.33	59.17	53.46	55.47	57.44
No households-	21.02	1.98	24.42	17.52	19.31	22.60

Data from Consumer Trends[3], *NPISH5H is expenditure of 'non profit institutions serving households' per household in 1995 prices.

The explanation of Saving behaviour

The next step is to estimate savings as a function of income and other socio economic variables. Although the Pellekaan and other studies emphasised numbers of children and age of head of household, only size of household was available for use in this study. The substantial decline from over 3 to under 2.5 persons per household is likely to have influenced expenditure levels and patterns.

Table 2 shows the results of estimates using savings as the dependent variable. Amongst the main findings are:

- Firstly that the overall goodness of fit is not high. In the earlier period the fit is better while in the latter it deteriorates.
- However, there is little change in the values of the coefficients apart from the constant, which supports the idea of a stable relationship.
- The model does not however, contain any lagged values or makes any allowance for the effects of interest rate changes over the period, and it is expected that adding these variables would improve the results.
- No further improvement was obtained by adding interest rate variables to the equation

Table B.3 *Savings (S5H) as a function of income (INCOME) and household size (SIZE)*

Period	Variable	C	INCOME	SIZE	R-Squared	R-Bar-Squared	No obsns
1963Q1	Coefficient	-1.43	0.19	0.32	0.41	0.40	142
to	St. Error	0.45	0.03	0.12			
1998Q2	T-Ratio	-3.19	5.90	2.63			
1963Q1	Coefficient	-2.61	0.38	0.50	0.61	0.60	68
to	St. Error	0.56	0.05	0.13			
1979Q4	T-Ratio	-4.66	7.13	3.71			
1980Q1	Coefficient	-2.35	0.22	0.63	0.27	0.25	74
to	St. Error	0.83	0.05	0.26			
1998Q2	T-Ratio	-2.84	4.65	2.47			

The second use of disposable income-Non profit institutions serving households (NPISH)

This new category within the national accounts, created in 1998, is the second item, which must be subtracted from the income series in order to obtain total expenditures by the household sector.

- The relationship between NPISH and income and size appears to be quite a strong one (see Table 3).
- Comparing the two subperiods with the overall period, we notice that the impact of SIZE is uncertain. In view of its lack of significance in the overall period it would seem wise to exclude it from the equation.
- The influence of INCOME is stronger in the latter period, suggesting a growing share of income devoted to these activities.

Table B.4 *NPISH as a function of INCOME and SIZE*

Period	Variables	C	INCOME	SIZE	R-Squared	R-Bar-Squared	N.obs
1963Q1	Coefficient	-0.15	0.05	0.01	0.96	0.95	142
to	St. Error	0.03	0.00	0.01			
1998Q2	T-Ratio	-4.49	21.30	1.53			
1963Q1	Coefficient	0.20	0.01	-0.06	0.81	0.80	68
to	St. Error	0.05	0.00	0.01			
1979Q4	T-Ratio	4.00	1.86	-4.78			
1980Q1	Coefficient	-0.02	0.05	-0.04	0.94	0.94	74
to	St. Error	0.05	0.00	0.02			
1998Q2	T-Ratio	-0.31	18.01	-2.39			

Consumer expenditure categories
Estimates of expenditure equations for the seven consumption categories are given in Table 5a. It should be remembered that the estimates are based on quarterly data and should be uprated to obtain their annual equivalents. The variables SR1, SR2 and SR3 are dummy seasonal variables designed to measure any systematic shifts in the intercept over the year. They take a value of 1 in the relevant quarter and zero otherwise. The variable TIME is a simple linear time trend introduced to allow for exogenous changes in the technology of consumption. It's value increases from 1 in 1963Q1 to 142 in 1998Q2.

- Income is particularly important for transport, services and other categories (luxuries) while much less important for food, house, and clothing categories. The coefficient is negative only for energy.
- There are significant negative own price effects only in the cases of food, energy and services.
- Overall the price of transport enters into most equations (7) with a positive effect indicating substitutes. Housing, food and clothing prices are least important outside their own categories.
- Time trends are significant statistically in three categories--but are of negligible importance as explanatory variables.

Table B.5a *Estimation results for individual expenditure categories 1963Q1 to 1998Q2*

Variable	C	PRF	PRH	PRC	PRE	PRT	PRS	PRO	INCOME	SR1	SR2	SR3	TIME	R-Squared	R-Bar-Squared
FOOD	1.00	-1.09		0.25		0.41			0.22	-0.06				0.92	0.92
	4.95	-10.24		14.55		6.74			5.19	-17.2790					
HOUSE	0.01				0.05	0.11	0.08	0.16	0.04				0.00	0.98	0.98
	0.18				5.17	4.82	3.37	6.43	2.21				12.69		
CLOTHING	-2.83	1.03	0.40	0.06	0.07	0.35	0.35	0.36	0.33	-0.03	-0.01	-0.02		0.98	0.98
	-12.35	15.08	11.09	2.77	3.46	8.52	9.52	7.51	12.26	-17.48	-7.49	-10.51			
ENERGY	0.05				-0.03	0.05	0.09		-0.01	0.05	-0.03	-0.05		0.94	0.93
	1.55				-2.77	2.01	2.66		-0.72	29.05	-16.13	-32.69			
TRANSPORT	-1.24					0.13		0.23	1.09	0.03	0.03	0.06		0.98	0.97
	-8.89					2.43		3.27	25.27	7.30	6.45	14.48			
SERVE	1.40	0.54		-0.49	-0.26	-0.51	-0.52	-0.81	1.69	0.03	0.02	0.03	-0.01	0.98	0.98
	2.36	2.10		-4.63	-4.15	-4.07	-3.59	-5.41	15.49	4.08	3.89	5.00	-5.30		
OTHER	-4.85	1.43	0.54	0.33	0.12	0.72	0.63	0.17	0.99	-0.01	-0.02	-0.04	0.00	0.99	0.99
	-12.31	11.33	8.93	6.99	3.26	10.35	9.57	2.17	18.85	-4.32	-9.27	-15.96	2.13		

T-Ratios on second line

- It is interesting to note that food and house expenditures are largely unaffected by seasonal factors whilst amongst the others the seasonal effects are most marked (not unexpectedly) for energy.
- The equations in general have a high level of goodness of fit as measured by R^2. However, this is not the only or indeed the most important measure of the adequacy of estimates. We should also test for departures from the classical assumptions of OLS, and also for stationarity. Where variables are found to be non stationary co-integration techniques such as those of Engel and Granger[4].can be applied. No effort has been made in the time available to test the time series properties of the equations. Nevertheless, many econometric investigations suggest the widespread existence of long run co-integrating relationships between economic variables and affirms the validity of OLS regression[5] at least for establishing long run relationships.

Major differences in results when the time period is subdivided (Table 5b and 5c)

The stability of estimates is important if the model is to be used for forecasting or policy evaluation purposes. Thus it is of some interest to compare estimates from the overall period with those from our subperiods.

The first observation is that the goodness of fit is not very different between periods, and is generally high. Over 95% of the variation is explained in each subperiod.

Not surprisingly, however, there are important differences but the interpretation of these differences is not without problem.

- In the first place, a strategy of general to specific modelling leads to the rejection of certain variables in the subperiods, which were included in the overall estimates. The price of transport for example appeared in 7 equations in the overall model, 2 in the early subperiod and 5 in the later subperiod, and a similar variation is observed for the other price variables. These results could be due to lack of variation within periods compared with the variation between periods. Nevertheless the lack of homogeneity suggests that the estimates should be used with cautions. Amongst the price variables, only the price of clothing has the same sign for each period or subperiod.
- Income and the first seasonal variable, by contrast, appear in much the same places in each set. Averaging their impacts in the different periods/subperiods indicates that the direction of impact of these variables remains the same however the periods are subdivided.
- One important difference relates to the measured impact of income-the average impact in the overall period (0.62) is much greater than that in either of the subperiods (0.12 in the first subperiod and 0.15 in the second). The reason for these differences is attributable to the lower income elasticities found for transport, services and other goods in the subperiod estimates. Over the longer period of time there has been much greater variation in income levels and this consideration would support the use of the overall measure rather than the latest subperiod estimates. However, there is clearly need for further research to clarify the changing nature of the influence of income on expenditure.

Table B.5b *Estimation results for individual expenditure categories 1963Q1 to 1979Q4*

Variable	C	PRF	PRH	PRC	PRE	PRT	PRS	PRO	INCOME	SR1	SR2	SR3	TIME	R-Squared	R-Bar-Squared
FOOD	1.09	-0.61		0.10					0.12	-0.05				0.96	0.96
	5.08	-4.36		5.27					5.10	-15.93					
HOUSE	0.37				0.03	-0.03	0.04	0.03	0.01				0.00	0.99	0.99
	9.23				2.23	-1.88	2.86	1.93	1.88				24.05		
CLOTHING	0.18		-0.10	-0.05	-0.06				0.06	-0.01				0.98	0.98
	3.89		-4.21	-3.04	-3.04				8.56	-11.05					
ENERGY	0.15				0.03				0.02	0.05	-0.02	-0.05		0.93	0.93
	4.54				-1.13				3.33	21.51	-8.78	-21.89			
TRANSPORT	-0.40					-0.23		0.26	0.21	0.02	0.03	0.04	0.00	0.97	0.96
	-2.87					-3.71		3.19	8.66	3.00	10.52	10.75	5.50		
SERVE	0.37				-0.08		-0.43		0.21		0.01	0.03	0.00	0.91	0.91
	3.08				-1.76		-6.61		12.90		3.25	11.50	-4.26		
OTHER	-0.17			0.07				-0.22	0.22	0.01	-0.02	-0.01	0.00	0.98	0.98
	-2.25			2.45				-4.73	12.53	1.46	-8.69	-7.53	1.50		

Table B.5c *Estimation results for individual expenditure categories 1980Q1 to 1998Q2*

Variable	C	PRF	PRH	PRC	PRE	PRT	PRS	PRO	INCOME	SR1	SR2	SR3	TIME	R-Squared	R-Bar-Squared
FOOD	0.21	-0.43		0.24		0.60			0.06	-0.06				0.91	0.90
	0.65	-1.69		5.62		4.19			5.46	-12.96					
HOUSE	-0.54		0.16		0.14	0.21	0.20	0.23	0.05	0.01	0.01	-0.01		0.83	0.81
	-2.52		4.72		5.95	3.95	2.46	2.69	7.75	4.41	3.46	-4.08			
CLOTHING	-3.34	1.33	0.49		0.10	0.14	0.48	0.76	0.08	-0.04	-0.02	-0.02		0.98	0.98
	-10.57	10.68	11.17		3.69	2.24	5.18	7.40	10.06	-16.33	-7.17	-7.94			
ENERGY	0.18				-0.02					0.05	-0.03	-0.05		0.96	0.96
	17.64				-1.98					29.11	-16.92	-29.52			
TRANSPORT	-0.34					-0.51		0.51	0.24	0.02	0.02	0.09		0.97	0.97
	-2.02					-3.44		4.93	19.30	4.10	3.48	19.69			
SERVE	4.76	-1.17		1.12		-1.29	-1.40	-2.72	0.39	0.05	0.04	0.05		0.99	0.99
	8.16	-3.35		6.08		-6.34	-4.89	-6.21	24.47	6.50	6.00	8.61			
OTHER	-0.82						0.42		0.25		-0.01	-0.05		0.98	0.98
	-5.60						2.58		39.44		-3.06	-14.51			

T-Ratios in brackets

B.6 Relating the expenditure estimates to the national input output accounts

Having estimated expenditure by category, the next problem is to relate the resulting estimates to the output side of the economy via input output relationships. The size of the problem is significant because the UK Input Output accounts[6] provide a breakdown of the economy into 123 products whereas there are only 7 expenditure categories. We wish to convert a given estimate of expenditure for the 7 categories into final demands either for all 123 products or for some arbitrary grouping. In principle we need a breakdown of consumption category expenditure by the 123 products for a base year. Then for each category, we need to find the proportion of expenditure, which is attributed to each of the 123 products. Assuming that these ratios remain constant over a period of time, we can then apply them to any forecast of expenditure in order to get a final demand breakdown.

The arrangement of the UK Input Output tables (UKIO) is not entirely conducive to this process. In the first place, the breakdown of expenditure by products uses different categories than this study. UKIO use a 29-category breakdown, which is based on a functional definition of expenditure whereas the expenditure data used in this study is based on a product definition. Nevertheless the UKIO tables give enough detail to enable a re-allocation into the seven categories used in this study. For the first five categories (food, house, clothing, energy and transport), it is possible to obtain a reasonably complete allocation of expenditure to UKIO products. The service and other goods categories are rather broad and so a considerable amount of effort is needed to make allocations for them. Table 5 presents a breakdown for each of the expenditure categories, of the proportions (measured in %) bought from each industry. Thus for example. 7.8% of the category Food consists of agricultural products (UKIO product 1), while 24.8% of Transport consists of Motor vehicles (UKIO product 77).

As an example, consider the situation in 1995. For that year, consumption expenditure by categories was

Expenditure on category	£ million
Food	86,730
House	57,798
Clothing	28,347
Energy	15,117
Transport	74,110
Service	103,657
Other	70,694
Total	438,453

The calculation of expenditure for UKIO product *i* is as follows-

(Percent of food in product i × Expenditure on food + Percent of housing in product i × Expenditure on housing + Percent of clothing in product i × Expenditure on clothing + Percent of energy in product i × Expenditure on energy + Percent of transport in product i × Expenditure on transport + Percent of services in product i × Expenditure on services + Percent of food in product i × Expenditure on other goods)/100.

For the first UKIO product (Agricultural products) the calculation is as follows:

$$(7.317 \times 86730 + 0 \times 57798 + 0 \times 28347 + 0 \times 15117 + 0 \times 74110 + 0.078 \times 103657 + 2.204 \times 70694)/100 = 7985 \text{ (Agriculture)}$$

The second and the third products (Forestry and Fishing) are evaluated in a similar way:

$$(0 \times 86730 + 0 \times 57798 + 0 \times 28347 + 0.06 \times 15117 + 0 \times 74110 + 0. \times 103657 + 0.146 \times 70694)/100 = 112 \text{ (Forestry)}$$

$$(0.121 \times 86730 + 0 \times 57798 + 0 \times 28347 + 0 \times 15117 + 0 \times 74110 + 0.002 \times 103657 + 0 \times 70694)/100 = 107 \text{ (Fishing)}$$

and so on for all 123 products. These results are identical to the expenditure by product information given in table 4 of the UKIO accounts.

We can simplify the calculations using matrices. The data in Table B.6 gives us a matrix of the proportions in which consumption of the categories are attributed to UKIO products. Call this matrix P, such that P is of dimension (UKIO products × Expenditure categories), in this case (123 × 7). Let E be the vector of expenditure categories (7 × 1) for a given year. The matrix product P times E gives a vector of expenditures by products which is suitable for use as a component of Final Demand in the Input Output analysis.

$\mathbf{E}'$ is (86730, 57798,28347, 15117, 74110, 103657, 70694)

Post-multiplying P by E yields the vector of expenditures given in the last column of Table B.6.

The actual IO groupings used in the project will be some combination of the 123 products above and a simple aggregation of the above detailed results will be all that is required.

Table B.6 *Relationship between Expenditure Categories and UK Input Output industry classifications*

	1995 prices × 100%						
	FOOD	HOUSE	CLOTHING	ENERGY	TRANSPORT	SERVICES	OTHER GOODS
IO cat. 1	7.317	0	0	0	0	0.078	2.204
2	0	0	0	0.060	0	0	0.146
3	0.121	0	0	0	0	0.002	0
4	0	0	0	3.486	0	0	0.004
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0.021	0	0	0	0	0	0
8	12.560	0	0	0	0	0.132	0.320
9	7.621	0	0	0	0	0.078	0.014
10	0.883	0	0	0	0	0.010	0.008
11	7.495	0	0	0	0	0.080	0.158
12	1.279	0	0	0	0	0.016	0.048
13	0	0	0	0	0	0	2.139
14	5.025	0	0	0	0	0.056	0.054
15	0.323	0	0	0	0	0.004	0.004
16	5.265	0	0	0	0	0.056	0.047
17	5.052	0	0	0	0	0.051	0.014
18	30.023	0	0	0	0	0.451	0.532
19	3.852	0	0	0	0	0.039	0.004
20	13.164	0	0	0	0	0	0.045
21	0	0	0	0	0	0	0.082
22	0	0	0	0	0	0	0.178
23	0	0	0	0	0	0	0.086
24	0	0	1.468	0	0	0	3.449
25	0	0	0	0	0	0	2.867
26	0	0	0.780	0	0	0	0
27	0	0	14.792	0	0	0	0.124
28	0	0	67.573	0	0	0	0
29	0	0	0	0	0	0	0.607
30	0	0	15.346	0	0	0	0
31	0	0	0	0.060	0	0	1.051
32	0	0	0	0	0	0	0
33	0	0	0	0	0	0	3.249
34	0	0	0	0	0.012	0	13.044
35	0	0	0	3.671	16.111	0	0.361
36	0	0	0	0	0	0	0.058
37	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0.332
40	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0.167
42	0	0	0	0	0	0	1.228
43	0	0	0	0	0	0	3.194
44	0	0	0	0	0	0	10.652
45	0	0	0	0	0	0	1.594
46	0	0	0	0	0	0	0
47	0	0	0	0	0.409	0	0.448
48	0	0	0.042	0	0	0	2.037
49	0	0	0	0	0.040	0	0.618
50	0	0	0	0	0	0	1.225

	1995 prices × 100%						
	FOOD	HOUSE	CLOTHING	ENERGY	TRANSPORT	SERVICES	OTHER GOODS
51	0	0	0	0	0	0	0.003
52	0	0	0	0	0	0	0.130
53	0	0	0	0	0	0	0.188
54	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0.037
56	0	0	0	0	0	0	0.006
57	0	0	0	0	0	0	0.102
58	0	0	0	0	0	0	0.166
59	0	0	0	0	0	0	0.006
60	0	0	0	0	0	0	0.935
61	0	0	0	0	0.366	0	1.191
62	0	0	0	0	0	0	0.637
63	0	0	0	0	0	0	0.622
64	0	0	0	0	0	0	0.004
65	0	0	0	0	0	0	0.157
66	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0.013
68	0	0	0	0	0	0	6.054
69	0	0	0	0	0	0	1.454
70	0	0	0	0	0	0	0.723
71	0	0	0	0	0	0	0.146
72	0	0	0	0	0.424	0	0.843
73	0	0	0	0	0	0	0.047
74	0	0	0	0	0	0	0.144
75	0	0	0	0	0	0	5.428
76	0	0	0	0	0	0	2.497
77	0	0	0	0	24.819	0	2.335
78	0	0	0	0	0.648	0	0.300
79	0	0	0	0	2.232	0	0.231
80	0	0	0	0	0	0	0.018
81	0	0	0	0	0	0	9.374
82	0	0	0	0	0	0	2.785
83	0	0	0	0	0	0	6.281
84	0	0	0	0	0	0	4.611
85	0	0	0	53.880	0	0	0
86	0	0	0	38.844	0	0	0
87	0	3.396	0	0	0	0	0.139
88	0	0	0	0	0	3.229	0
89	0	0	0	0	13.677	0	0
90	0	0	0	0	0	0	0
91	0	0	0	0	0	1.347	0
92	0	0	0	0	0	28.850	0
93	0	0	0	0	2.699	0.071	0
94	0	0	0	0	7.367	0.082	0
95	0	0	0	0	1.642	0.051	0
96	0	0	0	0	7.883	0.357	0
97	0	0	0	0	1.325	0.041	0
98	0	0	0	0	1.355	0.006	0
99	0	0	0	0	10.463	0	0
100	0	0	0	0	0	4.663	0

	1995 prices × 100%						
	FOOD	HOUSE	CLOTHING	ENERGY	TRANSPORT	SERVICES	OTHER GOODS
101	0	0	0	0	1.472	14.576	0
102	0	0	0	0	0	1.610	0
103	0	0	0	0	0	0	0
104	0	93.090	0	0	0	0	0
105	0	0	0	0	0	0.360	0.001
106	0	0	0	0	6.824	1.234	0
107	0	0	0	0	0	0	0
108	0	0	0	0	0	0	0
109	0	0	0	0	0	0.346	0
110	0	0	0	0	0	0.072	0
111	0	0	0	0	0	0	0
112	0	0	0	0	0	0.213	0
113	0	0	0	0	0	0.137	0
114	0	0	0	0	0	1.009	0
115	0	0	0	0	0	3.398	0
116	0	0	0	0	0.233	5.505	0
117	0	0	0	0	0	4.984	0
118	0	0	0	0	0	3.035	0
119	0	3.513	0	0	0	0	0
120	0	0	0	0	0	1.244	0
121	0	0	0	0	0	14.282	0
122	0	0	0	0	0	5.432	0
123	0	0	0	0	0	2.812	0
TOTAL	100	100	100	100	100	100	100

B.7 Conclusions

Although it has been possible to estimate expenditure functions using quarterly time series data of income and expenditure, one must be wary of straightforwardly using these in forecasting. Changes in coefficients between sub periods suggests that some care needs to be used in projecting more than a few periods ahead. The linear form of the expenditure model may not pick up some of the very complex relationships which are driving saving and expenditure behaviour during the period. It is possible to view the work in two parts-the first as providing provisional estimates, which may be useful for initial attempts to explore the introduction of policy measures. The second part provides a way of relating any expenditure estimates to the national accounts and could be used to explore the implications of a variety of models.

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ANNEX C MODEL CHARACTERISTICS AND INPUTS FOR FINLAND

Table C. 1 *The basic classifications of the FMS core model*

FMS CLASSIFICATIONS

INDUSTRIES	INSTITUTIONAL SECTORS
1 Agriculture & fishing	1 Enterprises & financial institutions
2 Forestry	2 General government
3 Mining	3 Private non-profit institutions
4 Food manufacturing	4 Households
5 Textiles, leather & footwear	5 Rest of the world
6 Manufacturing of wood	
7 Paper & pulp industry	**INCOME, OUTLAY & FINANCE**
8 Printing & publishing	1 Wages and salaries
9 Petroleum refineries	2 Employers' contr. to soc.security
10 Chemical industry	3 Operating surplus
11 Rubber & plastic products	4 Property income
12 Non-metallic mineral products	5 Indirect taxes
13 Basic metal industries	6 Direct taxes
14 Metal products	7 Employers' contr. to soc.security
15 Machinery	8 Insured persons´ contr. to s. sec.
16 Electrical products	9 Social security benefits
17 Transport equipment	10 Other current transfers
18 Other manufacturing	11 Disposable income
19 Electricity, heat & water	12 Consumption
20 Building	13 Saving
21 Other construction	14 Increase in social security funds
22 Wholesale & retail trade	15 Consumption of fixed capital
23 Hotels & restaurants	16 Capital formation
24 Transport	17 Net lending
25 Communication	
26 Finance & insurance	**HOUSEHOLD CONSUMPTION**
27 Other business services	1 Food
28 Social & personal services	2 Beverages & tobacco
FINAL SECTORS	3 Clothing & footwear
1 Government services	4 Gross rent, fuel & power
2 Other services	5 Furniture & furnishing
3 Dwellings	6 Household equipment
	7 Household operation
INVESTMENT COMMODITIES	8 Personal transport equipment
1 Residential buildings	9 Other pers. transport costs
2 Non-residential buildings	10 Purchased transport services
3 Other construction	11 Communication
4 Transport equipment	12 Radios, tv:s, pc:s etc.
5 Machinery & other equipment	13 Other recreation
	14 Books & newspapers.
	15 Restaurants & hotels.
IMPORTED ENERGY	16 Other goods & services
1 Crude oil	17 Purchases from government
2 Natural gas	18 Purch. from non-profit institutions
3 Coal	19 Direct purchase abroad
4 Nuclear fuel	20 Purchases by non-residents

ANNEX D LABOUR COEFFICIENTS FOR THE NETHERLANDS

Table D.1 *Labour coefficients for total labour force, employees and self-employed (CBS, 1997)*

Labour years × 1000/million guilders production value		Total	Employees	Self-employed
1	Agriculture + fishing	0.0060	0.0020	0.0041
2	Quarrying (incl. oil and gas)	0.0004	0.0004	0.0000
3	Food	0.0018	0.0015	0.0002
4	Textile	0.0050	0.0043	0.0007
5	Paper	0.0034	0.0032	0.0002
6	Oil industry	0.0004	0.0004	0.0000
7	Chemicals (basics)	0.0014	0.0014	0.0000
8	Chemicals (end products)	0.0032	0.0031	0.0001
9	Basic metal	0.0036	0.0034	0.0002
10	Metal products	0.0037	0.0037	0.0001
11	Electrical industry	0.0037	0.0036	0.0000
12	Transportation industry	0.0028	0.0027	0.0001
13	Other industry	0.0042	0.0038	0.0004
14	Electricity, natural gas and water (prod. and distr.)	0.0016	0.0016	0.0000
15	Construction and building materials	0.0044	0.0038	0.0006
16	Trade and repair	0.0075	0.0060	0.0015
17	Catering and lodging	0.0065	0.0048	0.0017
18	Transport and communication services	0.0049	0.0044	0.0004
19	Financial institutions	0.0035	0.0034	0.0002
20	Exploitation of real estate	0.0006	0.0006	0.0000
21	Business services and rental of moveable property	0.0076	0.0071	0.0006
22	Health and veterinary services	0.0090	0.0085	0.0006
23	Other services (excl. business services, government)	0.0083	0.0071	0.0012
24	Government	0.0068	0.0068	0.0000

Table D.2 *Labour coefficients for male and female workers (CBS, 1998a)*

Labour years × 1000/million guilders production value		Male	Female
1	Agriculture + fishing	0.0035	0.0012
2	Quarrying (incl. oil and gas)	0.0005	0.0000
3	Food	0.0011	0.0005
4	Textile	0.0012	0.0015
5	Paper	0.0023	0.0010
6	Oil industry	0.0002	0.0000
7	Chemicals (basics)	0.0012	0.0003
8	Chemicals (end products)	0.0023	0.0005
9	Basic metal	0.0032	0.0003
10	Metal products	0.0031	0.0004
11	Electrical industry	0.0028	0.0008
12	Transportation industry	0.0023	0.0000
13	Other industry	0.0060	0.0009
14	Electricity, natural gas and water (prod. and distr.)	0.0012	0.0002
15	Construction and building materials	0.0039	0.0003
16	Trade and repair	0.0039	0.0027
17	Catering and lodging	0.0034	0.0031
18	Transport and communication services	0.0035	0.0011
19	Financial institutions	0.0022	0.0018
20	Exploitation of real estate	0.0005	0.0003
21	Business services and rental of moveable property	0.0038	0.0023
22	Health and veterinary services	0.0030	0.0099
23	Other services (excl. business services, government)	0.0035	0.0037
24	Government	0.0049	0.0032

Table D.3 *Labour coefficients per age class (CBS, 1998a)*

Labour years × 1000/million guilders production value		Age 15-24	Age 25-44	Age 45-64
1	Agriculture + fishing	0.0007	0.0022	0.0018
2	Quarrying (incl. oil and gas)	0.0000	0.0003	0.0002
3	Food	0.0002	0.0010	0.0004
4	Textile	0.0000	0.0016	0.0005
5	Paper	0.0001	0.0021	0.0009
6	Oil industry	0.0000	0.0002	0.0000
7	Chemicals (basics)	0.0001	0.0010	0.0005
8	Chemicals (end products)	0.0000	0.0019	0.0007
9	Basic metal	0.0004	0.0021	0.0011
10	Metal products	0.0003	0.0022	0.0010
11	Electrical industry	0.0000	0.0023	0.0011
12	Transportation industry	0.0002	0.0015	0.0007
13	Other industry	0.0003	0.0041	0.0025
14	Electricity, natural gas and water (prod. and distr.)	0.0000	0.0007	0.0006
15	Construction and building materials	0.0007	0.0023	0.0012
16	Trade and repair	0.0014	0.0037	0.0016
17	Catering and lodging	0.0020	0.0032	0.0014
18	Transport and communication services	0.0005	0.0028	0.0013
19	Financial institutions	0.0004	0.0027	0.0009
20	Exploitation of real estate	0.0001	0.0005	0.0002
21	Business services and rental of moveable property	0.0006	0.0040	0.0016
22	Health and veterinary services	0.0012	0.0081	0.0035
23	Other services (excl. business services, government)	0.0009	0.0042	0.0020
24	Government	0.0004	0.0046	0.0031

Table D.4 *Labour coefficients per education level (CBS, 1998a)*

Labour years × 1000/million guilders production value		Elem. education	Primary education	Higher education	College + university
1	Agriculture + fishing	0.0006	0.0017	0.0024	0.0002
2	Quarrying (incl. oil and gas)	0.0000	0.0000	0.0002	0.0000
3	Food	0.0002	0.0005	0.0008	0.0002
4	Textile	0.0000	0.0000	0.0007	0.0000
5	Paper	0.0000	0.0004	0.0015	0.0004
6	Oil industry	0.0000	0.0000	0.0000	0.0000
7	Chemicals (basics)	0.0001	0.0003	0.0007	0.0004
8	Chemicals (end products)	0.0005	0.0007	0.0011	0.0000
9	Basic metal	0.0003	0.0011	0.0017	0.0002
10	Metal products	0.0002	0.0007	0.0019	0.0005
11	Electrical industry	0.0002	0.0003	0.0014	0.0009
12	Transportation industry	0.0000	0.0007	0.0012	0.0000
13	Other industry	0.0015	0.0024	0.0025	0.0002
14	Electricity, natural gas and water (prod. and distr.)	0.0000	0.0000	0.0008	0.0003
15	Construction and building materials	0.0005	0.0014	0.0021	0.0002
16	Trade and repair	0.0006	0.0019	0.0036	0.0008
17	Catering and lodging	0.0009	0.0020	0.0032	0.0005
18	Transport and communication services	0.0005	0.0014	0.0020	0.0007
19	Financial institutions	0.0000	0.0005	0.0023	0.0013
20	Exploitation of real estate	0.0000	0.0002	0.0004	0.0001
21	Business services and rental of moveable property	0.0004	0.0008	0.0022	0.0029
22	Health and veterinary services	0.0005	0.0015	0.0066	0.0046
23	Other services (excl. business services, government)	0.0004	0.0013	0.0031	0.0025
24	Government	0.0002	0.0008	0.0028	0.0044

Table D.5 *VAT-levels per expenditure category*

[%]	1995	2000	2010
Basic foodstuffs	6.0	6.0	6.0
Non-basic foodstuffs	6.0	6.0	6.0
Alcohol and tobacco	17.5	17.5	17.5
Outdoor meals and holidays	17.5	17.5	17.5
Clothing and footwear	17.5	17.5	17.5
Housing (rents, etc.)	0.0	0.0	0.0
Gardening, furniture, etc.	17.5	17.5	17.5
Domestic appliances	17.5	17.5	17.5
Car and motor purchases	17.5	17.5	17.5
Energy at home (gas, power, heat)	17.5	17.5	17.5
Motor fuels for private car	17.5	17.5	17.5
Health and personal care	17.5	17.5	17.5
Medical care	0.0	0.0	0.0
Development and leisure	17.5	17.5	17.5
Transport services, maintenance	6.0	6.0	6.0

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