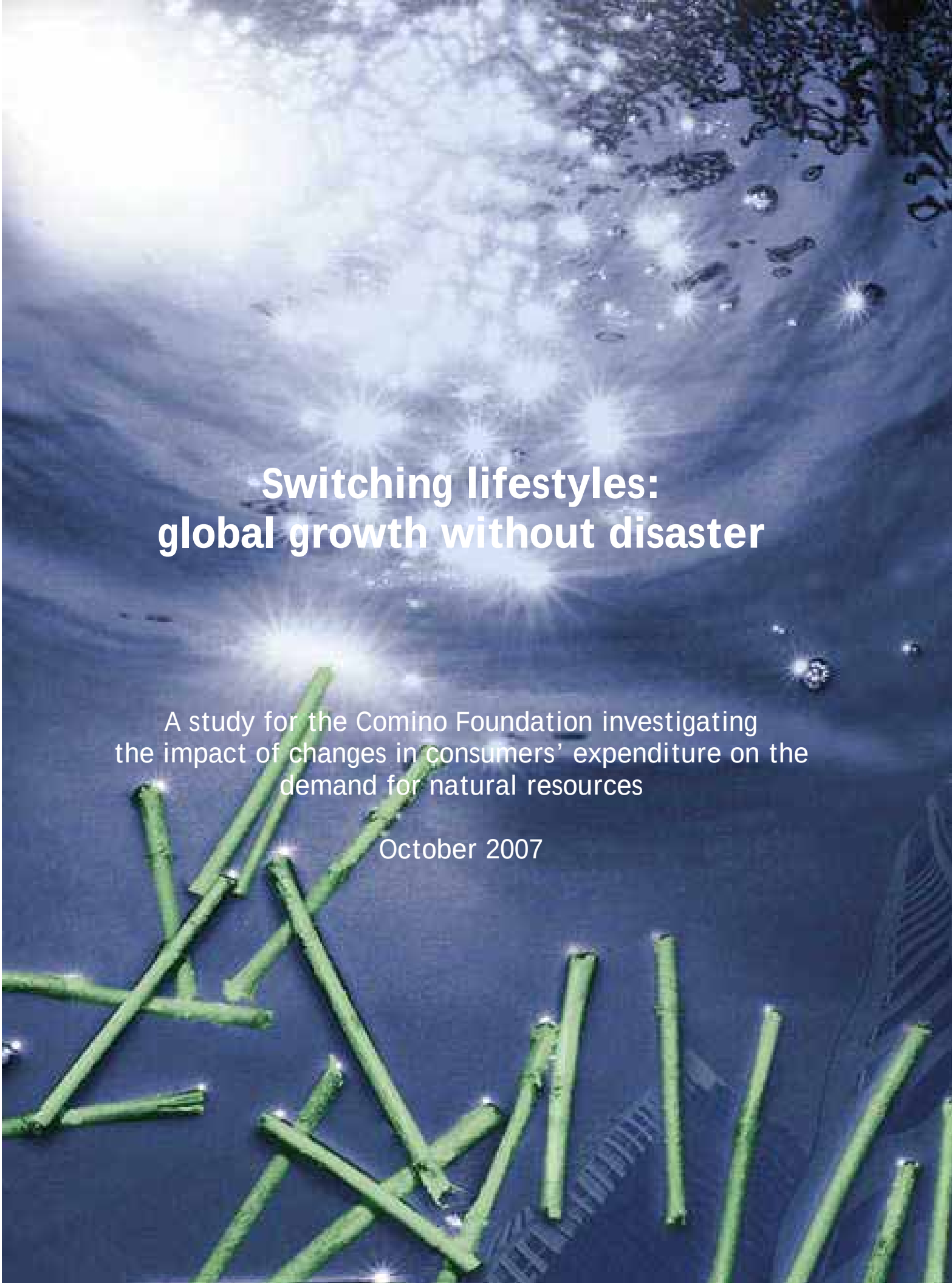

Switching lifestyles: global growth without disaster

A study for the Comino Foundation investigating the impact of changes in consumers' expenditure on the demand for natural resources

October 2007

This report is published by the Comino Foundation and has been produced by **cebr,** an independent economics and business research consultancy established in 1993 providing forecasts and advice to City of London institutions, government departments, local authorities and numerous blue chip companies throughout Europe. The contributors to this report are Douglas McWilliams, Jonathan Said and Dominic Walley.

London, October 2007

CONTENTS

1 INTRODUCTION AND SUMMARY

Summary

Consumer choices have a strong effect on greenhouse gas emissions. On present trends these emissions will increase by four per cent by 2015.

If consumers accelerate their preference for services over goods, this can be reversed and by 2015 emissions could be six percent lower than they would otherwise have been. This will give time for technological change which is the ultimate solution.

Everyone can help while enriching their lifestyles by their choices described in this report and so can business by providing the experiences to enjoy.

Objectives of the study

Organisations concerned with the protection of the environment have argued that the developed world's alleged obsession with the acquisition of material goods cannot be sustained without irreparable damage to the environment and the exhaustion of natural resources. As a result they argue that Western consumers should consider the environmental consequences of the goods and services they buy.

The Comino Foundation, whose purpose is to help people live fulfilled lives within a prosperous and responsible society, has for some time been suggesting that a change in consumption patterns in the Western economies towards less material means of satisfaction might make a significant contribution to ensuring sustainability in resource usage and slowing environmental depletion.

The Comino Foundation is concerned about the growth of emissions and the use of natural resources and is seeking ways to help businesses to achieve growth in areas which do not consume large quantities of material or energy.

In the February 2002 issue of Ingenia (the journal of the Royal Academy of Engineering) which is reproduced in Appendix the Appendix, KG Adams and WE Duckworth proposed that a solution to this dilemma might emerge if people were prepared to achieve personal fulfilment through intellectual, aesthetic, spiritual, physical and social activities rather than through material consumption. Further they claim that 'business can play a major part in the solution of the environmental dilemma by changing the aspirations of people in the developed world…'

The purpose of this study is to test whether a relatively small change in consumption patterns in the UK can have substantial implications for emissions and resource use.

We build a base scenario of likely future consumption patterns in 2015 based on current trends and demographic changes. We run an alternative scenario where we make a ten per cent transfer of consumption from goods to services. The transfer takes place gradually between 2007 and 2015. We use Input-Output tables and environmental accounts for the United Kingdom to test what the impact of the alternative scenario is upon the output of industrial sectors, natural resources and the environment, compared with the base scenario. We study the impact of changing UK consumer behaviour upon the demand for world resources, upon UK energy usage and upon UK emissions.

We test the plausibility of the change in consumer patterns in the alternative scenario and test the robustness of the results.

Key findings

We estimate that our alternative scenario of future consumption patterns, when compared with our base scenario of likely consumption, would:

- reduce green house gas emissions by six per cent in 2015, compared with four per cent growth expected on current trends between 2003 and 2015;
- reduce 2015 consumption of electricity, coal and natural gas by five per cent, eleven per cent and eight per cent respectively compared with trend growth between 2003 and 2015 of seventeen per cent, fourteen per cent and 45 per cent respectively;
- reduce the UK's extraction of oil and gas by seventeen per cent compared with the base scenario;
- contribute to limiting the output of refined plastic and synthetic resins, inorganic chemicals, iron and steel, and other non-ferrous metals;
- not have a significant impact upon the demand for wood and wood products and industrial gases and dyes and raise the demand for fertilisers by some eight per cent;
- reduce the demand for goods and services produced by the manufacturing sector, the energy sector, the retail sector and the mining sector;
- increase the demand for goods and services produced by the agriculture, fishing, health, finance, business services and education sectors and other community, social and personal services.

Our literature review suggests that:

- our findings are largely consistent with previous research. The Intergovernmental Panel on Climate Change forecasts an average reduction in the ratio of carbon dioxide emissions to gross domestic product over the period from 1990 to 2020 of twenty per cent.

Our sensitivity and plausibility tests suggest that:

- the impact upon the environment is inversely proportionate to the size of the transfer in consumption from goods to services;
- different compositions of the transfer do little to change the result;

- technological change could play a significant role in amplifying or diminishing the impact of the change in consumer patterns that we study;

- the change in consumer patterns is broadly plausible, but certain types of consumption may be difficult to change such as household electricity, gas and water consumption.

Structure of the report

In the next section we present a brief literature review of past, similar studies. In section three we examine past consumer trends in the United Kingdom, build a base scenario of likely future consumption in 2015 and then run an alternative scenario with alternative consumer patterns. In section four we analyse the impact of this alternative scenario upon industrial sectors, natural resources and, in section five, upon the environment.

In section six we test the sensitivity of our results and the plausibility of the change in consumption patterns in the alternative scenario. We then present the limitations of this study and our recommendations and then conclude in section eight.

2 LITERATURE REVIEW

Introduction

The environmental impact of changing consumption patterns has attracted a degree of attention in the academic literature. We look at five areas here:

1) The economic theory about changing consumption patterns

2) The sociological discussion about the potential impact of changing consumption patterns on the environment

3) A single quantitative study of the impact of changing consumption patterns on the environment

4) The major studies by the Intergovernmental Panel on Climate Change of the impact of economic changes on the environment

5) A study analysing the success of various initiatives to change consumer patterns in Australia

Economic theory and changing consumption patterns

As affluence became widespread in the late 1950s and 1960s in the United States, attention started to focus on how consumption patterns might change to reflect this affluence and on the implications of this. The two seminal papers on the subject were by Nobel prize winner Gary Becker[1] in 1965 and by the distinguished economist Kelvin Lancaster[2] who wrote two key papers in 1966[3].

Becker integrated time into his model of consumption, pointing out that with increasing numbers of women working, time saving was becoming a key consumption driver. This would cause people to develop trade-offs between convenience and consumption of material goods.

Lancaster's thinking had some similarities but his analysis hypothesised that as people become richer, they trade off quantity for quality. One can only eat so much food, but one can spend on increasingly fancy food or eat at increasingly fancy restaurants. So he hypothesized a model of consumption based on attributes and qualities rather than simply on material quantities.

[1] Becker, Gary S., 1965. '*A Theory of the Allocation of Time'*, Economic Journal, 75: 493-517.
[2] Lancaster, K. J., 1966a. '*A New Approach to Consumer Theory*', Journal of Political Economy, 74:132-157
[3] Lancaster, K. J., 1966b. '*Change and Innovation in the Technology of Consumption'*, American Economic Review, 56:14-23

Impact of consumption patterns on the environment

The discussion of the impact of changing consumption patterns on the environment has a number of roots. In Germany, the sociologist Fritz Reusswig[1] from the Potsdam Institute for Climate Impact Research has theorised about how different approaches to living and consuming could affect the environment, although he has not published quantitative research on the subject. The German government is investigating the implications of this approach.

The relationship between environmental quality and economic development has been empirically modelled through the emissions-income relationship by many authors, and the outcome of most of these studies has been formulated by the so called Environmental Kuznets Curve hypothesis. The Environmental Kuznets Curve (EKC) hypothesis proposes that there is an inverted U shaped relation between environmental degradation and income per capita, or a U-type relationship between environmental quality and income per capita. This means that economic development will eventually undo the negative environmental impacts of the early stages of economic development.

The concept is named after the famous economist Simon Kuznets who hypothesised that income inequality could rise in the initial stages of economic development and then fall thereafter as development matured. The EKC hypothesises a similar concept for the environment. It is associated with the work of Grossman and Krueger[2]. A key element in the EKC is that consumption patterns alter in an environmentally friendly fashion as people, after satisfying their basic material needs, become more prosperous.

Cross sectional research across OECD countries indicates some support for the EKC concept. A recent study in Turkey[3] indicated that the income level where pollution tended to decrease was $2,500 in residential and commercial areas in cities, $5,000 in industrial areas in cities and that there was little evidence for the EKC in suburban areas, presumably because of the relationship between income levels and road usage.

[1] Fritz Reusswig, '*Zu einer Soziologie des Globalen Wandels*', Potsdam Institute for Climate Impact Reseach, 1996

[2] Grossman, G.M., and A.B. Krueger, 1995, '*Economic Growth and the Environment'*, Quarterly Journal of Economics, 110, 353-77

[3] Economic Growth and Environmental Quality: A Non-Parametric Kernel Estimation of the Environmental Kuznets Curve Savas Alpay and Syed Mahmud *Department of Economics, Bilkent University, Bilkent, Ankara, Turkey*

But time series research has been less supportive[1]. The article on the subject in the International Society for Ecological Economics' internet encyclopedia concludes: 'The evidence presented in this paper shows that the statistical analysis on which the environmental Kuznets curve is based is not robust. There is little evidence for a common inverted U-shaped pathway which countries follow as their income rises. There may be an inverted U-shaped relation between urban ambient concentrations of some pollutants and income though this should be tested with more rigorous time series or panel data methods. It seems unlikely that the EKC is a complete model of emissions or concentrations'.

Meanwhile, in his presidential address to the American Agricultural Economics Association in 1999[2], John Antle addressed the topic of the 'new economics' of consumption of agricultural goods and the potential environmental impact. His concept was that as time and convenience became more important over time, the environmental impact of consumption of agricultural goods would diminish per dollar spent.

The US Department of Agriculture has followed up this work[3] and its current budget submission includes a $1.7 million request for continued research in this area.

Quantified studies of impact of changing consumption

Our desk research has only discovered one attempt so far to quantify the environmental impact of changing consumption patterns.

This study, by Inge Ropke of the Technical University in Denmark[4], asks the question 'how does environmental impact change when national income increases?'

It concludes that so far, this question has been mainly discussed from the point of view of production, but in recent years several studies have dealt with the question of whether consumption growth can be 'decoupled' from growth in environmental emissions as a result of a compositional change.

The optimistic subscribers to decoupling argue that with increasing income the composition of consumption changes in the direction of more environment-friendly goods and services.

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[1] David I. Stern, International Society for Ecological Economics, Internet Encyclopaedia of Ecological Economics, '*The Environmental Kuznets Curve*', Department of Economics, Rensselaer Polytechnic Institute, Troy, NY 12180, USA June 2003

[2] Antle, John M.. '*The New Economics of Agriculture'*, American Journal of Agriculture Economics, 81: 993-1010, 1999

[3] Senauer, '*Changes and Trends in Consumption Patterns*' Department of Applied Economics, University of Minnesota US Department of Agriculture briefing note, 2000

[4] Inge Ropke, '*The environmental impact of changing consumption patterns: a survey*', International Journal of Environment and Pollution (IJEP), Vol. 15, No. 2, 2001

The paper discusses this hypothesis critically on the basis of several studies dealing with historical experience.

The paper reaches two conclusions. First, it is argued that an overall assessment of the environmental impact is most appropriately based on an input approach (this is the approach taken in our report).

The quantified conclusion is that when 'data on input intensities for different categories of consumption goods are combined with data on changes in consumption patterns … it is concluded that the historical changes in the composition of consumption seem to have done little to counterbalance the environmental effects of growth'. This contrasts with the conclusion of the current work but of course is not comparing the same thing — the Ropke report studies the impact of consumption shifts that have taken place historically whereas the current study is looking at the hypothetical impact of a different change in tastes and behaviours in the future.

Quantified studies of links between the economy and the environment

The main examples of quantified work on the link between the economy and the environment are the reports of the International Panel on Climate Change Special Reports on Emissions Scenarios. The first report was produced in 1990, updated in 1992, and the most recent update of this work is dated 2000.

The panel taken from the recent House of Lords Economic Affairs Select Committee's report[1] on the Economic Aspects of Climate Change shows the main results of this work.

[1] House of Lords Select Committee on Economic Affairs 2nd Report of Session 2005-06 '*The Economics of Climate Change Volume I*', Report Ordered to be printed 21 June 2005 and published 6 July 2005 Published by the Authority of the House of Lords *London* : The Stationery Office Limited HL Paper 12-I

Table 2.1. The IPCC Emissions scenarios

BOX 8

The IPCC emissions scenarios

The IPCC *Special Report on Emissions Scenarios* (SRES) for 2000 groups "alternative futures" into four "families", A1, A2, B1 and B2. Within these families there are variations in assumptions about the underlying driving forces, especially technological change, so that, in all, there are 40 scenarios. While they are given different names, the basic differentiating features are:

- A1 has rapid economic growth and rapid technological change, with population peaking in the mid-21st century and declining thereafter. There is strong convergence of per capita incomes between rich and poor countries.
- A2 has slower economic growth and technological change.
- B1 has the same population assumptions as A1, strong convergence, and strong reductions in energy and materials intensity.
- B2 has rising population growth, "intermediate" economic growth, and slower technological change than A1 and B1.

The scenarios are associated with a range of temperature changes: each sub-scenario within the A1 scenarios, for example, has a range of temperature changes, and the range across the sub-scenarios tends to be quite wide, especially for A1 scenarios.

None of the scenarios includes explicit policies directed at controlling climate change. Summary statistics for the scenarios are given below:

Scenario	Population 2050 (billion)	Population 2100 (billion)	World GDP 2050 trillion $ 1990	World GDP 2100 trillion $ 1990	Convergence rich/poor 2100 (1990 = 16.1)	GDP growth rate 1990 - 2100 (% p.a.)	Cumulative Emissions 1990 - 2100 (GtC)
A1	8.7	7.0-7.1	164/ 187	525/ 550	1.5 – 1.6	3.0	1068-2189
A2	11.3	15.1	82	243	4.2	2.2	1862
B1	8.7	7.0	136	328	1.8	2.5	983
B2	9.3	10.4	110	235	3.0	2.2	1164

The range of temperature increases corresponding to these scenarios is 2.1 to 6.1°C for A1 by 2100, 3.0 to 5.2 °C for A2, 1.7 to 3.0 °C for B1 and 2.1 to 3.9 °C for B2

Source: adapted from data in N. Nakicenovic et el. *Emissions Scenarios*. Cambridge: Cambridge University Press. 2000. Note: these ratios are computed using MERs, not PPPs.

The implied annual movements in emissions are shown in Table 2.2 below. The House of Lords Report itself criticised the IPCC work as exaggerating the likely impact and concluded that the estimates at the lower end of the scale were more plausible. In particular, there is a 'schoolboy howler' pointed out by the House of Lords Committee in that the calculations for the impact of convergence in living standards in the emerging economies are carried out at market exchange rates rather than at purchasing power parity exchange rates.

Table 2.2. Average annual growth in carbon dioxide emissions (excluding land-use change), percentage per annum

1960-2000		2.3
1970-2000		1.6
1980-2000		1.3
1990-2000		1.2
	A1F1	2.1
	A1B	2.4
	A1T	1.7
	A2	2.0
	B1	1.7
IPCC Projections 1990-2020	B2	1.4

Source: House of Lords Report, Table 4 page 40. Note: The IPCC's A1 scenario is divided into three forms: A1F1 is fossil fuel intensive, A1B is balanced and A1T is predominantly non-fossil fuel.

The implication from this assessment is that growth in carbon dioxide emissions is expected to accelerate from that observed in the recent past, because of the growth in the emerging economies. Despite this, the IPCC modelling implies that the growth in carbon dioxide emissions will be slower than GDP growth. This implies potential impact for 'natural' changes in the composition of consumption as well as impacts from technology and other items.

Table 2.3 Estimated drop in ratio of carbon dioxide emissions to GDP between 1990 and 2020 for each IPCC Scenario

A1F1	23.1%
AIB	16.1%
A1T	31.7%
A2	5.7%
B1	20.9%
B2	21.0%

Source: cebr calculation from IPCC data in Tables 2.1 and 2.2 above.

The cebr analysis of the IPCC data is that all the scenarios indicate a reduction in the ratio of carbon dioxide emissions to gross domestic product over the period from 1990 to 2020, with an average decline of 19.8 per cent. Only in scenario A2, which has slow world economic growth and a rapid convergence of the emerging economies (and which by implication is especially affected by the error of using market exchange rates) is this decline below ten per cent. Excluding scenario A2, the average decline is 22.6 per cent.

These estimated changes caused by 'natural' effects indicate the potential scope for the impact of changing consumption patterns and compare well with the results shown in this report.

The success of initiatives to change consumer patterns

During the 1990s the Australian Department for Environment, Sport and the Territories, published a study that analysed the success of various initiatives undertaken to change consumer behaviour so as to reduce environmental impact[1]. The study looked at four types of initiatives:

1. Obligatory or coercive initiatives
2. Initiatives offering incentives
3. Use of communication and promotion
4. Information and education

The analysis showed that in initiatives where consumers had an obligation, or a perceived obligation, these initiatives were mostly all successful and the only initiatives that failed were because they were planned out badly or had fundamental difficulties.

More relevant to the current Comino Foundation report, initiatives based on incentives had more mixed results. Successful initiatives in this category were strongly publicised so that recognised that there was a personal benefit as well as helping the environment. These included a recycling program, the installation of solar water heaters and a more efficient and environment friendly rail line in Perth.

Initiatives that failed in this category did so because they did not offer sufficient reason for an action to be taken. In other words, matching personal benefit to environmental benefit is important.

Initiatives based on promotion also gave mixed results, showing that promotion is not sufficient for success. Those that succeeded used promotion together with information, helping consumers fully understand the benefits of altering their behaviour. Finally only two initiatives based on information and education alone were studied, and these proved unsuccessful. An incentive for action appears crucial.

[1] Australian Department for Environment, Sport and Territories, '*More with less: initiatives to support sustainable consumption*', 1990s
http://www.deh.gov.au/about/publications/economics/more/pubs/more.pdf

3 CHANGING CONSUMER PATTERNS

Introduction

The first stage of the study is to identify current trends consumption patterns in the United Kingdom and how they are likely to change in the future — our base scenario. Having done this, we then develop a plausible alternative scenario with a change in consumer patterns from relatively material goods intensive consumption to service intensive consumption when compared with the base scenario.

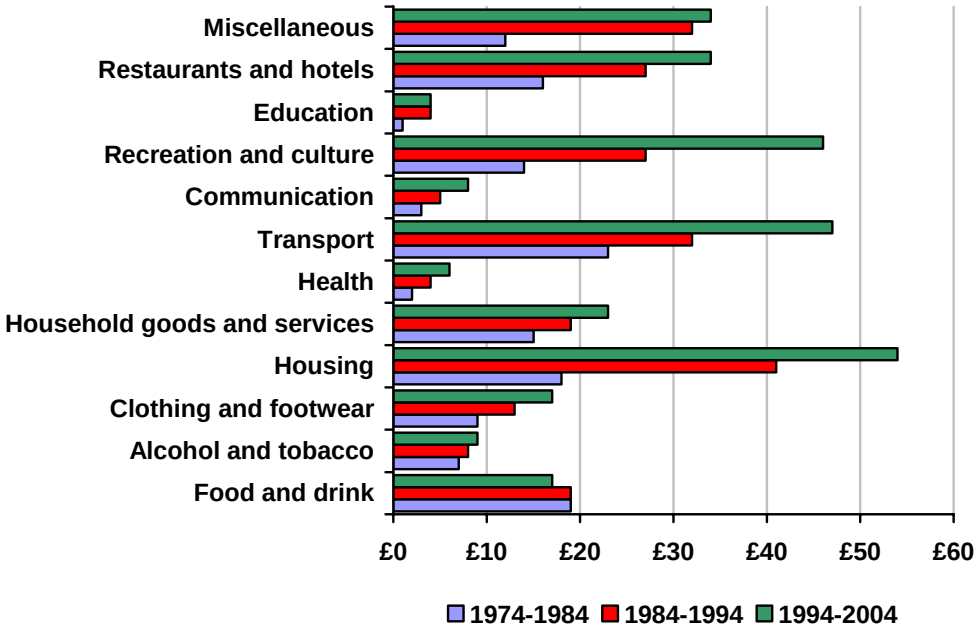
Past consumer trends

The level of consumption by UK consumers has grown strongly in recent decades. This is understandable given the strong growth in the size of the UK economy since the 1960s. Increased productivity has raised wages which has in turn raised the amount of goods and services the average consumers can purchase. Growth in the UK's population has also contributed to the increased consumption of goods and services.

Ignoring rises in prices, the UK economy is now two and a half times the size it was in 1964. This has resulted in roughly the same increase in the quantity of goods and services consumed by the UK.

However households have increased their consumption of certain goods and services more than other goods and services. Figure 3.1 below shows by how much the monetary value (including price rises) of different types of UK household consumption has grown in decade intervals between 1974 and 2004. The strongest growth has been in spending on transport, recreation and culture, housing and restaurants and hotels.

Figure 3.1: Growth in money value of UK household consumption of goods and services, £ billion current prices

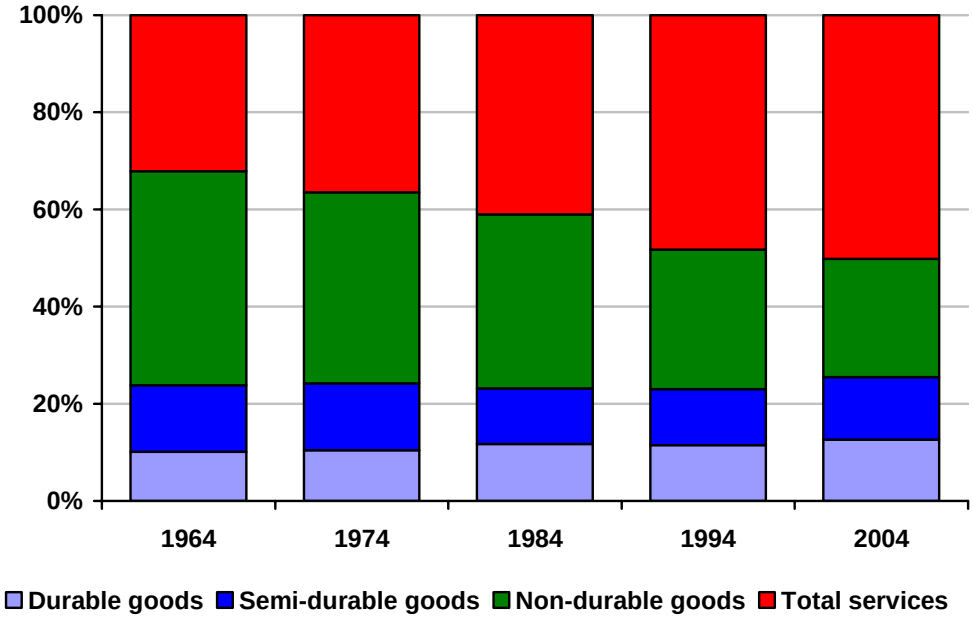


Source: ONS Household consumption statistics. Note: excludes government spending.

This classification of household spending aggregates spending on goods and spending on services together. Therefore part of spending on health for example, would include purchases on medicine (goods) and on medical services. The Office for National Statistics classifies spending in all areas into consumption of goods and services. It also classifies whether goods are durable, semi-durable or non-durable. For example transport spending by households will include the purchase of a car, which is a durable good, spending on fuels which is a non-durable good and the purchase of a rail ticket which is a service.

Over the past forty years the strongest growth has been in predominantly service oriented goods. Indeed the consumption of goods as a share of total consumption in the UK fell from 68 per cent to 50 per cent between 1964 and 2004.

Figure 3.2: Share of goods and services consumption,1964-2004



Source: ONS UK Consumption statistics.

A closer look at the growth of consumption between 1964 and 2004 reveals that the goods to services transfer was entirely from non-durable goods to services, rather than from durable or semi-durable goods. This will help us build our alternative scenario of future consumer spending.

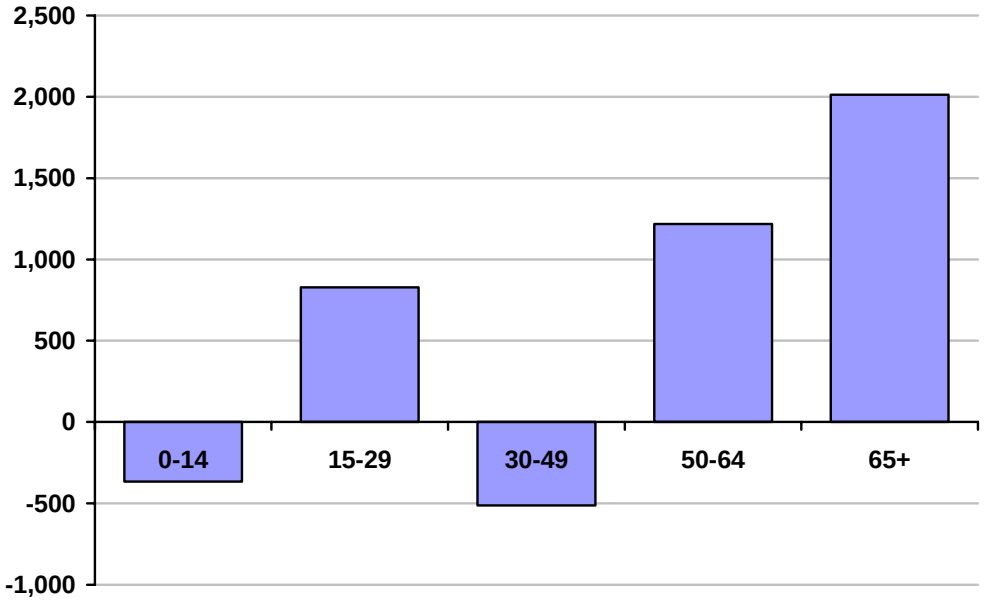
What is important is that whilst consumers in the UK are consuming more of all forms of goods, including durable and semi-durable goods, the satisfaction obtained from services has risen sharply.

Future consumption — base scenario

We have created a scenario of consumer spending in 2015 based on current trends in consumption and demographic changes. We create a picture of likely UK consumer patterns if current trends persist. We do not attempt to create an accurate forecast of consumer patterns in 2015 because amongst other factors we ignore any changes in the relative prices of substitute goods and services and government policy changes.

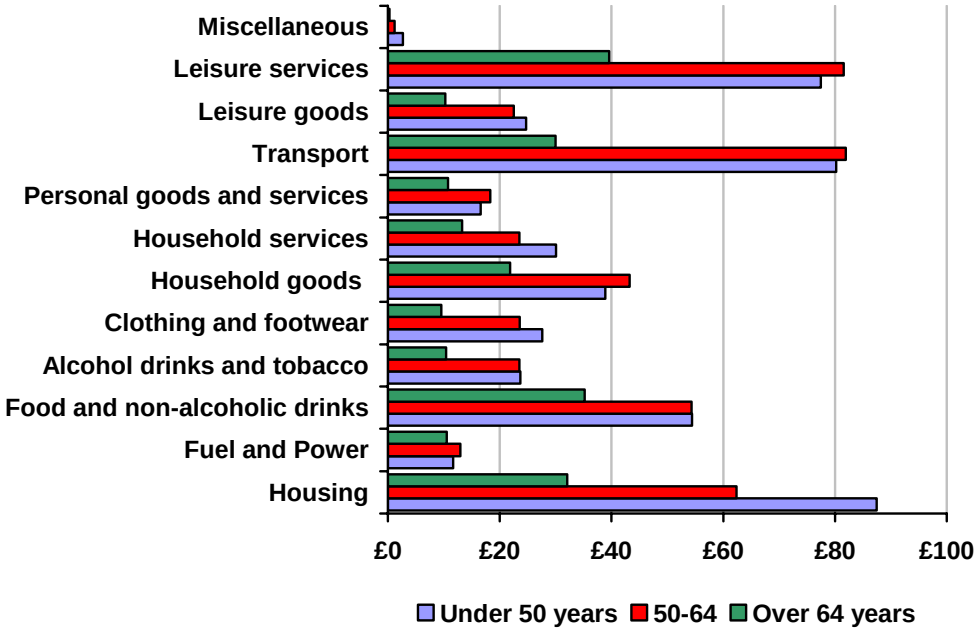
In building a scenario of future consumption patterns based on current trends, we adjust for demographic changes. As seen in Figure 3.3 below, the Government Actuaries Department forecasts that the UK's population growth to 2015 will be largely composed of people above the age of 50. By comparing how younger and older households spend their income, as presented in Figure 3.4, we adjust the growth rate of goods and services going forward to 2015.

Figure 3.3: Forecast population growth by age group, 2004-2015



Source: Government Actuaries Department.

Figure 3.4: Household spending by age group, £ per week

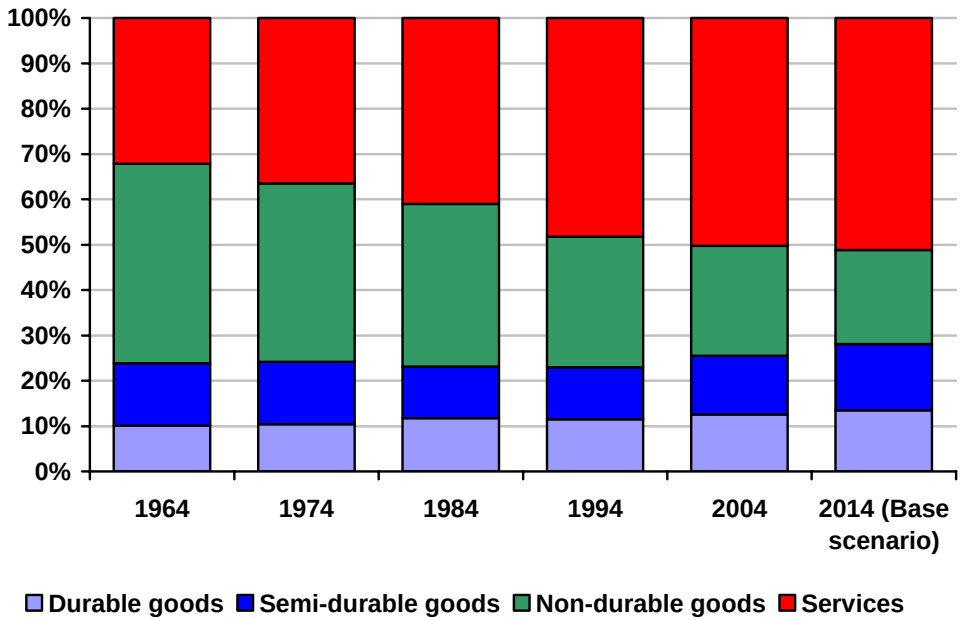


Source: Family Expenditure Survey 2002-2003.

Based on current trends and demographic changes, we expect the amount of money spent on services to grow by 78 per cent between 2004 and 2014, just the same as growth between 1994 and 2004. Spending on goods should rise 71 per cent, after rising 65 per cent in the ten years to 2004. These growth rates include rises in the prices of such goods and

services. On current trends spending on services will make up 51 per cent of all spending in 2014, up from 50 per cent in 2004, whilst goods will make up 49 per cent, down from 50 per cent in 2004.

Figure 3.5: Share of goods and services consumption in base scenario



Sources: ONS, Family Expenditure survey, Government Actuaries Department, cebr analysis. Note: 2014 is our base scenario forecast.

Future consumption — alternative scenario

The share of consumer expenditure spent on different classes of goods and services has changed over time and can be expected to continue to change more or less in line with our base scenario. However we would like to study the impact upon natural resources and the environment if the consumption of goods were ten per cent lower than estimated in our base scenario in 2015 and that difference in spending were transferred to services. We therefore run an alternative scenario to our base scenario of consumption to 2015.

We study the impact of a ten per cent transfer of consumption from goods to services because it is would be a relatively small change given how consumer trends in goods and services over the past forty years. We believe that this transfer is achievable and plausible. In chapters six and seven we test the plausibility of this transfer and also test a five per cent transfer and a fifteen per cent transfer.

We now construct the change in consumer patterns that we assume in our alternative scenario.

In building our alternative scenario we first ensure that in altering consumer patterns we do not increase total consumer spending.

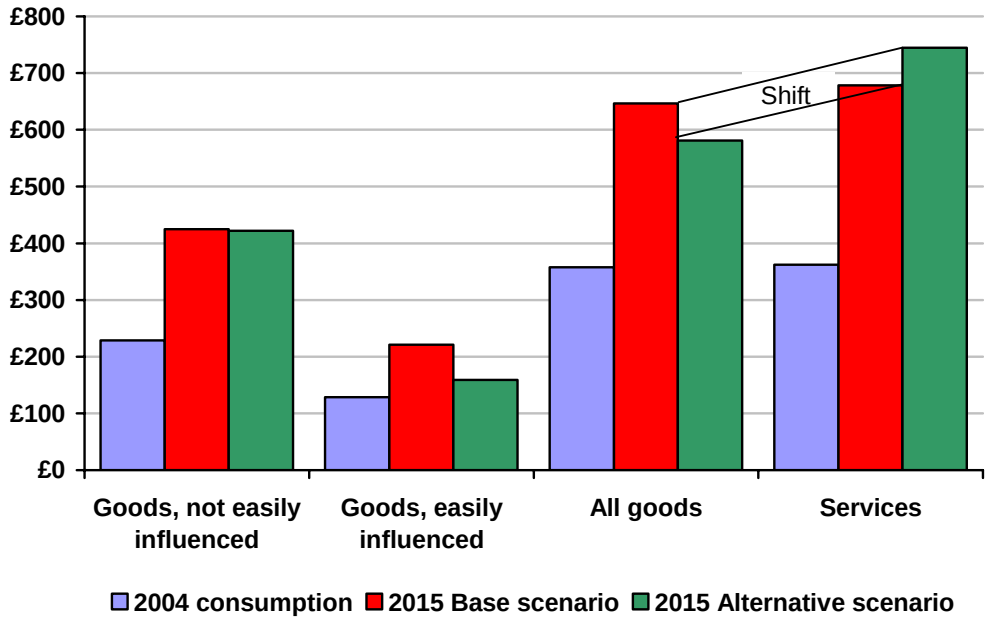
Second we make assumptions regarding changes in the pattern of consumption of goods and services. For example will we apply a larger reduction to the growth rate in the demand for motor cars or for household goods? In order to do this we have classified goods as being easily influenced or not — the consumption of food is more difficult to influence than the consumption of clothes or household appliances. We do not assume any change to goods and services that are not easily influenced such as food and drink. The assumptions that we make about changes in consumption in the alternative scenario are described in detail in the table in Appendix 1.

Third we try to ensure that the change in consumption is plausible. We do this rather rudimentarily by trying to keep to a minimum the difference between historical growth between 1994 and 2004 and the assumed change in our alternative scenario. The historical growth is provided in Appendix 1. In addition, in section six we further test the plausibility of the change by analysing what price changes would be necessary to bring about the change in the alternative scenario.

We end up with a ten per cent shift in consumer patterns from goods to services in 2015 which is largely plausible and which keeps total consumer spending equal to what it is likely to be in 2015 without the change.

The graph below compares the alternative scenario to our base scenario and to current consumption patterns and levels.

Figure 3.6: Consumption by goods and services in base and alternative scenarios, £ billion current prices



Sources: ONS, Family Expenditure survey, Government Actuaries Department, cebr analysis.

Table 3.1 below compares consumption patterns in the base and alternative scenarios.

In the alternative scenario there is a general transfer of spending from transport goods, clothing and footwear, tobacco and household goods toward services such as post and telephone, recreation and culture, education and restaurants and hotels. The categories of expenditure presented in the table are an aggregation of types of spending that fall within that category and therefore may include both goods and services. For example within purchases of transport goods and services there is less spending on motor cars and motor cycles and more spending on bicycles and on transport services such as buses and rail. The net effect is 19.3 per cent less spending on transport goods and services as a whole (including purchases of cars, fuel and rail tickets) in 2015 when compared with the base scenario.

As a whole, in the alternative scenario there is 10.1 per cent less consumption of goods and 9.8 per cent more consumption of services than in the base scenario. Total consumption is unchanged.

Table 3.1: The change in consumption from the base scenario to the alternative scenario by different types of household spending

Type of household expenditure	Difference in consumption between base and alternative scenarios	Comments
Food and drink	0.0%	No change in consumption imposed on food
Alcohol and Tobacco	-12.4%	-25% reduction in tobacco; none on alcohol
Clothing and Footwear	-21.9%	
Housing	-2.7%	
Household goods and services	-11.9%	Includes 20% cut back in electricity, gas and fuels
Health	-1.7%	All reduction is in therapeutic appliances and equipment; none on pharmaceuticals and medical services
Transport	-19.3%	Shift from cars and motor cycles to bicycles and public transport
Communication	+16.5%	Includes post and telephone
Recreation and Culture	+19.1%	Includes music, sports and cultural activities
Education	+23.4%	
Restaurants and hotels	+23.7%	
Miscellaneous	-1.5%	Reduction in jewellery and appliances for personal care; increase in insurance, financial services and social protection
Total goods change	**-10.1%**	
Total services change	**+9.8%**	

Note: See Appendix 1 for full list of consumables and the imposed change. These classifications of spend are composed of both goods and services. See the Appendix 1 for a detailed breakdown and the breakdown into goods and services.

We next test the impact of the alternative scenario when compared with the base scenario upon the demand for industrial sectors, natural resources and upon the environment.

4 IMPACT ON DEMAND FOR SECTORS AND RESOURCES

Introduction

This section describes what the impact of changing United Kingdom consumer patterns is likely to be upon different UK sectors and the demand for worldwide natural resources.

The decision by a consumer to purchase a good or service has implications for many industries involved in the production of that good or service, from those that supply the raw materials to the transport, logistics and retail elements of the supply chain.

Using our input-output model for the UK, we study how alternative future consumption patterns could affect the demand for different products produced by various sectors and the demand for natural resources. Input-output models show how the demand for goods produced in one sector of the economy — such as the demand for furniture — feed through to other sectors of the economy which supply inputs to those sectors — such as timber.

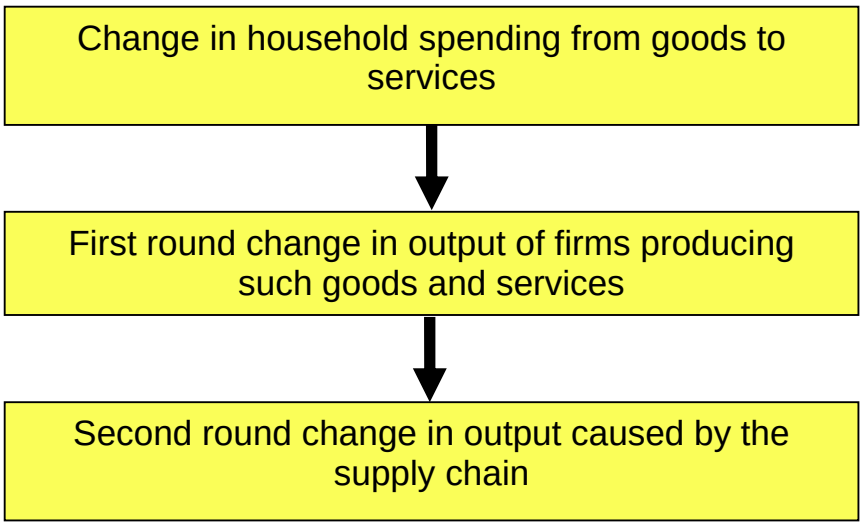
Impact of change on different sectors

We first present the impact of the change in consumption patterns from the base scenario to the alternative scenario upon different sectors of the economy.

The impact of any change in consumption upon the industries and natural resources is two-fold. The first round effect of the actual change in consumption captures how the demand for goods produced by various industries changes as a direct result of the change in consumer patterns. The second round effect captures how those sectors directly affected by the shift in consumption will respond by changing their demand for inputs, affecting other sectors in the economy. Finally there is a total change in the demand for raw materials and natural resources.

The graph below details the flow of the impact.

Graph 4.1: The flow of the impact of the change in consumer patterns



In Table 4.1 below we show the first round change in the output of firms in the alternative scenario when compared with the base scenario. This is the same shift presented in Table 3.1 above, but rather than showing the change in different types of goods and services purchased by households, it shows how the industrial sectors that produce those goods and services will change their output in the alternative scenario when compared with the base scenario. For example spending on motor cars is classified as spending by households on transport, but the sector that produces cars is the manufacturing sector.

Table 4.1: The first round change in output of production sectors in the alternative scenario compared with the base scenario

Industrial sector	First round change in output
Agriculture and forestry	+2.1%
Fishing	0.0%
Mining and Quarrying	0.0%
Manufacturing	-10.3%
Electricity, Gas and Water (Energy)	-18.5%
Construction	0.0%
Wholesale and Retail	-31.3%
Hotels and Restaurants	+23.7%
Transport and Communication	+12.9%
Finance	+12.6%
Business services	+0.6%
Public services	0.0%
Education	+23.4%
Health	+7.7%
Other community, social and personal services	+21.1%
Total impact on the economy	0.0%

Source: cebr analysis.

The alternative scenario results in a transfer of demand from goods and services produced by the manufacturing sector, the energy sector and retail (which is mostly the retailing of motor cars) toward hotels and restaurants, transport and communication, finance, education, health and community, social and personal services. We leave the impact on public services and on the total economy unchanged.

Using our input-output model, we now study how the direct effect of the different consumption patterns would translate into a total impact upon production sectors. This includes both the first and second round changes from the base scenario to the alternative scenario. The results are presented in Table 4.2.

Table 4.2: First and second round change in output of production sectors in the alternative scenario compared with the base scenario

Industrial sector	First round change in output	First and second round change in output
Agriculture and forestry	+2.1%	+2.9%
Fishing	0.0%	+1.8%
Mining and Quarrying	0.0%	-13.9%
Manufacturing	-10.3%	-5.6%
Electricity, Gas and Water (Energy)	-18.5%	-10.4%
Construction	0.0%	+0.1%
Wholesale and Retail	-31.3%	-2.9%
Hotels and Restaurants	+23.7%	+30.3%
Transport and Communication	+12.9%	+4.4%
Finance	+12.6%	+2.0%
Business services	+0.6%	+1.7%
Public services	0.0%	+0.1%
Education	23.4%	+3.3%
Health	+7.7%	+1.5%
Other community, social and personal services	+21.1%	+13.5%

Source: ONS Input-output tables, cebr analysis.

Although in our alternative scenario we have a first round reduction in manufacturing and energy output of 10.3 per cent and 18.5 per cent respectively, the total reduction would be lower at 5.6 per cent and 10.4 per cent respectively. This is because the consumption of services still requires the consumption of certain goods. For example increased sporting activities require the use of electricity, water and gas and the production of sporting equipment. Nonetheless the ten per cent shift results in a significant reduction in the output of these goods oriented sectors.

Other sectors such as retail, finance, business services, education and other community, social and personal services would also see a smaller final impact because of the linkages between sectors. However industries such as agriculture, fishing, health and mining would end up with a larger impact than under the original shift. Although we imposed

no direct impact on mining, the output of the sector would be 13.9 per cent smaller when compared with the base scenario of future consumption.

Impact of change on natural resources

Table 4.3 shows what the alternative scenario implies for the output of natural resources when compared with the base scenario. As part of the change in consumption patterns that we composed, the output of coke ovens, refined petroleum and nuclear fuel would be 31.2 per cent lower than in the base scenario. We assume this shift in the alternative scenario to reflect lower demand for motor cars and motor cycles. The direct consumption of other natural resources was not altered in the alternative scenario.

Once the impact of change in UK consumer patterns feeds down the supply chain and into imports, the output of many natural resources around the world that are required to supply the UK market would reduce sizeably. The output of coke ovens, refined petroleum and nuclear fuel would be 42.5 per cent lower than in the base scenario, with roughly three quarters of this being the assumed change made in the alternative scenario.

In money terms the consumption of oil and gas would also decline substantially. Relative to output in the base scenario, non-ferrous metals, metal castings, oil and gas extraction, coal extraction, inorganic chemicals and iron and steel would also see substantially lower output. On the other hand the output of fertilisers and pesticides would be 7.6 per cent and 0.9 per cent respectively higher with the change in consumer patterns.

Table 4.3: The impact of the change in consumption in the alternative scenario on worldwide natural resources when compared with the base scenario

Resource	Total change in demand in alternative scenario compared with base scenario, £ billion	Total % change in demand in alternative scenario compared with base scenario
Coal extraction	-0.1	-7.5%
Oil and gas extraction	-7.1	-16.6%
Metal ores extraction	0.0	0.0%
Wood and wood products	-0.2	-1.8%
Coke ovens, refined petroleum and nuclear fuel	-13.8	-42.4%
Industrial gases and dyes	-0.1	-2.3%
Inorganic chemicals	-0.2	-7.6%
Organic chemicals	-0.4	-3.5%
Fertilisers	0.1	+7.6%
Plastic and synthetic resins	-0.8	-12.4%
Pesticides	0.0	+0.9%
Paint, varnishes and printing ink	0.0	-0.9%
Iron and steel	-0.8	-6.9%
Non-ferrous metals	-0.7	-10.7%
Metal castings	-0.3	-9.8%
Structural metal products	-0.2	-1.3%
Metal boilers and radiators	-0.1	-3.2%
Metal forging and pressing	-0.9	-6.1%

Source: ONS Input-output tables, cebr analysis.

5 IMPACT ON THE ENVIRONMENT

Introduction

Consumer expenditure impacts upon the environment in two ways:

1. Direct impact — the consumption of goods and services that require energy usage or produce emissions, such as household electricity usage and the purchase of petrol for car usage

2. Indirect impact — the energy usage required and emissions produced by the industrial activity need to produce the goods and services bought by consumers

In this section we use the Office of National Statistics' environmental accounting framework to look at what the change in consumer expenditure and the output of the UK's industrial sectors in the alternative scenario implies for UK environmental emissions and energy usage.

The environmental accounts allow a detailed understanding of the indirect impact of consumer expenditure on the environment revealing energy usage and emissions of every sector of the economy. However the accounts disaggregate direct consumer expenditure only into travel spend and non-travel spend. This direct expenditure accounts for one fifth of total UK energy usage and emissions.

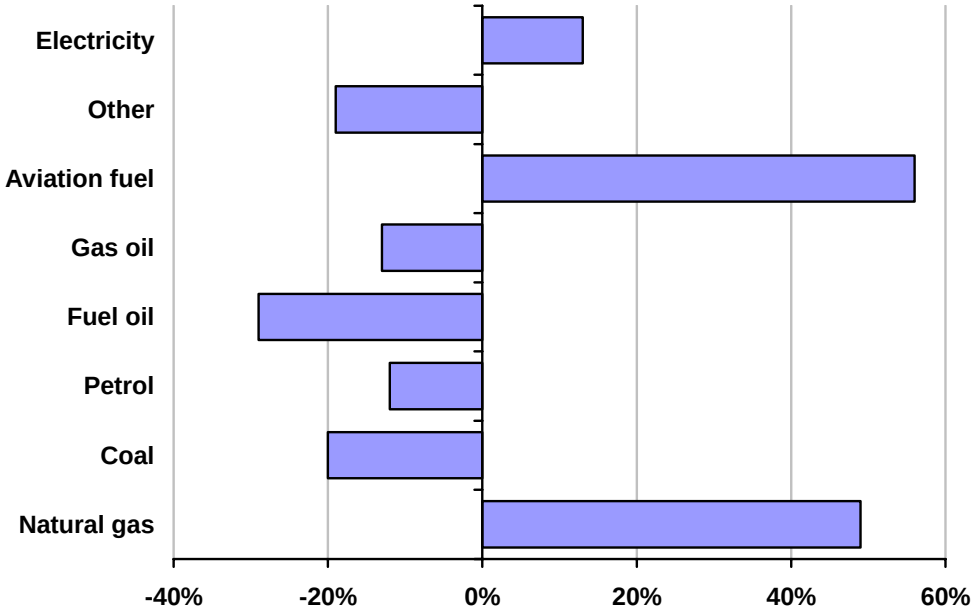
As a result of this low level of disaggregation we have adjusted the impact travel expenditure on energy usage and emissions based on the impact of transport services, transport goods manufacturing, car distribution, petroleum manufacture and oil and gas extraction. We have adjusted non-travel expenditure based on oil and gas extraction and all manufacture excluding transport goods manufacture, electricity production and distribution and gas and water supply.

In this chapter we first look at past trends in energy usage and emissions and then present the impact of the change in consumer patterns in the alternative scenario upon the environment.

Recent trends in energy usage and emissions

Between 1994 and 2003 the United Kingdom's consumption of natural gas and aviation fuel has grown rapidly. The consumption of electricity has also grown but by less than twenty per cent. However the usage of fuel and gas oils, petrol and coal decreased during the same time period.

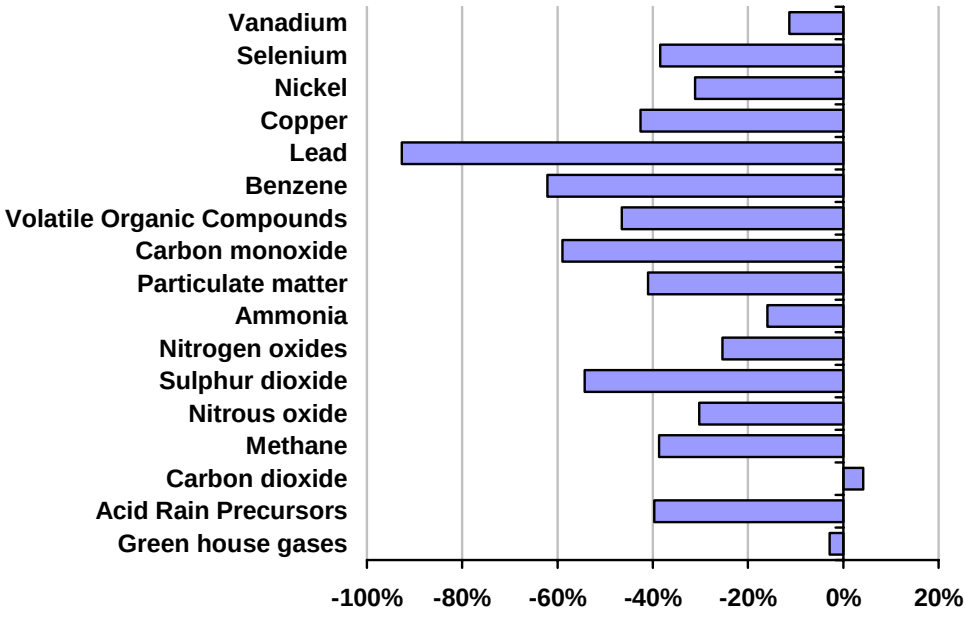
Figure 5.1: Growth in UK energy usage between 1994 and 2003



Source: ONS Environmental accounts.

The UK has been cutting back emissions in recent years. However although green house gases have been sized back by three per cent between 1994 and 2003, carbon dioxide emissions, which make up 87 per cent of such green house gases, have risen four per cent during the same time period. This is mostly due to the general growth of consumer expenditure and transport. If such trends continue green house gas emissions can be expected to rise again.

Figure 5.2: Growth in UK emissions between 1994 and 2003



Source: ONS Environmental accounts. Note: Green house gases include: carbon dioxide, methane and nitrous oxide. Acid rain precursors include ammonia, nitrogen oxides and sulphur dioxide.

Impact on energy usage

Table 5.1 below presents the difference in the usage of energy from the alternative scenario when compared with the base scenario. We also present the likely increase in energy usage and emissions if current trends continue and if there were no change in the relationship between sectors' output and energy usage. We ignore any impact that prices might have on the supply and demand of energy. Therefore the results are more indicative of the extent of the impact rather than an accurate impact of the shift upon energy usage in 2015.

The change in consumption patterns from goods toward services that we test in the alternative scenario would result in a significant impact on the usage of natural gas, coal, petrol and gas oil. Other types of energy such as electricity and fuel oil would be impacted less significantly.

Comparing the impact of the change in consumer patterns with current trends in the growth of energy usage, the impact of the shift would be effective in limiting the growth in natural gas and gas oil. The alternative scenario will likely undo any growth in coal usage and go some way to limiting the likely growth in electricity usage. In addition, the change in consumption patterns would lower the amount of petrol consumption to levels below the current amount.

Table 5.1: Difference in UK energy usage in alternative scenario compared with the base scenario

Type of energy	Growth on current trend 2003-2015*	Percentage growth on current trend 2003-2015	Difference in 2015 energy usage in alternative scenario compared with base scenario*	Percentage difference in 2015 energy usage in alternative scenario compared with base scenario
Natural gas	+42.1	+44.5%	-10.9	-8%
Coal	-5.5	-13.9%	-3.8	-11%
Petrol	-0.4	-1.9%	-2.0	-9%
Fuel oil	+3.8	+36.1%	-0.8	-6%
Gas oil	+2.1	+25.8%	-0.8	-8%
Aviation fuel	+5.2	+36.3%	0.1	1%
Electricity	+5.4	+17.3%	-1.8	-5%
Other	+1.8	+8.5%	-2.9	-12%

Sources: ONS UK Environmental accounts; ONS Input-Output tables; cebr analysis. *Note: units are in million tonnes of oil equivalent.

Impact on emissions

Table 5.2 below presents the likely impact of the consumer change upon emissions.

We estimate that if consumption patterns were to shift ten per cent from goods to services between 2007 and 2015, green house gas emissions would be six per cent lower than would otherwise be the case. This is significant because on current trends green house gas emissions are expected to rise some four per cent in the next ten years. The largest impact on green house gases is on carbon dioxide emissions which would be seven per cent lower than otherwise. On current trends, emissions of carbon dioxide would rise nine per cent between 2007 and 2015.

The emission of methane, also a green house gas, would be expected to decline by 26 per cent over the next ten years if current trends hold out. The change in consumer patterns that we study in this report would add a further one per cent reduction. A third component of green house gases is nitrous oxide. The alternative scenario would not cause any

substantial change in these emissions. However nitrous oxide only comprises six per cent of green house gases.

Acid rain precursors may be expected to decline two per cent due to the change in consumer patterns assumed in our alternative scenario, whilst other emissions should decline more significantly, such as carbon monoxide, volatile organic compounds, benzene, lead, nickel and selenium. Ammonia emissions could be expected to rise two per cent, countering a twelve per cent decline likely in the next ten years if current trends persist.

Table 5.2: Difference in UK emissions in alternative scenario compared with the base scenario

Type of emission	Growth on current trend 2003-2015	Percentage growth on current trend 2003-2015	Difference in 2015 emissions in alternative scenario compared with base scenario	Percentage difference in 2015 emissions in alternative scenario compared with base scenario
Green house gases	+26,862	+4%	-47,047	-6%
Acid rain precursors	-774	-24%	-44	-2%
Carbon dioxide	+55,770	+9%	-46,110	-7%
Methane	-10,721	-26%	-375	-1%
Nitrous oxide	+153	+0%	+180	+0%
Sulphur dioxide	-378	-29%	-30	-3%
Nitrogen oxides	-154	-11%	-34	-3%
Ammonia	-67	-12%	+11	+2%
Particulate matter	-39	-26%	-4	-4%
Carbon monoxide	-1,344	-47%	-107	-7%
Volatile organic compounds	-379	-72%	-59	-7%
Benzene	-5	-21%	-1	-7%
Lead	-81	-61%	-4	-8%
Copper	-10	-14%	-3	-6%
Nickel	+67	+18%	-36	-8%
Selenium	-6	-14%	-5	-13%
Zinc	-123	-25%	-22	-6%
Vanadium	+679	+34%	-159	-6%

Sources: ONS UK Environmental accounts; ONS Input-Output tables; cebr analysis. Note: Greenhouse gases are expressed in thousand tonnes of carbon dioxide equivalent. Acid rain precursor emissions are expressed in thousand tonnes of sulphur dioxide equivalent. All metals are expressed in tonnes. Green house gases include: carbon dioxide, methane and nitrous oxide. Acid rain precursors include ammonia, nitrogen oxides and sulphur dioxide.

6 TESTING THE RESULTS

In this report we have analysed what the likely impact of a ten per cent shift in consumer patterns from goods toward services would be upon the environment and natural resources. The shift in consumer patterns could take many forms and sizes, and so far we have only analysed one such possibility, as described in our alternative scenario.

We now test the sensitivity of our results to different assumptions. We test how the results change in response:

1. to a change in consumer patterns of different magnitudes;
2. to a different way of constructing the change in consumer patterns;
3. to technological change which would affect the relationships between different industries and sectors;
4. to technological change which would affect the relationships between industrial production or service provision and their emissions and demand for natural resources.

In the next chapter we analyse the plausibility of each of our consumer shift possibilities. We do this by estimating how much the price of the goods and services that we alter should change in order to achieve the required change in demand for those goods and services.

We start by analysing the sensitivity of our results.

Changing consumer patterns to a different degree

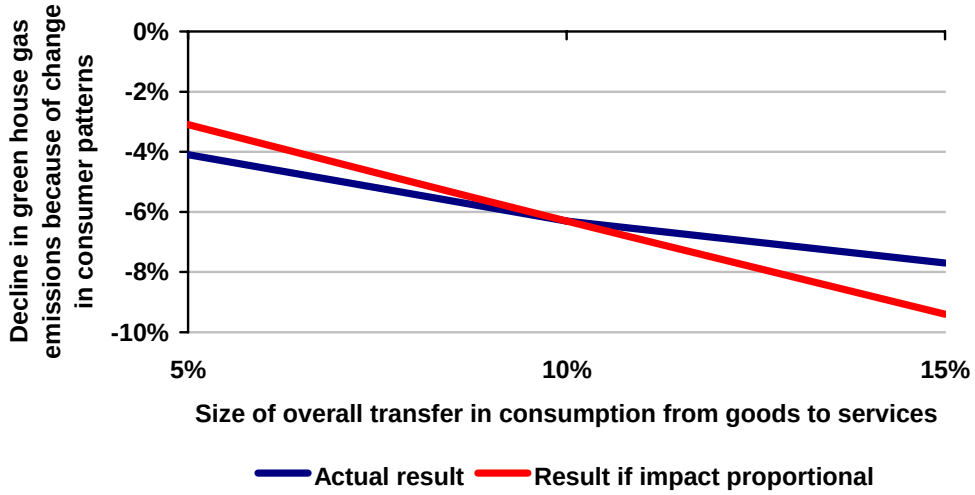
In our first sensitivity test we analyse how the impact upon natural resources and the environment would change if the size of the change in consumer patterns were different than ten per cent. We run two scenarios:

1. a larger transfer scenario — a larger shift in consumption from goods to services. We multiply the change in all goods and services in the alternative scenario by 1.5
2. a smaller transfer scenario — a transfer in consumption from goods to services. We multiply the change in all goods and services by 0.5

In both cases, we leave the composition of the transfer from goods to services unchanged.

We find that the impact on energy usage and emissions is not linearly proportional to the size of the shift in consumer patterns. The impact on the environment of the change in patterns we study grows at a slower rate than the growth in the size of the change from goods to services. Therefore a smaller overall transfer has a proportionately larger impact on energy usage and emissions than a larger overall transfer. This finding is true of all energy usages and emissions analysed in this analysis (see the Appendix 2.1 to 2.5 for detailed results).

Figure 6.1: Impact on UK green house gas emissions of different magnitudes of consumer change from goods to services



Source: cebr.

Altering the composition of the change in consumer patterns

In our second sensitivity test we study what the impact on energy usage and emissions would be if we constructed the ten per cent transfer of consumption from goods to services in a different manner. We look at four broad areas:

1. transport scenario — if the cut back in the consumption of goods was predominantly in transport goods (using cars less and using rail and bus services more than in the alternative scenario)

2. household goods scenario — if the cut back in the consumption of goods was predominantly in household goods

3. air travel scenario — if there was an increase in the air travel by UK consumers (in the alternative scenario air travel does not change)

4. clothes scenario — if the reduction in consumption of clothing and footwear were significantly lower

The overall transfer of consumption from goods to services remains at ten per cent in the first three cases, but slips to eight per cent in the last case. This is because we do not attempt to make up for the lower reduction in the consumption of clothes and footwear.

Generally, we find that despite some variation in the demand for goods produced by the mining and quarrying and the manufacturing sectors, there is little variation in the impact upon natural resources and emissions in all four sensitivity tests (see the Appendix 2.1 to 2.5 for the detailed results of these sensitivity tests).

The decline in green house gas emissions would be slightly lower in all three scenarios than in the alternative scenario and the smallest decline would be in the air travel scenario — a decline of 4.6 per cent as against a decline of 6.3 per cent in the alternative scenario.

Likewise the impact upon energy usage would not vary significantly. The demand for natural gas would not decline as much as in the alternative scenario but the smallest decline would be in the clothing scenario, where the demand for natural gas would slip 6.2 per cent compared to the base scenario. In the alternative scenario demand for natural gas would slip 8.0 per cent compared to the base case where there is no change in current consumer patterns.

The transport scenario, where the largest cut back in goods is in car and motor bike usage, results in the largest cut back in the demand for the mining and quarrying and the manufacturing sectors. This is because by cutting back on the usage of cars, the demand for oil and gas extraction, refined petroleum and metal casting and forging decreases more significantly than in all other scenarios.

As a result the usage of coal, petrol, gas oil and other energy sources would decline the most if the focus of the consumption transfer were on transport goods. However on the flip side, the emissions of acid rain precursors would increase in this scenario, unlike in all other scenarios, because higher demand for water transport services would result in higher sulphur dioxide emissions — a large component of acid rain precursors.

Contrary to the transport scenario, the household goods scenario results in the least downward pressure on the mining and quarrying and manufacturing sectors. Oil and gas extraction would only be twelve per cent lower than in the base scenario, compared with seventeen per cent in the alternative scenario and 21 per cent in the transport scenario. Likewise the demand for petroleum, nuclear fuel, metal casting and forging products would also decline by less than in the other scenarios. However the impact upon iron and steel, organic chemicals, wood and wood products, plastics and synthetic resins would be the largest in the household scenario.

In the air travel scenario — where we increase air travel by UK consumers by 20 per cent compared with no change in the alternative

scenario (and leaving all other types of consumption unchanged from the alternative scenario) — the only impact on sectoral output is in the transport sector, which increases nearly as much as in the transport scenario (Appendix 2.2). Increased air travel would have minimal impact upon energy usage and natural resources: the only impact is to reduce the reduction in petrol usage of the alternative scenario, though by less than in the household scenario. However this scenario would have a non negligible impact upon carbon dioxide emissions, reducing the impact of the transfer in consumer patterns from goods to services from seven per cent to five per cent (See appendix 2.5).

In the clothing scenario — where we deduct the consumption of clothing by five per cent compared to the base scenario, as against a 25 per cent reduction in the alternative scenario — there is a minimal impact upon the output of different sectors of the economy, energy usage and emissions. Output of the manufacturing sector would decline by 5.3 per cent as against 5.6 per cent in the alternative scenario, the usage of natural gas would decline 6.2 per cent as against 8.0 per cent, the usage of gas oil would slip 4.4 per cent rather than 7.7 per cent and green house gas emissions would decline by 5.5 per cent rather than 6.3 per cent. The impact upon all the output of other sectors, energy sources and emissions would be largely unchanged.

We conclude that constructing the changing in consumption patterns in a different manner to the alternative scenario is unlikely to result in a different overall environmental impact. However the impact on certain vulnerable sectors, such as manufacturing, may change if the focus of the transfer from goods to services changes (such as between transport goods and household goods).

Adjusting for technological change in industrial relationships

In our third sensitivity test we study how technological change — which affects what different sectors of the economy buy from other sectors of the economy — is likely to change the outcome of our alternative scenario.

In this test we leave the composition of the ten per cent shift in consumption from goods to services the same as in the alternative scenario. What we change are the parameters in the input-output table — these describe how much each sector buys from each other sector in the economy.

We test a twenty percentage point change in both directions (positive and negative) in the parameters of products that place a substantial burden upon the environment and that are likely to face technological change (see Appendix 2.6). For example, we test to see how the results of our alternative scenario would change if the production of electricity would require twenty per cent less coal input than on current trends in

2015 and twenty per cent more coal input that on current trends. Where the input requirement increases we call unfavourable technological change and where it decreases, favourable technological change.

Favourable technological change could reflect using an alternative input in the production of a good or increased efficiency in the use of an input so that waste is reduced. A higher parameter would reflect the inverse.

We find that technological change (to a twenty percentage point magnitude) can play an important role in amplifying or diminishing the impact upon the environment of the alternative scenario (see Appendix 2.2 to 2.5.)

Favourable technological change would lower the demand for electricity, gas and water by 21 per cent rather than ten per cent as in the alternative scenario. On the other hand, unfavourable change results in no change from the base scenario, effectively undoing the gains from the change in consumer patterns. The demand for petroleum would decline by 60 per cent with favourable technological change as against the 43 per cent in the alternative scenario. With unfavourable technological change, the demand for petroleum would decline by 26 per cent. The demand for the goods of other sectors does not change significantly.

Analysing the impact on emissions, technological change could play a substantial role in affecting the impact of a change in consumption patterns. With technological improvements, green house gas emissions would decline by nine per cent rather than six per cent as in the alternative scenario. Likewise, acid rain precursors would decline four per cent rather than two per cent. For both types of emissions, unfavourable technological change would broadly have the reverse, symmetric effect.

Technological change, to the order of twenty percentage points, could also alter the impact of changing consumer patterns upon energy usage. Favourable technological change will lower the usage of natural gas by ten per cent, compared with a decline of eight per cent in the alternative scenario. With unfavourable technological change, the decline would only be of three per cent.

Likewise, the impact on coal could change significantly (ranging from a decrease of 21 per cent with favourable technological change to a decline of four per cent with unfavourable change). However, the variation on other energy sources would be limited.

From this test we conclude that significant improvements in technology could sizeably alter the impact of a transfer in consumption from goods to services. Favourable advancements will amplify the impact, whilst unfavourable change with significantly diminish the impact upon natural resources and emissions.

Adjusting for technological change affecting the demand for natural resources and emissions

In the final sensitivity test we analyse whether different patterns of resource usage and emissions by household and the wider economy will change the impact of a shift in consumer patterns upon the environment. These can be driven by technological change which alters energy efficiency and what emissions are given off in the production of a good or delivery of a service.

We run two scenarios:

1. Low emissions scenario — where there are favourable changes in energy usage and emissions by industry and consumers

2. High emissions scenario — where there are unfavourable changes in energy usage and emissions by industry and consumers

In the low emissions scenario we jointly consider the impact upon the alternative scenario of:

- limiting the growth in air traffic energy consumption by half between 2003 and 2015

- increasing by an additional 50 per cent upon current trends the energy savings from energy efficiency improvements in cars

- increasing by an extra 50 per cent above current trends energy savings in energy usage from household insulating and heat efficiency

- increasing by an extra 50 per cent above current trends efficiency savings in industrial energy usage

- if industry carbon dioxide emissions that are forecast to grow slower than current trends by the Department for Trade and Industry[1] do so

- if greenhouse gas emissions per motor vehicle kilometre for the average car in the UK decline by 10.3 per cent (the minimum likely based on a five per cent confidence interval of the historical trend)

In the high emissions scenario we jointly consider the impact upon the alternative scenario of:

[1] Oxford Economic Forecasting for the Department for Trade and Industry, '*Research on output growth rates and carbon dioxide emissions of the industrial sectors of EU-ETS*' February 2006 and DTI consultation document '*EU ETS Phase II CO2 emissions projections'* February 2006. http://www.dti.gov.uk/energy/sepn/euets.shtml; http://www.dti.gov.uk/energy/consultations/

- doubling the growth on expected on current trends in air traffic energy consumption between 2003 and 2015

- no energy savings in cars between 2003 and 2015

- decreasing by half the savings in energy usage from household insulating and heat efficiency expected between 2003 to 2015

- no efficiency gains in industrial energy usage as expected on current trends between 2003 and 2015

- if industry carbon dioxide emissions that are forecast to grow faster than current trends by the Department for Trade and Industry[1] do so

- if greenhouse gas emissions per motor vehicle kilometre increase by 10.3 per cent (the maximum likely based on a five per cent confidence interval of the historical trend). This could represent stronger growth in the number of highly polluting vehicles on the road.

We find that technological changes affecting energy usage and emissions may also play a significant role in affecting the impact of a change in consumer patterns upon the environment.

The variable that is most sensitive to such technological changes is petrol. Given the range of our assumptions in this test, the impact on the usage of petrol could vary widely. In our low emissions scenario petrol usage declines 26 per cent when compared with the base scenario. This contrasts with a nine per cent decline in the alternative scenario and a 24 per cent rise in the high emissions scenario.

All other variables fluctuate to a lesser degree. The impact on coal usage varies between -18.0 per cent and -4.2 per cent, whilst the impact on natural gas ranges from -10.8 per cent to -4.3 per cent. The impact on electricity varies from -7.0 per cent to -2.0 per cent (see Appendix 2.4 and 2.5).

Likewise the impact of the consumption shift upon green house gas emissions could vary in a similar fashion in response to such technological change. In the low emissions scenario green house gases would be 11.1 per cent lower than were they would be on current growth trends in 2015 (the base scenario). This compares with an impact of -6.3 per cent in the alternative scenario and -3.1 per cent in the high emissions scenario.

We conclude from these sensitivity tests that technological change such as increased household insulation, higher household heat efficiency and cars and industry less dependent on emissions-intensive input could substantially contribute to lowering energy usage and carbon emissions. On the other hand, lower energy efficiency savings and more gas

[1] Ibid.

guzzling vehicles, could limit the environmental gains made from the shift in consumption from goods to services.

7 TESTING THE PLAUSIBILITY OF THE TRANSFER IN CONSUMPTION FROM GOODS TO SERVICES

In this section we now study how plausible the change in consumption patterns that we impose in each of our consumer scenarios is. These scenarios are:

- alternative scenario
- larger transfer scenario
- smaller transfer scenario
- transport scenario
- household goods scenario
- clothing scenario

In constructing the change in consumer patterns analysed we attempted to check its plausibility by looking at the historical growth rate in the consumption of each good. We now supplement this analysis by taking an alternative view of plausibility.

We use the price elasticity of demand for ten broad consumption categories to determine what price change would be needed between 2007 and 2015 in order to result in the desired change. The price elasticity of demand tells us how the demand for a certain good or services, such as entertainment, changes in responses to a change in the price of that good or service.

By looking at price elasticities, we can study how ready consumers are to change the consumption of certain goods. This is not to say that a change in consumer patterns should be driven by price changes. Rather changes could be voluntary, or through awareness campaigns, technological change and so on. Therefore this test serves as an indication of how easy or difficult it is to influence the demand for a good or service.

We source the price elasticity of demand for ten broad categories in the United Kingdom from Attfield (2005)[1]. We compare the required price changes for each scenario against the real price change between 1996 and 2005. The results are presented in Table 6.1. below.

[1] Attfield, '*A Time Series Aggregate Demand Model with Demographic and Income Distribution Indices*', December 2005, University of Bristol

We find that the change in consumer patterns described in the alternative scenario is largely plausible.

However whilst the required price change in most commodity groups is possible in economic terms, a high price change in some areas suggests that it may be difficult to change consumption of certain goods and services. One example is housing expenses, which include rent, water consumption and household repair and maintenance. The real price of these goods rose by three per cent between 1996 and 2005, but the change required in the alternative scenario would require a 200 per cent rise between 2007 and 2015. Though this suggests that it may be difficult to change consumption in this area, the largest single component of the change in consumption in this category is housing repair and maintenance. Lower consumption of this good in 2015 compared with current trends should be driven by weaker demand for household appliances and more efficient household goods.

Table 7.1: Price change for alternative scenario

Type of good or service	Real price change between 1996 and 2005	Real price change required for alternative scenario	Real price change required for transport scenario	Real price change required for household goods scenario
Food and drink	-2%	0%	0%	0%
Alcohol and tobacco*	20%	105%	105%	105%
Clothing and footwear	-47%	23%	11%	11%
Housing expenses**	3%	200%	211%	188%
Household goods***	-18%	34%	34%	89%
Health	0%	3%	3%	3%
Transport	38%	65%	80%	41%
Communication	-28%	-34%	-35%	-34%
Recreation	-5%	-28%	-29%	-28%
Restaurants and hotels	18%	-33%	-33%	-33%
Miscellaneous	-14%	1%	0%	3%

Sources: ONS Consumer Price Index; Attfield (2005) and cebr analysis. *The price of tobacco alone rose 51 per cent between 1996 and 2005. **Housing expenses includes water supply and repair and maintenance of household goods. *** Household goods include electricity and gas consumption. See Appendix 1 for a detailed breakdown of these categories.

A similar difficulty, though to a lesser extent, applies to areas such as household goods and clothing, where downward price pressure in the

economy, caused by global competition, will encourage the consumption of these goods. This suggests that the household scenario will possibly be more difficult to achieve.

Clearly these price changes only give an indication of how plausible the required consumption changes are. Indeed other measures apart from price changes, such as awareness campaigns and technological advancements, could assist in reaching the desired transfer in consumption.

Encouragingly, the required change in the price of transport is not significantly larger than the real price change experienced over the past ten years, even the required price change in the transport scenario. The change in consumption of other goods, such as communication and tobacco, is also possible to achieve though it may be more difficulty to raise spending on restaurants and hotels and recreation as this would require substantially lower prices of these services.

In the larger transfer scenario and smaller transfer scenario the demand upon prices grows broadly in line with the change in the magnitude of the shift. Clearly, the smaller transfer scenario is the easiest to achieve.

8 DIFFICULTIES WITH THIS RESEARCH AND RECOMMENDATIONS

The aim of this research is to get an idea of whether a relatively small change in future consumption patterns can have a sizeable impact upon natural resources and the environment. The results of the analysis are indicative of the impact of our alternative scenario rather than an accurate representation of the likely nature and growth of future changes in consumption. What is important is studying the relationship between the size of change in consumer patterns assumed in the alternative scenario and the final impact (first and second round effects).

In this report we analysed four possible compositions of a change in consumer patterns. The sensitivity tests suggest that we can be fairly confident that different compositions of the change in consumer patterns will not have a substantially different impact upon the environment.

Though this analysis allows us to be relatively confident about the plausibility of the achieving the ten per cent transfer from goods to services, it remains unclear what this would mean for the average household and how effective different measures can be. A study in Australia analysed the success of different measures undertaken to alter consumer patterns[1]. In addition, though this report gives some indication of where to focus one's attention, it is unclear what the optimal strategy would be to achieve such a change in consumption patterns.

A further limitation of this study is that it does not translate technological change — affecting how different sectors interact with one another and affecting energy usage and emissions by household and industry — into tangible measures that need to be taken on a household, business and nationwide level.

In this study we only analysed private expenditure and excluded government consumption.

This study focused solely on the United Kingdom and demonstrates that a change in consumer patterns can make a different upon environmental pressures. Further research could expand the analysis on a global level, given that industrial activity is being transferred to fast growing, emerging economies such as China and India, and given that the US remains the world's largest polluter.

[1] Australian Department for Environment, Sport and Territories, '*More with less: initiatives to support sustainable consumption*', 1990s
http://www.deh.gov.au/about/publications/economics/more/pubs/more.pdf

9 CONCLUSION

The purpose of this study is to assess whether a plausible change in future consumer patterns from materially oriented goods toward services will have a significant impact upon the demand for natural resources and the environment.

We find that the transfer in consumption that we have assumed in our alternative scenario from a number of goods toward a number of services between 2007 and 2015 does have an important impact upon the demand for natural resources and the environment. We find that there would be lower demand for the mining of oil, gas and coal. The output of refined plastic and synthetic resins, inorganic chemicals, iron and steel, and other non-ferrous metals is limited in the alternative scenario. However the demand for wood and wood products and industrial gases and dyes would not be significantly affected. The alternative scenario raises the demand for fertilisers by some eight per cent when compared with the base scenario.

In terms of volumes of energy usage the change will likely have a significant impact on the usage of coal, petrol and natural gas. There will be less of an impact on electricity and fuel oil, though nonetheless significant.

The alternative scenario would substantially lower green house gas emissions, particularly carbon dioxide, when compared with our base scenario. The change in consumption would tend to accelerate the rate of reduction in emissions such as carbon monoxide, lead, benzene, nickel and selenium. However we expect that it will do little to reduce the rate of increase methane and nitrous oxide emissions. Ammonia emissions could increase relative to the base scenario.

The literature review and our sensitivity tests suggest that a ten per cent transfer of consumption from goods to services is largely plausible and that different compositions of the transfer will do little to affect the overall outcome. However technological change could significant alter the impact of the transfer in consumption patterns upon the environment.

10 APPENDIX

Appendix 1. Assumed change in consumption in alternative scenario by detailed consumer goods and services

Type of good and service	Growth between 1994-2004	Change in alternative scenario
Food and drink		
Bread and cereals	40%	0%
Meat	28%	0%
Fish	43%	0%
Milk, cheese and eggs	22%	0%
Oils and fats	7%	0%
Fruit	65%	0%
Vegetables	33%	0%
Sugar, confectionery and ice-cream	28%	0%
Other food	48%	0%
Coffee, tea and cocoa	21%	0%
Fruit and vegetable juices and other soft drinks	60%	0%
Alcohol and tobacco		
Spirits	30%	0%
Wines, cider and perry	101%	0%
Beer	56%	0%
Tobacco	42%	-25%
Clothing and footwear		
Clothing materials	30%	-23%
Garments	70%	-23%
Other articles of clothing and clothing accessories	41%	-23%
Cleaning and hire of clothing	45%	-23%
Shoes and other footwear	44%	-23%
Repair and hire of footwear	-17%	-23%
Housing expenses		
Actual rentals for housing	59%	0%
Imputed rentals for housing	104%	0%
Repair Materials	83%	-25%
Repair Services	60%	10%
Water supply	35%	-10%
Refuse collection	152%	-5%
Sewerage collection	43%	-5%
Other services	0%	0%
Household goods and services		
Electricity	5%	-20%
Gas	25%	-20%
Liquid fuels	98%	-20%
Solid fuels	-48%	-20%
Heat energy	0%	0%
Furniture and furnishings	117%	-10%
Carpets and other floor coverings	70%	-10%
Repair of furniture, furnishings and floor coverings	-10%	-10%
Household textiles	87%	0%
Major appliances whether electrical or not	38%	-25%
Small electric household appliances	65%	-20%

Source: cebr. Note: Change is on consumption in 2015 but is imposed gradually between 2007 and 2015. Growth between 1994 and 2004 and the assumed future changes are in nominal prices.

Type of good and service	Growth between 1994-2004	Change in alternative scenario
Household goods and services continued		
Repair of household appliances	42%	-20%
Glassware, tableware and household appliances	76%	-20%
Major tools and equipment	47%	-25%
Small tools and equipment	120%	-20%
Non-durable household goods	43%	-20%
Domestic and household services	86%	0%
Health		
Pharmaceutical products	74%	0%
Other medical products	45%	0%
Therapeutic appliances and equipment	142%	-5%
Medical services	57%	0%
Dental services	67%	0%
Paramedical services	82%	0%
Hospital services	117%	0%
Transport		
Motor cars	68%	-35%
Motor cycles	99%	-35%
Bicycles	121%	30%
Spare parts and accessories for personal transport equipment	86%	-35%
Fuels and lubricants for personal transport equipment	62%	-35%
Maintenance and repair of personal transport equipment	97%	-35%
Other services in respect of personal transport equipment	99%	-35%
Rail	83%	20%
Road	74%	20%
Air	101%	0%
Sea and inland waterway	109%	5%
Other purchased transport services	140%	10%
Communication		
Postal services	-7%	5%
Telephone and telefax equipment	182%	15%
Telephone and telefax services	101%	15%
Recreation and culture		
Audio visual and recording equipment	44%	15%
Photographic etc equipment	253%	15%
Information processing equipment	170%	10%
Recording media	120%	5%
Repairs of audio-visual etc equipment	66%	10%
Major durables for outdoor recreation	217%	15%
Musical instruments and major durables for indoor recreation	26%	15%
Maintenance and repairs of other major durables	188%	15%
Games, toys and hobbies	217%	15%
Equipment for sport, camping and open-air recreation	101%	15%
Garden, plants and flowers	87%	5%
Pets and related products	50%	5%
Veterinary and other services for pets	77%	20%
Recreational and sporting services	67%	25%

Source: cebr. Note: Change is on consumption in 2015 but is imposed gradually between 2007 and 2015. Growth between 1994 and 2004 and the assumed future changes are in nominal prices.

Type of good and service	Growth between 1994-2004	Change in alternative scenario
Recreation and culture continued		
Cultural services	80%	25%
Games of chance	121%	25%
Books	66%	25%
Newspapers	15%	15%
Miscellaneous printed matter	35%	20%
Stationery and drawing materials	24%	20%
Package holidays	0%	0%
Education	81%	23%
Restaurants and Hotels		
Catering services	74%	20%
Accommodation	47%	20%
Miscellaneous		
Hairdressing salons and personal grooming establishments	102%	0%
Electrical appliances for personal care	173%	-30%
Other appliances, articles and products for personal care	117%	-30%
Jewellery clocks and watches	62%	-30%
Other personal effects	205%	-30%
Social protection	17%	10%
Life insurance	64%	10%
Insurance connected with the dwelling	24%	0%
Insurance connected with health	44%	0%
Insurance connected with transport	58%	0%
Other insurance	0%	0%
Financial services n.e.c (excluding FISIM)	142%	17%
Other services n.e.c	36%	10%

Source: cebr. Note: Change is on consumption in 2015 but is imposed gradually between 2007 and 2015. Growth between 1994 and 2004 and the assumed future changes are in nominal prices.

Appendix 2.1. Sensitivity tests: change in consumer patterns

Change in demand for goods/services	Alternative scenario	Smaller transfer scenario	Larger transfer scenario	Clothing scenario	Transport scenario	Household goods scenario	Air travel scenario
Total goods to services transfer	-10%	-6%	-14%	-8%	-10%	-10%	-10%
Food and drink	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Alcohol and tobacco	-12.4%	-6.6%	-17.6%	-12.4%	-12.4%	-12.4%	-12.4%
Clothing and footwear	-21.9%	-11.6%	-31.2%	-5.2%	-10.2%	-10.2%	-21.9%
Housing	-2.7%	-1.4%	-3.8%	-2.7%	-2.8%	-2.4%	-2.7%
Household goods and services	-11.9%	-6.2%	-17.2%	-11.9%	-12.0%	-31.0%	-11.9%
Health	-1.7%	-0.8%	-2.5%	-1.7%	-1.7%	-1.7%	-1.7%
Transport	-19.3%	-10.7%	-26.1%	-19.3%	-23.7%	-12.0%	-16.5%
Communication	16.5%	8.0%	25.7%	16.5%	16.7%	16.5%	16.5%
Recreation and culture	19.1%	9.1%	30.0%	19.1%	19.5%	19.1%	19.1%
Education	23.4%	11.2%	36.9%	23.4%	23.4%	23.4%	23.4%
Restaurants and hotels	23.7%	11.3%	37.2%	23.7%	23.7%	23.7%	23.7%
Miscellaneous	-1.5%	-1.2%	-1.1%	-1.5%	0.4%	-4.0%	-1.5%

Source: cebr.

Appendix 2.2. Sensitivity tests: change in output of sectors

First and second round sector impact	Alterna-tive scenario	Smaller transfer scenario	Larger transfer scenario	Clothing scenario	Trans-port scenario	House-hold goods scenario	Air travel scenario	Favour-able techno. change	Unfavour-able techno. change
Agriculture and forestry	2.9%	1.4%	4.5%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%
Fishing	1.8%	0.9%	2.9%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%
Mining and quarrying	-13.9%	-7.7%	-19.0%	-13.9%	-17.5%	-10.0%	-13.9%	-13.4%	-14.3%
Manufacturing	-5.6%	-4.0%	-5.8%	-5.3%	-7.2%	-5.0%	-5.4%	-6.4%	-4.7%
Electricity, Gas and water	-10.4%	-5.7%	-14.3%	-10.3%	-10.8%	-11.0%	-10.3%	-20.9%	0.1%
Construction	0.1%	0.0%	0.3%	0.1%	0.1%	0.2%	0.2%	0.1%	0.2%
Wholesale and retail	-2.9%	-1.6%	-3.9%	-2.9%	-3.8%	-1.7%	-2.8%	-3.1%	-2.6%
Hotels and restaurants	30.3%	14.4%	47.8%	30.3%	30.3%	30.3%	30.4%	30.3%	30.3%
Transport and communication	4.4%	2.0%	7.2%	4.5%	6.4%	3.6%	6.3%	3.5%	5.4%
Finance	2.0%	0.9%	3.3%	2.0%	2.0%	2.0%	2.1%	2.0%	2.0%
Business services	1.7%	0.7%	2.9%	1.7%	1.7%	2.0%	1.9%	1.7%	1.7%
Public services	0.1%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Education	3.3%	1.6%	5.2%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%
Health	1.5%	0.7%	2.3%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
Other community and personal services	13.5%	6.3%	21.5%	13.6%	13.6%	13.4%	13.5%	13.5%	13.5%

Source: cebr.

Appendix 2.3. Sensitivity tests: change in natural resources

Consumption of natural resources	Alterna-tive scenario	Smaller transfer scenario	Larger transfer scenario	Clothing scenario	Trans-port scenario	House-hold goods scenario	Air travel scenario	Favour-able techno. change	Unfavour-able techno. change
Coal extraction	-7.5%	-4.2%	-10.1%	-7.4%	-7.6%	-7.7%	-7.4%	-6.8%	-8.0%
Oil and gas extraction	-16.6%	-9.1%	-22.7%	-16.6%	-20.9%	-11.6%	-16.1%	-15.9%	-17.0%
Metal ores extraction	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Wood and wood products	-1.8%	-1.1%	-2.1%	-1.8%	-3.7%	-5.1%	-1.8%	-1.8%	-1.8%
Coke ovens, refined petroleum and nuclear fuel	-42.5%	-23.4%	-57.9%	-42.4%	-56.1%	-26.5%	-41.0%	-59.5%	-25.5%
Industrial gases and dyes	-2.3%	-1.6%	-2.6%	-2.2%	-2.6%	-2.7%	-2.2%	-2.2%	-2.4%
Inorganic chemicals	-7.6%	-5.4%	-9.0%	-7.6%	-8.9%	-8.3%	-7.5%	-7.3%	-7.9%
Organic chemicals	-3.5%	-2.5%	-4.1%	-3.5%	-3.6%	-4.5%	-3.4%	-3.5%	-3.5%
Fertilisers	7.6%	3.6%	12.1%	7.6%	7.6%	7.7%	7.7%	7.6%	7.6%
Plastics & Synthetic resins etc	-12.4%	-7.3%	-16.3%	-12.3%	-13.2%	-14.8%	-12.3%	-14.3%	-10.4%
Pesticides	0.9%	0.4%	1.5%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%
Paints, varnishes, printing ink etc	-0.9%	-0.8%	-0.4%	-0.9%	-1.6%	-0.9%	-0.8%	-0.9%	-0.8%
Iron and steel	-6.9%	-4.0%	-8.7%	-6.9%	-7.4%	-9.1%	-6.8%	-7.0%	-6.8%
Non-ferrous metals	-10.7%	-6.4%	-13.6%	-10.6%	-12.0%	-11.0%	-10.7%	-10.8%	-10.5%
Metal castings	-9.8%	-5.4%	-13.1%	-9.8%	-12.5%	-6.6%	-9.8%	-10.0%	-9.7%
Structural metal products	-1.3%	-0.8%	-1.7%	-1.3%	-1.6%	-1.2%	-1.3%	-1.3%	-1.4%
Metal boilers and radiators	-3.2%	-1.8%	-4.3%	-3.2%	-3.7%	-3.0%	-3.2%	-3.4%	-3.1%
Metal forging, pressing, etc	-6.1%	-3.5%	-7.9%	-6.1%	-7.6%	-4.5%	-6.0%	-6.2%	-6.0%

Source: cebr.

Appendix 2.4. Sensitivity tests: change in energy usage

Energy Usage	Alterna-tive	Smaller transfer	Larger transfer	Clothing	Trans-port	House-hold goods	Air travel	Favour-able techno. change	Unfavou-rable techno. change	Low emiss-ions	High emiss-ions
Natural gas	-8.0%	-5.6%	-9.5%	-6.2%	-7.2%	-6.8%	-7.8%	-10.2%	-3.0%	-10.8%	-4.3%
Coal	-11.3%	-6.3%	-15.3%	-11.3%	-12.6%	-10.3%	-11.1%	-20.6%	-4.2%	-17.5%	-4.2%
Petrol	-9.2%	-5.2%	-12.0%	-9.2%	-11.2%	-5.8%	-7.1%	-11.2%	-8.5%	-26.0%	24.4%
Fuel oil	-5.5%	-3.2%	-7.1%	-5.5%	-3.8%	-3.8%	-5.3%	-8.1%	-6.6%	-6.0%	-4.6%
Gas oil	-7.5%	-4.8%	-7.9%	-4.4%	-5.7%	-6.5%	-7.4%	-8.1%	-7.6%	-8.5%	-5.6%
Aviation fuel	0.7%	0.3%	1.2%	0.7%	0.7%	0.8%	19.7%	-2.4%	3.7%	0.7%	0.7%
Other	-12.3%	-7.6%	-15.7%	-11.4%	-14.7%	-10.7%	-12.0%	-15.9%	-11.3%	-16.8%	-3.8%
Electricity	-5.1%	-4.1%	-5.2%	-3.2%	-3.9%	-4.0%	-4.9%	-5.3%	-1.8%	-7.0%	-2.0%

Source: cebr.

Appendix 2.5. Sensitivity tests: change in emissions

Emiss-ions	Alterna-tive	Smaller transfer	Larger transfer	Clothing	Trans-port	House-hold goods	Air travel	Favour-able techno. change	Unfavou-rable techno. change	Low emiss-ions	High emiss-ions
Green house gases	-6.3%	-4.1%	-7.7%	-5.5%	-6.1%	-5.1%	-4.6%	-9.4%	-2.7%	-11.1%	-3.1%
Acid rain precurs-ors	-1.7%	-1.3%	-1.8%	-1.5%	0.6%	-1.3%	-1.4%	-3.8%	0.0%	-1.7%	-1.7%
Carbon dioxide	-6.7%	-4.3%	-8.3%	-5.9%	-6.6%	-5.6%	-4.6%	-10.0%	-3.0%	-12.0%	-3.4%
Methane	-1.3%	-0.9%	-1.2%	-1.2%	-1.4%	-1.2%	-1.2%	-3.9%	1.5%	-3.0%	-1.2%
Nitrous oxide	0.4%	0.0%	1.4%	0.5%	0.1%	1.1%	1.0%	-0.6%	1.2%	-2.3%	1.9%
Sulphur dioxide	-3.2%	-1.9%	-3.9%	-3.1%	-0.1%	-2.7%	-3.0%	-6.3%	-1.0%	-3.2%	-3.2%
Nitrogen oxides	-2.8%	-2.0%	-3.1%	-2.4%	-0.4%	-2.4%	-2.3%	-4.8%	-0.6%	-2.8%	-2.8%
Ammonia	2.3%	0.8%	4.1%	2.5%	2.3%	2.7%	2.5%	2.3%	2.6%	2.3%	2.3%
Particul-ate matter	-3.7%	-2.8%	-4.1%	-2.8%	-3.0%	-3.2%	-3.5%	-4.0%	-2.5%	-3.7%	-3.7%
Carbon monoxide	-6.9%	-4.5%	-8.3%	-6.0%	-7.2%	-6.2%	-6.2%	-7.5%	-5.6%	-6.9%	-6.9%
Volatile organic comp-ounds	-7.3%	-4.8%	-8.8%	-6.3%	-8.2%	-5.6%	-7.0%	-8.4%	-5.4%	-7.3%	-7.3%
Benzene	-6.8%	-5.5%	-7.5%	-4.1%	-3.3%	-4.6%	-6.7%	-6.0%	-3.5%	-6.8%	-6.8%
Butadiene	-1.3%	-1.1%	-1.1%	-0.9%	-0.8%	-1.4%	-0.9%	-1.6%	-0.5%	-1.3%	-1.3%
Lead	-7.8%	-4.6%	-10.0%	-7.6%	-8.1%	-8.6%	-7.6%	-9.3%	-7.5%	-7.8%	-7.8%
Copper	-5.9%	-3.6%	-7.2%	-5.6%	-6.1%	-4.8%	-5.3%	-7.5%	-5.1%	-5.9%	-5.9%
Nickel	-8.3%	-4.7%	-10.9%	-8.2%	-7.2%	-5.1%	-7.9%	-11.9%	-10.0%	-8.3%	-8.3%
Selenium	-13.4%	-7.5%	-18.1%	-13.3%	-11.6%	-23.6%	-12.8%	-15.1%	-12.3%	-13.4%	-13.4%
Zinc	-5.8%	-3.3%	-7.5%	-5.8%	-6.2%	-5.4%	-5.5%	-9.7%	-2.5%	-5.8%	-5.8%
Vanadium	-5.9%	-3.5%	-7.5%	-5.9%	-5.2%	-4.0%	-5.5%	-8.8%	-6.6%	-5.9%	-5.9%

Source: cebr.

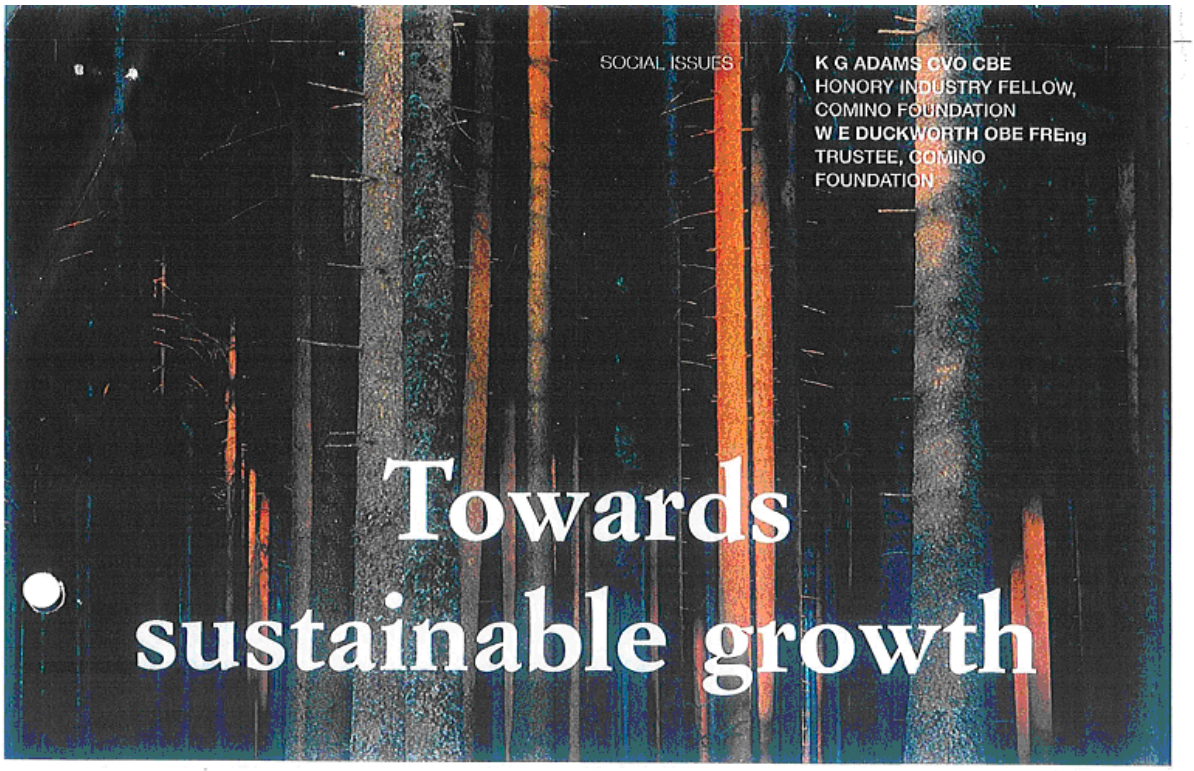
Appendix 2.6. Input-output sensitivity tests

We alter the following input output parameters in the input-output sensitivity tests (all by 20 per cent and in both directions):

- coal usage in electricity production
- oil and gas usage in electricity production
- oil and gas usage in gas distribution
- oil and gas usage in the production of coke ovens, petroleum and nuclear fuels

- coke ovens, petroleum and nuclear fuels in the production and distribution of electricity
- coke ovens, petroleum and nuclear fuels in gas distribution
- coke ovens, petroleum and nuclear fuels in motor vehicle distribution and repair
- coke ovens, petroleum and nuclear fuels in railway transport
- coke ovens, petroleum and nuclear fuels in land transport other than rail
- coke ovens, petroleum and nuclear fuels in air transport
- industrial gases and dyes in the production of plastics and synthetic resins
- inorganic chemicals in the production of plastics and synthetic resins
- plastics and synthetic resins in the production of domestic appliances
- plastics and synthetic resins in the production of motor vehicles
- plastic products in the production of motor vehicles
- plastic products in motor vehicle distribution and repair
- electricity in the distribution of gas
- gas distribution in the production and distribution of electricity
- gas distribution in the distribution of gas (gas distribution becomes more efficient)
- electricity production and distribution in the supply of water

Appendix 3. Article from February 2002 issue of Ingenia (the journal of The Royal Academy of Engineering)



SOCIAL ISSUES

K G ADAMS CVO CBE
HONORY INDUSTRY FELLOW,
COMINO FOUNDATION
W E DUCKWORTH OBE FREng
TRUSTEE, COMINO
FOUNDATION

Towards sustainable growth

In the August 2001 issue of Ingenia, *Professor Meredith Thring commented on the problems posed by our ever-increasing consumption of natural resources and the pollution of the environment. KG Adams and WE Duckworth, in a letter in the November 2001 issue suggested that, in future, people should achieve personal fulfilment through intellectual, aesthetic, spiritual, physical and social activities, rather than through material consumption. Here they expand upon this idea.*

The problem

Organisations such as Greenpeace and Friends of the Earth have been promulgating, for the last two decades or so, the message that the developed world's obsession with the acquisition of material goods cannot be sustained without irrepairable damage to the environment and exhaustion of natural resources. Their essential plea to Western people is 'stop consuming'.

This request is very difficult for the general population to absorb and act upon. The satisfaction of needs is an essential part of human nature. Acquisition and the satisfaction of desires have become part of current behaviour in the Western world. The triumph of the market economy over communism has demonstrated the power of the consumer today. Marketing and not production is now the dominant force. Production is in the service of what the market can sell.

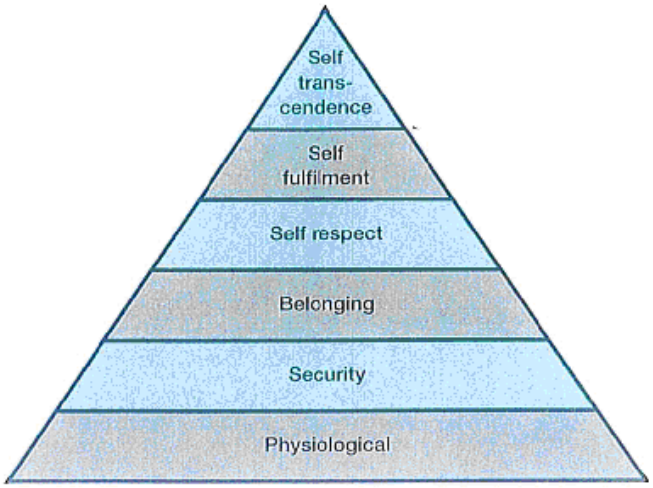
In his book *The Practice of Management* (1955) Peter Drucker said 'There is only one valid definition of business purpose: to create a customer'. Business is therefore about finding new customers for new products or more customers for old ones. Underlying this is an understanding of humanity which sees people as having limitless latent desires which can be continuously and progressively stimulated into felt wants. Business therefore cannot respond to a plea to reduce consumption.

Reduced consumption would also be disastrous for the world economy. Because marketing seeks continually to extend the range of human desires it ensures economic growth. Without that the market stagnates and recession occurs. The hardest hit would be the developing world which the environmentalists seek to defend. The world economy thus depends upon the ever-hungry consumer.

Those who lead in marketing study how to sell their services or products by appealing to one or more of the full range of human needs from those basic to survival, from fresh air, food and water, to those for security, love, self-respect and self-fulfilment. They are continually exploring what latent areas of human desire can be aroused or re-awakened to open up new markets or expand old ones. Growth in these desires and aspirations is the fuel that drives market economies.

As Meredith Thring and others have pointed out this growth is already beginning to place an intolerable burden upon the environment. So market economies would appear to have within them the seeds of their own destruction.

Figure 1



A possible solution

What we will now suggest is a process for business to change the direction of the market drive and thus consumer demand into one less dependent on the acquisition of material goods. The key factor which has not been examined in the exposure of the dilemma is the truth or falsehood of the view of humanity on which the marketing concept rests. Long ago Abraham Maslow pointed out that there is a hierarchy of human needs which is often presented in the pyramid form shown above.

Life depends upon our physiological needs being met for air, water, food, warmth, etc., but as we progress up the pyramid these needs are no longer directly promoting survival but are those that allow us to develop. In a paper published in the November 1990 journal of the RSA (the Royal Society for the encouragement of Arts, Manufactures and Commerce), one of us (KGA) pointed out that the representation of Maslow's ideas made it look as if our greatest needs lie at the bottom of the pyramid. Although these are essential they are limited. One can only eat so much food, drink so much water, breathe so much air. This is also true at the next level. Only one suit, one room, one car can be used at a time.

As the hierarchy is ascended the picture changes and as the needs for self-fulfilment and self-transcendence into new experiences are realised the restricting factors seem to fall away: these needs feel limitless. Adams proposed that the real picture of our needs was the inverse of the popular way in which Maslow's ideas are presented as shown in the second diagram (Figure 2).

The needs are in the same order, but the picture reveals the limited nature of our physical needs, and the limitless desires for intellectual, aesthetic and spiritual growth and delight. There is no top to this pyramid. This new picture affirms that the underlying view of human beings as creatures of limitless latent needs on which the marketing concept rests is true, but the great growth markets are not in our physical needs which place high material demands on the environment. They are in those that can place a very small demand on material resources and energy. A realisation of this by the business communities of the developed world will show that their main future markets no longer lie in producing more energy-consuming and polluting physical products but in gratifying our less material desires.

To some extent this is already occurring. Martin Hayward of the Henley Centre pointed to this in an article in the June 2001 issue of *The Director*, the magazine of The Institute of Directors, when he drew attention to a search for satisfaction in new consumer areas being potentially a precursor to a post-materialist swing. Last Christmas, he wrote, the luxuries that many consumers wanted were intangible. More rest, a couple of days without the children, someone to cook the dinner, a nice day out or a holiday, were far more popular than traditional products. Boots, WH Smith, Thomas Cook and Marks & Spencer had all developed new products for sale: a day at a health farm; learning to rally drive; a flight in a hot air balloon. These 'experiences' were on sale alongside the more traditional gift items and the market for innovative thrills is growing rapidly.

This realisation of where the growth markets lie for those who have enough in material terms is of profound importance. Those of us who have enough still need to be motivated to continue to play a vital part in the production of the material needs of all the other people in the world. We will generally only be so motivated by reward which we can devote to our own growth.

If the latter continues to be expressed in material terms we will fail to supply the needs of the rest of the world and will destroy our environment. If we change our aspirations we will do neither. The new markets are already appearing in extended education, entertainment, music, garden and leisure centres, provision for better health and a more secure old age.

In this vision of the new markets, business is not simply called upon to be more green in its operations in a negative way. It becomes the leading force in solving our environmental dilemma through its marketing skills in changing aspirations.

Issues

We are aware that the changes we urge on business will concern those who wish

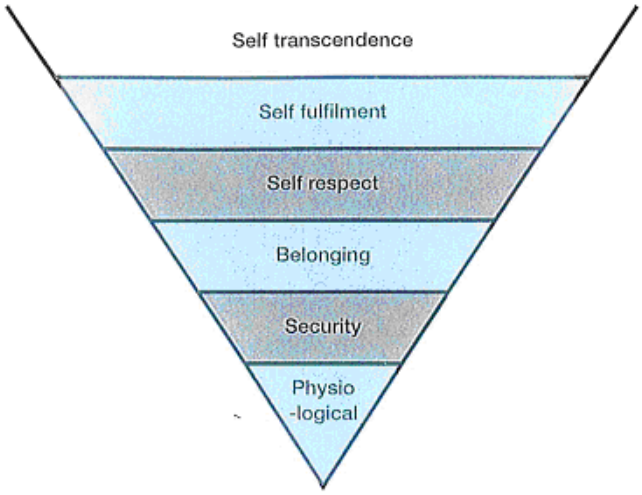


Figure 2

to preserve in the West the traditional hardware manufacturing industries. These will still be needed because many of their products will still be required, but with a greater emphasis on exports to the developing world. They will, in any case, be less material and energy-intensive than at present following trends which have been underway for many years. (See 'Present and Future Patterns of Material Use'. *Chemistry and Industry* Nov. 1982.)

These natural trends, plus the increasing outsourcing forced by competitive pressures, have already moved major manufacturing operations into developing countries to their great benefit. Even such a staunch supporter of British manufacture and design as James Dyson has had to follow this practice. What matters is not the decline of industries. This can never be halted, as post-war governments have found to the taxpayers' cost. It is jobs that must be preserved and increased in value. This will be much better done in applications that are sustainable rather than in jobs that are continually under threat from environmental pressures.

The skills of modern manufacturing can be readily used in the leisure industries of the future. The software that enables plant makers to explore three-dimensional models of their designs can be adapted to enable realistic holiday tours to be enjoyed from an armchair with none of the hassle of actually travelling. Three-dimensional laser holography could eventually make videoconferencing totally acceptable. Inexpensive numerically controlled tools would transform many hobbies. Distance learning and other techniques common in business will improve the capacity to enjoy leisure, and will produce many creative outlets. Instantaneous language translation will foster more international friendships.

The opportunities are endless. Manufacturing has long ceased to be just a matter of metal bashing. As Dr Ivan Yates has said, it is better defined as a process in which the product is distinct from the means of its creation. With this acceptance, there will be no end to manufacturing nor of the skills employed within it in environmentally friendly use.

Summary

To sum up: We maintain that business can play a major part in the solution of our environmental dilemma by changing the aspirations of people in the developed world through the expansion of its markets in the areas of intellectual, aesthetic, spiritual, physical and social delight, because these are not highly consumptive of materials or energy.

The Comino Foundation, whose purpose is to help people in Britain live fulfilled lives within a prosperous and responsible society, is interested in encouraging debate on the validity of our argument. We would value comments on how best to initiate that debate. ■

Further information and offers to assist in the work of the Comino Foundation should be directed to:

K G Adams CVO CBE Honorary Industry Fellow, Comino Foundation. Kenneth Adams was a regular Army Officer until 1959. He then became a director of Hays Wharf and a non-executive director of other companies. He was also involved in the Industrial Mission of the Church. In 1969 he was appointed the first Director of Studies at St. George's House, Windsor Castle and in 1975 initiated a movement to develop an affirmative cultural attitude to industry in Britain. This led to the setting up of many institutions now pursuing this activity and the promotion of Industry Year 1986.

Eric Duckworth is a minor polymath. After graduating in metallurgy from Cambridge he took up industrial statistics and then operational research while working in the motor industry. He returned to metallurgy in the steel industry before becoming managing director of the Fulmer Research Institute, the first contract research organisation in the UK, and became a physicist and materials engineer, hence his Fellowship of the Royal Academy. He has written books and many papers on all his chosen disciplines.