OXFORD ECONOMICS

Fossil fuel price shocks and a low carbon economy

December 2011

A report for the Department of Energy and Climate Change

OXFORD ECONOMICS

Contents

Executive Summary

Disclaimer: This Working Paper should not be reported as representing the views of the Department of Energy and Climate Change (DECC). The views expressed in this paper are those of Oxford Economics and do not necessarily represent those of DECC or DECC policy. This paper has been published to elicit comments and to further debate.

The aim of this report is to enrich the discussion on the UK's climate change policies by assessing how these policies could improve the stability of the UK economy in the face of global energy price shocks. Energy prices have been trending up over the past decade and have also seen increased volatility in recent years. High and volatile energy prices have a negative effect on the economy of an oil and gas importing country such as the UK.

Policies aimed at reducing the UK's dependence on fossil fuels intuitively will reduce the economy's vulnerability to fluctuations in global commodity markets. To assess the impact of climate change policy on reducing the sensitivity of the UK economy to such shocks, we develop scenarios using both the Oxford Economics' UK Energy and Industry Model and its Global Economic Model. The impacts of global commodity price shocks on the UK economy are assessed in 2010, 2020 and 2050 on two alternative baseline forecasts:

- **Business as Usual (BAU)** – this is Oxford Economics' central forecast to 2050.
- **Low-Carbon (LC) scenario** – this scenario assumes that oil demand is reduced by 10% of 2010 levels by 2020 and 50% by 2050, gas demand is reduced by 20% of 2010 levels by 2020 and 70% by 2050 and the corresponding reductions for coal are 50% by 2020 and 90% by 2050. It is assumed that these reductions in energy demand are achieved through improved energy efficiency across sectors rather than lower output[1].

Moreover, two types of commodity price shock are considered:

- **Demand shock** – a shock in which increasing global growth leads to higher demand for commodities, driving up prices. This is similar to the situation witnessed prior to the Global Financial Crisis when oil prices rose to nearly $150 per barrel (pb) in mid-2008 from around $20pb at the beginning of 2002 as strong growth in emerging markets fuelled energy demand.
- **Supply shock** – a shock in which a disruption to global supply causes commodity prices to spike. This is similar to the OPEC oil shocks in the

[1] It should be noted that the focus of this study is not how to achieve the reductions in energy demand but to highlight the impact on the UK's sensitivity to fossil fuel price shock once the reductions in demand have been achieved.

1970s and 1980s, and more recently following the political uncertainty in North Africa earlier in 2011.

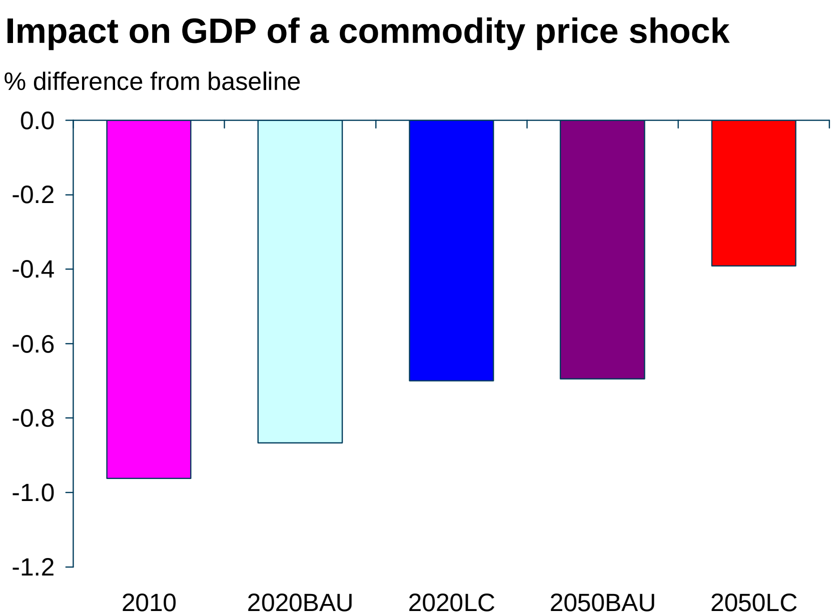
The dynamics of a commodity price shock's impact on the UK economy would be the same across scenarios: high commodity prices push up consumer prices directly and through the supply chain, squeezing household real income and dampening investment. Sectors hit hardest are those for which energy accounts for a large share of input costs – typically heavy manufacturing and transport services. These sectors see a large rise in relative output prices and are forced to scrap capacity as production becomes less profitable. Domestic demand is also hit through higher interest rates as the Bank of England tries to contain second round inflationary pressure.

A key difference between the demand and supply shock is the world growth backdrop: in the demand shock, stronger world growth boosts exporters, offsetting some of the negative impact in the UK market. This impact becomes more visible from the second year of the fossil fuel price shock as the boost to world trade accumulates. This offset is not present in the supply shock as global growth is hit by higher commodity prices.

Although the transmission of fossil fuel price shocks remains similar across time and across the various scenarios, the impact on the UK economy does diminish as energy demand diminishes. This is driven by:

- **Improved energy efficiency** across sectors, in particular lower consumption of fossil fuels. The LC scenario also assumes a significant increase in the share of renewable energy in the power sector.
- **An increasing proportion of a final energy prices being accounted for by a carbon tax**, which dampens the responsiveness of final energy prices to fluctuations in fossil fuel prices.

Chart 1: Impact of supply shock to fossil fuels on UK GDP



Source : Oxford Economics

The key findings of this study are that the impact of a 50% increase in oil and gas prices (resulting from a supply shock) reduces UK GDP by:

- **Around 1.0% in 2010.**
- **About 0.9% in 2020 under the BAU scenario and 0.7% under the LC scenario of reduced energy demand.**[2]
- **About 0.7% in 2050 under the BAU scenario and less than 0.4% under the LC scenario of reduced energy demand.**

Our modelling results therefore indicate that the impact on UK output from oil and gas price shocks could be reduced by around 60% in 2050 through the introduction of such climate change policies. Sectors with the largest energy intensity of production in 2010 (such as transport services and manufacturing) are likely to witness the greatest benefits over the forecast period (but also the largest adjustment costs), as it will be these sectors that would make the largest adjustments in terms of improved energy efficiency.

We also conducted a range of tests to explore the sensitivity of our modelling results to various assumptions. Some of the key findings of this exercise were:

- **The impact on the UK is fairly linear** – a 25% increase in oil and gas prices has around half the impact of a 50% increase in the same commodity prices.
- **Compared to an oil or coal price shock, a shock to gas prices has a greater impact at the whole economy level and across all sectors other than transport.** This reflects the importance of gas-fuelled power stations in electricity generation and the relatively large share of electricity in energy inputs.
- **Improved energy efficiency is more important for reducing the vulnerability of the economy to fossil fuel price shocks than the carbon tax.** Our results show that a 50% commodity price shock results in a GDP decline of almost 0.8% in 2020 without carbon taxes, compared to a 0.7% fall in the LC scenario (with carbon taxes set at around €70/tC). In 2050, the same shock results in a GDP decline of 0.5% without carbon taxes, compared to 0.3% in the LC scenario (with carbon taxes set at around €300/tC).
- **The monetary policy response to the fossil fuel price shock has only a marginal impact on the results** - keeping interest rates unchanged, our results indicate that GDP would fall by around 0.6% following an oil and gas price hike in 2020, compared to a 0.7% drop with slightly higher interest rates in the LC scenario.

[2] The impact falls under the BAU scenario because energy efficiency improves gradually and the share of gas in overall primary energy demand rises.

1 Introduction

High and volatile energy prices have a negative effect on the economy of a fossil-fuel importing country such as the UK: they dampen economic activity and they lead to an increase in the price level and potentially an increase in the inflation rate. Since fossil fuels are an input into many goods, both consumers and producers bear losses.

One way of reducing the UK economy's exposure to developments in energy markets is to reduce its dependence on fossil fuels either by reducing the energy intensity of output or by increasing the use of renewable forms of energy in both energy production and energy use by households. Underpinning the UK's carbon mitigation strategies are policies aimed at reducing the consumption of fossil fuels. To the extent to which these strategies are successful, a consequence of these policies would be a reduction in the UK's exposure to price developments in international energy markets.

Against this background, this project was commissioned to examine the potential for climate change policies to reduce the vulnerability of the UK economy to global energy price shocks. A set of scenarios are explored to highlight how the future impact of an energy price shock would be likely to differ between the central 'Business as Usual' (BAU) forecast for energy use and a Low-Carbon (LC) scenario in which climate change policies are adopted to lower future demand for energy[3]. This document sets out the key findings from that study.

The rest of this report is organised as follows:

- **Chapter 2** describes the outlook for the UK economy and energy demand in the LC scenario.
- The approach to modelling commodity price shocks is outlined in **Chapter 3**
- **Chapter 4** describes the impact of commodity prices shocks on the UK economy in 2010, 2020 and 2050 and describes how energy reduction strategies may impact these results.
- Analysis of key sensitivities around the modelling results is presented in **Chapter 5.**
- **Chapter 6** makes some concluding remarks.
- Details of the UK Energy Industry Model and Oxford's Global Economic Model, and results for a range of commodity prices, are included in Annexes.

[3] It should be noted that the focus of this study is not how to achieve the reductions in energy demand but to highlight the impact on the UK's sensitivity to fossil fuel price shocks once the reductions in demand have been achieved.

2 Outlook for the UK economy

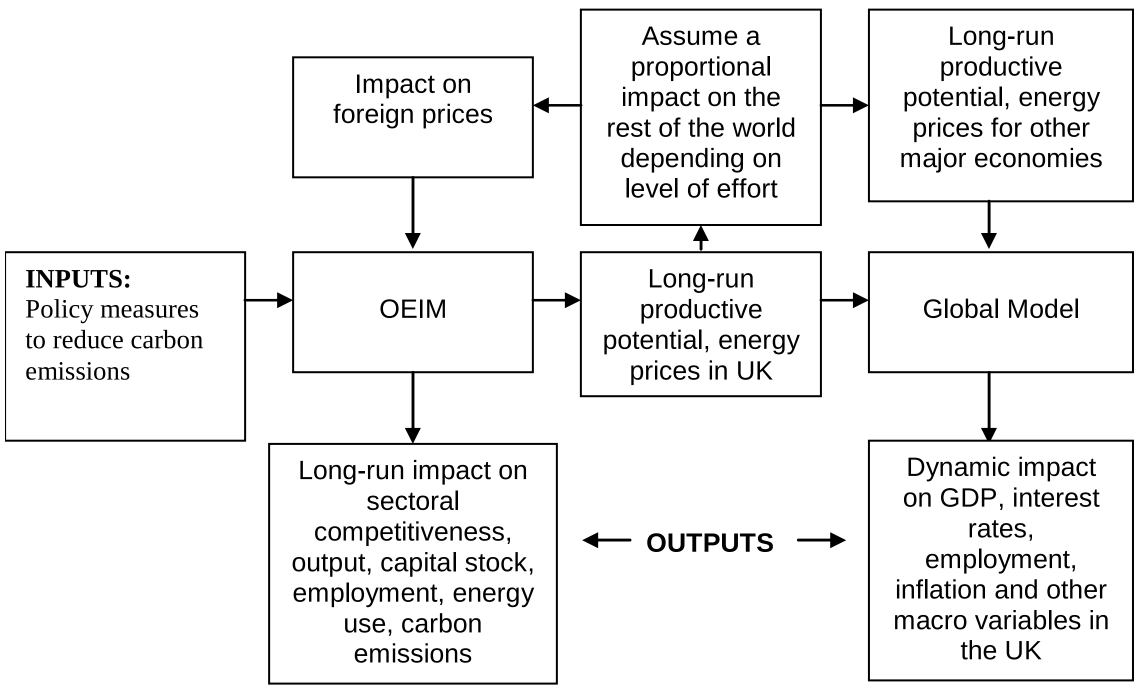
2.1 Methodology for achieving energy reduction targets

2.1.1 Modelling approach

For the purposes of this project we have used two different economic models - the Oxford UK Energy Industry Model (OEIM) and the Oxford Global Macroeconomic Model (described in more detail in Annex A). The OEIM is a detailed energy-industry model that identifies output and energy usage (among other variables) across thirty industrial sectors in the UK. The OEIM provides the long-run impact on sectoral competitiveness, output, capital stock, employment, and energy use of alternative assumptions relating to energy use and global energy prices.

The UK macroeconomic model is embedded within the Global Model, which covers some 46 economies in detail and allows the implications of alternative global scenarios and policy developments to be readily analysed at both the macro and broad sectoral level in the UK. The OEIM was used to provide some constraints to be imposed on the Global Model in order to assess the dynamic response of the UK to developments in international energy prices.

Chart 2.1: Interaction between the OEIM and Global Model



2.1.2 Specification of scenarios

In order to examine how climate change policies have the potential to mitigate the adverse impact of a fossil fuel price shock on the economy, we considered two baseline scenarios. The first was our central projection for energy usage, referred to as the ‘Business as Usual’ (BAU) forecast. The second was a Low-Carbon (LC) scenario where a reduction in energy demand is achieved through the introduction of a carbon tax. The impact of a carbon tax on the price of energy to each sector depends on:

- The carbon-intensity of each fuel type
- The mix of different fuel types (including electricity) in total energy consumption in that sector
- The fuel mix in the electricity generation sector

In addition, climate change policies were assumed to promote substitution between different fuel types within each sector, and within the electricity generation sector.

These climate change policies lead to a reduction in demand of 10% for oil, 20% for gas and 50% for coal by 2020 relative to their 2010 levels. Energy demand continues to fall in this LC scenario so as to achieve a decline in demand of 50% for oil, 70% for gas and 90% for coal by 2050 relative to their 2010 levels.

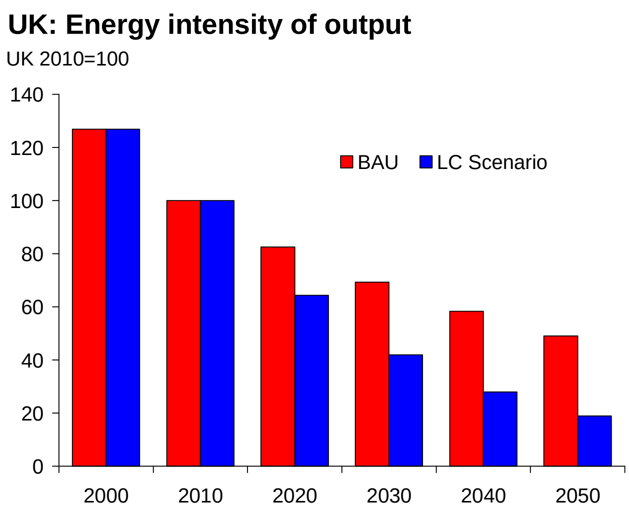
In the LC scenario, it is assumed that the reduction in fuel demand is achieved through enhanced energy efficiency, with essentially no cost for the economy in terms of output losses. In other words, it was assumed that the carbon tax encourages rapid technological progress to enhance fuel efficiency. The only sector that witnesses a loss in output is the energy and utilities sector, which reflects the decline in energy demand relative to the BAU forecast. As this sector represents a very small share of overall output in the economy (around 4% in 2010), the impact on overall GDP growth is not significant.

2.2 Low Carbon scenario

2.2.1 Trends in energy demand

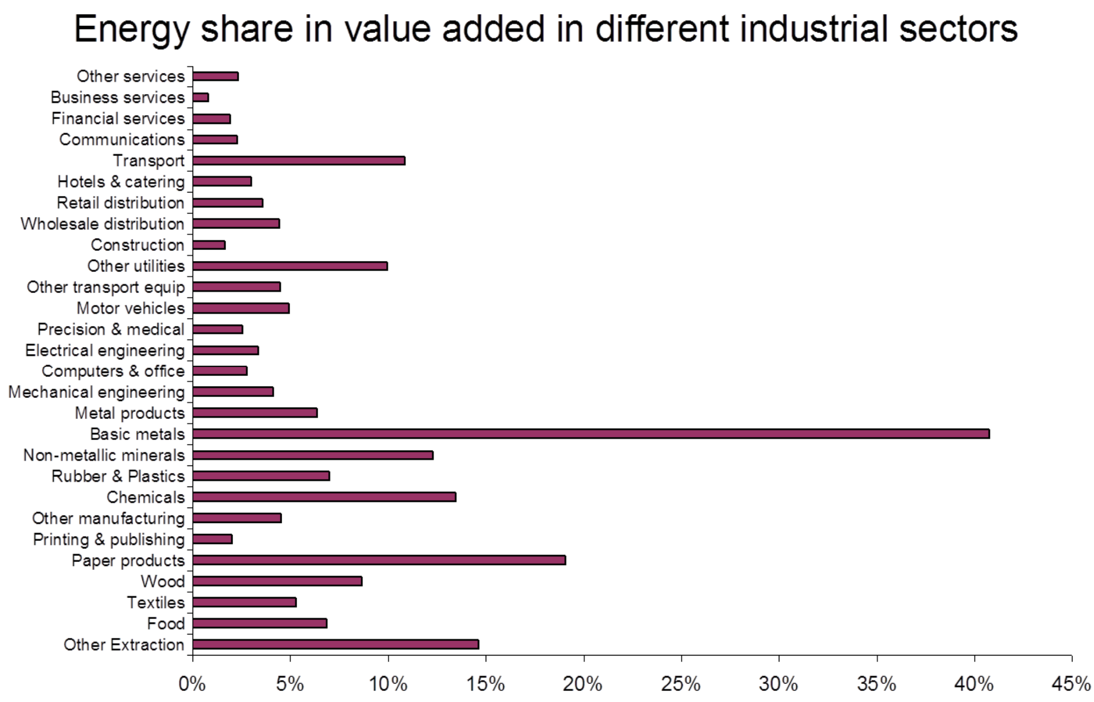
As explained in Section 2.1, we assume that climate change policies encourage rapid technological progress to enhance the energy efficiency of the UK economy in the LC scenario. Relative to its level in 2010, the energy intensity of UK output would have to decline by around 35% by 2020 and by 80% by 2050 in order to meet the energy demand outcomes specified in the 2020 and 2050 in the LC scenario. Relative to the BAU forecast, this implies a further 25% decline by 2020 and an additional 60% fall by 2050.

Chart 2.2: Trends in energy efficiency



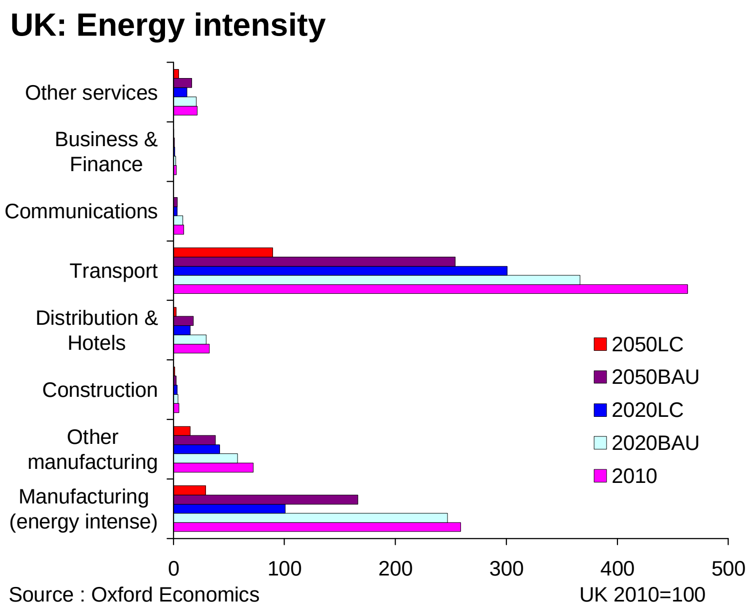
Source : Oxford Economics

Chart 2.3: Energy efficiency across sectors in 2010



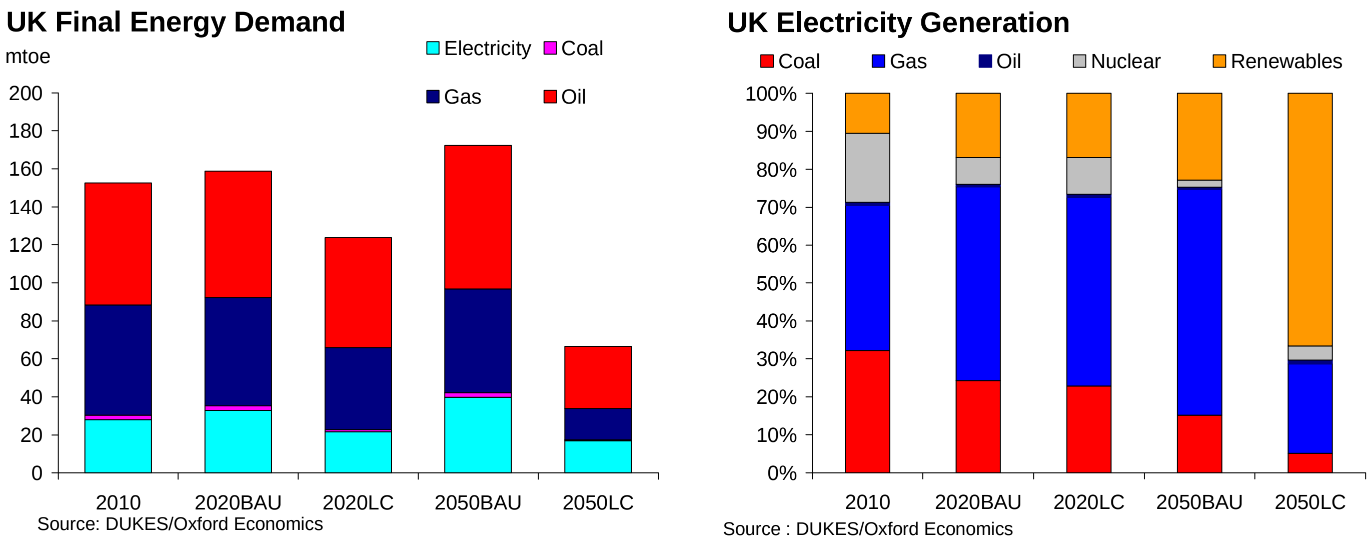
Looking in more detail at the energy intensity of output across different sectors, manufacturing, energy and utilities are generally more energy intensive than services sectors (see Chart 2.3). Achieving the fuel efficiency targets in the LC scenario would require industrial sectors with the highest energy-intensities of production to make the largest adjustments in terms of increased efficiency.

Chart 2.4: Trends in energy intensity across sectors



As illustrated by Chart 2.4, this implies that the burden of adjustment would fall disproportionately on the transport sector and energy-intensive manufacturing (such as basic metals, wood, paper and minerals sectors). So while the energy intensity of UK output is 60% below the BAU forecast by 2050, energy intensity declines by more than 65% in the transport sector and by around 80% in the energy-intensive manufacturing sector relative to the BAU forecast in 2050.

Chart 2.5: Energy consumption



In addition, adjustments are made to the mix of fuel inputs in the power generation sector to achieve a reduction in UK coal consumption to 90% below 2010 levels by 2050 in the LC scenario. In particular, the share of renewables is increased substantially. The higher share of non-fossil fuels in electricity generation reduces the sensitivity of the sector to commodity price shocks.

Box A: Defining the BAU and LC scenarios

The key difference between the BAU and LC scenarios is that energy demand is assumed to be reduced in the latter through climate change policies that encourage increased energy efficiency. The transition to the low carbon economy is assumed to be essentially costless in terms of lost output, so there is little difference between the key macroeconomic indicators in each scenario.

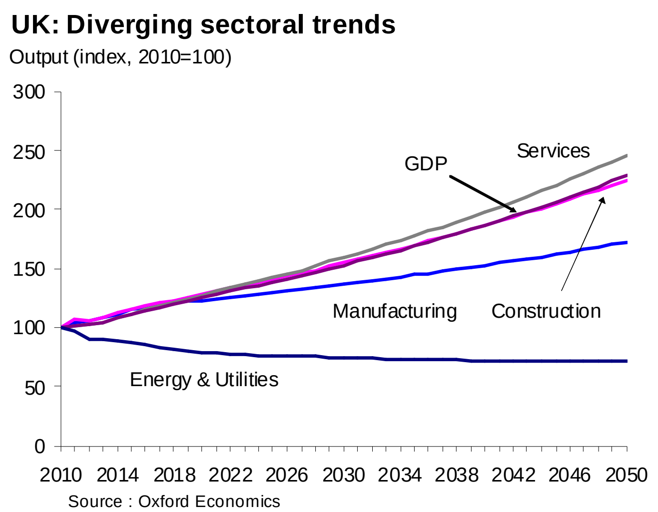
The table below shows the key indicators of energy demand/efficiency within the BAU and LC scenarios, with differences relative to their levels in 2010.

	BAU scenario		LC scenario	
	2020	2050	2020	2050
Oil use	4%	17%	-10%	-50%
Gas use	9%	21%	-20%	-70%
Coal use	-22%	-43%	-50%	-90%
Energy intensity of UK output	**-17%**	**-50%**	**-35%**	**-80%**

2.2.2 Key macroeconomic variables

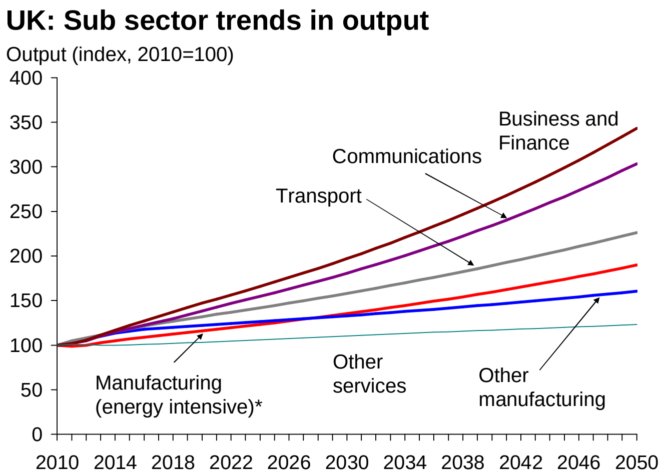
The LC scenario for the UK economy envisages GDP growing on average by 2.3% a year over the next 10 years to 2020, with the pace of expansion moderating to around 2% a year thereafter. At the sector level, growth will be led by services, driven mainly by the UK's competitive advantage in finance and business services. Despite some near-term weakness, construction activity is expected to grow in line with the broader economy over the medium term, but growth in manufacturing is set to lag behind the overall economy, given increased competition from low cost suppliers in Asia and other emerging markets. Slow growth in the energy and utilities sector reflects in part the ongoing decline of North Sea oil output, but also the impact of climate change policies that reduce energy demand.

Chart 2.6: Low Carbon scenario for the UK economy



Drilling down to examine trends at the sub-sector level in more detail, although business and finance will be the fastest growing industry within the services sector, communications are also forecast to enjoy fairly rapid growth as advances in technology enable more businesses to move online. Transport services will struggle to match growth in the wider economy, however, as the sector contends with a long term trend toward sustained cost increases. For government and other services, ongoing cost-cutting reforms will restrain the sector's long-term growth potential. Growth in manufacturing will be driven mainly by chemicals, engineering, and motor vehicles, while output of low-end goods declines.

Chart 2.7: Low Carbon scenario for sub-sector output

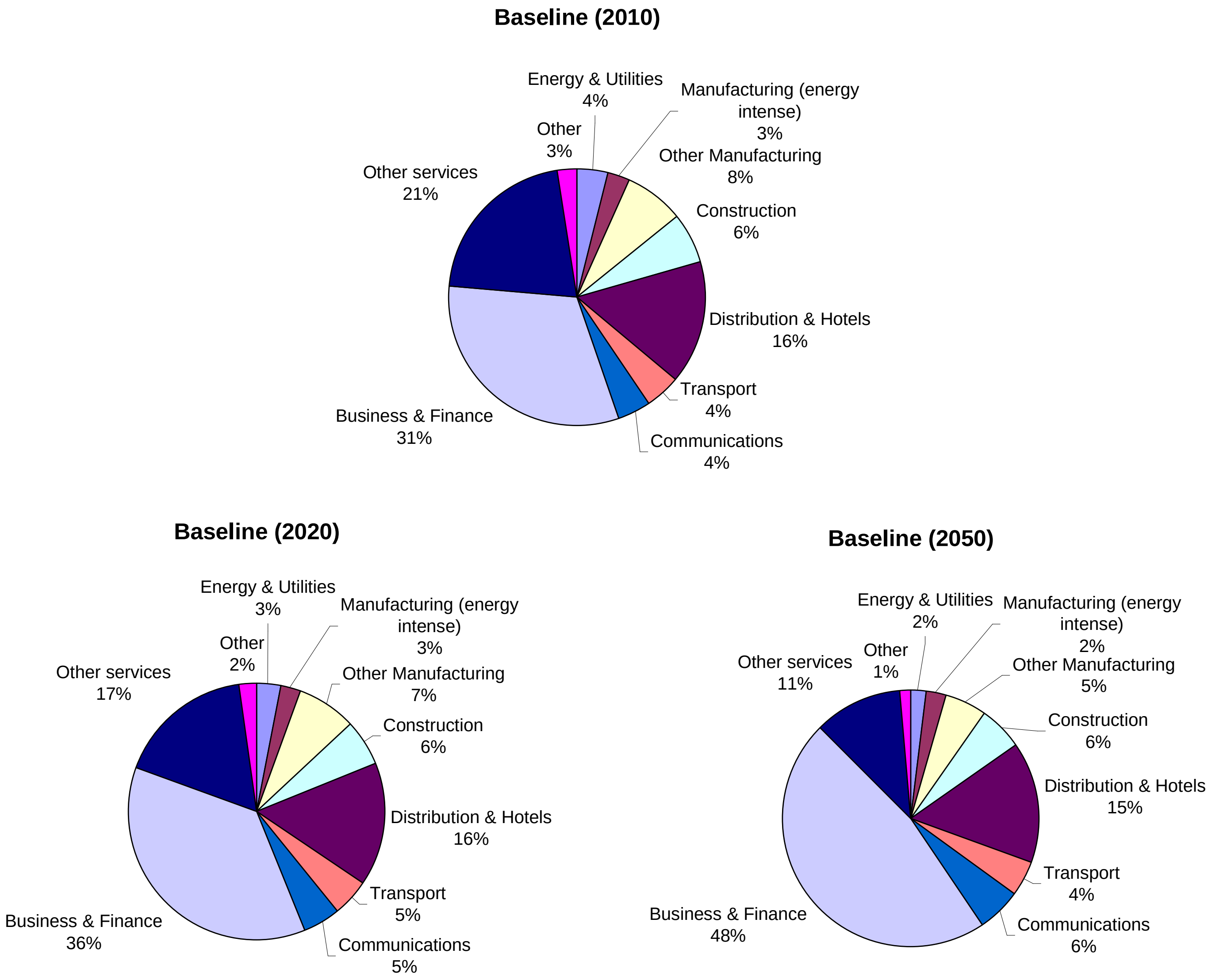


*includes basic metals, wood, paper and minerals sectors
Source : Oxford Economics

The implication of these divergent trends is that the sectoral composition of output will shift over time. Rapid growth in business and finance, for example, will raise the sub-sector's share in total output from 31% in 2010 to 36% in 2020 and 48% by 2050. In contrast, the share of manufacturing will continue to decline, falling from 10% in 2010 to 7% by 2050 (see Chart 2.8).

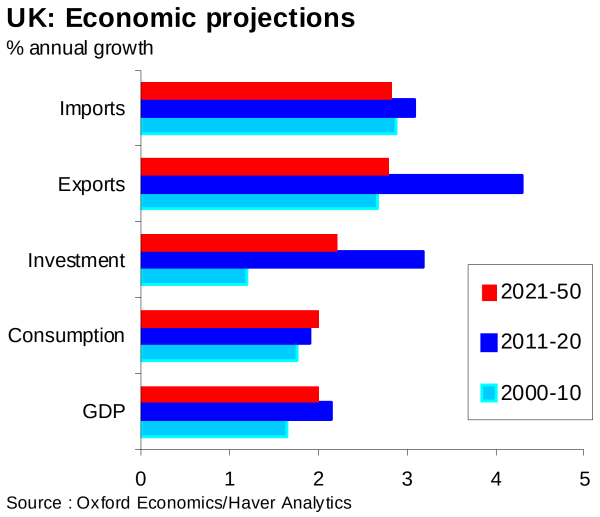
We assume that the gradual decline in the energy intensity of output across sectors will continue over the forecast period. Our forecasts for energy intensity at the whole economy level reflect these improvements in energy efficiency at the sector level, as well as the changing composition of the UK economy, i.e. less energy intensive sectors such as financial and business services will see the fastest growth.

Chart 2.8: The sectoral composition of output



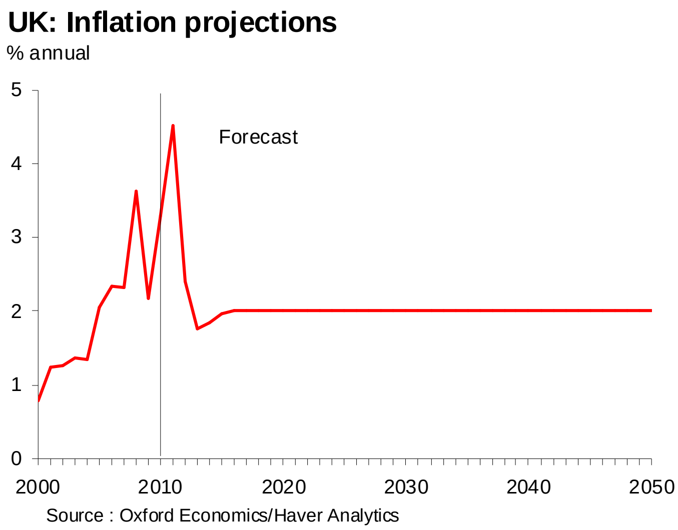
On the expenditure side, economic growth over the coming decade will be underpinned by a rebound in investment from currently depressed levels, a rebalancing of the economy towards external demand, and a moderate acceleration in consumption as household income growth recovers (again, this is the same for both the BAU and LC scenarios). The components of demand will become more balanced over the period 2021-50 (see Chart 2.9), with a moderate slowdown in the economy's potential rate of expansion reflecting in particular the impact of an ageing population.

Chart 2.9: Expenditure components of GDP



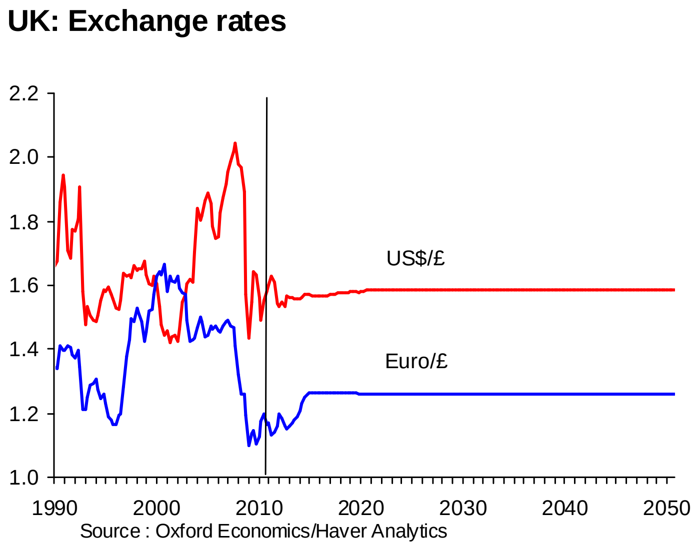
Although inflation is currently above the Bank of England's 2% target rate due to a number of transitory factors, we expect the annual growth rate in the CPI to settle back around the 2% target by 2015 and to remain close to this level over the medium term.

Chart 2.10: Inflation projections



Our forecast for the sterling exchange rate assumes that it stabilises at a rate of $1.59 and €1.26 over the medium term. This represents our estimates of the equilibrium level for the exchange rate – the level which produces a stable current account balance. Within the Oxford Global Model, exchange rates are determined by the uncovered interest rate parity condition (i.e. the difference in interest rates between two countries is equal to the expected change in exchange rates between the countries' currencies).

Chart 2.11: Exchange rate projections



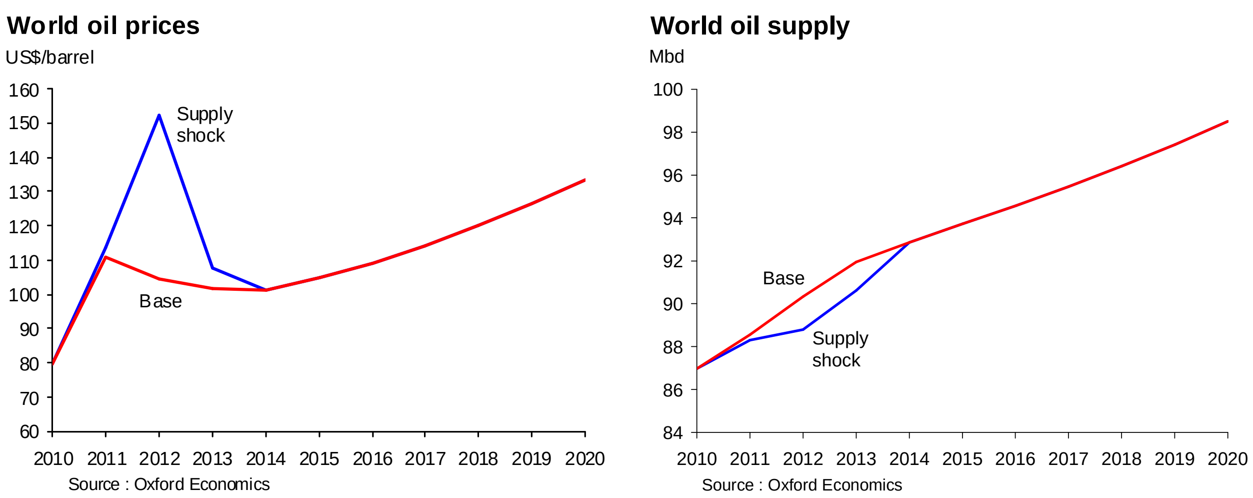
3 Modelling commodity price shocks

Fluctuations in global fossil fuel prices can be caused by either shocks to demand or supply. The distinction matters because fossil fuel price rises linked to the strength of the world economy are less likely to have a substantial negative impact on growth. The period between 2003 and 2007 provides one such example, when the real price of oil doubled with few obvious negative effects on the global economy. In contrast, exogenous supply shocks are more likely to be stagflationary in nature (i.e. inflation rises at the same time as growth is depressed).

3.1 Supply shock

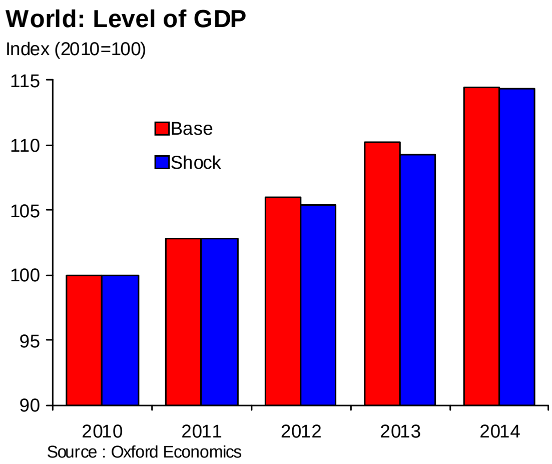
We first consider the impact on the UK economy of a shock to fossil fuel prices caused by a supply disruption. We begin by using the Oxford Global Model to examine the shock to oil supply required to lift global prices by 50% (on average) above the baseline (either BAU or LC scenario) for one year. Our results show that global oil supplies would need to be around 2-2.5mbd below their levels in the baseline to generate a rise in prices of this magnitude.

Chart 3.1: Global oil prices (nominal) and oil supply



A supply shock will dampen growth in oil-importing countries, as it increases operating costs for firms and reduces disposable incomes for households through its impact on consumer prices. With global growth reduced, this will also lower demand for UK exports, compounding the negative impact on UK output. Our modelling results indicate that a supply shock would result in world GDP being 0.6% below baseline in year one with a slight further fall in year two.

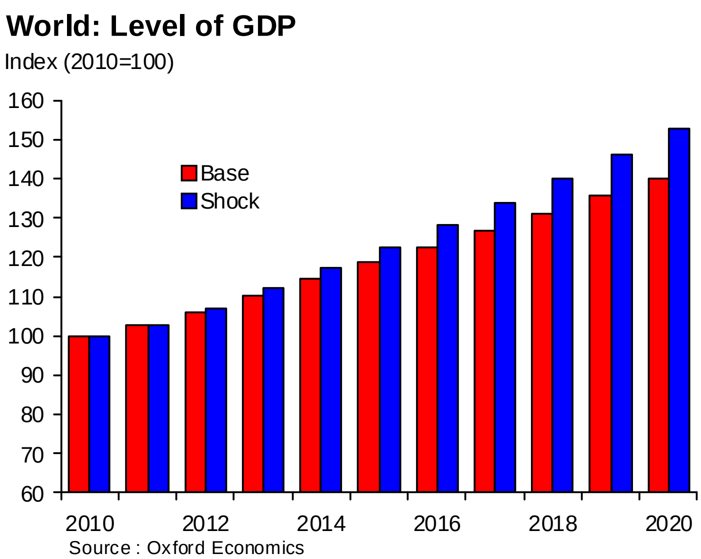
Chart 3.2: Impact on global GDP of fossil fuel price shock



3.2 Demand shock

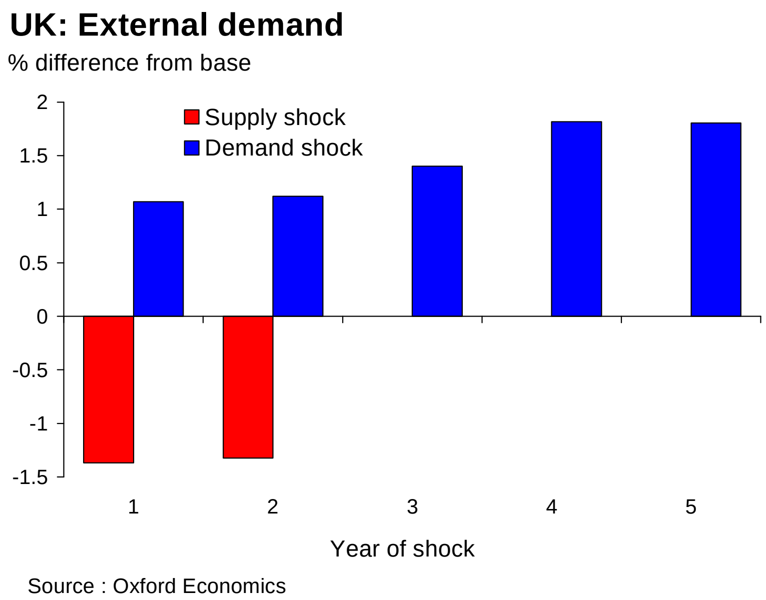
We next consider the impact of a demand shock and use the Global Model to examine the size of shock required to raise global oil prices by 50% relative to baseline (either BAU or LC scenario). The shock was modelled by changing growth in the US and China – our results suggest that global GDP growth needs to be around 1% pa higher than assumed in the baseline.

Chart 3.3: Global GDP in a demand shock scenario



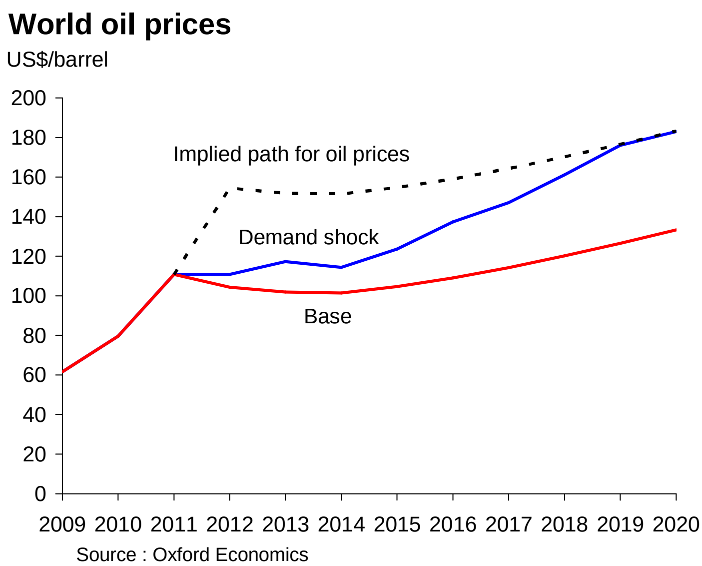
For the UK economy, the transmission of the fossil fuel price shock is essentially the same for the demand and supply shock, except that the implications for foreign trade differ. A supply shock will dampen demand for UK exports, compounding the negative impact on UK output. A demand shock has the opposite effect, however, helping to offset the negative impact of higher oil prices on UK output (see Chart 3.4).

Chart 3.4: Impact of demand and supply shocks on UK trade



The impact of growth on commodity markets is more gradual than a supply disruption, as illustrated by the blue line in Chart 3.5. However, if economic growth prospects were revised higher, it is likely that markets would bring forward the consequent rise in oil prices rather than waiting for growth to translate into greater oil demand before reacting. In effect, this would translate into an immediate shock to oil prices that is permanent in nature, as illustrated by the dotted line in Chart 3.5.

Chart 3.5: Oil prices in a demand shock scenario



3.3 Key factors determining impact of an energy price shock

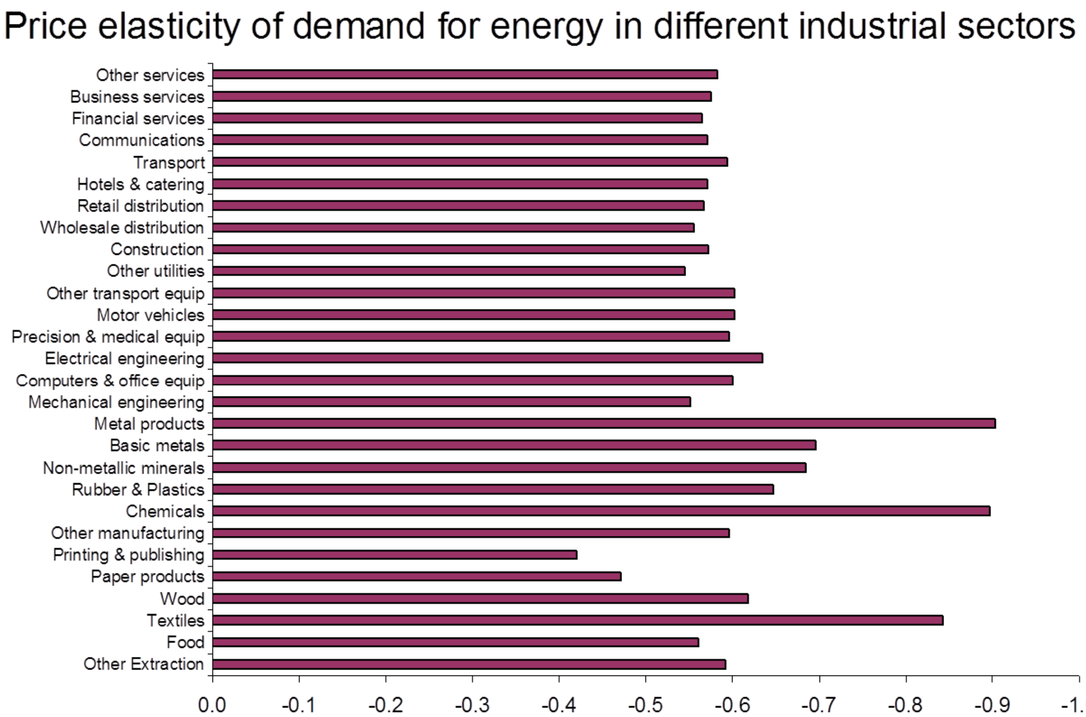
The impact of changes to energy input prices on the output of each sector will depend upon:

- The energy intensity of production in each sector
- The price elasticity of demand for energy in each sector

Chart 3.6 illustrates our estimates of how the price elasticity of demand for energy varies across sectors, based on econometric analysis. It shows the first-round effect on energy demand of a change in energy input prices. Our estimates indicate that the sectors with the highest price elasticities are metal products, chemicals and textiles, where a 10% rise in energy prices leads to a fall in energy demand of 8% or more.

The features of the UK economy illustrated in charts 2.3 and 3.6 imply that the whole-economy impact of a fossil fuel price shock is distributed highly unevenly across the industrial sectors. The sectors (typically in manufacturing) that are hit hardest are those that make intensive use of energy in their production technology, and those that have a low price elasticity of demand for energy, which makes it difficult to substitute out of energy (Section 5.4 presents a sensitivity analysis of these price elasticity estimates). Those that are hit least hard are the sectors (typically in service industries) that make relatively little use of energy in their production process.

Chart 3.6: Price elasticity estimates by sector



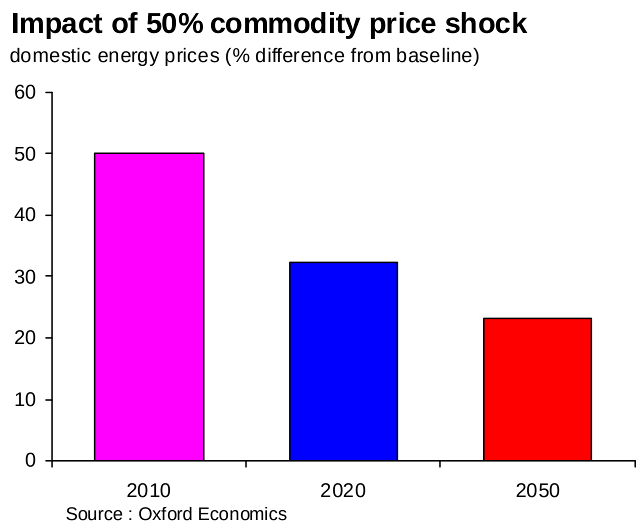
3.4 Energy prices

Within the LC scenario, the only instrument used to reduce emissions are fuel taxes (mainly a carbon tax) – in reality a mix of different instruments (tax, regulation, subsidies, information etc.) would be used. The fuel taxes are set at a level consistent with the energy demand outcomes specified in the 2020 and 2050 LC scenarios, which equates to a carbon price of €70/tC in 2020 and €300/tC in 2050. Policy is implemented at the EU level. The carbon tax is assumed to act as a catalyst to technological change so that lower energy demand is achieved without a GDP cost.

As higher energy prices are needed to stimulate improved energy efficiency, this also means that energy expenditure per unit of GDP declines much less than energy intensity in the LC scenario. The sensitivity of final energy prices is therefore the key metric for assessing the differential impact of shocks to fossil fuel prices on the UK economy.

The imposition of a carbon tax creates a 'wedge' between global fossil fuel prices and the final price of energy facing the domestic economy. As a consequence, the proportion of energy prices vulnerable to a change in fossil fuel prices is smaller in the carbon reduction scenario than in 2010 and the baseline projections. Chart 3.9 illustrates this effect – a 50% shock to all fossil fuel prices (assuming no change in the energy mix) would feed through to a 50% rise in domestic energy prices in 2010, but only 32% in 2020 and 23% in 2050. The carbon tax assumptions are discussed in more detail in Section 5.3.

Chart 3.7: Sensitivity of domestic energy prices to a fossil fuel price shock in the LC scenario



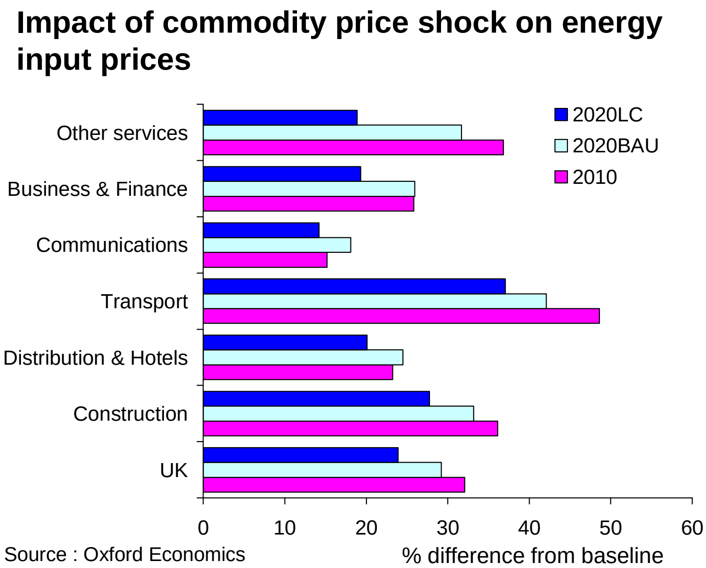
4 Scenario results

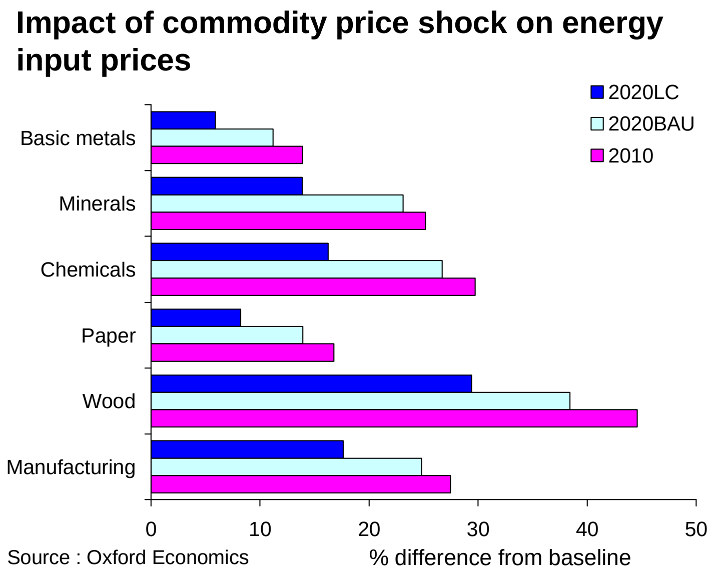
4.1 Demand shock

The demand shock we explore here results in a 50% shock to the global price of both oil and gas (Annex B also considers demand shocks to oil and gas prices separately). At the domestic level, the initial impact on energy input prices will differ across sectors depending on the mix of different fuel types (including electricity) in total energy consumption in that sector. For example, petroleum products make up the majority of fuel inputs for the transport sector, so the shock to oil prices could be expected to have a large impact on energy prices facing this sector. In contrast, energy use by the business and finance sector comprises mainly electricity, so any rise in energy prices facing this sector will depend on the mix of fuel inputs to electricity generation.

The resulting increase in domestic energy input prices facing each sector is illustrated by Chart 4.1. Within the BAU forecast, the impact of a fossil fuel price shock on energy input prices increases slightly for some sectors between 2010 and 2020, which reflects the increasing share of oil and gas in energy demand within these sectors. In contrast, the impact of higher oil and gas prices on energy input prices diminishes over time for all sectors within the LC scenario. This reflects the higher share of tax in final prices, as well as the higher share of renewables in electricity generation and, hence, total energy demand.

Chart 4.1: Impact on energy prices by sector



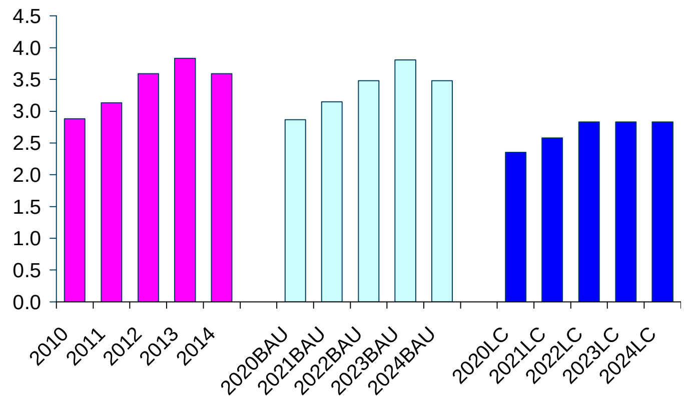


Whether the increase in the price level translates into a shift in core inflation depends on the "second round" effects – i.e. whether workers and/or enterprises are able to compensate for the income loss through higher wages and prices – which, in turn, depends on the monetary policy regime in place (see Section 5.5 for a more detailed discussion). Interest rates are assumed to rise in order to reduce the risk of permanent higher commodity prices translating into a wage-price spiral (see Chart 4.2). This contributes to GDP remaining below baseline by weighing on consumer and investment spending.

Chart 4.2: Impact on inflation and interest rates of fossil fuel price shock

Impact on CPI of a commodity price shock

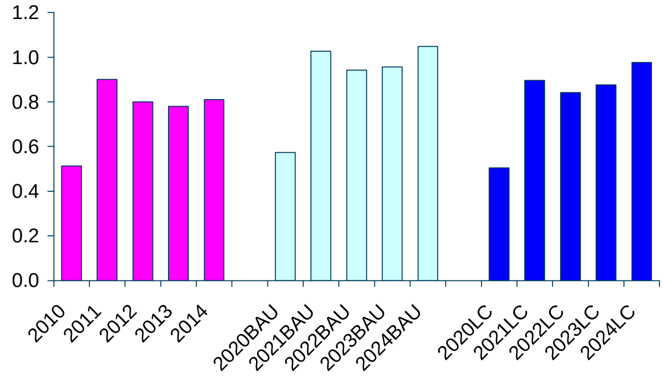
% difference from baseline



Source : Oxford Economics

Impact on interest rates of a commodity price shock

% point difference from baseline



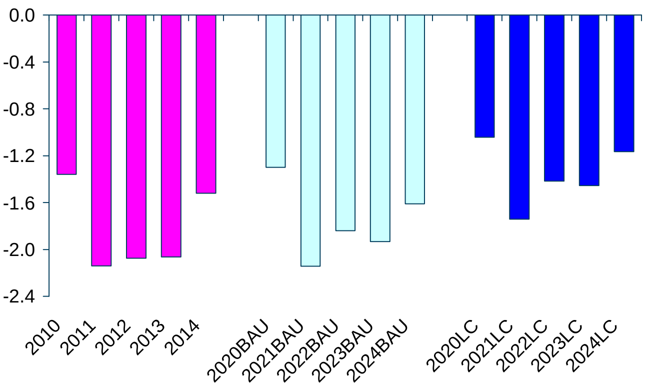
Source : Oxford Economics

On the expenditure side, higher fossil fuel prices will dampen domestic demand through their impact on incomes (note that government spending is assumed to remain unchanged). Since energy is an input into many goods, both consumers and producers would bear losses (see Chart 4.3). Higher energy costs would affect producers by reducing their profit margins and lowering demand for their output. Returns on capital would fall, with adverse consequences for investment (although this decline would be mitigated to the extent that firms invest in more energy efficient capital). In turn, this has second-round effects on aggregate demand in the economy.

Chart 4.3: Impact on investment and consumption of fuel price shock

Impact on investment of a commodity price shock

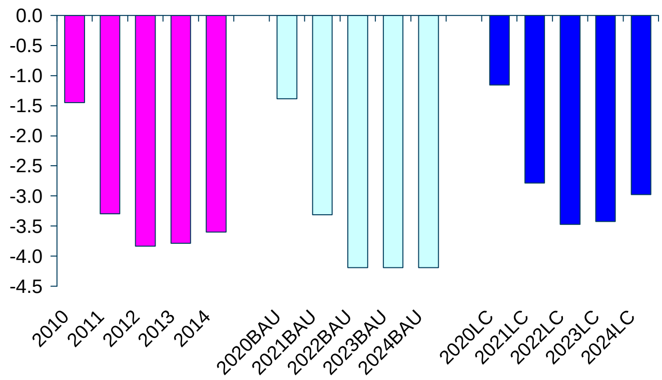
% difference from baseline



Source : Oxford Economics

Impact on consumption of a commodity price shock

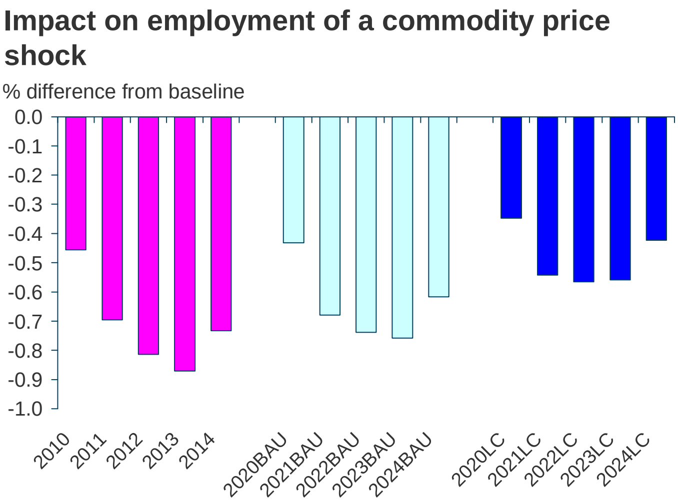
% difference from baseline



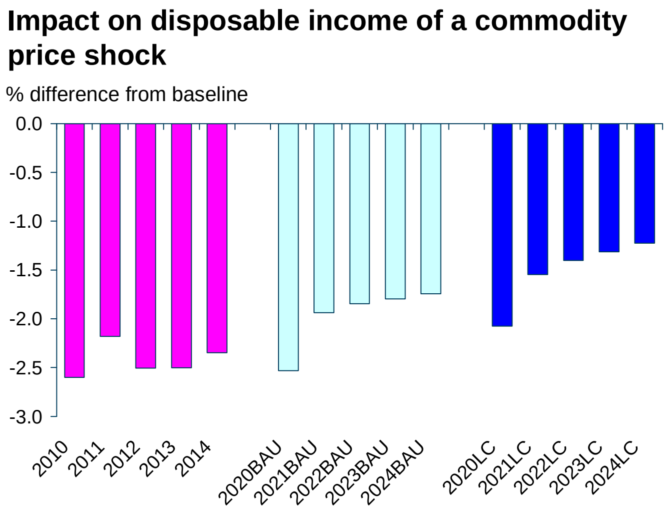
Source : Oxford Economics

Losses would also be borne by consumers to the extent that the shock to energy prices raises inflation and so reduces real disposable incomes (see Chart 4.4). Incomes also suffer as a result of the fall in output, which weakens the labour market. Households adjust spending with a lag to changes in income, so while consumer spending initially falls by less than incomes, the decline becomes steeper in subsequent years, as higher interest rates also discourage consumer spending. The decline in consumer spending relative to the LC scenario will also have second-round effects for output and employment.

Chart 4.4: Impact on employment and incomes of fuel price shock



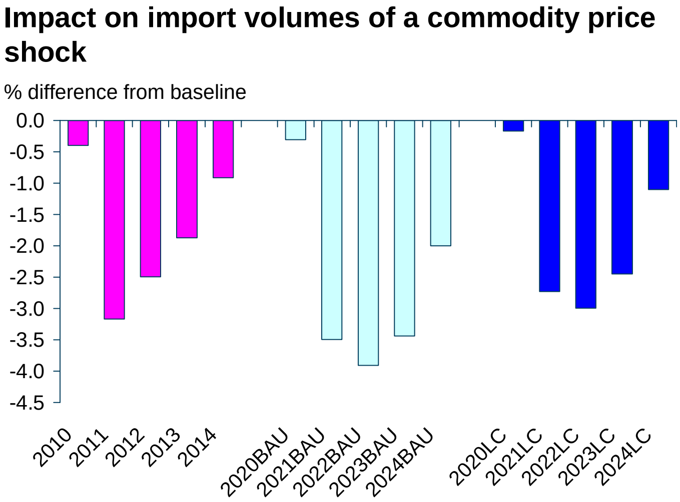
Source : Oxford Economics



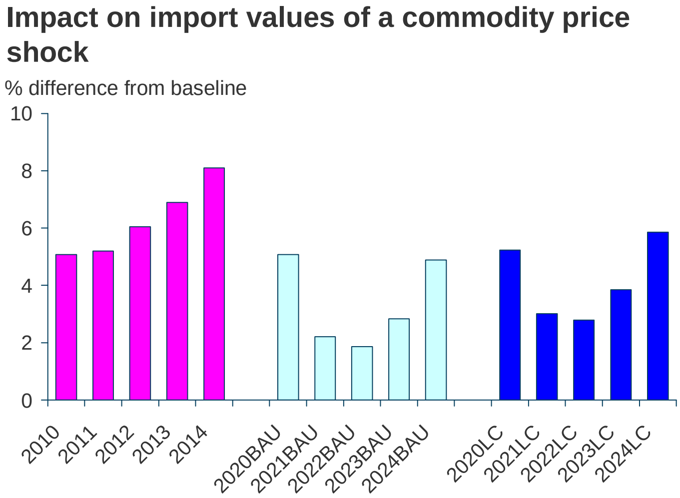
Source : Oxford Economics

The negative impact of the fossil fuel price rise on domestic demand and income will diminish over time as consumers and producers modify their behaviour (the longer-run price elasticity of demand is higher than the short-run elasticity). Imports also move in line with domestic demand, which is hit by higher energy prices, especially consumer demand. However, Chart 4.5 also shows that although the *volume* of imports declines, the overall *value* of those imports rises, reflecting the increase in price of fossil fuel imports.

Chart 4.5: Impact on imports of fuel price shock



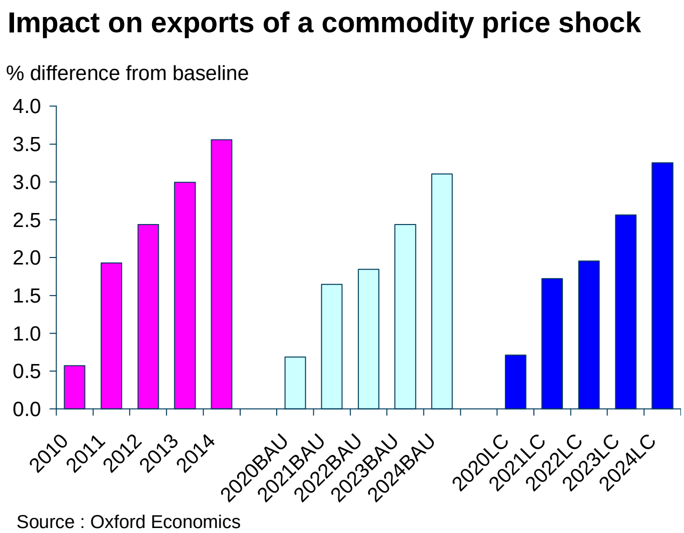
Source : Oxford Economics



Source : Oxford Economics

But a scenario where energy prices are pushed up by demand factors also contains positive components for the UK economy. More specifically, UK exports are boosted by the strength of the world economy, which also contributes to the negative impact on GDP fading over time (see Chart 4.6).

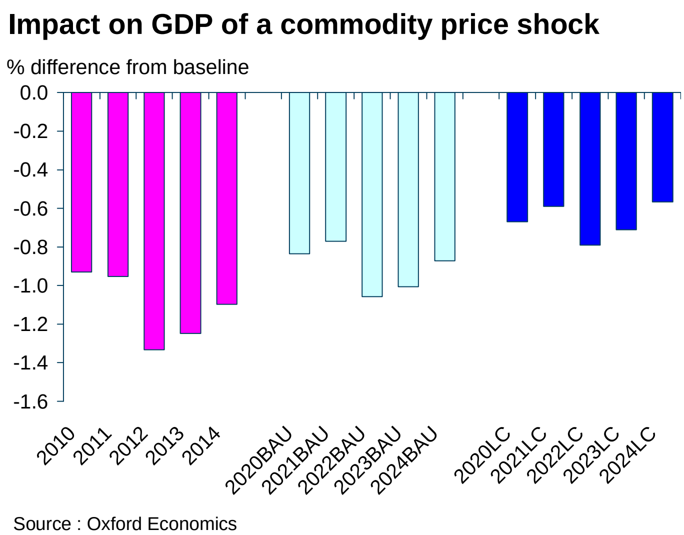
Chart 4.6: Impact on exports of fuel price shock



The net impact on the current account depends on trends in both imports and exports. In the BAU forecast, the UK becomes a larger net importer of fossil fuels between 2010 and 2020, so the impact of a fuel price shock on the current account increases over time. In contrast, within the LC scenario fossil fuel demand and fossil fuel imports decline, so the impact on the current account is less pronounced.

The impact of permanently higher oil and gas prices results in a permanent loss in GDP. The negative impact on GDP stabilises after around five years.

Chart 4.7: Impact on GDP of fossil fuel price shock



As discussed in Section 3.3, the impact of these changes to energy input prices on the output of each sector will depend upon the energy intensity of production in that sector and the sector's price elasticity of demand for energy. The extent to which different sectors are able to pass on the increase in costs to consumers will also depend upon the price elasticity of demand for their output. As a result of improved energy efficiency and a 'smaller' shock to energy prices, the impact of a demand shock to oil and gas prices is smaller in 2020 than in 2010 across all sectors.

Chart 4.8: Impact of energy price shock on output

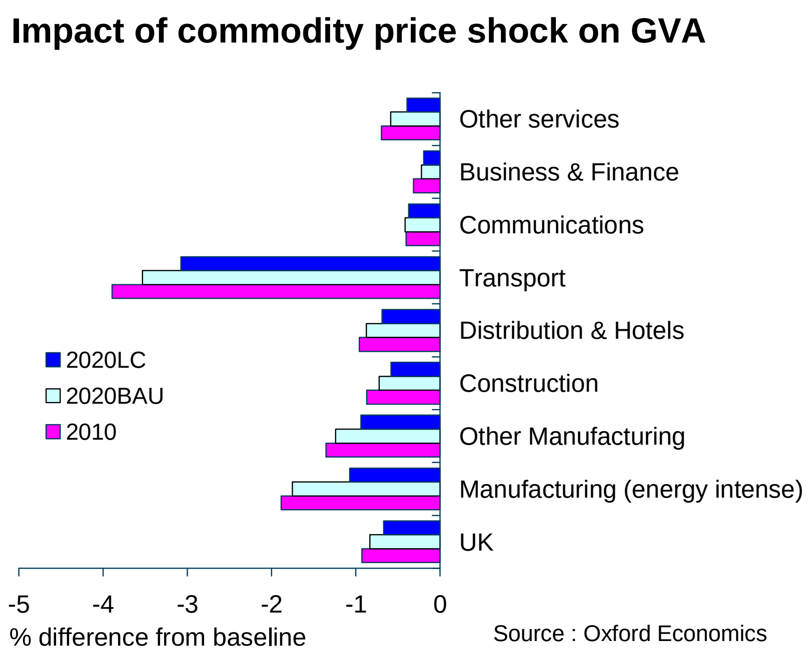


Chart 4.8 illustrates that energy intensive manufacturing (which includes basic metals, non-metallic minerals, chemicals, and paper products) and transport services see the biggest reduction in vulnerability to shocks to oil and gas prices, as these sectors witness the largest absolute declines in energy intensity over the forecast period. The impact of a 50% rise in oil and gas prices on the output of the transport sector falls from 3.9% in 2010 to 3.1% in 2020 once climate change measures have been implemented within the LC scenario. Similarly, within energy intensive manufacturing, the impact declines from 1.9% to 1.1% over the same period. The impact on other manufacturing also witnesses a substantial decline, from 1.4% to 0.9%. Services sub-sectors generally witness a less marked reduction in their sensitivity to oil and gas price shocks in absolute terms.

Overall, the impact of a 50% rise in oil and gas prices on the UK economy falls from 0.9% in 2010 to 0.7% in 2020 once climate change measures have been implemented within the LC scenario. Table 4.1 summarises the impacts on the main macroeconomic indicators within the BAU and LC scenarios.

Table 4.1: Summary impact of fossil fuel price shock

Summary table (% difference from base, unless specified)				BAU Scenario			LC Scenario		
	2010	2011	2012	2020	2021	2022	2020	2021	2022
GDP	-0.9	-1.0	-1.3	-0.8	-0.8	-1.1	-0.7	-0.6	-0.8
Private Consumption	-1.4	-3.3	-3.8	-1.4	-3.3	-4.2	-1.2	-2.8	-3.5
Fixed Investment	-1.4	-2.1	-2.1	-1.3	-2.1	-1.8	-1.0	-1.7	-1.4
Exports	0.6	1.9	2.4	0.7	1.6	1.8	0.7	1.7	2.0
Imports	-0.4	-3.2	-2.5	-0.3	-3.5	-3.9	-0.2	-2.7	-3.0
CPI	2.9	3.1	3.6	2.9	3.1	3.5	2.4	2.6	2.8
Employment	-0.5	-0.7	-0.8	-0.4	-0.7	-0.7	-0.3	-0.5	-0.6
Short-Term Interest rate*	0.5	0.9	0.8	0.6	1.0	0.9	0.5	0.9	0.8

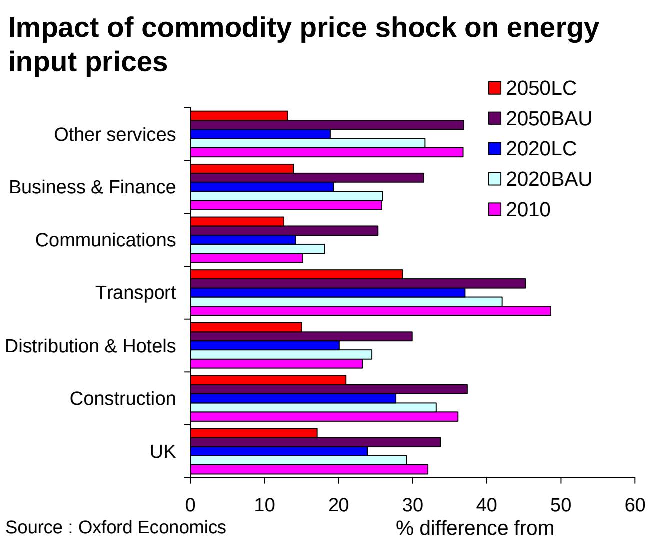
*refers to percentage point difference

In summary, the findings in this Section confirm that climate change policies have the potential to significantly dampen the sensitivity of UK output to fossil fuel price shocks. Those sectors with the largest energy intensity of production in 2010 (such as transport services and manufacturing) are likely to witness the greatest benefits over the forecast period (but also the largest adjustment costs), as it will be these sectors that would make the largest adjustments in terms of improved energy efficiency.

4.2 Supply shock

In the BAU forecast, the share of oil and gas in total energy demand for the UK economy rises between 2010 and 2050, implying that the impact of a fossil fuel price shock on domestic energy prices increases slightly over time. Within the LC scenario, the impact of higher oil and gas prices on energy input prices diminishes over time, reflecting the higher share of renewables in electricity generation as well as the carbon tax 'wedge' that has been introduced to final energy price

Chart 4.9: Impact on energy prices by sector of fuel price shock



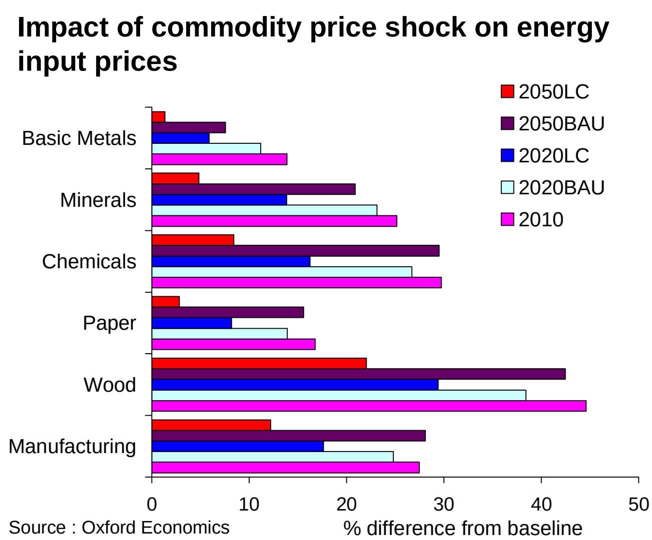
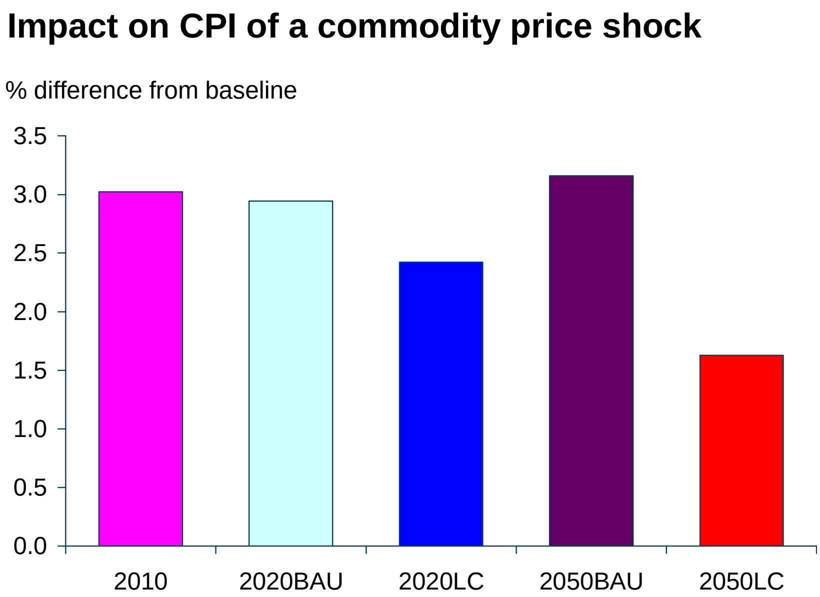


Chart 4.10 illustrates the feed through of higher energy prices to headline inflation. As with the demand shock, the final impact on inflation depends upon the monetary policy response function. The monetary policy response function in the Oxford Model results in a modest increase in interest rates of around 0.5%, which is lower than the interest rate rise in the demand shock as the negative impact on output in the economy is greater.

In the BAU forecast, the impact on consumer prices rises over time, reflecting the increased feed-through of higher fossil fuel prices to domestic energy prices. In the LC scenario, the impact on CPI declines over time with the lower pass-through to energy input prices. The impact of a 50% rise in oil and gas prices on the CPI falls from 3% in 2010 to 2.4% in 2020 and 1.6% by 2050.

Chart 4.10: Impact on CPI of fossil fuel price shock



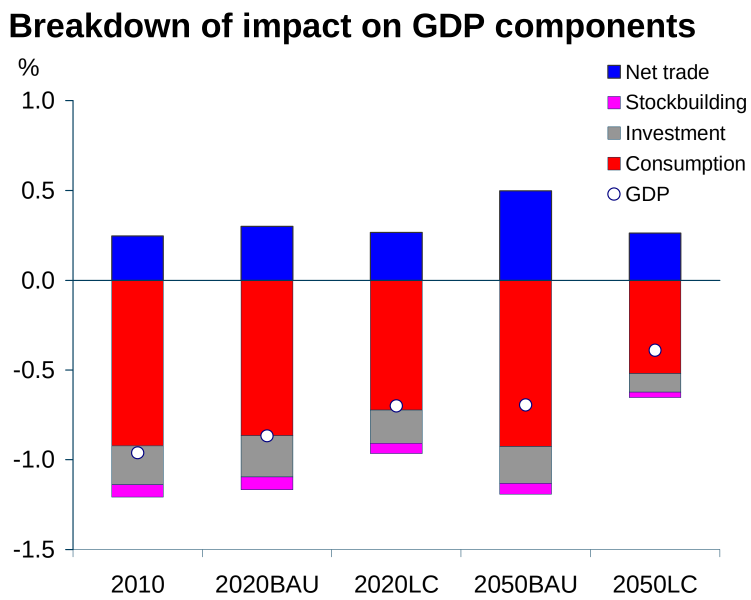
Source : Oxford Economics

On the expenditure side, higher fossil fuel prices will dampen consumer spending by lowering incomes, while firms will also scale back investment in response to reduced demand for their products and higher input prices that lower the return on capital. Within the LC scenario, the commodity price shock reduces consumer spending by 1.4% in 2010, 1.2% in 2020 and 0.8% in 2050. For investment, the impact falls from 0.4% in 2010 to 0.2% by 2050.

In contrast to the demand shock, a shock to fossil fuel supply has negative implications for foreign trade as world growth is lowered. In the BAU forecast the negative impact on exports increases over time as the pass through from higher fossil fuel prices to domestic energy input prices increases, reducing the competitiveness of UK exporters. The negative impact on imports also rises over time in the BAU forecast, as the UK becomes a larger net importer of fossil fuels. However, within the LC scenario, the impact on exports and imports in 2020 and

2050 is mitigated by the lower level of fossil fuel demand and the lower pass through of fossil fuel prices to domestic energy input prices.

Chart 4.11: Contribution of expenditure components to change in GDP in response to a supply shock



Source : Oxford Economics

Chart 4.11 pulls together the various impacts on domestic demand and trade to illustrate their relative contributions to the change in GDP in response to a fuel price shock. Focusing on trade, the chart illustrates how the shock has a positive impact on net export volumes, which partially offsets the negative impact on other demand components. This reflects the fact that import volumes contract more sharply than export volumes. The positive contribution of net trade is lower in the LC scenario due to the reduced level of demand for fossil fuel imports. In other words, the initial level of fossil fuel imports is lower in the LC scenario than the BAU scenario, so there is less scope for these imports to decline following the shock.

In terms of nominal values, the shock to fossil fuel prices results in a deterioration of the balance of payments, as the total *value* of imports increases (the rise in price of fossil fuel imports more than offsets the fall in volumes) while the value of exports declines. The impact on the balance of payment is less pronounced in the LC scenario, however, reflecting the economy's lower reliance on fossil fuel imports as well as the reduced impact on export competitiveness.

The first year impacts of a demand and supply shock are very similar, so the effect on output across sectors in 2020 shown in Chart 4.13 is comparable to that shown in Chart 4.1. But Chart 4.13 also illustrates how the impact of a commodity price shock on the UK economy exhibits a further decline from 0.7% in 2020 to 0.4% in 2050 within the LC scenario, reflecting additional improvements in energy efficiency. Again, these improvements are more heavily concentrated within the transport and manufacturing sectors.

Chart 4.13: Impact on output by sector of fuel price shock

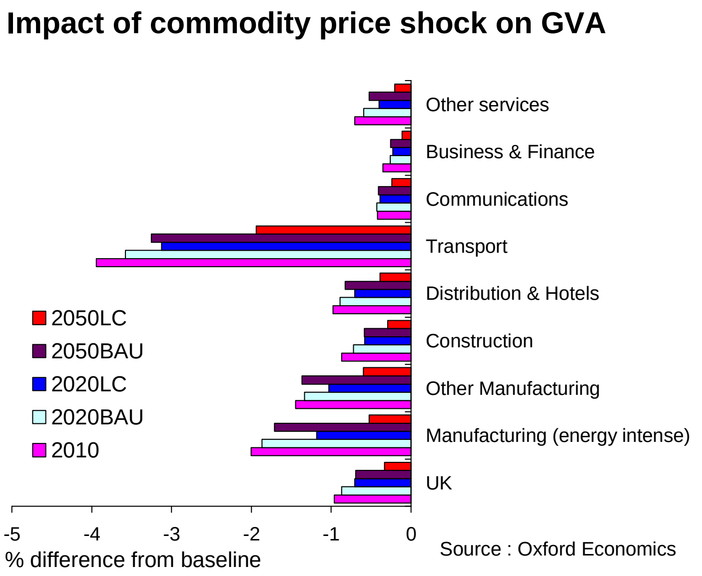


Chart 4.13 shows that the impact of a 50% rise in oil and gas prices on the output of the transport sector falls from 3.9% in 2010 to 3.1% in 2020 and just 1.9% in 2050 in the LC scenario. Within manufacturing (both energy intensive and other), the negative impact on output is reduced to around 0.6% by 2050. Within all the services sub-sectors, the impact on output is reduced to below 0.4% by 2050.

Table 4.2: Summary table

Summary table (% difference from base, unless specified)		BAU scenario		LC scenario	
	2010	2020	2050	2020	2050
GDP	-1.0	-0.9	-0.7	-0.7	-0.4
Private Consumption	-1.4	-1.4	-1.5	-1.2	-0.8
Fixed Investment	-1.4	-1.3	-1.1	-1.1	-0.6
Exports	-0.7	-0.9	-1.1	-0.9	-0.9
Imports	-1.4	-1.9	-2.5	-1.7	-1.7
CPI	3.0	2.9	3.2	2.4	1.6
Employment	-0.5	-0.4	-0.4	-0.4	-0.2
Short-Term Interest rate*	0.5	0.5	0.9	0.5	0.5

* refers to percentage point difference

Table 4.2 summarises the impacts on the main macroeconomic indicators within the BAU and LC scenarios. Building on the results of Section 4.1, the analysis presented in this Section shows that climate change policies that result in further reductions in energy demand by 2050 would produce additional benefits in terms of reduced sensitivity to fossil fuel price shocks. The adjustment would continue to fall most heavily upon those sectors with the highest energy intensity of output (transport and manufacturing), but it would also be these sectors that would gain the greatest benefits from their lower reliance on fossil fuels.

5 Sensitivity analysis

We also conducted a range of tests to explore the sensitivity of our modelling results to various assumptions, including:

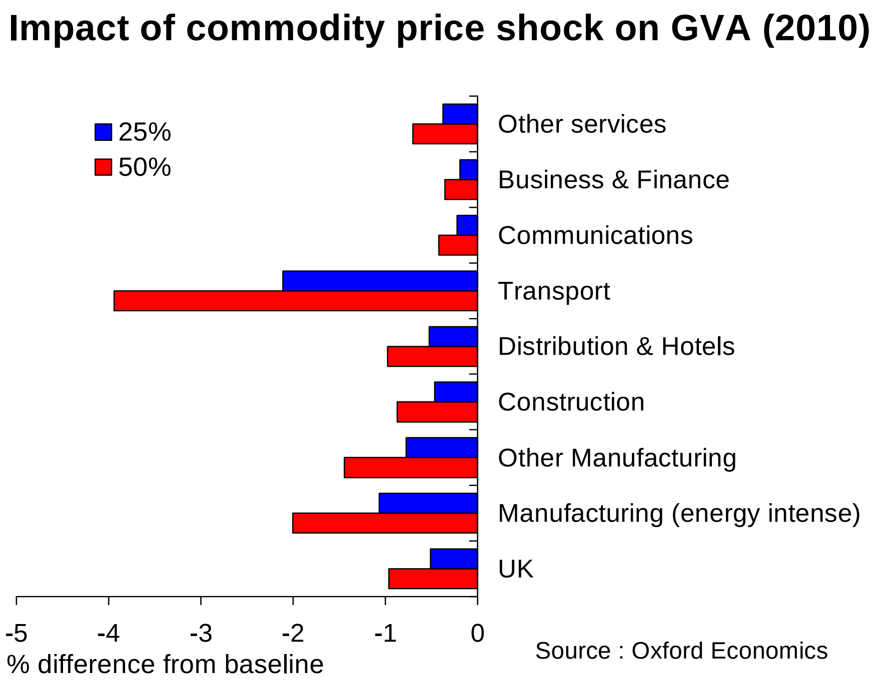
- Size and direction of commodity price shock
- Type of commodity price shock
- Level of carbon tax
- Price elasticity of demand for energy
- Role of monetary policy

This section presents the results of this analysis.

5.1 Size and direction of commodity price shock

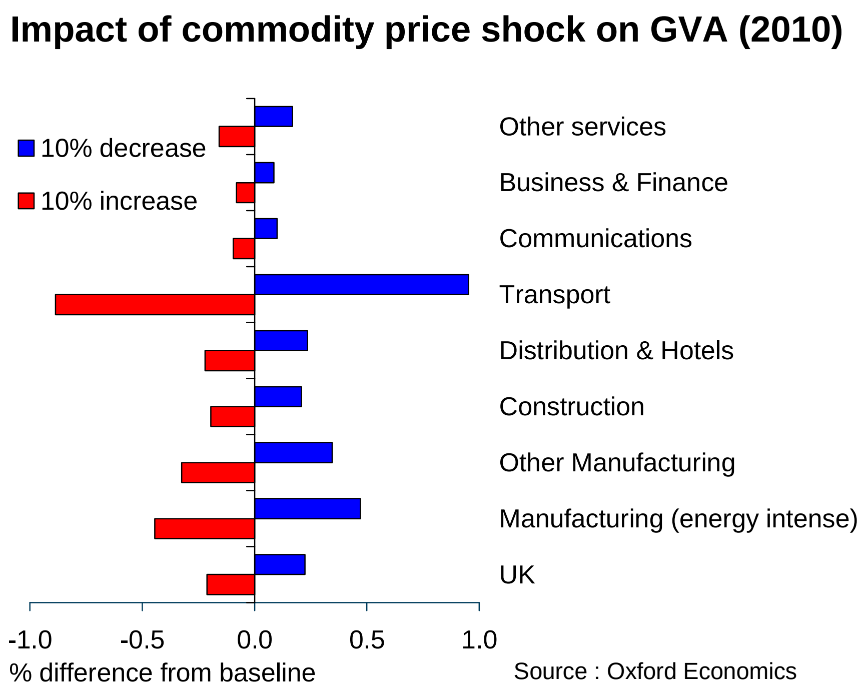
The scenarios we explore in this report involve a 50% shock to oil and gas prices. While it is tempting to make a simple extrapolation from these results to consider the impact of different price shocks on the economy, this would only be valid if the model results were linear. Therefore, we tested this hypothesis by modelling a 25% shock to oil and gas prices in 2010 (so there is no difference between the BAU and LC scenarios). As shown by Chart 5.1, the impact on the UK is indeed fairly linear – a 25% increase in oil and gas prices has just over half (approx 53%) of the impact of a 50% increase in the same commodity prices.

Chart 5.1: Linearity of model results



Similarly, it is possible that the impact of a positive shock to commodity prices could differ in absolute size from that of a negative shock. This 'symmetry' hypothesis was tested by comparing the impact of a 10% increase in oil and gas prices in 2010 to a shock where gas and oil prices experience a 10% fall. The economy is slightly more sensitive to higher commodity prices as this leads to the scrapping of equipment that is no longer productive. However, as illustrated by Chart 5.2, the impact of these shocks is indeed roughly symmetrical.

Chart 5.2: Symmetry of model results

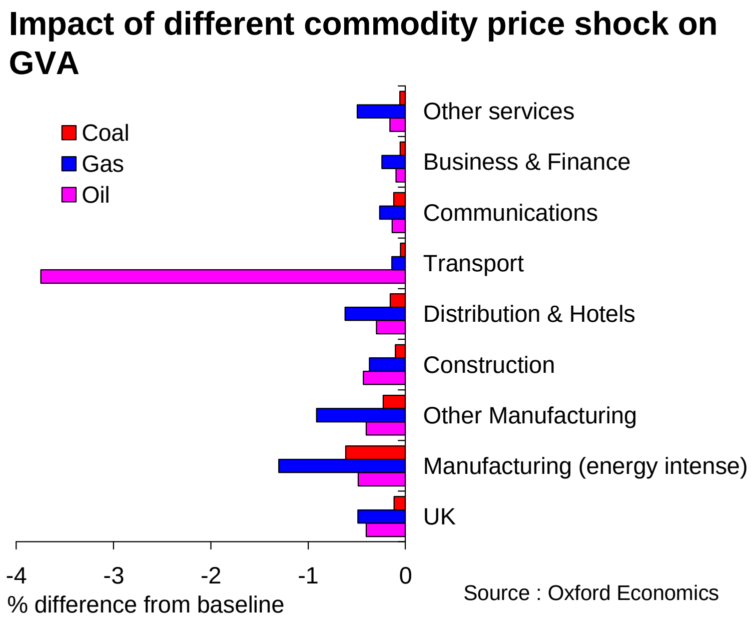


There are reasons to believe that the response of the economy to a commodity price shock may be more asymmetric than implied in the model. Fluctuations in fossil fuel prices will tend to promote a reallocation of capital and labour in the economy, while also creating uncertainty about the future path of the price of energy. These effects amplify the response of macroeconomic aggregates to energy price increases, but reduce the corresponding response to falling energy prices. This is also consistent with the perception that negative fossil fuel price shocks do not generate expansions of comparable magnitude to the contractions in output generated by positive fossil fuel price shocks. These are potential limitations to the model that should be taken into account when interpreting results.

5.2 Type of commodity price shock

As described in the main report, the impact across sectors of a shock to fossil fuel prices will differ depending in part upon the fuel mix (including electricity) within the energy inputs to each sector. To explore this effect, we considered 50% supply shocks to the price of oil, gas and coal in 2010 separately. The results illustrated in Chart 5.3 show that the shock to gas prices has the greatest impact at the whole economy level and across all sectors other than transport. This reflects the importance of gas-fired power stations in electricity generation and the relatively large share of electricity in energy inputs.

Chart 5.3: Impact of different fuel price shocks

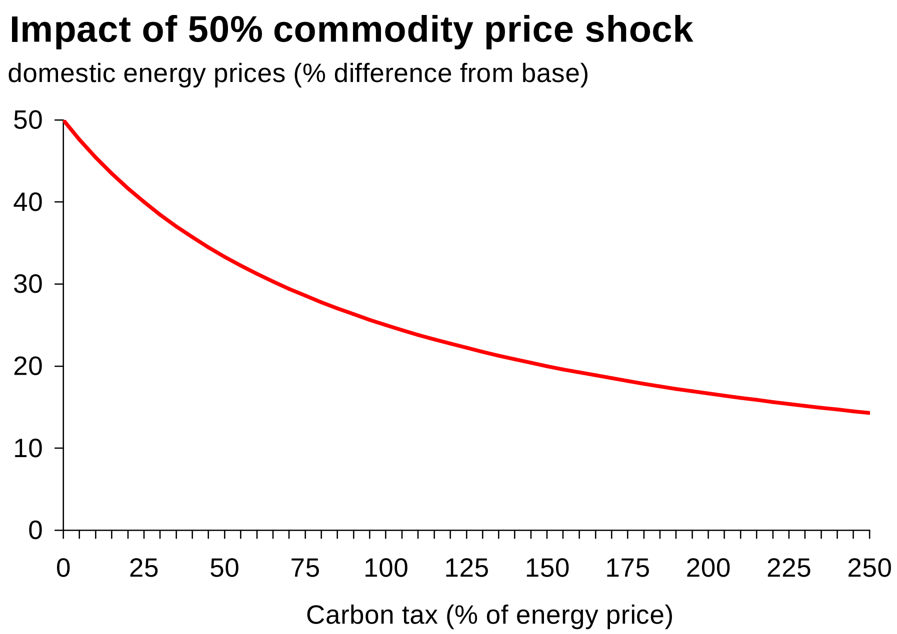


The transport sector is a notable exception in Chart 5.3, as the oil price shock has a much larger impact for transport than other sectors. This reflects the importance of petroleum products for this sector. The only sector where coal has a significant impact on output is energy-intensive manufacturing, as coal is used in the production of products such as basic metals. Coal has a relatively small impact on the economy (outside of energy intensive manufacturing) and its main transmission is through the power sector and its impact on electricity prices. More detail on these scenarios are presented in annex B.

5.3 Level of carbon tax

The imposition of a carbon tax creates a 'wedge' between global fossil fuel prices and the final price of energy facing the domestic economy. The proportional impact of a commodity price rise is inversely related to the tax content of the retail price, but the relationship is non-linear. Chart 5.4 illustrates this effect – without any carbon tax, a 50% shock to all fossil fuel prices (assuming no change in the energy mix) would feed through to a 50% rise in domestic energy prices; but with a carbon tax set at 100% of domestic energy prices, the 50% shock to fossil fuel prices would result in a 25% rise in domestic energy prices; and with the carbon tax set at a level of 200%, the 50% shock to fossil fuel prices results in a 17% rise in domestic energy prices. This shows that raising the level of carbon tax will result in declining marginal benefits in terms of reducing the sensitivity of domestic energy prices to an energy price shock.

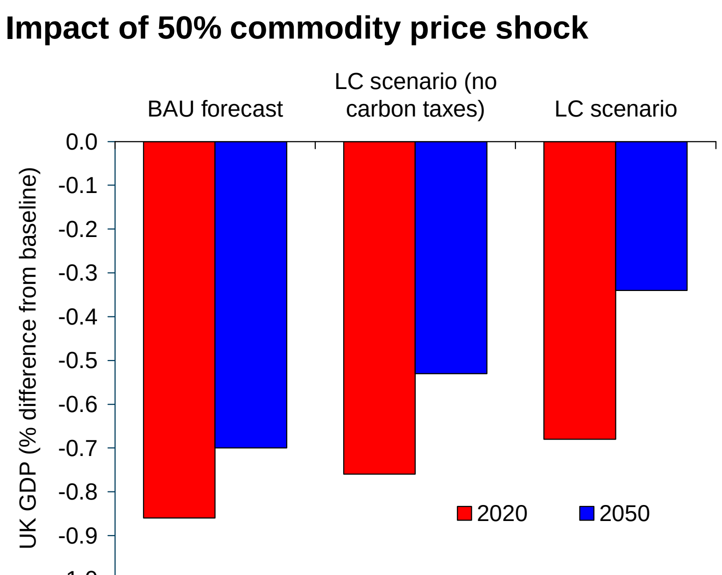
Chart 5.4: Non-linear effect of a carbon tax



Source : Oxford Economics

We have also explored the impact of a supply shock to fossil fuel prices within the LC scenario where carbon taxes are set to zero. This helps to differentiate the influence of the carbon tax in reducing the vulnerability of the economy to fossil fuel price shocks from the dampening effect caused by the economy's lower energy intensity. As shown in Chart 5.5, a 50% commodity price shock results in a GDP decline of almost 0.8% in 2020 without carbon taxes, compared to a 0.7% fall in the LC scenario. In 2050, the same shock results in a GDP decline of 0.5% without carbon taxes, compared to 0.3% in the LC scenario.

Chart 5.5: Impact on GDP of fossil fuel price shock



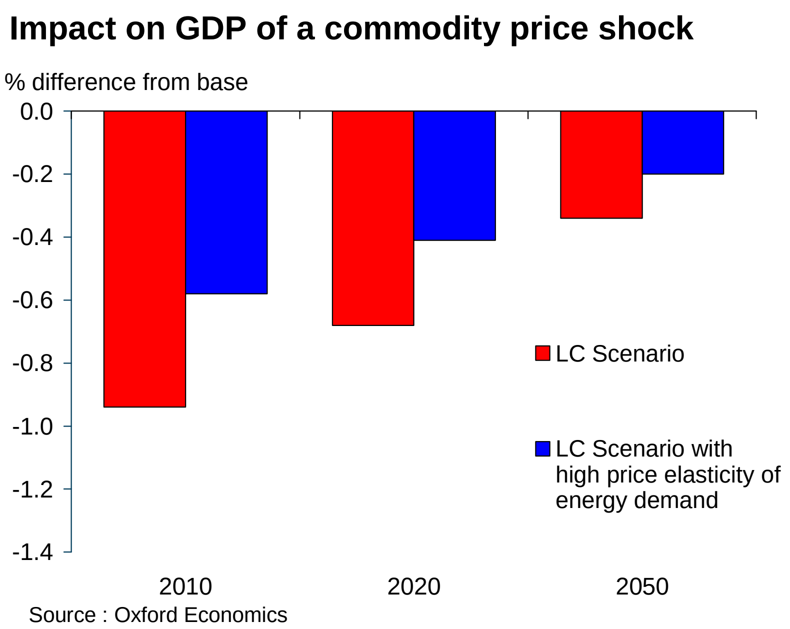
Source : Oxford Economics

5.4 Price elasticity of demand for energy

The LC scenario incorporates our estimates of the price elasticity of demand for energy, which averages 0.6 across the economy as a whole, although it is higher than that average in some sectors and lower in others. Our estimates are derived from a cross-sectional analysis of UK energy demand. As such econometric estimates are necessarily subject to a degree of uncertainty, it is possible that the price elasticity could be higher or lower than we have assumed in this report. To evaluate the sensitivity of our analysis to this uncertainty, we have assessed the impact of assuming a higher price-elasticity of energy demand of 1 (the higher price elasticity is scaled across sectors).

The higher price elasticity of demand means firms can substitute out of energy more easily, thereby reducing the impact of the commodity price shock on their energy bill and mitigating the impact on output. The impact on UK GDP from a supply shock that affects commodity prices is illustrated by Chart 5.6 and the relationship is broadly that a doubling of the price elasticity of demand would halve the impact on GDP.

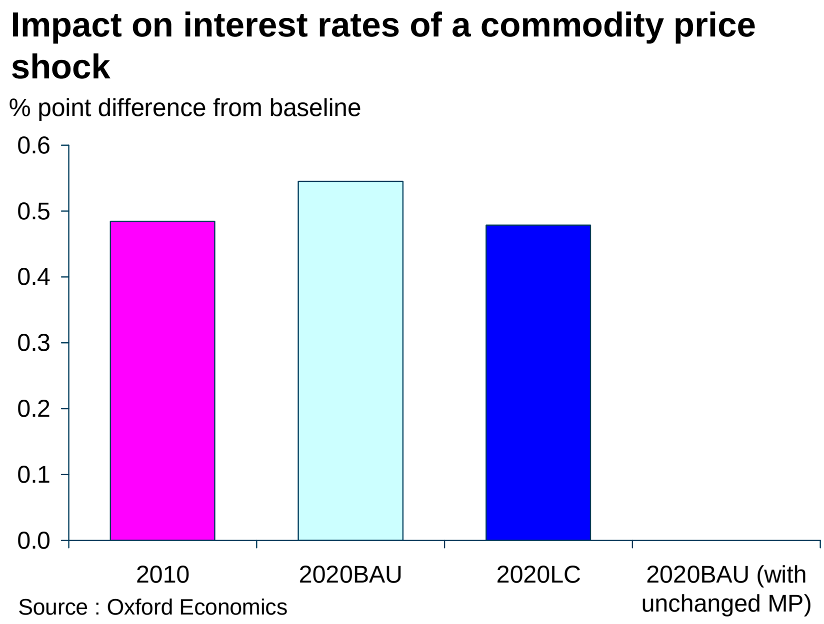
Chart 5.6: Impact on GDP of varying price elasticity



5.5 Role of monetary policy

Regarding the impact of a commodity price shock on headline consumer price inflation, domestic taxes on fuel help to insulate the price level from changes in commodity prices, fundamentally by helping to reduce energy intensity in the longer run, but also statistically in the short term, since the proportional impact of a commodity price rise is inversely related to the tax content of the retail price. But the extent to which an increase in domestic energy prices translates into higher core inflation depends on the monetary policy regime in place. More specifically, monetary policy needs to weigh together the inflationary impact on prices against the deflationary impact on economic activity.

Chart 5.7: Monetary policy response to a commodity price shock

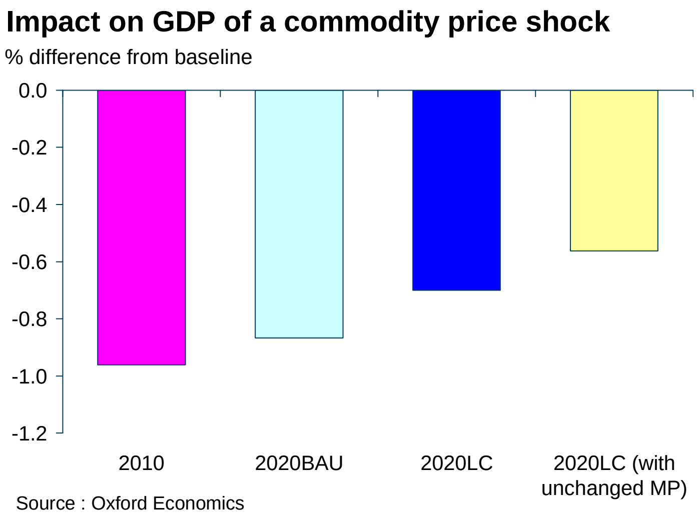


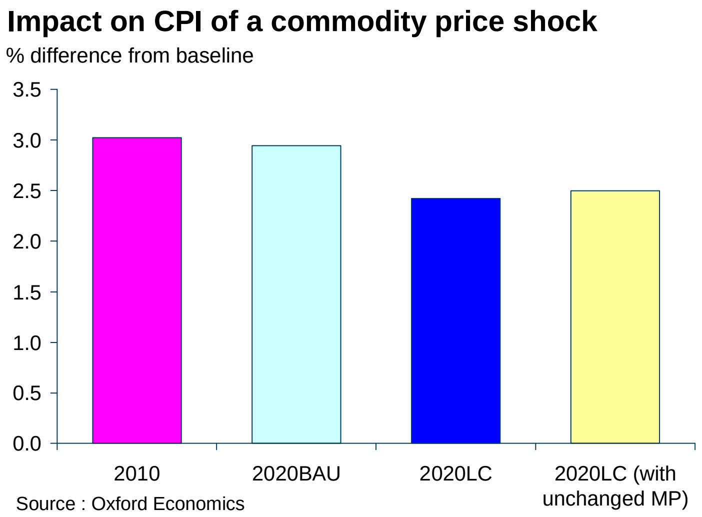
The scenario results presented in the main report assume that monetary policy responds to the energy price shock based on a 'Taylor rule' principle[4] that takes into account changes in both inflation and output. The monetary policy response function in the Oxford Model results in a modest increase in interest rates as the inflation impact dominates.

On the other hand, it is possible that the central bank could instead choose to accommodate the temporary spike in commodity prices, which would then improve the GDP outcome. If, for example, interest rates were left unchanged, then GDP would fall by around 0.6% following an oil and gas price hike in 2020, compared to a 0.7% drop with slightly higher interest rates in the LC scenario (see Chart 5.8). Looser monetary policy would also imply a more significant impact on consumer prices from the commodity price shock, however, with the CPI rising by 2.5% compared to 2.4% in the LC scenario.

[4] The Taylor rule is a monetary-policy rule that stipulates how much the central bank should change the nominal interest rate in response to (1) deviations of inflation from the central bank's target, (2) how far economic activity is above or below its "full employment" level, and (3) what the level of the short-term interest rate is that would be consistent with 'full employment'.

Chart 5.8: Monetary policy impact on GDP and inflation





6 Conclusion

The UK economy is set to become less energy intensive over the next four decades. This reflects:

- Increased energy efficiency across all sectors
- Changing composition of output, as growth in services outpaces manufacturing

Nonetheless, achieving more ambitious targets for reducing energy demand would require the introduction of climate change policies such as a carbon tax. This could also have the beneficial effect of reducing the UK's exposure to future commodity price shocks by:

- Increasing energy efficiency
- Making end-user energy prices more stable in the face of fluctuations in fossil fuel prices

The degree to which these policies would reduce the UK's vulnerability to developments in global energy prices was explored using the Oxford Economics UK Energy Industry Model and the Oxford Global Economic Model. More specifically, we compared the economic impact of a shock to fuel prices in our central 'Business As Usual' (BAU) scenario with a Low Carbon (LC) scenario where coal demand declines to 90% of 2010 levels, gas demand by 70% and oil by 30% by 2050.

The key findings of this study are that the impact of a 50% increase in oil and gas prices reduces GDP by:

- Around 1.0% in 2010.
- About 0.9% in 2020 under the BAU scenario and 0.7% under the LC scenario of reduced energy demand.[5]
- About 0.7% in 2050 under the BAU scenario and less than 0.4% under the LC scenario of reduced energy demand.

Our modelling results therefore indicate that the UK's sensitivity to oil and gas price shocks could be reduced by around 60% in 2050 through the introduction of such climate change policies. Sectors with the largest energy intensity of production in 2010 (such as transport services and manufacturing) are likely to witness the greatest benefits over the forecast period (but also the largest adjustment costs), as it will be these sectors that would make the largest adjustments in terms of improved energy efficiency.

[5] The impact falls under the BAU scenario because energy efficiency improves gradually and the share of gas in overall primary energy demand rises.

Annex A: Modelling Approach

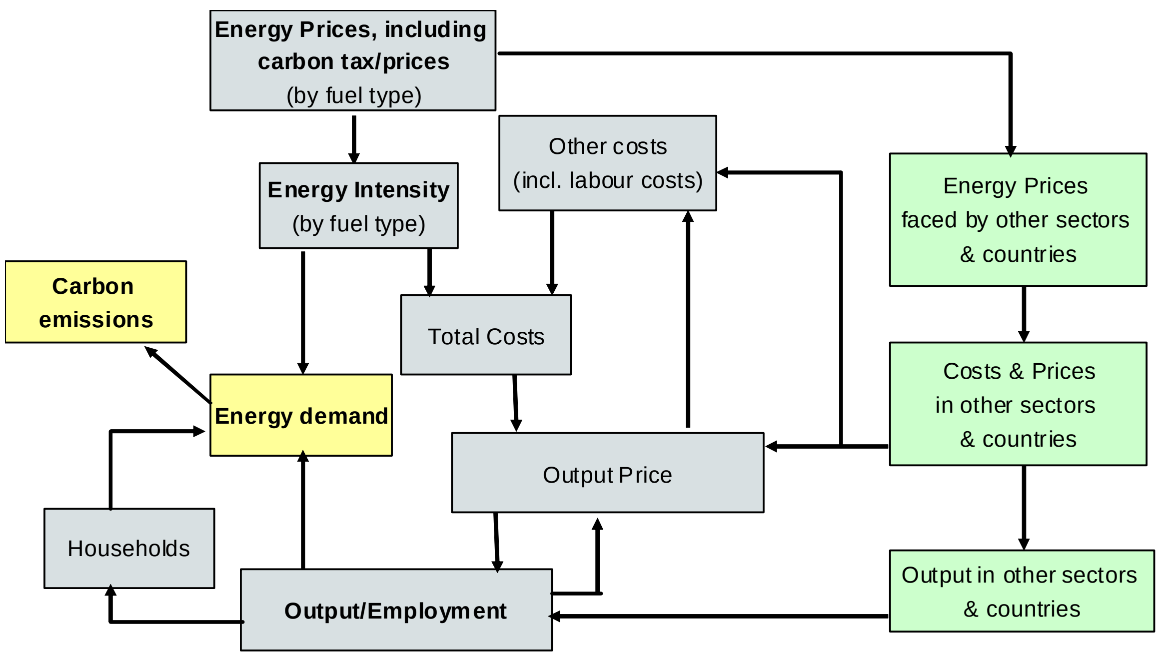
For the purposes of this project, we have used two different economic models. The first is the Oxford UK Energy Industry Model, and the second is the Oxford Global Macroeconomic Model.

The Oxford UK Energy Industry Model

The Oxford UK Energy Industry Model **(**OEIM) is a thirty-sector model of the UK economy, where the gross output of each sector is a function of four inputs to the production process: fixed capital, labour, energy, and other intermediate inputs. Changes in the real price of any one of those inputs to the production process will change the equilibrium quantity of that factor of production that is employed, and will therefore also change the equilibrium level of output in each sector. Household energy demand, including domestic transport use, is modelled separately.

The OEIM also captures the way the economy shifts towards its new equilibrium, but it is really a general equilibrium model. It assumes that, while the economy might operate away from its efficient equilibrium for short periods of time (for the length of a typical business cycle, for example), eventually it will converge on that efficient equilibrium.

Figure A1: Overview of the Oxford UK Energy Industry Model (OEIM)



Critically for this project, the OEIM allows for an assessment of how changes in the price of energy – whether from global market changes or as a result of government policies and regulations – impact on the amount, type and cost of energy used by companies and households. The impact of energy prices will depend crucially on the energy intensity of the sector. The change in a sector's energy bill then impacts on the rest of the economy through demand and competitiveness channels: in so far as higher energy prices reduce households' purchasing power, this reduces aggregate demand in the economy, while firms will try to pass on higher energy prices, which discourages demand by raising output prices and possibly eroding UK firms' competitiveness.

The OEIM provides the long-run impact on sectoral competitiveness, output, capital stock, employment, and energy use of alternative assumptions relating to energy use and global energy prices. It also provides some constraints that will be imposed on the UK Macroeconomic Model in order to assess the dynamic response of the UK economy to developments in international energy prices. The key variables to be copied over from the OEIM to the UK Macroeconomic Model are the productive potential of the economy and the price implications of higher energy costs.

The Global Economic Model

The UK macroeconomic model is embedded in Oxford Economics' Global Economic Model, which covers some 46 economies in detail and allows the implications of alternative global scenarios and policy developments to be readily analysed at both the macro and broad sectoral level in the UK. In the model, domestic and external demand are the key drivers of the UK economy in the short term. In terms of private demand, consumers' expenditure is a function of incomes, wealth and real interest rates. Government expenditures are assumed to be a policy choice. Business investment is determined by the level of relative return on capital, but is mainly driven by an 'accelerator' mechanism – that is, higher output leads to greater investment – while residential investment is modelled in a similar way to consumption. Exports are a function of world demand, domestic capacity and competitiveness, while imports are determined by real domestic demand and competitiveness.

The key underpinning for the model for UK is that the long-run properties of the economy are determined on the supply side. Put simply, the long-run trend rate of growth of the economy depends on the growth in the population of working age, the speed with which the capital available to workers increases, and total factor productivity growth. While the government can use policy to drive output above its potential level in the short term, in the medium term such excessive spending will be self-defeating as it will put pressure on capacity and then inflation and imports. In this project, we constrained the supply-side of the UK macroeconomic model to be consistent with the outputs of the OEIM.

In the economy, output cycles around potential output. Domestic firms are assumed to set prices given output and the capital stock, but the labour market is imperfectly competitive. Firms in each sector bargain with workers over wages, but they get to choose the level of employment. High real wages – relative to productivity – results in higher unemployment in the long run, and if real wages are rigid then unemployment is persistently high.

Inflation depends on domestic and imported prices and prices are modelled as a mark-up cost, with the level of demand in the economy relative to capacity determining the mark-up ie excess demand will result in higher prices as firms increase margins. Energy prices are an input determinant of costs and the impact of higher energy prices will be brought in from the OEIM.

The Bank of England adjusts interest rates in line with inflation and demand developments – the so-called Taylor Rule – while interest rate differentials with other countries are crucial for determining exchange rates.

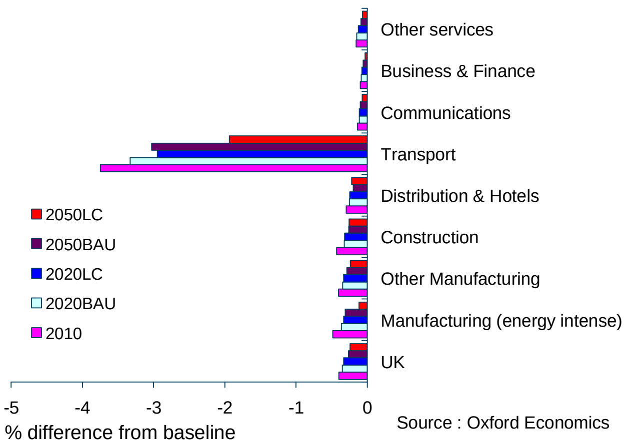
The output of the UK Macroeconomic Model is then the dynamic impact on GDP, interest rates, employment, inflation and other macro variables in the UK.

Annex B: Alternative shock scenarios

A number of alternative shocks to commodity prices were also explored as part of a sensitivity analysis of the results presented in the main report. The results are presented below.

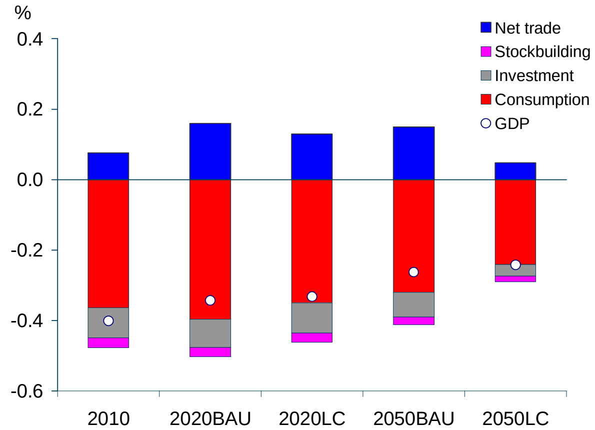
Scenario: 50% temporary increase in oil prices

Impact of commodity price shock on GVA



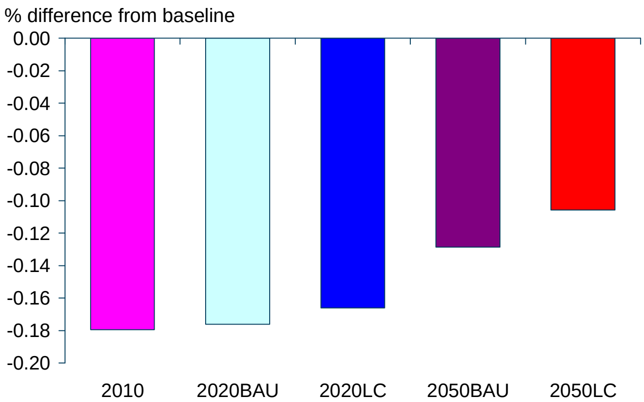
Source : Oxford Economics

Breakdown of impact on GDP components



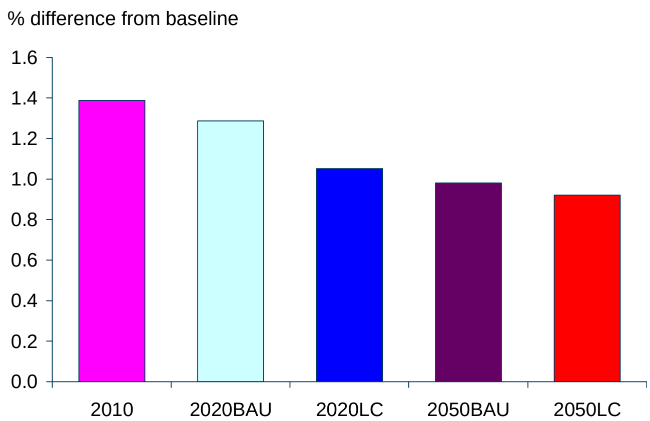
Source : Oxford Economics

Impact on employment of a commodity price shock



Source : Oxford Economics

Impact on CPI of a commodity price shock



Source : Oxford Economics

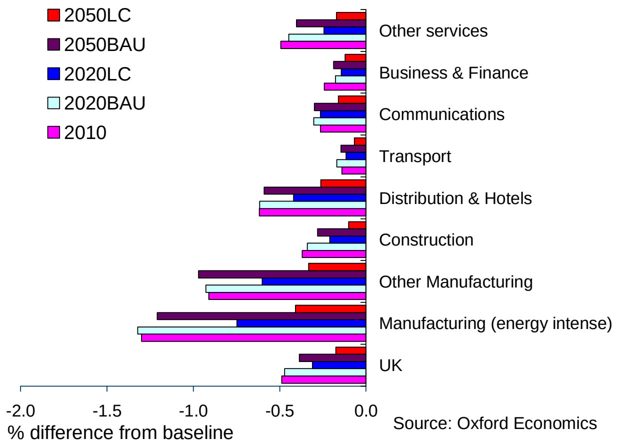
Summary table
(% difference from base, unless specified)

		BAU scenario		LC scenario	
	2010	2020	2050	2020	2050
GDP	-0.4	-0.3	-0.3	-0.3	-0.2
Private Consumption	-0.6	-0.6	-0.5	-0.6	-0.4
Fixed Investment	-0.5	-0.5	-0.4	-0.5	-0.2
Exports	-0.4	-0.6	-0.7	-0.6	-0.5
Imports	-0.7	-1.1	-1.1	-1.0	-0.7
CPI	1.4	1.3	1.0	1.1	0.9
Employment	-0.2	-0.2	-0.1	-0.2	-0.1
Short-Term Interest rate*	0.1	0.2	0.3	0.2	0.3

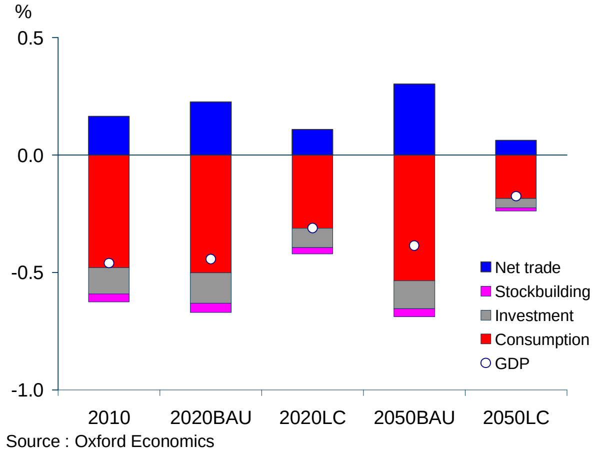
*refers to percentage point difference

Scenario: 50% temporary increase in gas prices

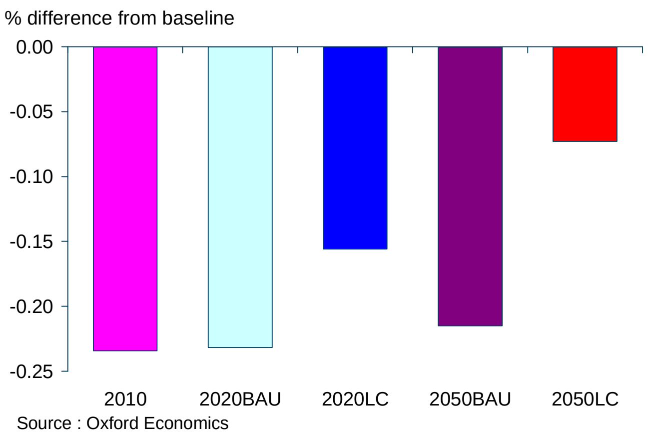
Impact of commodity price shock on GVA



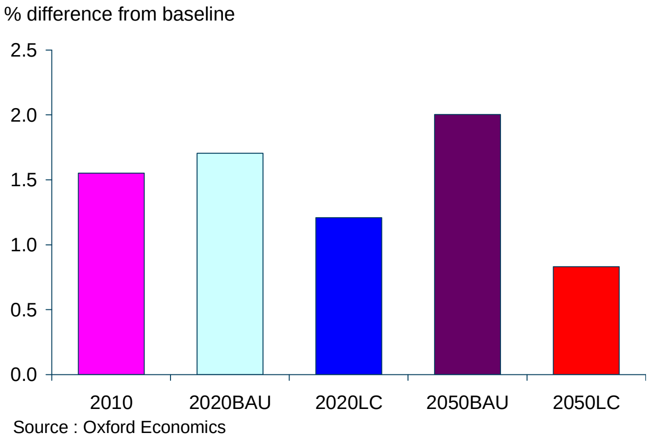
Breakdown of impact on GDP components



Impact on employment of a commodity price shock



Impact on CPI of a commodity price shock



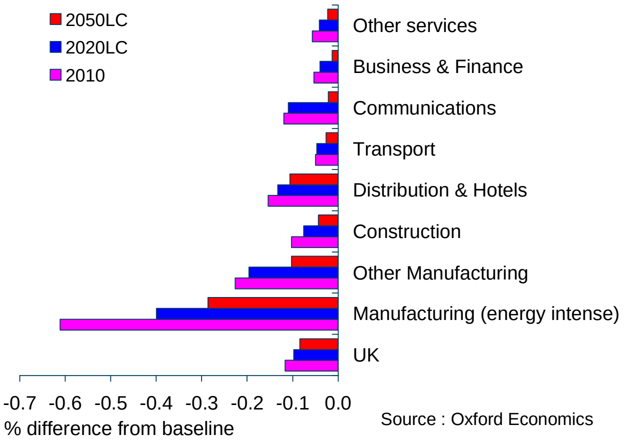
Summary table
(% difference from base, unless specified)

		BAU scenario		LC scenario	
	2010	2020	2050	2020	2050
GDP	-0.5	-0.4	-0.4	-0.3	-0.2
Private Consumption	-0.8	-0.8	-0.9	-0.5	-0.3
Fixed Investment	-0.7	-0.7	-0.7	-0.5	-0.2
Exports	-0.3	-0.4	-0.4	-0.3	-0.2
Imports	-0.8	-1.1	-1.3	-0.6	-0.4
CPI	1.6	1.7	2.0	1.2	0.8
Employment	-0.2	-0.2	-0.2	-0.2	-0.1
Short-Term Interest rate*	0.3	0.4	0.6	0.2	0.1

*refers to percentage point difference

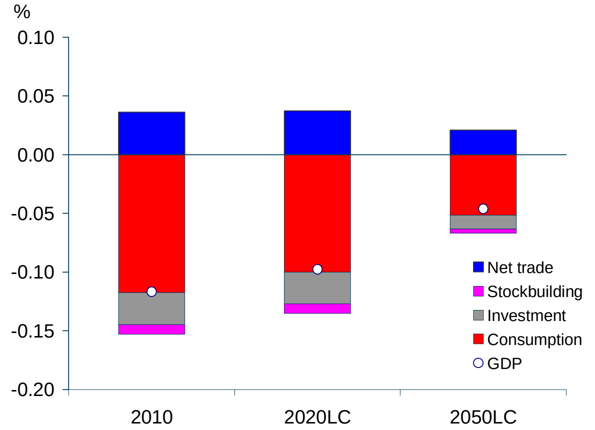
Scenario: 50% temporary increase in coal prices

Impact of commodity price shock on GVA



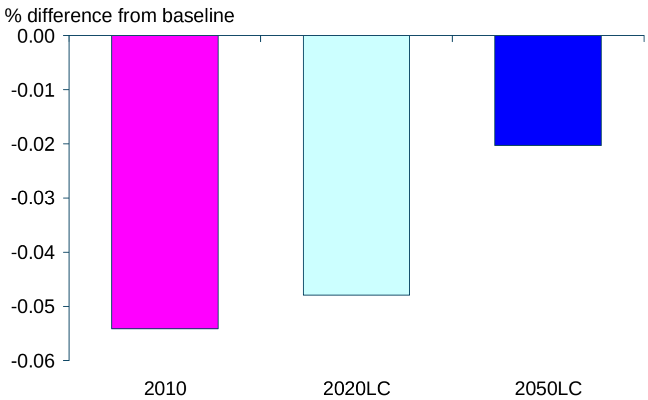
Source : Oxford Economics

Breakdown of impact on GDP components



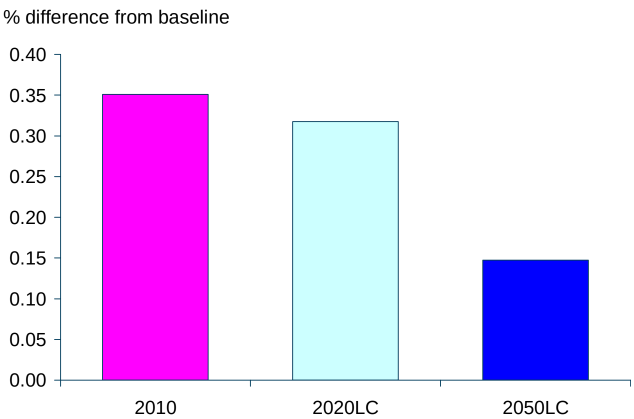
Source : Oxford Economics

Impact on employment of a commodity price shock



Source : Oxford Economics

Impact on CPI of a commodity price shock



Source : Oxford Economics

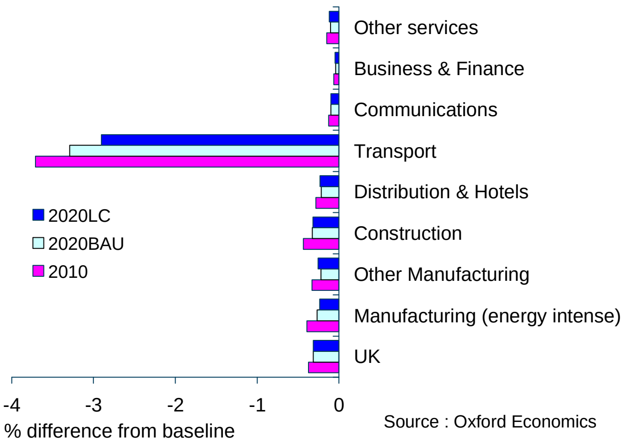
Summary table
(% difference from base, unless specified)

	2010	2020	2050
GDP	-0.1	-0.1	0.0
Private Consumption	-0.2	-0.2	-0.1
Fixed Investment	-0.2	-0.2	-0.1
Exports	-0.2	-0.2	-0.2
Imports	-0.3	-0.3	-0.2
CPI	0.4	0.3	0.1
Employment	-0.1	0.0	0.0
Short-Term Interest rate*	0.0	0.1	0.0

*refers to percentage point difference

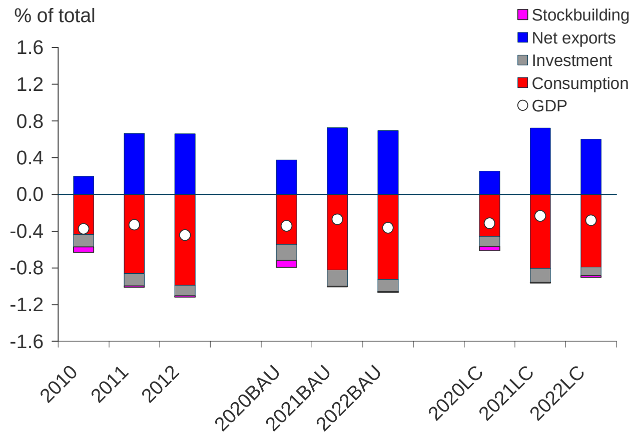
Scenario: 50% permanent increase in oil prices

Impact of commodity price shock on GVA



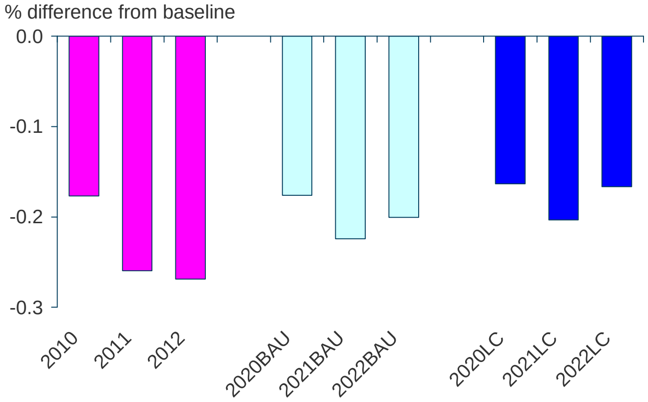
Source : Oxford Economics

Breakdown of impact on GDP components



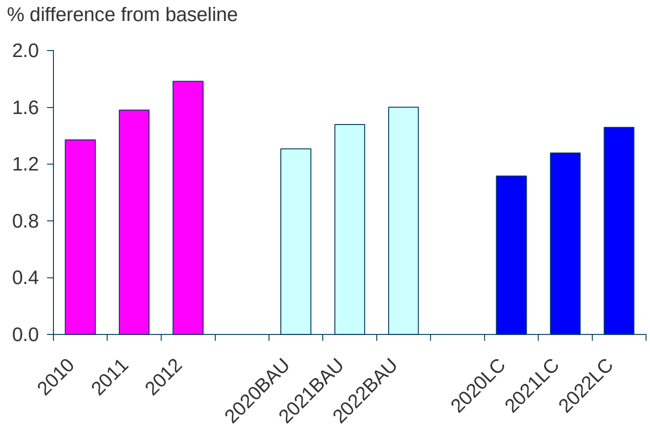
Source : Oxford Economics

Impact on employment of a commodity price shock



Source : Oxford Economics

Impact on CPI of a commodity price shock



Source : Oxford Economics

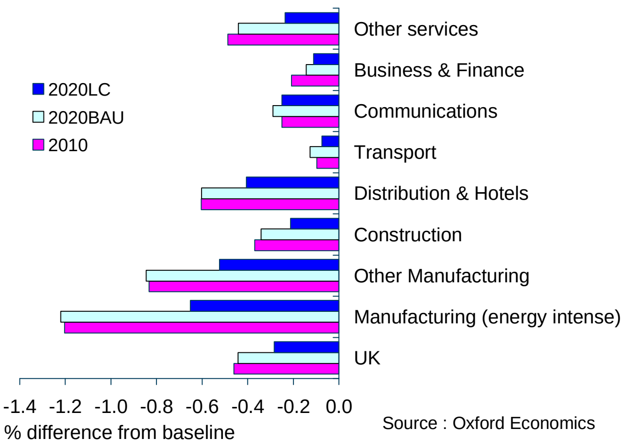
Summary table
(% difference from base, unless specified)

				BAU Scenario			LC Scenario		
	2010	2011	2012	2020	2021	2022	2020	2021	2022
GDP	-0.4	-0.3	-0.4	-0.3	-0.3	-0.4	-0.3	-0.2	-0.3
Private Consumption	-0.6	-1.3	-1.5	-0.5	-1.3	-1.5	-0.5	-1.2	-1.4
Fixed Investment	-0.7	-0.8	-0.7	-0.6	-1.0	-0.7	-0.5	-0.8	-0.6
Exports	0.6	1.9	2.1	0.6	1.7	1.8	0.6	1.8	1.9
Imports	-0.1	-0.3	-0.1	-0.1	-0.4	-0.2	0.1	-0.2	-0.1
CPI	1.4	1.6	1.8	1.3	1.5	1.6	1.1	1.3	1.5
Employment	-0.2	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Short-Term Interest rate*	0.1	0.5	0.4	0.2	0.4	0.4	0.3	0.5	0.5

*refers to percentage point difference

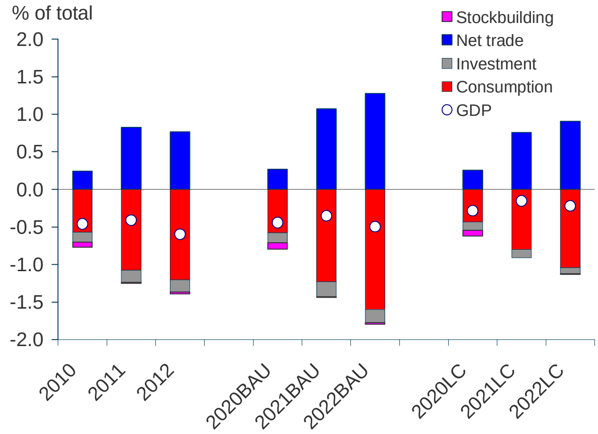
Scenario: 50% permanent increase in gas prices

Impact of commodity price shock on GVA



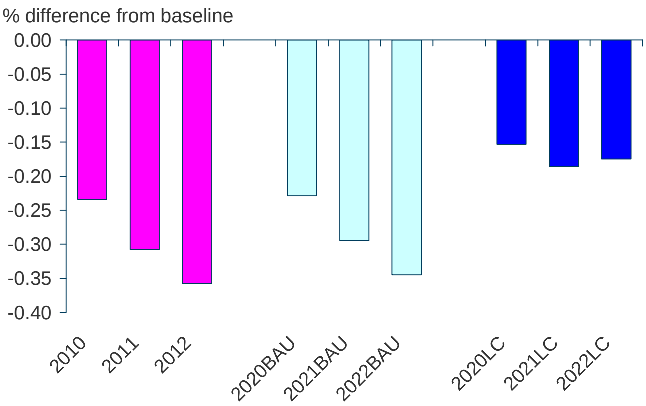
Source : Oxford Economics

Breakdown of impact on GDP components



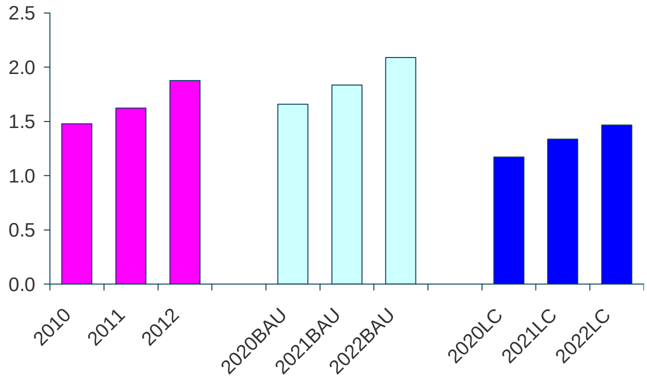
Source : Oxford Economics

Impact on employment of a commodity price shock



Source : Oxford Economics

Impact on CPI of a commodity price shock



Source : Oxford Economics

Summary table
(% difference from base, unless specified)

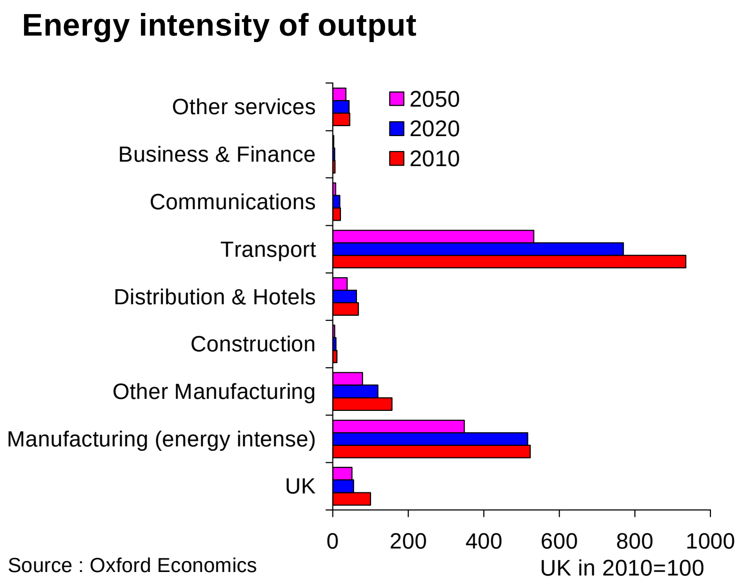
				BAU Scenario			LC Scenario		
	2010	2011	2012	2020	2021	2022	2020	2021	2022
GDP	-0.5	-0.4	-0.6	-0.4	-0.4	-0.5	-0.3	-0.2	-0.2
Private Consumption	-0.8	-1.6	-1.8	-0.8	-1.9	-2.4	-0.5	-1.3	-1.6
Fixed Investment	-0.7	-1.0	-1.0	-0.6	-1.1	-1.0	-0.5	-0.6	-0.4
Exports	0.7	2.1	2.2	0.7	1.8	2.3	0.8	1.9	2.5
Imports	-0.1	-0.7	-0.3	0.0	-1.3	-1.3	0.2	-0.3	-0.1
CPI	1.5	1.6	1.9	1.7	1.8	2.1	1.2	1.3	1.5
Employment	-0.2	-0.3	-0.4	-0.2	-0.3	-0.3	-0.2	-0.2	-0.2
Short-Term Interest rate*	0.3	0.5	0.4	0.4	0.7	0.8	0.2	0.5	0.5

*refers to percentage point difference

Annex C: The BAU forecast

In the 'business as usual' (BAU) forecast, total fuel consumption in the UK economy is forecast to increase only gradually over the medium term as the energy intensity of output falls. Our forecasts for energy intensity at the whole economy level reflect improvements in energy efficiency at the sector level and the changing composition of the UK economy, i.e. less energy intensive sectors such as financial and business services will see the fastest growth.

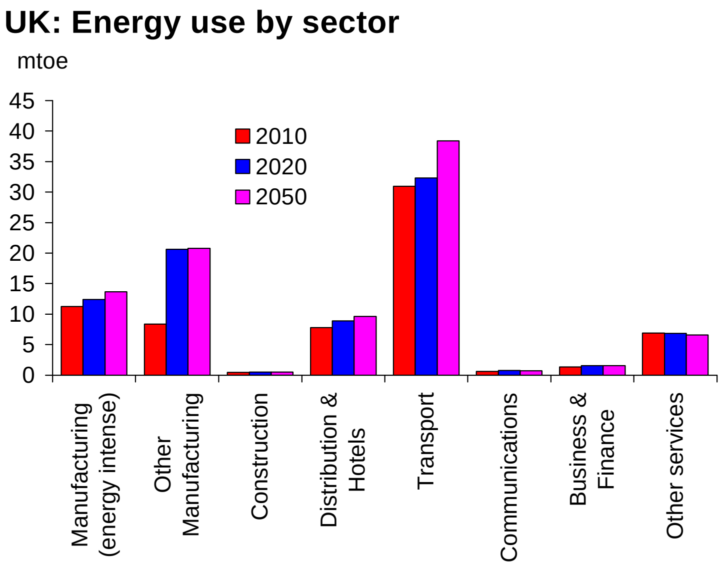
Chart C1



Source : Oxford Economics

The implications for total energy use by sector are illustrated in Chart C2. Energy use in services is set to increase, reflecting the strong growth in this sector. The biggest rise is seen in the transport sector, in part reflecting increased aviation demand. Energy use within manufacturing will remain broadly flat in the longer term, reflecting sluggish growth in activity combined with substantial improvements in energy efficiency.

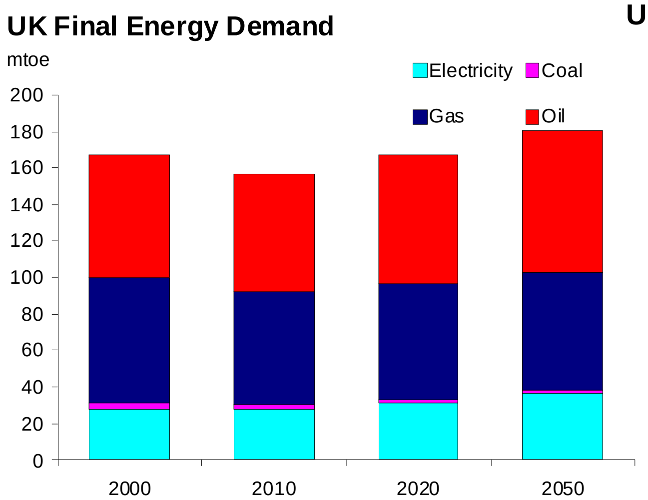
Chart C2



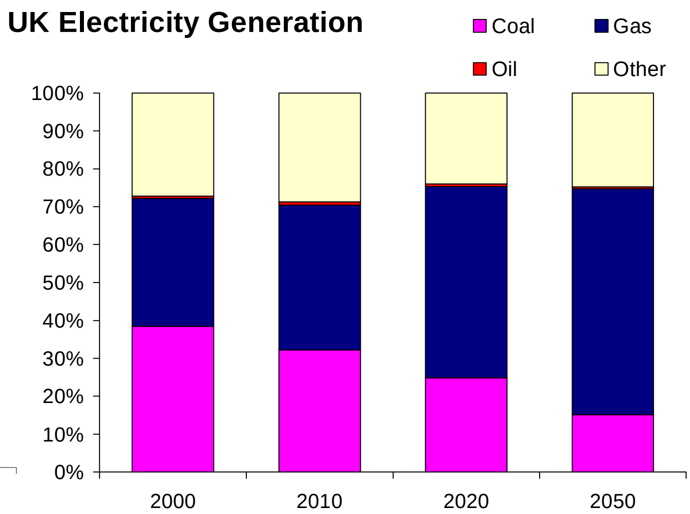
Source : Oxford Economics

There is expected to be a gradual trend towards increased electricity and oil consumption, with the relative importance of gas and coal declining. In electricity generation, the importance of gas is expected to increase, while coal-fired power stations become less important. The share of other sources of electricity generation (nuclear and renewables) remains broadly stable over the forecast horizon.

Chart C3



Source: DUKES/Oxford Economics



Source: DUKES/Oxford Economics

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