DTI Energy Price Scenarios in the Oxford Models

Introduction

The DTI asked Oxford Economic Forecasting to undertake scenario analysis exploring the transitional impact on the UK economy of changes in energy prices in the context of our suite of economic models. This note summarises the results of this analysis.

The suite of models

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

The Energy-Industry Model (EIM) 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.

Some sectors make more intensive use of energy in their production process than others. A change in the real price of energy that is symmetric across all sectors will therefore have a disproportionately large impact on output in the more energy-intensive sectors. In the long-run, an increase in the real price of energy will lead to lower output in all sectors, but more so in the most energy intensive sectors. That disproportionate effect on the energy-intensive sectors will lead to a shift in the composition of employment across the sectors. In the long run, total employment will not change as a result of a shock to energy prices. But the composition of that employment will change: higher energy prices will shift jobs out of energy-intensive sectors and into other sectors.

The impact on employment and output in energy-intensive sectors will be amplified to the extent that the shock to energy prices is specific to the UK. If it is a global shock, then the competitiveness of the energy-intensive sectors in the UK relative to their counterparts overseas will not be affected. But if it is a UK-specific shock, it will drive up the real exchange rate of the energy intensive sectors and lead to weaker demand for the output of those sectors, amplifying and hastening the shift in employment to other sectors.

Overall, the EIM captures the long run impact of changes in energy prices on output at the whole economy level and on the composition of output and employment across the industrial sectors. A permanent increase in the real price of energy has a permanent negative impact on whole economy output.

For this project, we have used the EIM to estimate the impact of a range of different energy price scenarios on whole economy output out to 2020. But the focus of this project is the short- to medium-term 'transitional' effects of changes in energy prices. The EIM has only a very rudimentary treatment of short- to medium-term dynamics, so it is not the appropriate tool for assessing these effects. Instead, we have used the Global Macroeconomic Model for this purpose.

The **Global Macroeconomic Model** (GMM) is fully linked global model including detailed models of over forty economies including the UK. Each country model, including the UK, captures all the key macroeconomic variables, has a well-defined long-run that is consistent with economic theory, and a rich representation of the short- to medium-term dynamic properties of the economy in question. In the short run, shocks to demand, to prices, to the levers of macroeconomic policy, to exchange rates etc, generate real effects, changing output and employment at the whole economy level. But in the long-run, real variables reflect supply-side constraints. Shocks that change real variables in the short run will trigger a round of nominal adjustments (to prices, wages, exchange and interest rates) which will ensure real variables converge on their equilibrium values in the long run.

One of the long-run supply-side constraints in the GMM is the level of 'potential output' in each economy. This is the variable that we use as the link between the GMM and the EIM for the purposes of this project. The EIM generates impacts on long-run output in response to the different energy price scenarios. We then impose these changes on potential output in the GMM – along with all the relevant changes in energy prices – and allow the GMM to identify the transition path to that long-run outcome.

Higher energy prices mean lower output in the long run, according to the EIM. Imposing that on potential output in the GMM means pushing down potential output. If potential output falls, in the long run actual output must also fall, in order to stabilize inflation in the GMM. The GMM captures the mechanisms that ensure actual output converges on the new, lower equilibrium for potential output, and describes the transitional impacts on prices, exchange rates, interest rates, employment and so on.

The scenarios

For this project, we have explored the following scenarios, looking at the impact between 2010 (when the scenarios start) and 2020:

1. A 30% increase in all energy end-user prices; first for the UK only, then for the whole of the EU, then globally
2. A 10% and a 30% increase in the producer price of oil
3. A 10% and a 30% increase in the producer price of gas
4. An increase of 15 euros per tonne of carbon emissions in the EU Emissions Trading System (ETS)
5. A backwards engineering scenario to reduce UK carbon emissions by 60% relative to their 1990 levels by 2050

Below, we go through each of these scenarios in turn.

Scenario 1: end-user energy price shocks

These scenarios see the price of all energy types to the final consumer increase by 30% permanently from 2010 onwards. Since energy represents about 5% of the total costs of production in the UK (on average across all industries) this implies a 1.5% increase in total costs to industry. And, since energy represents about 10% of the cost of the average basket of consumer goods in the UK, it also implies a 3% increase in consumer prices, and therefore a 3% reduction in consumers' real income.

Higher costs of production and lower real incomes mean lower investment and lower consumer spending. Aggregate demand (GDP) falls relative to the base forecast, at the same time as general prices rise. Weaker GDP translates to weaker employment, driving down real incomes further. At the same time, higher prices mean the MPC has to push up interest rates to bring inflation under control. Higher interest rates damage GDP still further. Aggregate demand needs to fall to bring it into line with the new, lower equilibrium for potential output: higher interest rates and lower real incomes are the mechanisms that help bring this convergence about. In fact, the negative impact on demand goes too far – with aggregate demand falling below its new, lower long-run equilibrium. So interest rates fall back, causing GDP and inflation to stabilise.

That pattern is common across all three scenarios in this group – a UK-specific change in end-user prices; a change across the EU as a whole; and a symmetric global shock. But the magnitude of the negative effects is worse by 2020 in the UK-specific shock, and

least bad in the global shock. That is because the UK-specific shock involves permanent damage to the competitiveness of energy-intensive industry in the UK, so that the shift of employment out of those (relatively high-productivity) sectors into other sectors of the economy is accelerated in this case, damaging average labour productivity across the UK as a whole. In the global scenario (and – to a lesser extent – in the EU scenario), these competitiveness effects are not present. Energy-intensive industry is still hit hardest, but it is also hit in other countries, so the impact on demand for the output of UK energy-intensive industry is less pronounced.

By contrast, the short-term negative impact is worst in the global scenario and least bad in the UK-specific case. That is because the global (and to a lesser extent the EU) scenario sees inflation increase in other countries, hitting real incomes in those countries and causing interest rates to rise there. So aggregate demand outside the UK falls, reducing demand for UK exports, and aggravating the short-run effects on UK aggregate demand via a negative impact on UK net trade.

The percentage differences from the base forecast across a range of key variables in the UK for each of these three cases are set out in Table 1. The impact on the level of GDP varies between -1.1% (world shock) and -2.1% (UK-specific shock) by 2020: implying that a 30% increase in the end-user price of all energy types would shave between 1% and 2% off the level of GDP in the UK by 2020.

Note that that by 2020 there are also negative impacts on whole-economy employment. That is the result of the fact that, after ten years, the economy has still not fully converged on its equilibrium. After twenty years or so, these employment effects would disappear – which would also reduce the negative impact on GDP in each scenario.

Table 1: impact of a 30% increase in the end-user price of energy from 2010 to 2020: percentage differences from levels in base forecast

UK-specific shock

YEARS BEGINNING Q1	CONSUMER EXPEND-ITURE	REAL PERSONAL INCOME	GDP	INDUSTRIAL OUTPUT	UNEM-PLOYMENT ('000S)	EMPLOYMENT	AVERAGE EARNINGS	CONSUMER PRICES (ex.MIPS)	SHORT-TERM INTEREST RATE (PTS)	EFFECTIVE EXCHANGE RATE	CURRENT ACCOUNT (% OF GDP!)
2010	-1.5	-1.9	-0.8	-0.4	103.9	-0.3	0.3	2.3	0.3	0.3	0.3
2011	-2.9	-2.2	-1.7	-1.3	330.7	-1.0	0.0	2.1	-0.1	-0.4	0.6
2012	-2.9	-2.3	-1.6	-1.1	374.5	-1.2	-0.3	1.7	0.0	0.4	0.6
2013	-2.9	-2.1	-1.6	-1.0	314.5	-1.0	-0.4	1.4	0.3	1.1	0.5
2014	-3.0	-2.0	-1.7	-1.2	284.6	-0.9	-0.4	1.4	0.5	1.1	0.5
2015	-3.0	-2.0	-1.8	-1.4	267.5	-0.9	-0.3	1.5	0.5	1.0	0.4
2016	-3.0	-1.9	-1.8	-1.7	246.5	-0.8	-0.2	1.6	0.5	0.9	0.3
2017	-3.0	-1.9	-1.9	-1.9	231.3	-0.8	0.0	1.8	0.5	0.7	0.2
2018	-3.0	-1.8	-2.0	-2.1	224.8	-0.8	0.1	1.9	0.4	0.6	0.1
2019	-3.1	-1.8	-2.0	-2.3	221.4	-0.8	0.2	2.0	0.3	0.4	0.1
2020	-3.1	-1.8	-2.1	-2.4	216.4	-0.8	0.2	2.1	0.3	0.4	0.0

EU-specific shock

YEARS BEGINNING Q1	CONSUMER EXPEND-ITURE	REAL PERSONAL INCOME	GDP	INDUSTRIAL OUTPUT	UNEM-PLOYMENT ('000S)	EMPLOYMENT	AVERAGE EARNINGS	CONSUMER PRICES (ex.MIPS)	SHORT-TERM INTEREST RATE (PTS)	EFFECTIVE EXCHANGE RATE	CURRENT ACCOUNT (% OF GDP!)
2010	-2.2	-2.0	-1.2	-0.8	163.1	-0.5	0.3	2.2	1.0	-1.3	0.4
2011	-3.4	-2.5	-2.0	-1.4	435.8	-1.4	-0.5	1.8	-0.6	-0.1	0.8
2012	-2.9	-2.5	-1.7	-1.0	391.4	-1.2	-1.1	1.3	-0.5	2.1	0.6
2013	-2.8	-2.4	-1.6	-1.1	301.7	-1.0	-1.5	0.9	-0.4	3.2	0.4
2014	-2.7	-2.4	-1.7	-1.3	264.1	-0.9	-1.8	0.6	-0.4	3.5	0.3
2015	-2.6	-2.3	-1.6	-1.3	216.0	-0.7	-1.8	0.6	-0.2	3.2	0.3
2016	-2.8	-2.3	-1.6	-1.4	188.5	-0.6	-1.7	0.6	0.1	2.6	0.3
2017	-3.1	-2.2	-1.7	-1.3	192.9	-0.7	-1.6	0.6	0.1	2.0	0.4
2018	-3.2	-2.1	-1.6	-1.1	178.0	-0.6	-1.4	0.7	0.1	1.7	0.4
2019	-3.1	-2.0	-1.6	-1.0	150.4	-0.5	-1.3	0.8	0.1	1.8	0.4
2020	-3.1	-1.9	-1.6	-1.1	136.2	-0.5	-1.1	0.9	0.1	2.4	0.4

Global shock

YEARS BEGINNING Q1	CONSUMER EXPEND-ITURE	REAL PERSONAL INCOME	GDP	INDUSTRIAL OUTPUT	UNEM-PLOYMENT ('000S)	EMPLOYMENT	AVERAGE EARNINGS	CONSUMER PRICES (ex.MIPS)	SHORT-TERM INTEREST RATE (PTS)	EFFECTIVE EXCHANGE RATE	CURRENT ACCOUNT (% OF GDP!)
2010	-2.2	-2.1	-1.3	-1.0	171.5	-0.5	0.2	2.2	0.9	-1.6	0.3
2011	-3.5	-2.7	-2.2	-1.7	463.9	-1.4	-0.8	1.8	-0.9	-0.1	0.7
2012	-2.8	-2.8	-1.9	-1.4	423.5	-1.3	-1.6	1.1	-1.1	2.5	0.4
2013	-2.3	-2.7	-1.6	-1.3	308.0	-1.0	-2.3	0.6	-1.0	4.0	0.2
2014	-2.0	-2.6	-1.3	-1.0	199.1	-0.7	-2.4	0.3	-0.7	3.9	0.1
2015	-2.2	-2.5	-1.2	-0.8	137.6	-0.5	-2.3	0.2	-0.3	2.8	0.2
2016	-2.7	-2.5	-1.3	-0.9	145.3	-0.5	-2.3	0.2	-0.3	1.7	0.3
2017	-2.9	-2.4	-1.4	-0.7	159.5	-0.6	-2.3	0.2	-0.2	1.2	0.4
2018	-3.0	-2.3	-1.3	-0.3	141.1	-0.5	-2.2	0.2	-0.1	1.0	0.5
2019	-3.0	-2.1	-1.2	-0.1	113.8	-0.4	-2.1	0.2	-0.1	1.2	0.6
2020	-3.0	-2.0	-1.1	0.1	82.8	-0.3	-2.0	0.2	-0.1	1.8	0.7

Scenario 2: higher oil prices

These scenarios see the global price of oil (Brent crude) increase by 10% (in the first case) and by 30% (in the second case). The short- and medium-term impacts have a similar structure to the end-user price shocks above, though with slightly different lags (reflecting the time it takes for a shock to Brent crude to feed through to the end-user price) and a different magnitude (reflecting the proportion of total energy costs that are accounted for by oil among the other primary fuels). Higher prices hit consumers' real incomes and increase firms' costs – more so for firms that make intensive use of energy and particularly those that make intensive use of oil. Aggregate demand falls, while prices rise, and interest rates move to bring aggregate demand into line with potential output.

But the impact by 2020 is different than in the case of a shock to all end-user energy prices. Since only the price of oil has increased, firms and consumers are free to substitute into other fuel types and, over a ten-year period – they do so. As a result, the impact on the overall price of energy by 2020 is slight, as is the impact on overall energy consumption. Oil consumption falls, but the consumption of other energy types increases, so that overall energy consumption is largely unchanged. Therefore, the impact on productive potential by 2020 is also very small. Table 2 sets out the impact of the 10% and 30% oil price scenarios.

Table 2: Impact of higher Brent crude prices on the UK economy

10% increase in price of Brent crude

YEARS BEGINNING Q1	CONSUMER EXPEND-ITURE	REAL PERSONAL INCOME	GDP	INDUSTRIAL OUTPUT	UNEM-PLOYMENT ('000S)	EMPLOYMENT	AVERAGE EARNINGS	CONSUMER PRICES (ex.MIPS)	SHORT-TERM INTEREST RATE (PTS)	EFFECTIVE EXCHANGE RATE	CURRENT ACCOUNT (% OF GDP!)
2010	-0.2	-0.1	-0.1	-0.1	12.5	0	0	0.2	0.1	-0.2	0
2011	-0.3	-0.1	-0.1	0	30.4	-0.1	0	0.1	0	-0.1	0.1
2012	-0.2	-0.1	0	0.1	16.1	0	0	0.1	0	0.1	0
2013	-0.1	0	0	0.1	5.3	0	0	0.1	0	0.2	0
2014	0	0	0	0.1	-3.4	0	0.1	0.2	0	0.2	0
2015	0	0	0.1	0.2	-12	0	0.1	0.2	0.1	0.2	0
2016	0	0	0	0.1	-7.4	0	0.2	0.3	0.1	0.1	0
2017	0	0	0	0.1	0.3	0	0.2	0.3	0.1	0	0
2018	0	0	0	0	1.8	0	0.2	0.3	0	0	0
2019	0	0	0	0	2.2	0	0.3	0.3	0	0.1	0
2020	0	0	0	0	4	0	0.2	0.4	0	0.1	-0.1

30% increase in price of Brent crude

YEARS BEGINNING Q1	CONSUMER EXPEND-ITURE	REAL PERSONAL INCOME	GDP	INDUSTRIAL OUTPUT	UNEM-PLOYMENT ('000S)	EMPLOYMENT	AVERAGE EARNINGS	CONSUMER PRICES (ex.MIPS)	SHORT-TERM INTEREST RATE (PTS)	EFFECTIVE EXCHANGE RATE	CURRENT ACCOUNT (% OF GDP!)
2010	-0.5	-0.4	-0.3	-0.2	36.3	-0.1	0.1	0.5	0.3	-0.5	0
2011	-0.7	-0.4	-0.3	-0.1	87	-0.3	0	0.4	0	-0.2	0.2
2012	-0.5	-0.2	-0.1	0.3	45.9	-0.1	0.1	0.4	0.1	0.3	0.1
2013	-0.4	-0.1	-0.1	0.3	18.3	-0.1	0.1	0.4	0	0.6	0.1
2014	-0.1	0	0	0.4	-0.7	0	0.2	0.5	0.1	0.7	0
2015	0	0.1	0.1	0.4	-24.6	0.1	0.4	0.6	0.2	0.6	0
2016	-0.1	0.1	0	0.2	-15.5	0	0.6	0.7	0.2	0.3	0
2017	-0.1	0.1	0	0.1	3.8	0	0.7	0.9	0.2	0.2	-0.1
2018	-0.1	0.1	0	0.1	8.2	0	0.8	1	0.2	0.2	-0.1
2019	0	0.1	0	0	9.7	0	0.8	1	0.1	0.3	-0.1
2020	0	0.1	-0.1	-0.1	13.5	0	0.8	1.1	0.1	0.4	-0.2

Scenario 3: higher gas prices

A 10% and a 30% increase in the NBP producer price of gas have similar impacts to the Brent crude price shocks above, though the magnitude is slightly larger (reflecting a higher share of gas than oil among the primary fuel types in the UK). The impact on GDP is negative in the short- to medium-term, but close to zero by 2020, as firms and consumers substitute into other fuel types in order to avoid the higher price of gas. Gas consumption falls, while the consumption of other fuel types increases.

Table 3 sets out the impact of the 10% and 30% gas producer price scenarios.

Table 3: Impact of higher gas prices on the UK economy

10% increase in the NBP price of gas

YEARS BEGINNING Q1	CONSUMER EXPEND-ITURE	REAL PERSONAL INCOME	GDP	INDUSTRIAL OUTPUT	UNEM-PLOYMENT ('000S)	EMPLOYMENT	AVERAGE EARNINGS	CONSUMER PRICES (ex.MIPS)	SHORT-TERM INTEREST RATE (PTS)	EFFECTIVE EXCHANGE RATE	CURRENT ACCOUNT (% OF GDP!)
2010	-0.3	-0.2	-0.1	-0.1	18.9	-0.1	0	0.2	0.1	-0.2	0
2011	-0.4	-0.3	-0.2	-0.2	49.5	-0.2	-0.1	0.2	-0.1	-0.1	0.1
2012	-0.3	-0.3	-0.1	0	36.8	-0.1	-0.1	0.1	-0.1	0.2	0
2013	-0.2	-0.2	-0.1	0	16.9	-0.1	-0.2	0.1	-0.1	0.4	0
2014	-0.1	-0.2	0	0.1	0.5	0	-0.2	0.1	-0.1	0.4	0
2015	-0.1	-0.2	0	0.1	-9.1	0	-0.1	0.1	0	0.2	0
2016	-0.2	-0.2	0	0.1	-3.7	0	-0.1	0.1	0	0	0.1
2017	-0.3	-0.2	0	0.2	3	0	0	0.2	0	0	0.1
2018	-0.3	-0.2	0	0.2	2.9	0	0	0.2	0	0.1	0.1
2019	-0.3	-0.2	0	0.2	2.7	0	0	0.2	0	0.2	0.1
2020	-0.3	-0.2	0	0.2	6.8	0	0	0.1	0	0.4	0.1

30% increase in the NBP price of gas

YEARS BEGINNING Q1	CONSUMER EXPEND-ITURE	REAL PERSONAL INCOME	GDP	INDUSTRIAL OUTPUT	UNEM-PLOYMENT ('000S)	EMPLOYMENT	AVERAGE EARNINGS	CONSUMER PRICES (ex.MIPS)	SHORT-TERM INTEREST RATE (PTS)	EFFECTIVE EXCHANGE RATE	CURRENT ACCOUNT (% OF GDP!)
2010	-0.7	-0.7	-0.4	-0.3	53.7	-0.2	0.1	0.7	0.3	-0.6	0.1
2011	-1.1	-0.8	-0.6	-0.4	138.9	-0.4	-0.2	0.6	-0.2	-0.2	0.2
2012	-0.8	-0.7	-0.4	-0.1	106.6	-0.3	-0.3	0.4	-0.2	0.6	0.2
2013	-0.6	-0.7	-0.3	0	58.9	-0.2	-0.5	0.3	-0.3	1.1	0.1
2014	-0.4	-0.6	-0.1	0.2	18.5	-0.1	-0.4	0.3	-0.1	1.1	0.1
2015	-0.5	-0.5	0	0.3	-9.8	0	-0.3	0.3	0	0.7	0.1
2016	-0.6	-0.5	-0.1	0.3	-5.1	0	-0.2	0.4	0	0.3	0.2
2017	-0.7	-0.5	-0.1	0.4	1.9	0	0	0.5	0.1	0.2	0.3
2018	-0.7	-0.4	0	0.5	0.1	0	0.1	0.5	0.2	0.4	0.3
2019	-0.8	-0.4	-0.1	0.6	3.8	0	0.2	0.6	0.2	0.7	0.4
2020	-0.8	-0.3	-0.1	0.5	9.4	0	0.2	0.6	0.2	1.3	0.4

Scenario 4: higher carbon tax

This scenario sees the ETS price of carbon increase by 15 euros per tonne of CO2 (from its level of 20 euros per tonne in the baseline forecast). The ETS price only applies across a subset of the industrial sectors – but it applies across all primary fuel types in proportion as they generate carbon emissions. Therefore, for those industries that are affected, the structure of this shock is similar to that of the shock to end-user prices of all energy types. The scope for substitution out of carbon intensive fuel types is very limited, so consumption of energy by the sectors that are affected falls permanently – as does the level of output those sectors produce.

Of course the magnitude of the shock is far smaller than in the 30% end-user price scenarios. But the negative impact on GDP, though smaller, persists out to 2020. Table 4 sets out the impact of an increase in the price of carbon on the UK economy

Table 4: Impact on the UK of an increase in the price of carbon in the ETS from 20 to 35 euros per tonne of CO2

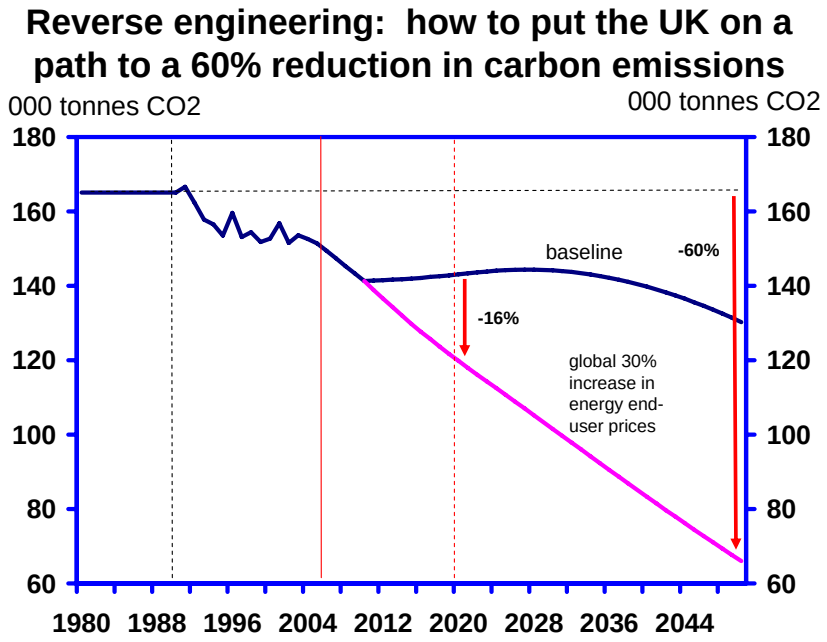
YEARS BEGINNING Q1	CONSUMER EXPEND-ITURE	REAL PERSONAL INCOME	GDP	INDUSTRIAL OUTPUT	UNEM-PLOYMENT ('000S)	EMPLOYMENT	AVERAGE EARNINGS	CONSUMER PRICES (ex.MIPS)	SHORT-TERM INTEREST RATE (PTS)	EFFECTIVE EXCHANGE RATE	CURRENT ACCOUNT (% OF GDP!)
2010	-0.1	-0.1	-0.1	0	8.4	0	0	0.2	0	0	0
2011	-0.2	-0.2	-0.1	-0.1	26.2	-0.1	0	0.1	0	-0.1	0
2012	-0.2	-0.2	-0.1	-0.1	25.8	-0.1	0	0.1	0	0	0
2013	-0.1	-0.1	-0.1	0	15.5	0	-0.1	0.1	0	0.1	0
2014	-0.2	-0.1	-0.1	0	11.6	0	-0.1	0.1	0	0.1	0
2015	-0.2	-0.1	-0.1	-0.1	11.7	0	-0.1	0.1	0	0.1	0
2016	-0.2	-0.1	-0.1	-0.1	11.4	0	-0.1	0.1	0	0.1	0
2017	-0.2	-0.1	-0.1	-0.1	10.9	0	-0.1	0	0	0.1	0
2018	-0.2	-0.2	-0.1	-0.1	10.8	0	-0.1	0	0	0.1	0
2019	-0.2	-0.2	-0.1	-0.1	11.1	0	-0.2	0	0	0.1	0
2020	-0.2	-0.2	-0.1	-0.1	11.1	0	-0.2	0	0	0.2	0

Scenario 5: backwards engineering

For this scenario, we considered what sort of increase in the price of energy would be required to put the UK economy on a path towards a 60% reduction in carbon emissions relative to 1990 levels by 2050.

Chart 1 shows how UK carbon emissions evolve in our central forecast, extrapolated out to 2050, and compares that with a scenario that sees carbon emissions fall by the required 60% by 2050.

Chart 1



In our baseline forecast, UK carbon emissions recommence their downwards trend after 2025 when the phasing out of the nuclear power industry comes to an end. But that

downwards trend is not sufficient to bring about the required reduction in carbon emissions by 2050 – our baseline suggests the reduction in carbon emissions is about one third of what is required by that horizon, given current expectations of energy prices and output growth.

The pink line is an alternative scenario for UK carbon emissions that does achieve the desired 60% reduction by 2050. To get on this path would require a significant reduction in carbon emissions in the short to medium term, too. In fact, by 2020, UK carbon emissions in the alternative scenario are already some 16% lower than in our baseline forecast.

It turns out that one of the scenarios we have explored above: a global increase in end-user prices of 30% - delivers this 16% reduction in UK carbon emissions by 2020, putting the UK on track to achieve the desired 60% reduction by 2050. It should be noted, here, that putting the UK on a track to this desired reduction is not the same thing as achieving such a reduction. Our model-based analysis only extends out to 2020. For the full reduction in carbon emissions to be achieved, it might be necessary to further increase the price of energy after 2020 (though, equally, this might not be necessary). The model is silent on the question of what price changes would be appropriate post 2020.

Conclusions

All the scenarios above involve increasing the real price of one or more energy types to firms and to consumers. The consequence of that is a negative impact on GDP. In the cases where only one fuel type is affected, the negative impacts are relatively small and are short-lived, as firms and consumers substitute into other fuel types. In the cases where all fuel types are affected, there is a permanent negative effect on the level of output in the UK. And, in these cases, the impact in 2020 is largest when it is a UK-specific shock, and smallest when it is a global shock.