The macroeconomic impact of higher energy prices on the UK economy

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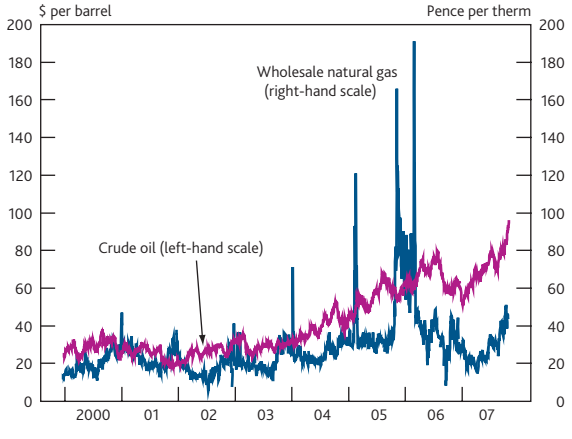
This article explores the macroeconomic impact of the rise in energy prices since 2004. The article discusses the various channels through which rising energy prices are likely to influence the degree of inflationary pressure in the UK economy. Rising energy costs put upward pressure on the prices of energy-intensive goods and services, and can affect both aggregate demand and potential supply. The adjustment of prices and quantities in the labour market are particularly important in this regard. Ultimately though the impact on inflation will depend on monetary policy and the behaviour of inflation expectations. Some past episodes in which energy prices increased sharply preceded a marked deterioration in the macroeconomic environment. The evidence so far suggests a more muted impact on the economy than in these previous cases.

Introduction

There have been large shifts in the price of crude oil and natural gas since the beginning of 2004. Crude oil prices rose from around $30 (£17) per barrel to just under $100 (£45) (**Chart 1**), at the time of the November 2007 *Inflation Report*. And the sterling price of oil relative to other UK goods and services — the 'real' price — doubled between 2004 Q1 and 2007 Q3 (**Chart 2**). The futures price of oil suggests that most of the increase since 2004 is expected to persist although there are good reasons for believing they may not be a good guide to expected spot prices in the future.(1) Gas prices have behaved somewhat differently to crude oil prices. UK wholesale gas prices rose sharply in late 2005, and remained elevated throughout the winter of 2005/06, averaging around 75 pence per therm (**Chart 1**), but have since fallen back from those peaks. Nevertheless gas prices have risen more recently and remain significantly above their pre-2005 levels and gas futures prices remain elevated.

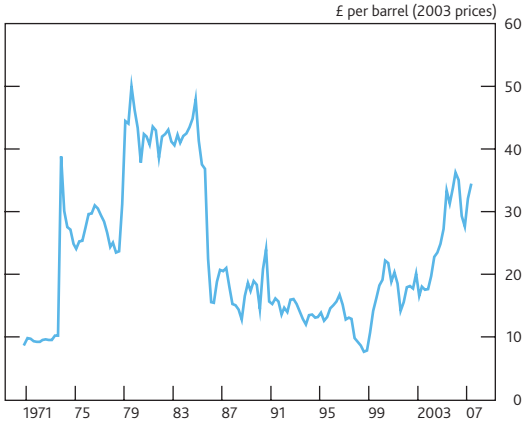
Some past episodes in which energy prices increased sharply preceded a marked deterioration in the macroeconomic environment. For example, real sterling oil prices almost trebled between 1973 Q4 and 1974 Q4 and more than doubled between 1978 Q4 and 1979 Q4. In both cases annual

Chart 1 Daily spot crude oil and wholesale natural gas price



Sources: Bloomberg, Intercontinental Exchange and Reuters.

Chart 2 Quarterly real price of crude oil(a)



Sources: ONS and Thomson Datastream.

(a) Oil price divided by household consumption deflator. Quarterly averages.

(1) For more information on the economics of the oil futures market see the box on pages 28–29 of the November 2004 *Inflation Report*.

consumer price inflation in the United Kingdom subsequently doubled to over 20%, and the economy went into recession. Such a deterioration in the UK macroeconomic outlook has not so far been the case for the recent episode; nor was it the case following the doubling in oil prices between early 1999 and 2000. Understanding the factors underlying these different responses to energy price increases is an important issue for monetary policy makers.

This article explores the channels through which variations in the price of energy affect the UK economy, focusing in particular on the consequences for CPI inflation.(1) It sets out a macroeconomic framework for analysing the various channels of transmission, and identifies some of the key pieces of data that will be affected by higher energy prices.

Do higher energy prices lead to higher inflation?

In 1974, Milton Friedman(2) argued that a change in the relative price of a good such as energy might not necessarily have any effect on the general price level and its rate of inflation:

'It is essential to distinguish changes in relative prices from changes in absolute prices. The special conditions that drove up the price of oil and food required purchasers to spend more on them, leaving them less to spend on other items. Did that not force other prices to go down or rise less rapidly than otherwise? Why should the average level of prices be affected significantly by changes in the price of some things relative to others?'

This section considers the channels through which a change in the relative price of energy can affect inflation in an open economy like the United Kingdom. A simple aggregate demand-supply framework is used to illustrate the main points and show the conditions under which Friedman's 'relative price hypothesis' holds. For the most part, the analysis abstracts from the underlying factors that have caused the rise in energy prices, but in practice this will be an important consideration for policymakers. The rise in energy prices since the beginning of 2004 is likely to be the result of rapid growth in global demand as well as constraints on global supply.(3) And these underlying shocks may have an effect on the UK economy over and above the impact of energy prices — for example, higher global demand is likely to raise UK exports. In the analysis below these additional effects are identified when relevant.

The impact is analysed in several stages. First, the impact on companies' costs is considered along with a discussion of how higher energy costs are passed through into final goods and services prices. At this stage it is assumed that wages and other input prices are unaffected and that the level of nominal spending in the economy is unchanged. This provides a benchmark case of what might be called the 'first-round' effects. The more general impact of higher energy prices is then considered by looking at the adjustment of wages and other input prices, and the impact on potential supply and aggregate demand. Finally the response of monetary policy and inflation expectations is considered.

The impact of energy prices on an individual firm's costs

Most finished goods and services are likely to require inputs of oil and/or gas at some stage in their production process. For example, almost all companies use electricity, and the production of electricity relies heavily on the use of gas-fired power stations. A key factor that determines the impact of higher energy costs on the price of a finished good or service is the energy intensity of production — the share of production costs accounted for by the use of oil and gas.

Companies will tend to set the price of a finished good or service as a mark-up on the marginal cost of producing an extra unit of output. If, at all stages in the production process, energy is used in fixed proportions to other inputs of production (so that no substitution between energy and other inputs is possible), then, other things being equal, the marginal cost of producing a final good or service will respond to a rise in energy prices according to the relationship:

% change in marginal cost = initial share of energy in costs x % change in energy prices.

So, for example, if the initial share of oil in the cost of producing a good is 2% and oil prices double, the marginal cost of production will increase by around 2%. If energy can be substituted for other factors of production, then the rise in the cost of production will be less extreme than this.(4) The extent to which different factors of production are free to vary over time is also a factor. It may only be feasible to change factors like capital and energy in the long run. So expenditure on energy by companies may largely reflect 'overheads' or fixed costs of production in the short run. In this case, short-run marginal costs will be less affected by a rise in energy prices, although average costs will be higher.

(1) For a detailed analysis of this question from the perspective of a monetary policy maker see the speech given by David Walton on 23 February 2006, at www.bankofengland.co.uk/publications/speeches/2006/speech268.pdf.
(2) Friedman, M (1974), 'Perspectives on inflation', *Newsweek*, 24 June. Reprinted in Friedman, M (1975), *There's no such thing as a free lunch*, Open Court, pages 113–15.
(3) This is less true for gas where certain structural features of the UK domestic gas market are likely to have been behind some of the recent movements in prices.
(4) For example, a standard assumption is the 'Cobb-Douglas' case where the elasticity of substitution between different factors of production is equal to 1. This means that relative factor inputs respond (negatively) in proportion to changes in their relative prices. In this case the relationship becomes:
change in the log of marginal cost = initial share of energy in costs x change in log of energy prices.
In this case a 100% energy price increase leads to around a 1.4% increase in marginal cost if the initial share is around 2%.

The impact on aggregate costs and the price level

In practice, energy intensity varies considerably across goods and services and across industries. For example, crude oil represents a large chunk of petrol refiners' costs, as does natural gas in the costs of gas and electricity providers. By contrast, the energy intensity of other finished goods and services may be relatively small. This suggests that some prices are more likely to rise than others, leading to significant movements in the relative prices of finished goods and services. And just as companies have an incentive to substitute away from energy in production, households have an incentive to substitute away from energy-intensive goods and services.

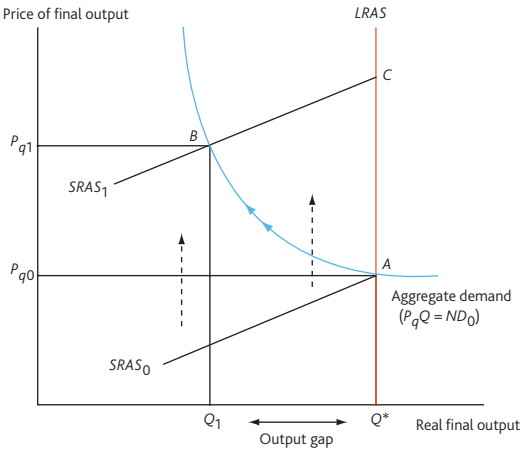
To analyse the impact on the aggregate price level and the macroeconomy it is useful, as a first step, to abstract from these relative price movements and imagine there is a single finished good produced. By netting out all the intermediate use of domestic output by each industry, it is possible to summarise aggregate marginal costs in the finished goods sector of the economy in terms of the costs of four primary inputs — capital, labour, overseas inputs of goods and services and inputs of oil and gas. This can be written as:(1)

$$MC = c\,(W, P_k, P_e, P_m)$$

where W = wages; P_k = price of renting/using capital; P_e = price of energy; P_m = price of non-energy imports and c reflects how different factor prices affect marginal cost, which depends on the aggregate degree of substitutability in the economy. In this highly stylised set-up it is possible to think of the aggregate price level for finished goods and services as a mark-up on this marginal cost measure as if it were a single good or service.

As higher energy prices push up marginal cost, companies will want to raise the price they charge for their goods and services. **Figure 1** illustrates the issue in terms of a standard aggregate demand and supply framework.

Figure 1 Initial effects of rise in the price of energy



The economy is initially at point *A*. The non-oil and gas producing sector(2) of the economy produces output of finished goods,(3) Q^*, at a final price P_{q0}. Point *A* represents the equilibrium between the aggregate demand for final goods and services and long-run or 'potential' supply of these goods. It is assumed initially that the level of nominal expenditure on finished goods and services in the economy is fixed. As a result the aggregate demand curve is a downward-sloping curve that traces out the combinations of real output and final output prices consistent with a given level of nominal demand: $P_qQ = ND_0$. Ultimately the level of nominal demand is pinned down by monetary policy as is discussed later.

The long-run aggregate supply (*LRAS*) curve shows the combinations of nominal prices and finished output that can be achieved in the long run if nominal prices and wages are perfectly flexible. It is a vertical line because long-run final output (Q^*) is determined independently of the nominal price level and depends on underlying demand and supply conditions for the different factors of production, as discussed below. Point *A* also lies on a short-run aggregate supply curve ($SRAS_0$). This describes the level of output supplied at each and every aggregate price level, but with factor input prices and the capital stock assumed to be fixed in the short run.

Assume that there is an unexpected and permanent increase in the relative price of energy. Because nominal wages and other factor prices are assumed to be fixed, it is now more costly to produce any given level of output. So marginal cost and the price companies wish to charge increases at each and every level of output.(4) This leads to a shift in the short-run aggregate supply curve to $SRAS_1$. As firms increase their prices they find that the demand for their output falls, given that nominal expenditure is unchanged at ND_0. As a result the economy moves to point *B* with the aggregate price level higher and output lower than at point *A*. So in this stylised example firms have been unable to pass on the full increase in their energy costs to prices (which would occur at point *C*). As a result output falls, marginal costs fall back somewhat as variable factors of production get used less intensively and a negative output gap ($Q_1 - Q^*$) has been created.

(1) Assuming constant returns to scale.
(2) Any production of oil and gas by the economy is assumed to be a fixed amount that requires no labour or other goods and services to produce. Energy inputs used by the non-oil and gas extraction sector are assumed to be met at the margin from overseas at a globally determined price, so production is equal to, or lower than, consumption.
(3) Note that the finished goods sector's output is a gross or final measure of output that reflects the contributions of all the inputs used in production, including imports and energy. So it is not the same concept as GDP or the value added of the non-oil and gas extraction sector, which are measures that only reflect the contributions of capital and labour to output.
(4) The upward shift in aggregate costs and prices in response to an increase in *real* energy prices can be expressed in a similar way to the response of an individual firm's costs to a nominal energy price increase. In the case where energy is used in fixed proportions to other factors of production and there is a fixed proportional mark-up on costs, the relationship is given by:
$$\frac{\textit{initial share of energy}}{1 - \textit{initial share of energy}} \times \%\ \textit{change in real energy prices}.$$

The above analysis assumes that the shift in the supply curve occurs immediately. This may not be the case if energy-using industries face large financial or contractual costs of changing prices. So there may be a delay between the timing of the 'cost shock' and the change in final output prices. In reality, higher energy costs will be passed through the succession of firms that make up the UK supply chain and at each stage there may be some sluggishness in price adjustment. So initially companies at various stages of the chain may absorb the impact of higher energy costs in lower profit margins.

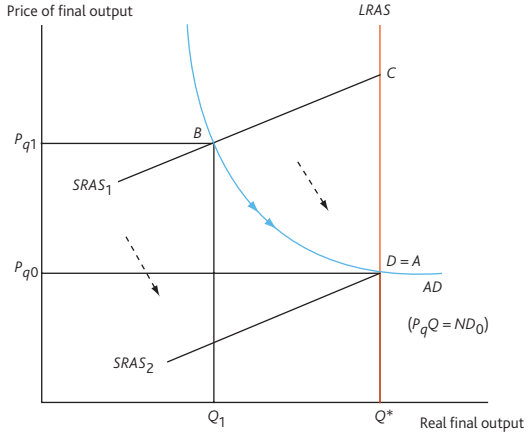
It is also useful to note what happens at a more disaggregated level as the economy moves from *A* to *B*. The major impact of higher energy prices on firms that use little or no energy will be a fall in demand for their products, rather than a rise in their costs. This will arise if the higher prices of energy-intensive goods result in increased nominal spending on these items, leaving less of a given amount of aggregate nominal expenditure for the less energy-intensive goods and services in the economy. This would happen if energy-intensive goods and services have a low degree of substitutability with other goods and services. This fall in demand lowers the output of the less energy-intensive sectors given no reduction in their other input costs.

The effect on wages and other costs

So far it has been assumed that the cost of other inputs of production have been unaffected by energy price changes. But the costs of capital and imported materials are both likely to increase if energy is required to produce these goods as well. In that case, the initial shift in marginal cost will be even larger(1) if these factors are variable inputs.

The negative output gap that emerges under the assumptions underlying **Figure 1** is likely to lead to downward pressure on nominal earnings. This is because the fall in output is likely to reduce the demand for labour, and unemployment may rise relative to its long-run equilibrium or 'natural' rate. **Figure 2** shows how long-run equilibrium is restored if nominal wages fall in response to the increase in unemployment. Starting from point *B*, the short-run aggregate supply curve shifts to $SRAS_2$ and the economy 'slides down' the aggregate demand curve to point *D*, which coincides with the initial equilibrium (point *A* in **Figure 1**). So at the aggregate level, the fall in nominal wages reduces the cost of producing a given level of output and offsets the rise in energy costs. The fall in labour costs allows the aggregate price level to return to its initial level. The required fall in nominal wages will be larger if, as discussed above, capital and import prices have also increased as a result of higher energy prices. At a disaggregated level, prices that are less energy-intensive (and more labour-intensive) will fall to offset the rise in the prices of energy-intensive goods and services. Since nominal spending is fixed in this example, the falls in wages and output prices are accompanied by a recovery in real output back to its initial level.

Figure 2 Restoration of long-run equilibrium



This is effectively the process described by Friedman. The rise in energy costs and energy-intensive goods and services prices is offset by falls in nominal wages and the prices of goods and services in less energy-intensive sectors. Just as prices may be slow to change following the initial impact of the rise in energy prices (the move from *A* to *B*), there may also be nominal rigidities in a downward direction, that slow the adjustment from *B* to *D*. In this case the degree of sluggishness of wages as well as prices will also be a factor. If these nominal rigidities are significant the price level and unemployment rate could remain high relative to their initial levels for some time.

The effect on potential supply

A key assumption in **Figure 2** is that long-run potential supply remains unaffected. But permanent changes in energy and other input prices are likely to lead to changes in the demand for labour, capital, energy and imports in the long run. The supply of each factor is also likely to be affected. Potential supply will remain unchanged only if the factors of production have to be used in fixed proportions and the supply of at least one of the factors is fixed. But what about the more general case?

In theory, companies will demand a factor of production up to the point at which the extra real output or 'marginal product' that it produces is equal to its real cost — the nominal price of the factor divided by the price of final output. At this point, it is not profitable for the firm to employ more or less of the factor. A rise in the real price of energy is likely to lead to a decrease in the demand for energy inputs, provided companies can substitute other factors for energy. Energy inputs will be cut back relative to other inputs, until the marginal product of energy rises in line with the higher real

(1) If the production of imports and capital goods has the same energy intensity as the production of domestic goods, then in the case where all inputs are variable and used in fixed proportions and nominal wages are fixed, the impact on marginal cost and prices will be given by: $\frac{\textit{initial share of energy}}{\textit{initial share of labour}} \times$ *% change in real energy prices.*

cost. As companies cut back on their use of energy it is likely that the marginal product of non-energy inputs will fall. This will occur when energy and the other factors are 'co-operant' or 'aggregate complements' in production,(1) and will lead to a fall in the demand for capital, labour and imported intermediates at each level of their factor price.(2) The greater the degree of substitutability between energy and a given non-energy input, the smaller will be the fall in the demand for that input.

In practice, the degree of substitutability will depend on the time horizon. For example, certain types of capital equipment may 'embody' a particular energy intensity that is difficult to alter once it is installed. So firms may only be able to change the energy intensity of their production in the long run, once they have had a chance to withdraw the least energy-efficient equipment from production — sometimes known as capital 'scrapping' — and replace it with alternatives with a lower built-in intensity.

Even though the *demand* for factor inputs is likely to fall as a result of higher energy prices, there will only be an impact on potential output if the long-run *supply* of each factor contracts in response to the downward pressure on relative factor prices. So what might we expect to happen to the relative price and supply of non-energy inputs?

The real cost of capital and imported materials are similar to energy prices in that they are largely determined by global conditions.(3) So, as far as the United Kingdom is concerned, the long-run supply of these factors will be close to perfectly elastic at a globally determined relative price. And, as discussed earlier, the costs of producing capital and imported goods at a global level are likely to respond to energy prices in a similar way to those of other finished goods and services. So the *relative* price of imports and capital are unlikely to fall substantially following a rise in energy prices. And any fall in demand for these factors will typically lead to a lower amount employed in the long run and a contraction in potential supply.

The impact of higher energy prices on the supply of labour is less clear and depends on the extent to which workers' wage aspirations adjust to a higher energy price. **Figure 2** showed that in order to restore employment and the price level to their initial levels the nominal wage had to fall sufficiently to offset the impact of higher energy costs. In other words there has to be sufficient downward adjustment in the 'real consumption wage' of workers — the quantity of final or 'consumer' goods that the nominal wage can buy — to ensure employment does not contract in the long run. This will only occur in practice if labour supply is 'perfectly inelastic' or insensitive to the level of real consumption wages — where workers (or their representatives) are prepared to lower their real wage aspirations by whatever amount it takes to keep aggregate employment unchanged. If real wage aspirations do not adjust sufficiently, then labour supply is likely to be 'upward sloping' and workers will reduce the amount of labour they are willing to supply as real consumption wages decline. This is sometimes termed 'real wage resistance' and results in lower potential output.

Whether that reduction in potential output is temporary or permanent will depend on the extent to which wage aspirations adjust over time. If the adjustment of wage aspirations occurs gradually, then real wage resistance may well be only a temporary phenomenon. In this case, the negative impact on potential supply will diminish over time. If wage aspirations fail to adjust downwards, however, then a higher natural rate of unemployment would be required in the long run to make workers accept a fall in the real consumption wage with different implications for the observed path of unemployment and inflation.(4) So distinguishing between temporary and permanent real wage resistance is important for monetary policy makers.

The required adjustment of real consumption wages can also be viewed from the perspective of restoring companies' profitability. A rise in the price of energy initially raises costs and reduces companies' profits if nominal wages do not adjust. Other things being equal this gives companies the incentive to reduce output and employment. To restore employment and profitability to their initial levels requires some combination of lower nominal wages and higher final goods prices. Either way the purchasing power of workers' take-home pay must decline if companies' profitability is to be restored.

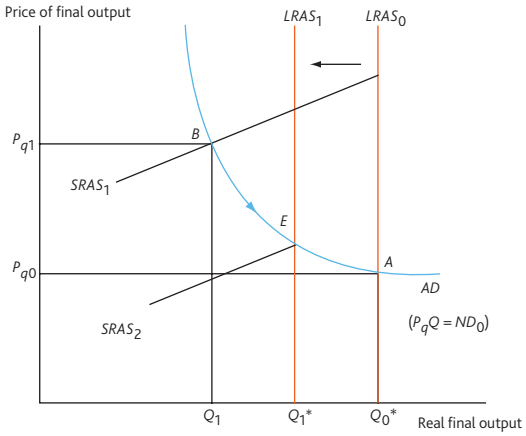
A useful indicator that is often used to monitor the adjustment of the labour market to a change in energy prices is the real 'product' wage — the nominal wage divided by the price of companies' value added. In aggregate, the price of companies' value added is the price of their final output *net* of their energy and import costs. As energy costs rise this price initially declines, if final goods prices do not adjust immediately, and there is a fall in companies' profitability. As a result real product wages increase, companies have an incentive to reduce employment, and a 'wedge' opens up with the real

(1) See Hogan (1979) and Solow (1979) for a discussion.
(2) This change in the demand for factor inputs can be thought of as the result of two effects: a 'substitution' effect that reduces the demand for energy and increases the demand for other factors at a given level of output; and a 'scale effect' that reduces the demand for all factors because the profit-maximising level of output falls as a result of the energy price increases, assuming the price of the other factors remains unchanged. In the case of energy, the two effects reinforce each other. For other factors the effects are offsetting. Typically the scale effect will dominate the substitution effect given the usual assumptions that are made about production technology (although in principle the effect could go either way). This is effectively what happens in **Figure 1** where the fall in output leads to a fall in the demand for labour and other variable factors given unchanged factor prices.
(3) The exception would be domestically produced capital goods.
(4) See Layard, Nickell and Jackman (1991) for a discussion in a wage-bargaining framework. Similar issues arise in an efficiency wages model of the labour market, see Carruth *et al* (1998).

consumption wage. Only if the real product wage returns to its initial level, so that the 'wedge' is entirely reflected in a lower real consumption wage, will companies want to retain the initial workforce.(1) This can only happen if nominal wages fall back or final goods prices rise. So, as is shown later, movements in the real product wage (relative to what otherwise would have been expected from productivity growth and other factors) are likely to be a useful summary statistic of the degree of real wage resistance and the pressure on firms to cut employment.

The effects of a shift in long-run potential supply are shown in **Figure 3**. As in **Figure 1** the rise in the energy price initially shifts the short-run aggregate supply curve to $SRAS_1$. But the energy price increase also reduces the level of long-run aggregate supply and the long-run aggregate supply curve moves inwards to $LRAS_1$. Now as wages fall over time, the economy slides down the aggregate demand curve to a new equilibrium point *E* rather than the initial point *A*. The aggregate price level in the new equilibrium is higher than the original equilibrium because the nominal wage does not fall sufficiently to offset the energy price rise.

Figure 3 Long-run supply effects of relative price rise



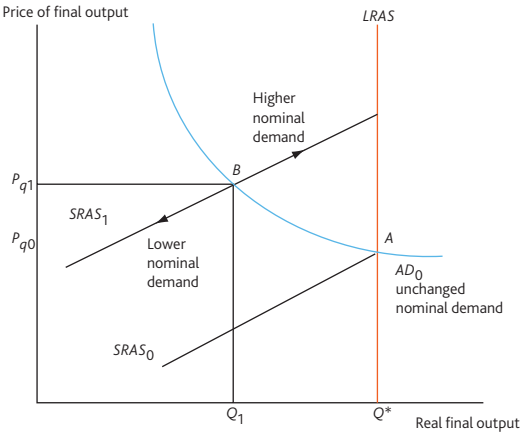
The impact of energy prices on aggregate demand

In the analysis so far nominal spending in the economy has been held fixed. But in practice nominal spending is also likely to adjust in response to a change in energy prices, increasing or decreasing the price level response to the initial rise in costs and affecting the size of the output gap that emerges (**Figure 4**). That adjustment may take place through variations in household, corporate and government spending plans as well as the reaction of monetary policy.

Impact on household, corporate and government spending plans

Nominal spending might respond differently if higher energy prices lead to a change in planned real spending by companies and households but with interest rates set at the same level as point *B*.

Figure 4 The impact of an adjustment in nominal demand



A rise in energy prices might influence the level of demand by affecting consumer spending. As discussed above, the rise in energy prices will tend to squeeze the purchasing power of labour income through a fall in the real consumption wage. If the increase in energy prices is believed to be permanent, then households should expect that the reduction in their purchasing power will also be permanent. That reduction in permanent labour income should lead to a fall in consumer spending.

But labour income is not the only source of funds which households use to finance consumption, and it is likely that non-labour income will increase. Oil and gas extraction companies, operating both domestically and overseas, should benefit from the increase in the price of their output. Part of the higher profit income is likely to benefit both domestic households and the government. Domestic households' non-labour income and financial wealth will be boosted to the extent that: (a) domestic residents have shareholdings in energy companies and (b) post-tax incomes are boosted by the current and future reductions in household taxes that are made possible by the extra corporation and energy taxes earned by the government from the domestic-based energy extraction sector.

Even if households' total permanent income is broadly unaffected there may be distributional effects. If wealthy households tend to consume a smaller fraction of any additional income than the typical household, then the drag on consumption from the squeeze in labour income (which affects a broad spectrum of households) will tend to dominate the boost to consumption from the higher dividends and share prices (which may affect wealthy households the most).

(1) See Rotemberg and Woodford (1996) for a discussion of the exact conditions under which this holds. If the capital stock falls in response to energy prices and if firms charge a significant proportional mark-up on all their costs, then it is likely that the real product wage needs to fall below its initial level to restore employment.

Another channel through which the rise in energy prices may affect the level of demand is through its impact on investment spending, which may fall as a result of higher energy prices. But, as noted previously, firms might respond by scrapping energy-intensive capital and replacing it with more energy-efficient alternatives. In this scenario, the rise in energy prices would lead to a simultaneous decrease in potential supply and an increase in investment demand — both of which would tend to raise inflationary pressure in the economy for a period.

The government may benefit from the higher corporation and other energy taxes that result from higher energy prices. The key issue for both the composition and total level of aggregate demand is whether the government spends this money or whether it is ultimately expected to return it to households in the form of lower taxes, allowing household consumption to increase. If the government decides not to spend the revenue then the impact will depend on whether households expect this to lead to future tax cuts and adjust their consumption accordingly.

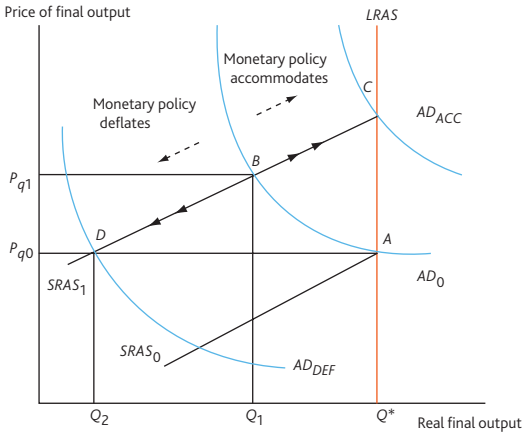
Higher energy prices could have influenced the spending behaviour of overseas households and companies through the same channels discussed above. The rise in energy prices will lead to a transfer of resources from countries/regions which are net importers of energy, to those countries/regions which are net exporters of energy. If national savings rates in these energy-importing countries differ from those in the energy-exporting countries then this transfer of income could lead to an overall shift in the level of global demand in general, and the global demand for UK output in particular. Savings rates have tended to be relatively high in the energy-exporting nations, so it is possible that this transfer of income may have depressed demand for UK exports.

As discussed earlier, the latest rise in oil prices should not be treated as an exogenous macroeconomic shock in its own right. Rather it may reflect more underlying forces such as strong global demand and/or constraints on the global supply of energy. This could have different implications for UK aggregate demand depending on which of the underlying forces is the most important in driving up energy prices. For example, strong global growth should be reflected in an increased demand for UK exports. And that boost to UK exports should be counted against any impact eg from the transfer of national income from low-saving energy-importers to high-saving energy-exporters.

The monetary policy response

Even though higher energy prices may lead to changes in planned expenditure by households and companies, ultimately the level of nominal expenditure in the economy is pinned down by monetary policy, through setting an appropriate level of interest rates. **Figure 5** considers two stylised examples of how nominal demand might be allowed to adjust following an increase in energy prices.

Figure 5 Alternative monetary policy responses to an energy price rise



One response is to allow the amount of nominal spending in the economy to increase — that is, to 'accommodate' the initial first-round effects of the energy price shock. This rise in nominal spending is represented by the rightward shift in the nominal demand schedule in **Figure 5**. The economy (assuming prices are fully flexible) moves immediately from point *A* to point *C*, which represents a new long-run equilibrium position with a permanently higher price level and unchanged output. In this case, the required fall in real consumption wages is achieved through an increase in the general price level rather than a fall in nominal wages. And, provided there are no further increases in prices and wages, the implied increase in inflation is only temporary and there is only a one-off shift in the price level.

But a key risk here is that accommodating the first-round increase in the price level leads to an increase in inflation expectations (assumed fixed in **Figure 5** above), putting additional upward pressure on wages and prices. It is possible that agents might not revise their expectations of inflation at all if they understand what policymakers are trying to achieve. But the fact that policymakers do not respond to the rise in inflation could lead agents to believe that there has been a *de facto* change in the policy target. An intermediate case might be one in which agents continue to believe that policymakers are only prepared to accommodate a temporary increase in inflation but expect them to allow inflation to remain higher for a period of time. In all but the first scenario, the initial rise in inflation increases inflation expectations to some extent, providing an additional stimulus to the medium-term outlook for inflation.

An alternative response would be to reduce nominal demand, preventing even a one-off increase in the price level. In this case nominal aggregate demand needs to be reduced,

represented by the leftward shift in the aggregate demand curve in **Figure 5**. This approach might help anchor inflation expectations by encouraging wages and less energy-intensive goods prices to fall more quickly than in the fixed nominal demand case. The cost is that the economy moves from point *A* to point *D* with a larger short-term fall in output and employment than for the case in which policy maintains nominal spending. Over time, as wages fall and the short-run aggregate supply curve moves back to its original position ($SRAS_0$) the policymaker can allow aggregate nominal spending to recover to offset the effect of falling nominal wages on the general price level. And the economy gradually moves from point *D* to point *A* with the price level unchanged.

In the United Kingdom, monetary policy is set by the Bank of England's Monetary Policy Committee to achieve the Government's 2% CPI inflation target, and subject to that, to support the economic policy of the Government including its objectives for growth and employment.(1) The two stylised responses shown in **Figure 5** highlight the fundamental trade-off facing a central bank. The central bank can act by setting a level of interest rates that attempt to prevent any rise in energy costs from filtering through to prices and inflation expectations, but at the cost of a larger fall in output and employment in the short run. Full accommodation avoids a negative output gap emerging but at the cost of inflation picking up relative to target, with the risk that inflation expectations become dislodged. Of course the stylised examples presented here only consider how policy might respond to a single shock — a rise in energy prices. In practice, it is likely that a number of shocks will be affecting the economy at any given time, and policymakers need to respond to the combined effect of those shocks.

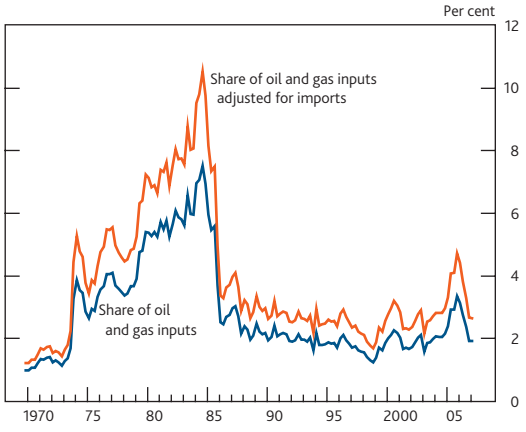
How has the rise in energy prices affected the economy?

This section of the article briefly discusses the various pieces of evidence that are available on each of the channels discussed above. More analysis can be found in recent *Inflation Reports*.

Chart 3 shows an estimate of the value or 'nominal' share of crude oil and natural gas inputs in the final expenditure on non-oil and gas products in the United Kingdom derived from the National Accounts.(2) It also shows an implicit share of expenditure if it is assumed that the energy intensity of imported non-energy goods and services is the same as that of the United Kingdom.(3) This suggests the share of energy inputs in final expenditure was around 2% in 2004 prior to the energy price shock. Calculations based on the Input-Output Supply and Use Tables suggest a similar share for final consumption expenditure.

Following the initial rise in energy prices the share rose significantly. This was similar to the response in the early 1970s. A rise in the share suggests there is little ability to substitute away from energy in the short term because the increase in oil and gas prices is not offset by a proportionate fall in energy inputs used. Since 2006 the share has fallen back and in 2007 Q2 stood at around pre-shock levels. This partly reflects the fact that wholesale gas and oil prices fell back in the first half of 2007. But oil prices were still almost double their 2004 level in 2007 Q2. The lack of a significant change in the share of energy suggests that there has been some substitution away from energy although the most recent data are subject to revision. A greater degree of substitutability may be one reason why the recent impact of higher energy prices may have been less than in previous episodes. The energy share increases observed in the 1970s were not reversed until oil prices fell sharply in the mid-1980s. Of course, the rise in energy prices since 2007 Q2 may push up on the share.

Chart 3 Nominal share of energy inputs in total final expenditure



Sources: ONS and Bank calculations.

Chart 4 shows nominal demand growth over this period. As discussed, developments in nominal demand are important in determining how much of the rise in costs will ultimately feed into higher aggregate prices. Nominal expenditure slowed significantly in 2005 before recovering somewhat in 2006 and 2007 (**Chart 4**). This is different to the experience in the 1970s and early 1980s, when nominal spending growth picked up significantly following the energy price increases. It is difficult to judge how much of the slowdown in nominal demand growth in 2005 is attributable to energy prices. As discussed

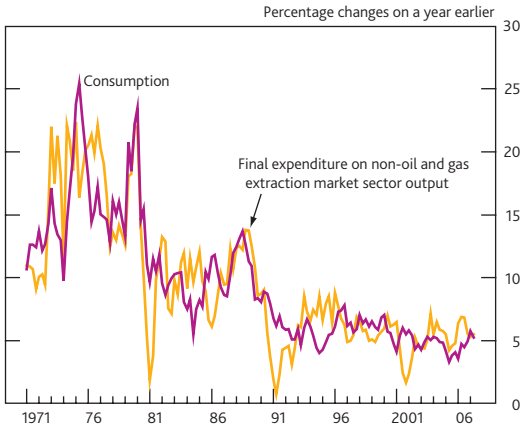
(1) See www.hm-treasury.gov.uk/documents/uk_economy/monetary_policy/ukecon_mon_index.cfm.

(2) Energy inputs are defined as the UK output of oil and gas products less own use by the oil and gas extraction sector plus imports of crude oil and natural gas, less exports of crude oil and natural gas. Final expenditure (at basic prices) on non-oil and gas products is estimated as total final expenditure (adjusted for MTIC fraud) less general government value added, imputed rents, indirect taxes net of subsidies and exports of crude oil and natural gas. The share in **Chart 3** can be thought of as an approximation to the share of oil and gas inputs in domestic market sector final output if all imports are assumed to be intermediate inputs, and as the share of oil and gas inputs in companies' costs if additionally companies operate under conditions close to perfect competition.

(3) This is estimated as the share of oil and gas inputs divided by one minus the share of non-oil and gas imports.

earlier, the behaviour of nominal demand is a complex interaction between the real spending plans of households and companies and monetary policy decisions. And shocks other than energy prices will have affected nominal demand over this period.

Chart 4 Nominal demand growth



Sources: ONS and Bank calculations.

Chart 5 shows evidence on the real spending behaviour of households. Real household labour income slowed in the period following the energy price increase. At least part of that is accounted for by a fall in the rate of growth of real consumption wages. Consumption appeared to respond to this slowdown in labour income growth relatively quickly. This could reflect the cash-flow constraints on households or it may be that the propensity to consume out of labour income is higher than other forms of income. But it could also reflect households revising down their permanent income, perhaps because they did not expect the squeeze on labour incomes from higher energy prices to be offset by lower future taxes or higher dividends from the ownership of oil companies. Since 2006 consumption has picked up although labour income growth has remained subdued.

There is little hard evidence on the extent to which UK households' non-labour income may have benefited from higher energy prices. For example, it is difficult to know how different taxes and government spending would have been in the absence of the energy price rises. And there is no comprehensive evidence on UK residents' total earnings from the energy price increases. It is known that UK residents hold substantial shareholdings in some of the major energy companies. That may imply significant earnings from higher energy prices given the extent of these companies' overseas operations. But many of the gains would have accrued to institutional shareholders such as pension funds. It is not clear whether households recognised these gains and adjusted their consumption.

Chart 6 shows the behaviour of the CPI inflation rate over this period together with some of the key components. In general the rise in CPI inflation over this period was modest compared to what might have been expected from previous episodes when energy prices increased. But the upward influence of the energy-intensive components on CPI inflation was not offset by a significant decline in the inflation rate of the less energy-intensive sectors over this period. And partly as a result CPI inflation increased over this period, reaching a peak of 3.1% in March 2007. That might reflect stickiness in both nominal wages and prices in the less energy-intensive sectors, at least in the period when nominal demand was slowing. Later on, the pickup in nominal demand over the 2006/07 period may have helped to accommodate the rise in energy prices, requiring less downward adjustment of nominal wages and prices in the less energy-intensive sectors. But it is impossible to know the counterfactual. Other shocks may have pushed up inflation over this period, so that in the absence of the energy shock, CPI inflation excluding fuels and energy utilities would have picked up by even more.

Chart 5 Real consumption and contributions to real labour income growth

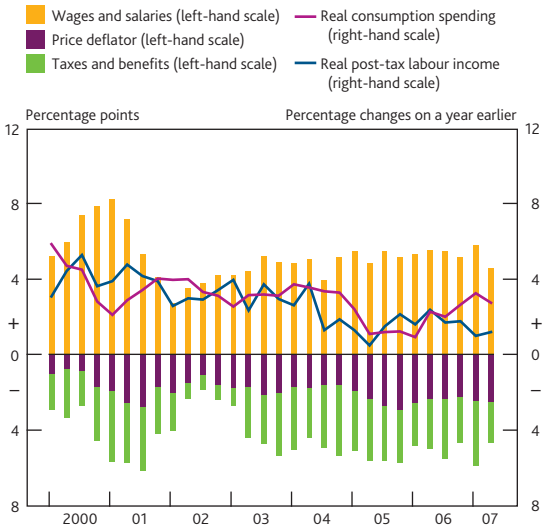
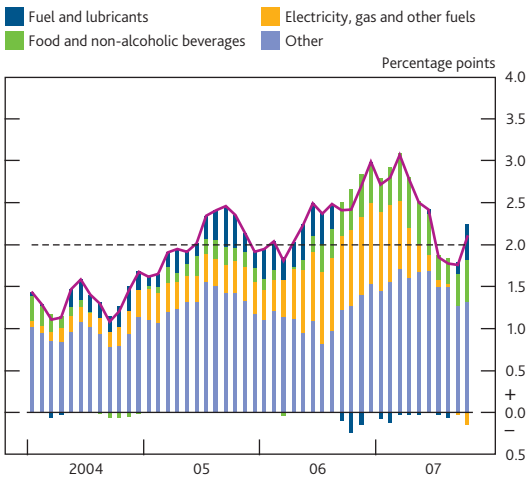
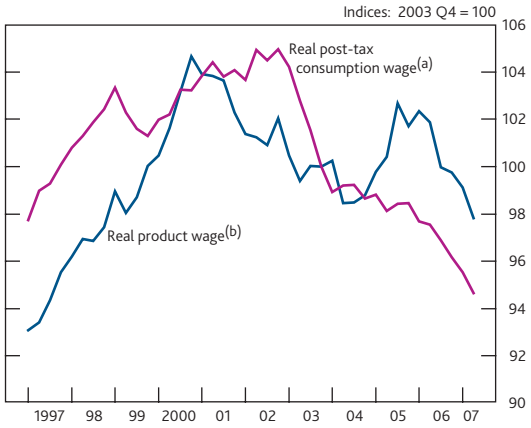


Chart 6 Contributions to annual CPI inflation



One reason why inflation excluding the energy-intensive components did not fall back might be due to the impact of energy prices on the supply side. There is limited evidence that companies have utilised their capital less intensively, or scrapped some capital altogether. But there is information on the impact of rising energy prices on the level of employment. **Chart 7** shows estimates of real wages. In the absence of shocks, both real product and real consumption wages would be expected to grow in line with labour productivity growth. This ensures that the share of profits in the value of output will be stable over time. So both real wage measures have been adjusted for productivity in **Chart 7**. The real consumption wage fell significantly relative to labour productivity between 2004 and 2007. Initially this fall may not have been sufficient to maintain employment. The real product wage initially increased relative to productivity, reflecting the fact that firms did not immediately pass on the increase in costs, but also the fact that nominal wages did not adjust sufficiently to offset the rise in energy costs. The implied squeeze in average profit margins may have given firms an incentive to lower their demand for labour. And indeed unemployment rose over this period (**Chart 8**).

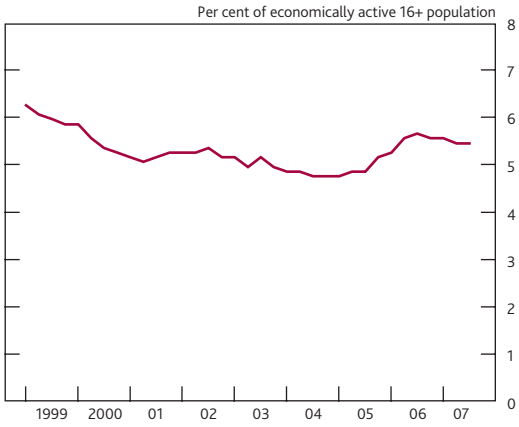
Chart 7 Real product and consumption wages adjusted for productivity



(a) Household post-tax wages and salaries per head divided by the consumption deflator. Includes non-profit institutions serving households. Productivity is calculated from ONS data on non-oil and gas market sector output divided by private sector employees.
(b) Total compensation of employees per head divided by the gross value added (GVA) deflator of the non-oil and gas market sector. Productivity is calculated from ONS data on non-oil and gas market sector output divided by private sector employees.

Since 2006 the productivity-adjusted real product wage has fallen back to its 2004 level implying that companies have been able to restore their profitability. This suggests that most of the required adjustment of the real consumption wage may now have taken place. So any real wage resistance in response to the rise in energy prices over the 2004–06 period looks to have been temporary. Nevertheless unemployment remains higher than its level in 2004. And workers may not have fully adjusted their wage aspirations so they might attempt to recover some of the squeeze in their real take-home pay in the future.

Chart 8 Unemployment



Looking ahead, the increase in energy prices in 2007 is likely to increase the wedge between final output and value-added prices further. And in the long run that should imply a further adjustment in real consumption wages, and perhaps the level of unemployment too if workers resist a further erosion in their real take-home pay. The effect on unemployment so far appears modest relative to the movements in previous episodes of large changes in energy prices.

Conclusions

This article has explored the macroeconomic impact of the latest rise in energy prices. It has set out a framework involving a number of distinct channels through which rising energy prices can influence the degree of inflationary pressure in the economy. It has also set out the various pieces of evidence and data that need to be considered in assessing the impact of higher energy prices on the UK economy. These are being continually monitored given ongoing developments in the price of energy. The evidence so far suggests that the impact of energy prices on both the demand and supply side of the economy have been small relative to some previous episodes of similar energy price increases. In particular there may be more flexibility in both the goods and labour markets that have allowed a more muted impact of higher energy prices on the economy than previously. And nominal demand growth over this period has been more stable than that observed in the 1970s, part of which may be related to the current monetary policy framework. But we have little evidence on how the quantity and utilisation of capital services has been affected by energy prices. And the latest energy price increases will require further adjustment in real consumption wages which may have implications for wage pressures going forward if employees resist further erosions in their real take-home pay.

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