

Macroeconomic uncertainty: what is it, how can we measure it and why does it matter?

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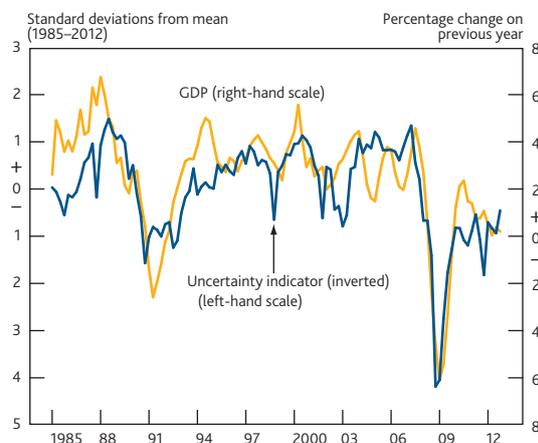
The onset of the financial crisis in 2008 brought an end to the 'Great Stability' period, making prospects for UK and global economic growth appear not just weaker, but more uncertain. This elevated uncertainty is likely to have adversely affected spending decisions and contributed to the depth of the recent recession and the weakness of the recovery. While uncertainty is not directly observable, this article constructs an aggregate measure of the economic uncertainty faced by households and companies, based on a number of proxy indicators. It also provides some quantitative analysis of the impact of uncertainty on economic activity, drawing a distinction between shocks to uncertainty that are short-lived and those that are more persistent.

Since mid-2008, the UK economy has faced an unprecedented series of large adverse shocks that have led companies and households to become more uncertain about future economic prospects. These shocks include one of the United Kingdom's largest ever financial crises, continuing headwinds from the euro-area debt crisis and the implementation of the Government's fiscal consolidation programme. The unusual size and nature of these shocks might have led households and companies to reassess their beliefs about the range of possible paths the economy can take. In other words, they may have become more 'uncertain' about the current and future economic climate.

Elevated levels of uncertainty have had an adverse effect on the UK economy in the recent past (**Chart 1**) by affecting decision-making in all parts of the economy, including households, companies, banks and financial markets, as well as policymakers. Evidence of that effect can be seen in spending patterns, investment decisions, asset prices and policy choices. The Monetary Policy Committee (MPC) has warned that high levels of uncertainty are likely both to have contributed to the weakness in UK demand since the onset of the recession and to pose a key risk to future demand prospects.⁽³⁾

To understand how changes in uncertainty affect the economy, it is important to recognise their source. Different types of uncertainty are likely to affect individual sectors of the economy differently and also have different degrees of persistence. So the nature of an uncertainty shock has an

Chart 1 Uncertainty and GDP



Sources: ONS for GDP, Table B for the uncertainty indicator.

important bearing on how demand and supply prospects and, ultimately, the inflation outlook are affected.

This article explains how macroeconomic uncertainty matters for the UK economy. It outlines the different ways in which uncertainty can affect real economic activity. It describes the level of uncertainty in the United Kingdom and other countries and its evolution during the recent recession. It also explores the extent to which elevated levels of uncertainty can explain the recent weakness in UK activity using a number of empirical

(1) The authors would like to thank Lai Wah Co and Jeanne Le Roux for their help in producing this article.

(2) To watch a short video explaining some of the key points from this article, see: <http://www.youtube.com/watch?v=7fht63NXToC>

(3) For example, see the May 2013 *Inflation Report*.

estimates. A deeper understanding of how uncertainty shocks have affected the UK economy in the recent past is likely to help policymakers assess how future shocks to uncertainty might affect demand and supply prospects.

Why does uncertainty matter?

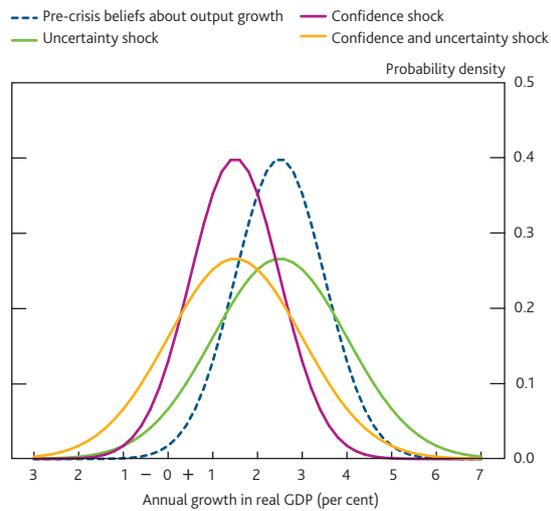
No one can predict exactly what will happen in the future. But in order to make everyday economic decisions — about work, spending, investments, education and so on — people use information around them to form judgements about what might happen. This includes families assessing prospects for future take-home pay, or companies evaluating the outlook for demand for their goods and services. These judgements carry uncertainty over the likelihood of alternative outcomes.⁽¹⁾ For example, it might be possible to form a judgement that there is a 50% chance it will rain tomorrow, but that probability is an estimate. In contrast, the probability that an unbiased coin will land on heads when tossed is 50%; and that is known with certainty.

Some underlying level of uncertainty always exists in an economy. Indeed, the MPC gives an explicit account of its uncertainty around the economic outlook by publishing its forecasts for growth and inflation in the form of ‘fan charts’, rather than single-point forecasts.⁽²⁾ But as uncertainty about future economic conditions changes over time it can affect spending decisions. If one company is taken over by another, the employees may feel more uncertain about whether next year’s pay will be higher or lower than currently. Or businesses may become more unsure about the level of next year’s orders if there is a change of government in one of their export markets.

Probability theory can help to provide a more precise definition of uncertainty. A probability density function (pdf) describes the set of probabilities assigned to different outcomes for a given phenomenon, such as economic growth. While in reality, precise distributions around future events are usually not possible to construct, a pdf can be used as a simple illustrative device for thinking about uncertainty and its distinction from other related concepts, such as confidence. While the most likely outcome is described by the mean or ‘first moment’ of the distribution, the width, or ‘second moment’ of the distribution can be thought of as the uncertainty associated with that outcome because it captures the range of possible outcomes or the volatility in outcomes.

Chart 2 illustrates how this framework can be used to understand how expectations for future economic growth might respond to different combinations of confidence and uncertainty shocks. Suppose the dashed blue line represents companies’ starting beliefs about future annual growth in real GDP. The growth rate they believe to be most likely is shown

Chart 2 A stylised probability density function illustrating the impact of uncertainty and confidence shocks on expectations of GDP growth



Source: Bank calculations.

by the mode of the distribution — here taken to be 2.5%.⁽³⁾ They also attribute a non-negligible chance to GDP growth being as low as zero and as high as 5%; this range of outcomes captures the level of perceived uncertainty. Now suppose companies become more uncertain about the economy and attach greater probability to the occurrence of both higher and lower growth rates, while still believing the most likely outcome will be growth of 2.5%. This is reflected in **Chart 2** by an increase in the width, or ‘second moment’ of the pdf, which shifts from the dashed blue line to the green line; the range of possible outcomes for growth now lies between -2% and 7%.

In practice, however, uncertainty or ‘second moment’ shocks are unlikely to occur independently of shocks to other moments. Particularly during a crisis, shocks to uncertainty may coincide with shocks to the mean (first moment) of the distribution, sometimes described as changes in ‘confidence’. For example, following a financial crisis, say, companies may believe the economy is likely to grow at a lower rate than before, but they may also think a greater number of outcomes is possible. On its own, a ‘confidence’ shock would induce a leftward shift in the pdf with a lower modal outcome: from the dashed blue line to the magenta line in **Chart 2**. If, however, companies became both less confident and more uncertain about future economic growth, the pdf would both widen and shift to the left, shown by the orange line. Moreover, the rise in uncertainty might also be associated with increased concern about extreme events, skewed towards worries about bad or disastrous events. In fact, asymmetric

(1) This aligns with Frank Knight’s description of uncertainty — referring to an event whose probability is either unknowable or impossible to measure accurately, versus the concept of risk, where probability can be determined. See Knight (1921).

(2) See the box on page 39 of the November 2007 *Inflation Report*.

(3) The average annual growth rate of UK real GDP between 1956 and 2007 was 2.8%.

Table A Channels through which uncertainty affects the economy

Sector	Channel	Description	References	Economic variable affected
Households	Precautionary savings	Households unsure about labour income and postpone consumption to insure against temporary shocks to income.	Carroll (1996)	Consumption
Firms	'Wait and see'	Firms uncertain about future sales and profits postpone production and investment until uncertainty is resolved.	Dixit and Pindyck (1994)	Investment and productivity
	'Entry and exit'	Firms postpone entering new markets, including export markets. These firms are likely to be the most productive.	Bloom (2009), Disney, Haskell and Heden (2003)	Productivity and exports
	Labour market distortions	Households unwilling to search for more productive jobs, firms unwilling to post vacancies so the resulting matches are less productive.	Lazear and Spletzer (2011)	Productivity
All sectors	Financial	Uncertainty over future asset price volatility raises risk premia and the cost of credit to households and companies.	Whaley (2000), Gilchrist, Sim and Zakrajsek (2010)	Credit, consumption and investment

shocks that generate a higher perceived probability of bad or extreme events occurring are likely to affect the skew of outcomes or 'third moment' of the probability distribution. But here the focus is on uncertainty shocks that increase people's perceptions of the probability of both high and low outcomes occurring in an equal way.⁽¹⁾

This article focuses on the uncertainty faced by households and companies. Economic activity is also likely to be affected by the way that other economic agents, for example financial market participants and policymakers, respond to changes in uncertainty. For example, the Bank of England's policymakers must take uncertainty about both the current and future state of the economy into account when making policy decisions.⁽²⁾ And to meet their objectives for price stability and financial stability, the MPC and the Financial Policy Committee need to act to mitigate the effects of changes in uncertainty.

How do uncertainty shocks affect economic activity?

Shocks to uncertainty affect economic activity through a number of channels. They affect the level of demand for goods and services in the economy, via consumption and investment decisions. But uncertainty can also have an impact on the supply side of the economy, by affecting productivity growth or credit provision. These channels are summarised in **Table A**. It is important to consider how uncertainty shocks affect these demand and supply channels because they have different implications for activity and inflationary pressure. So it is crucial to understand these effects in order to determine the appropriate monetary policy response. For example, if an increase in uncertainty reduces demand but has no impact on supply it will tend to put downward pressure on inflation as a margin of slack opens up in the economy. By contrast, if an increase in uncertainty also reduces supply, it would lessen the amount of slack and downward pressure on inflation so monetary policy makers might, other things equal, need to loosen policy less to maintain stable inflation.

Demand-side channels

Higher uncertainty can induce households to save more. Faced with uncertainty about their future labour income, households might build up a 'buffer stock' of savings to draw on in periods of temporarily low income (Carroll (1996), Romer (1990)).⁽³⁾ The flipside of increased saving for the future is a reduction in household consumption today. For example, Benito (2004) finds that a one standard deviation rise in unemployment risk for the head of the household reduces consumption in the United Kingdom by 2.7%. The effect on saving and spending is temporary, however, and will dissipate, once households have saved the amount they require as insurance against future fluctuations in their income.

The effect on consumption might also be skewed towards particular types of spending. For example, the decision to buy durable goods, especially big-ticket items such as cars, is particularly sensitive to uncertainty shocks because these purchases are costly to reverse (Romer (1990)). Buying a new car entails a particularly high fixed cost since there is a large drop in its value after being used for the first time. So households would rather wait to see the outcome of economic conditions before purchasing such durable goods. Benito's study of UK households suggests unemployment risk causes purchases of durables to be significantly delayed.

For similar reasons, uncertainty faced by companies can lead them to postpone investment. Investing in new projects typically involves fixed installation costs, so companies value the option of delaying investment decisions until uncertainty about the viability of a project has been resolved (Dixit and Pindyck (1994)). Heightened uncertainty is likely to raise the value of this 'wait and see' option and therefore depress investment spending temporarily.

(1) Uncertainty shocks that affect the 'third moment' of probability distributions or the skew of outcomes have traditionally been used to explain financial market puzzles.

This article excludes discussion of higher moments but some recent applications of these types of uncertainty shocks can be found in Barro (2006) and Gabaix (2012).

(2) A discussion of the ways that the Bank of England deals with these uncertainty challenges in the context of monetary policy is given in 'Uncertainty in macroeconomic policy making: art or science?' — lecture by Mervyn King at the Royal Society, March 2010. See also Batini, Martin and Salmon (1999) for a review of the types of uncertainty faced by policymakers.

(3) This result relies on the assumption of convex marginal utility.

Supply-side channels

Uncertainty can also affect the productive potential, or the 'supply side', of the economy. For example, if higher levels of uncertainty lead companies to postpone their investment plans it not only affects demand today but also the future supply capacity of the economy. The growth rate of the capital stock is lower when investment spending falls, which is likely to restrict the amount companies can produce in the future. Also, in times of heightened uncertainty about demand, companies may be more reluctant to enter new export markets. There is evidence that such activities are an important source of productivity growth as Disney, Haskell and Heden (2003) show for the manufacturing sector. So such behaviour may prevent the most productive use of resources and reduce supply.

Activity in the labour market is also likely to be affected by uncertainty. Bloom (2009) suggests that uncertainty can cause companies to postpone hiring and firing decisions. And uncertainty may make workers less willing to seek new jobs, leading to less 'churn' in the labour market, which in turn could impact on productivity growth through less efficient matching of skills to jobs (Lazear and Spletzer (2011)).

Finally, the banking sector and financial markets are affected by uncertainty which, as well as having negative consequences for demand, can have particularly adverse impacts on the supply side of the economy. For example, uncertainty about the macroeconomic outlook is likely to have a negative effect on asset prices because investors require compensation that captures the risk of holding the asset — a risk premium.⁽¹⁾ During periods of heightened uncertainty, investors require greater compensation as insurance against future risks. This reduces asset prices and the financial wealth of investors holding those assets. Asset prices also tend to be more volatile during periods of heightened uncertainty. Lower and more volatile asset prices are likely to discourage investment by making borrowing more expensive, since the cost of credit tends to be negatively related to the financial wealth of borrowers. Elevated risk premia can have a particularly large impact on the banking sector. In addition, general macroeconomic uncertainty is likely to reduce banks' incentives to provide loans for households and companies. So increased uncertainty may lead to a tightening in credit conditions and restrict investment and funding for new start-up companies, which are typically an important source of innovation (Gilchrist, Sim and Zakrajsek (2010)).

How can uncertainty be measured?

Economic uncertainty is difficult to quantify. In contrast to variables such as inflation, uncertainty cannot be directly observed, since it relates to individuals' subjective beliefs about the economy. There are different types of uncertainty, which may affect households and companies differently. And

there are different sources of uncertainty, from unexpected changes in economic policies to natural disasters or wars (Bloom, Kose and Terrones (2013)).

But it is possible to observe uncertainty indirectly using a number of proxy indicators. **Table B** summarises some of the publicly available measures for the United Kingdom. These measures are primarily based on financial market data or results from surveys and cover a range of different types of uncertainty.

Table B Indicators of economic uncertainty for the United Kingdom

Variable	Data type	Sector
FTSE option-implied volatility ^(a)	Financial market	Whole economy
Sterling option-implied volatility ^(b)	Financial market	Whole economy
Dispersion of company earnings forecasts ^(c)	Financial market/ survey	Firm
Dispersion of annual GDP growth forecasts ^(d)	Financial market/ survey	Whole economy
GfK unemployment expectations balance ^(e)	Survey	Household
CBI 'demand uncertainty limiting investment' score ^(f)	Survey	Firm
Number of press articles citing 'economic uncertainty' ^(g)	Media	Whole economy

- (a) Three-month option-implied volatility of the FTSE All-Share index. Option-implied volatility not available before 1992. Prior to this date, realised volatility is used (calculated as the rolling 65-day standard deviation), with data available from 1975. Sources: London Stock Exchange and New York Stock Exchange/London International Financial Futures and Options Exchange (NYSE Liffe).
- (b) Three-month option-implied volatility of the sterling-euro and sterling-dollar export-weighted exchange rate. Data available from 2001. Source: British Bankers' Association.
- (c) Standard deviation of analysts' forecasts for earnings growth over the next twelve months. Data available from 1998. Source: Institutional Brokers' Estimate System.
- (d) Standard deviation of external forecasts for annual GDP growth for the current and following calendar year, combined as a simple unweighted average. Data are first seasonally adjusted to account for the varying degree of information available to forecasters over the data cycle. Data available from 1989. Source: Consensus Economics.
- (e) Headline balance from the question 'How do you expect the number of people unemployed in this country will change over the next twelve months?'. Data available from 1985. Source: GfK.
- (f) 'Uncertainty about demand' score from the question 'What factors are likely to limit your capital expenditure authorisations over the next twelve months?' in the Confederation of British Industry's (CBI) *Quarterly Industrial Trends and Service Sector surveys*. Data available from 1979. Prior to 1998 only the manufacturing survey is available. Post-1998 the scores from each survey are weighted together to derive a whole-economy score based on the shares of manufacturing and services in gross value added. Source: CBI.
- (g) Sample covers printed editions of the *Financial Times*, *The Guardian*, *The Independent* and *The Times*. Data available from 1988. Source: Factiva.

One of the most widely used indicators of uncertainty is the option-implied volatility of equity prices, based on the prices of options contracts traded on the FTSE All-Share index.⁽²⁾ In principle, the more uncertainty exists about the future path of the stock market, the higher the price that investors are willing to pay for options contracts that protect them against changes in its level. To the extent that uncertainty about companies' equity prices reflects uncertainty about those companies' demand prospects, this measure may provide a reasonable guide to uncertainty at the whole-economy level.

Other measures derived from financial markets also provide useful indicators of uncertainty. The option-implied volatility of the exchange rate may provide a measure of companies' uncertainty about export receipts or the costs of imported inputs into production. And the variation among external

(1) See Inkinen, Stringa and Voutsinou (2010) for more details.

(2) One of the most commonly used is the VIX index, which measures the implied volatility of options on the S&P 500 index.

forecasts of future GDP outturns or company earnings may reflect the degree of uncertainty about the level of future demand.

Survey-based measures of uncertainty attempt to measure directly the uncertainty faced by households or companies. The GfK consumer confidence survey asks households how they expect the number of unemployed to change over the next year. The Confederation of British Industry (CBI) conducts a quarterly survey of companies and asks whether uncertainty about future demand is posing a constraint on their investment plans.

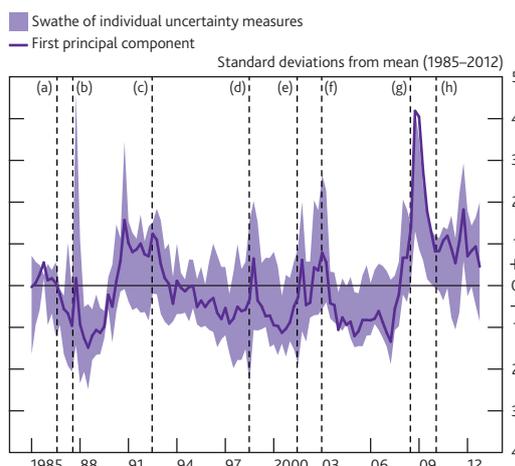
Another, rather different measure of uncertainty is based on the number of citations of 'economic uncertainty' in the printed press. To the extent that newspapers reflect (and influence) the public mood, this measure could provide a barometer for uncertainty in the economy.

None of the above measures is a perfect proxy for uncertainty, however, and each has disadvantages. Financial market measures can be influenced by external conditions and so may not accurately reflect the degree of uncertainty in the UK economy. Measures of implied volatility are also sensitive to the assumptions of the models used to generate them. Some of the survey measures may proxy not just second moment (uncertainty) but also first moment (confidence) shocks.⁽¹⁾ And the number of citations of uncertainty in the press may be influenced by structural trends in the newspaper industry. But taken together, the set of indicators is likely to give a useful steer on the degree of uncertainty in the economy.

How has uncertainty evolved over the recent UK recession?

To assess how economic uncertainty in the United Kingdom has evolved over time, **Chart 3** shows a time-series swathe of the seven uncertainty measures from **Table B**. While there is some variation among the different measures of uncertainty, they do tend to move together, suggesting there is a common 'uncertainty' component to all the measures. The individual measures are also combined into a single summary uncertainty index using a statistical technique called principal components analysis. This method involves extracting from a set of related variables a smaller number of new variables, called principal components, which explain most of the variation in the original set. The 'first principal component' accounts for the greatest amount of variation in the original set of variables and is shown by the solid purple line in **Chart 3**. Each of the seven individual uncertainty measures is strongly correlated with the first principal component, although the financial market measures appear to have the strongest correlation (**Table C**).

Chart 3 A time series of uncertainty indicators



Sources: See **Table B**.

- (a) 'Big Bang' (October 1986).
- (b) 'Black Monday' (October 1987).
- (c) Sterling exits ERM (September 1992).
- (d) LTCM failure (September 1998).
- (e) September 11 attacks (September 2001).
- (f) Iraq war (March 2003).
- (g) Lehman Brothers' failure (September 2008).
- (h) Greece requests EU/IMF assistance (April 2010).

Table C Correlation of individual uncertainty measures with principal component

Uncertainty measure	Correlation with first principal component (2001 Q4–2012 Q4)
Dispersion of company earnings forecasts	0.92
Sterling option-implied volatility	0.89
CBI 'demand uncertainty limiting investment' score	0.85
FTSE option-implied volatility	0.84
GfK unemployment expectations balance	0.83
Number of press articles citing 'economic uncertainty'	0.63
Dispersion of annual GDP growth forecasts	0.59

Sources: See **Table B**.

The uncertainty index shown in **Chart 3** suggests the UK economy has experienced a number of uncertainty 'shocks' over the past two decades. The largest rises in uncertainty occurred during recessions (1990 and 2008). But the uncertainty index also rose above its mean on other occasions which coincided with particular 'bad news' events. In 1998, uncertainty increased in the wake of the failure of the US hedge fund Long Term Capital Management (LTCM). There was then a double-peak rise in uncertainty during the early 2000s which coincided with the September 11 attacks and the onset of the Iraq war.⁽²⁾

Conversely, uncertainty was at an unusually low level for a prolonged period just prior to the recent crisis. In 2003, the

(1) For example, the wording of the question used to generate the CBI demand uncertainty measure does not clearly distinguish between a change in the variance of demand and a change in the level of expected demand. And households' expectations about unemployment may also proxy for their (first moment) expectations about economic growth.

(2) Other selected events include: (a) the 'Big Bang' — liberalisation of the London Stock Exchange in 1986; (b) 'Black Monday' — record falls in world stock markets in October 1987; and (c) sterling's exit from the European Exchange Rate Mechanism (ERM).

index fell sharply, to over one standard deviation below its mean. The experience of unprecedented stability in both the UK and world economies before the crisis might have altered — in hindsight, perhaps unrealistically — individuals' perceptions of the likelihood of future economic shocks occurring.

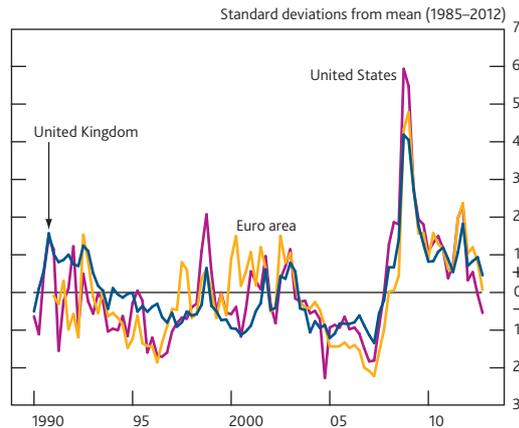
But the magnitude of the uncertainty shock experienced in the recent financial crisis was unprecedented over the period covered. During late 2008, the uncertainty index rose to over four standard deviations above its mean. In part, this might have reflected a rapid reassessment of risks from the financial sector in the wake of the failure of Lehman Brothers. The shock to uncertainty during the recent crisis has also been unusually persistent. In each previous episode of heightened uncertainty, shown in **Chart 3**, the uncertainty index began to fall back within one to three years of the original shock, including following the 1990s recession. By contrast, uncertainty has remained one standard deviation above its mean for most of the past five years and still appears to be elevated.⁽¹⁾

The initial shock to uncertainty in 2008 might have been followed by additional uncertainty shocks stemming from a variety of sources. For example, the increase in the uncertainty index during late 2010 coincided with the intensification of the euro-area sovereign debt crisis, which might have raised companies' uncertainty about external demand conditions. An alternative explanation is that the low level of uncertainty prior to the crisis was simply misplaced, as people mistakenly believed that the economic cycle had become much less volatile than is really the case.

The recent evolution of uncertainty in the United Kingdom has been strikingly similar to that in other advanced economies. **Chart 4** shows the uncertainty index for the United Kingdom alongside the corresponding indices for the euro area and the United States. All indices rose sharply in 2008, fell back somewhat over 2009 and 2010 and picked up again in the second half of 2011. The close correlation of uncertainty across different countries suggests that external factors, such as global financial stress, have been important drivers of the uncertainty shock in the United Kingdom.

The increase in uncertainty during the recent crisis also appears to have coincided with an adverse shock to confidence. For example, businesses might have become both more uncertain and more pessimistic about the level of next year's orders. **Chart 5** shows the uncertainty index alongside a confidence index constructed using the same statistical method.⁽²⁾ The two indices are closely correlated (inversely) and the confidence index fell sharply as uncertainty rose in late 2008. This combined shock to uncertainty and to confidence suggests that following the recent crisis, firms and households have revised down their central expectation of the economic

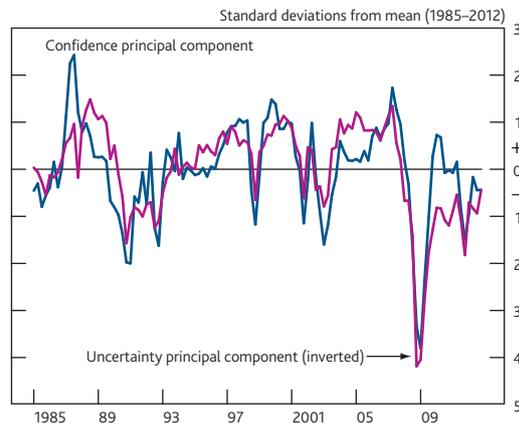
Chart 4 Uncertainty in selected advanced countries^(a)



Sources: Thomson Reuters Datastream for euro-area and US uncertainty measures, see **Table B** for the UK uncertainty measure.

(a) Uncertainty indicators for the euro area and United States include option-implied volatility of exchange rates and equity prices, and unemployment expectations balances.

Chart 5 Uncertainty and confidence indicators^(a)



Sources: Thomson Reuters Datastream and sources in **Table B**.

(a) See footnote (2) at the bottom of this page for the confidence principal component and **Table B** for the uncertainty principal component.

outlook, while also perceiving a higher probability of extreme events occurring either side of that (more pessimistic) central case.⁽³⁾

This raises the question of whether the uncertainty index can be considered a true measure of uncertainty, or whether instead it may simply be picking up the effect of changes in confidence around future outcomes. But results from statistical 'Granger causality' tests suggest that this is not the case. These tests determine whether one time-series variable contains useful information for forecasting another and, although a positive result does not necessarily indicate the presence of true causality, it is usually consistent with it.⁽⁴⁾ In fact, changes in uncertainty are found to 'Granger cause'

(1) This broad narrative of the evolution of uncertainty still holds when the indicator in **Chart 3** is normalised over the pre-crisis period.
 (2) The confidence index is constructed as the first principal component of the detrended FTSE index, and business and consumer confidence balances.
 (3) A combined shock to confidence and uncertainty is illustrated by a shift from the blue line to the orange line in **Chart 2**.
 (4) See Granger (1969).

Table D Granger causality tests for relationships between uncertainty, confidence and GDP growth (1985–2012)^(a)

		To		
		Uncertainty	Confidence	GDP growth
From	Uncertainty	–	***	**
	Confidence	–	–	***
	GDP growth	**	***	–

(a) Three stars, two stars and one star denote statistical significance at the 1%, 5% and 10% levels, respectively. Tests run using two lags.

changes in confidence, whereas confidence appears to have no such effect on uncertainty (Table D).

Empirical effect of uncertainty shocks on the UK economy

It is important for policymakers to quantify the effects of uncertainty on the economy. There is a strong theoretical basis for an impact of uncertainty on economic activity (Table A). And as shown in Chart 1, empirically, uncertainty appears to be countercyclical, rising in recessions and falling in periods of economic stability. The correlation of the uncertainty index with annual output growth is high, at around -0.7. And Kose and Terrones (2012) find that uncertainty is systematically high during recessions and low during expansions across a sample of 21 economies.

Establishing that uncertainty 'causes' fluctuations in output growth in the United Kingdom is not straightforward, however. As discussed above, it is difficult to know whether proxy measures accurately reflect true uncertainty. But even if one is confident in the measure of uncertainty, changes in the index may not arise solely from shocks to uncertainty itself. It is plausible, for example, that a shock to output may itself cause a rise in uncertainty. Indeed, this two-way causality is exactly what is suggested by Granger causality tests (Table D). In other words, there is likely to be an endogenous relationship between uncertainty and activity, meaning that separating the two effects is difficult.

A vector autoregression (VAR) provides one way to estimate the impact of uncertainty on activity. More details on the VAR presented here are provided in the appendix. A VAR model is a system of equations where every variable is dependent on its own past values and the past values of every other variable in the system. So an advantage of this approach is that it allows uncertainty and economic growth to depend on one another. In this set-up, it is possible to introduce an exogenous 'shock' to the uncertainty equation, then observe how that affects other variables within the system, such as output.

VAR analysis has been used in previous studies using US data. For example, Bloom (2009) used this approach to estimate the

effect of uncertainty on industrial production, and Lee, Rabanal and Sandri (2010) used a VAR to estimate the impact of uncertainty on household precautionary savings. Both studies found that heightened uncertainty can have a (statistically significant) negative impact on demand and output. But the persistence of the effects differ somewhat. Bloom (2009) finds that uncertainty shocks have relatively short-lived effects on activity, with evidence of some recovery in the output that was 'lost' during the period of heightened uncertainty. On the other hand, Lee, Rabanal and Sandri (2010) find a more persistent effect on household consumption, relative to income.

Estimating a similar VAR for the United Kingdom suggests that uncertainty shocks have a negative and statistically significant impact on GDP. In addition, the model controls for other important macroeconomic variables including CPI inflation, employment, Bank Rate and an indicator of credit conditions (see appendix for details on the data used).

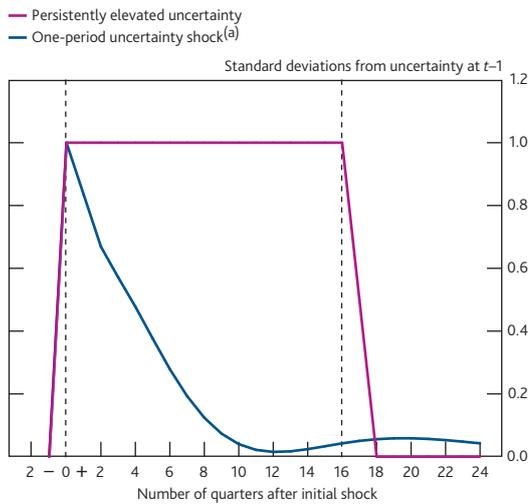
This result is robust to the inclusion of other variables that might also have had large effects on GDP in recent years, such as credit conditions.⁽¹⁾ The effect of uncertainty on output also appears similar, and remains statistically significant, when our confidence measure (as shown on Chart 5) is included. Taken together, these results provide evidence that uncertainty shocks matter, and might be one cause of the United Kingdom's disappointing economic performance since 2008.

In the past, uncertainty shocks have tended to unwind fairly quickly (Chart 3), so their effects on real activity have not been very persistent. The estimates from the model imply that a one standard deviation uncertainty shock unwinds fairly rapidly, with half the rise in uncertainty unwinding within a year (blue line in Chart 6). Consequently, the peak impact on the level of GDP occurs after four quarters (peaking at around -0.5%, shown by the blue line in Chart 7) then the level recovers within three years.

But the experience of the UK economy following the financial crisis suggests that uncertainty shocks can be very large (Chart 3). And their effects on activity are not always so brief (see previous section). While the effects of such unusual events are difficult to quantify, one way of doing so is to consider a thought experiment where uncertainty remains one standard deviation above normal for 16 quarters (magenta line in Chart 6). Unsurprisingly, the model suggests that this would have a larger and more persistent impact on GDP (magenta line in Chart 7). So given evidence of persistently high uncertainty in recent years, uncertainty effects might have played a material role in depressing economic activity since 2008.

(1) The results also suggest that adverse shocks to credit conditions have a negative impact on GDP.

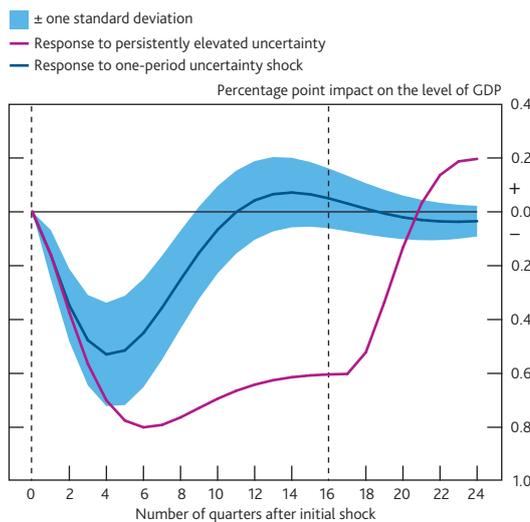
Chart 6 Assumed paths for uncertainty for persistent and one-period shocks



Sources and calculations are detailed in the appendix.

(a) Following shock at time period = 0, uncertainty evolves according to dynamics of the model.

Chart 7 Impact of uncertainty on UK GDP



Sources and calculations are detailed in the appendix.

That said, a rapid fall in uncertainty might lead to a sharp pickup in GDP growth. In the thought experiment in **Chart 6**, uncertainty falls back rapidly to its initial level. That results in a sharp recovery in the level of GDP (magenta line in **Chart 7**). So while the sources of uncertainty currently affecting the United Kingdom, such as the euro-area debt crisis, may be persistent, if they were to dissipate rapidly, that could lead to a period of above-trend growth.⁽¹⁾

Conclusion

A wide range of measures suggest that households and companies have become more uncertain about future economic prospects since the onset of the financial crisis, and these measures have remained much higher in the past five years than in the preceding decade. The sources of this rise in uncertainty appear widespread, and are both domestic and international. The increase in uncertainty has also coincided with a general weakening of confidence in the strength of economic prospects.

Combining our understanding of how uncertainty can affect the decisions made by households and companies with some simple empirical estimates supports the view, often asserted, that elevated uncertainty has been a factor restraining economic recovery in the United Kingdom.

Uncertainty has remained relatively elevated over the past five years. With little recent precedent of such extended periods of high uncertainty, it is difficult to know how this might affect the behaviour of households and companies. Considering different strands of theory and evidence on how households and companies respond to uncertainty suggest that, as long as it remains elevated, some restraining effect on the level of consumer spending and investment may continue.

(1) This is considered as an upside risk to the MPC's forecast in page 41 of the May 2013 *Inflation Report*.

Appendix

Constructing a VAR model to estimate the impact of uncertainty on the UK economy

This appendix sets out how we constructed a vector autoregression (VAR) model to estimate the impact of macroeconomic uncertainty shocks on UK GDP. The approach has been used to identify uncertainty effects on the US economy (see Bloom (2009)). More recently, Denis and Kannan (2013) use a VAR to quantify the (negative) effect of uncertainty shocks on UK industrial production.

Generally speaking, a VAR is a statistical model that allows for an examination of linear interdependencies between variables of interest. For example, it is possible to extract the relationship between uncertainty and GDP, conditional on other variables in the model. The VAR in this article includes six macroeconomic variables, including an uncertainty indicator.⁽¹⁾

The first step in constructing the VAR is to express the variables in terms of a set of equations. In these equations, every variable is dependent on its own past values, the past values of every other variable in the model, plus a contemporaneous 'shock' term, which captures the effect of phenomena unobserved by the model.

For the VAR in this article, each of the six variables in the model depends on the first two lags of itself and every other variable, plus a 'shock' term. The model uses quarterly data and the estimation period is 1989–2012. The set of (six) equations in the model are written below. It shows that the current values of each variable (at time t), on the left-hand side, depends on the first two lags of itself and all other variables (observed values at time $t-1$ and $t-2$), plus a contemporaneous shock, ε_t :

$$\begin{bmatrix} u_t \\ GDP_t \\ L_t \\ CPI_t \\ r_t \\ credit_t \end{bmatrix} = A_1 \begin{bmatrix} u_{t-1} \\ GDP_{t-1} \\ L_{t-1} \\ CPI_{t-1} \\ r_{t-1} \\ credit_{t-1} \end{bmatrix} + A_2 \begin{bmatrix} u_{t-2} \\ GDP_{t-2} \\ L_{t-2} \\ CPI_{t-2} \\ r_{t-2} \\ credit_{t-2} \end{bmatrix} + \varepsilon_t$$

where:

u_t is an uncertainty indicator. It is the first principal component of four of the indicators in **Table B**. These are: the CBI 'demand uncertainty' score, the GfK 'unemployment expectations' balance, FTSE option-implied volatility and number of press articles citing 'economic uncertainty'.

GDP_t is the quarterly level of GDP in log deviations from a statistical trend.⁽²⁾

L_t is the quarterly level of employment in hours worked, in log deviations from a statistical trend.⁽²⁾

CPI_t is the seasonally adjusted⁽³⁾ level of the consumer prices index, in log deviation from a statistical trend.⁽²⁾

r_t is the level of Bank Rate.

$credit_t$ is an indicator of credit conditions. Pre-1995, the credit conditions indicator is taken from Fernandez-Corugedo and Muellbauer (2006). From 1995 onwards, we use a weighted average of interest rates facing households for credit card loans, personal loans and mortgages.

The extent to which each variable is affected by movements in other variables is described by coefficients in the matrices A_1 and A_2 . We estimate the coefficients to 'optimally' describe these data by estimating all six equations using ordinary least squares estimation.

Once the coefficients have been estimated, it is possible to trace through the effect of a shock in the uncertainty equation at time t . This shock raises the uncertainty indicator by one standard deviation at time t , and affects other variables in subsequent time periods. The effect of such an uncertainty shock (of one standard deviation) on GDP is shown in the blue lines in **Charts 6** and **7**. The effect of the shock largely unwinds after around ten quarters.

We can also use the VAR to estimate the effect of persistently elevated uncertainty, as shown in the magenta lines in **Charts 6** and **7**. Rather than applying a single shock in time t and then allowing the effect to unwind, as shown in the blue lines, we applied a series of shocks to the uncertainty equation. We applied shocks such that the uncertainty indicator remained one standard deviation higher than average for 16 quarters.

(1) Data are sourced from the ONS and Bank of England unless otherwise stated.

(2) The trend is estimated using a Hodrick-Prescott filter, where the parameter, lambda, which determines the sensitivity of the trend to short-term fluctuations in the data, is set equal to 1600.

(3) Seasonal adjustment uses the Census X-12 ARIMA methodology.

References

- Barro, R (2006)**, 'Rare disasters and asset markets in the twentieth century', *Quarterly Journal of Economics*, Vol. 121(3), pages 823–66.
- Batini, N, Martin, B and Salmon, C (1999)**, 'Monetary policy and uncertainty', *Bank of England Quarterly Bulletin*, May, pages 183–89.
- Benito, A (2004)**, 'Does job insecurity affect household consumption?', *Bank of England Working Paper No. 220*.
- Bloom, N (2009)**, 'The impact of uncertainty shocks', *Econometrica*, Vol. 77, pages 623–85.
- Bloom, N, Kose, M and Terrones, M (2013)**, 'Held back by uncertainty', *Finance and Development*, Vol. 50, No. 1, pages 38–41.
- Carroll, C (1996)**, 'Buffer-stock saving and the life cycle/permanent income hypothesis', *NBER Working Paper No. 5788*.
- Denis, S and Kannan, P (2013)**, 'The impact of uncertainty shocks on the UK economy', *IMF Working Paper No. 13/66*.
- Disney, R, Haskell, J and Heden, Y (2003)**, 'Restructuring and productivity growth in UK manufacturing', *Economic Journal*, Vol. 113, Issue 489, pages 666–94.
- Dixit, A and Pindyck, R (1994)**, *Investment under uncertainty*, Princeton University Press, Princeton.
- Fernandez-Corugedo, E and Muellbauer, J (2006)**, 'Consumer credit conditions in the United Kingdom', *Bank of England Working Paper No. 314*.
- Gabaix, X (2012)**, 'Variable rare disasters: an exactly solved framework for ten puzzles in macro-finance', *Quarterly Journal of Economics*, Oxford University Press, Vol. 127(2), pages 645–700.
- Gilchrist, S, Sim, J and Zakrajsek, E (2010)**, 'Uncertainty, financial frictions, and investment dynamics', *2010 Meeting Papers No. 1285*, Society for Economic Dynamics.
- Granger, C (1969)**, 'Investigating causal relations by econometric models and cross-spectral methods', *Econometrica*, Vol. 37(3), pages 424–38.
- Inkinen, M, Stringa, M and Voutsinou, K (2010)**, 'Interpreting equity price movements since the start of the financial crisis', *Bank of England Quarterly Bulletin*, Vol. 50, No. 1, pages 24–33.
- King, M (2010)**, 'Uncertainty in macroeconomic policy making: art or science?', available at www.bankofengland.co.uk/publications/Documents/speeches/2010/speech432.pdf.
- Knight, F (1921)**, *Risk, uncertainty and profit*, Signalman Publishing, Kissimmee, Florida.
- Kose, A and Terrones, M (2012)**, 'How does uncertainty affect economic performance?', *World Economic Outlook*, October, pages 49–53.
- Lazear, E and Spletzer, R (2011)**, 'Hiring, churn and the business cycle', *NBER Working Paper No. 17910*.
- Lee, J, Rabanal, P and Sandri, D (2010)**, 'US consumption after the 2008 crisis', *IMF Staff Position Note 10/01*.
- Romer, C (1990)**, 'The Great Crash and the onset of the Great Depression', *Quarterly Journal of Economics*, Vol. 105(3), pages 597–624.
- Whaley, R (2000)**, 'The investor fear gauge', *Journal of Portfolio Management*, Vol. 26, No. 3, pages 12–17.