Uncertainty shocks slowing down business

Adrien Zakhartchouk

Division Synthèses conjoncturelles

Concerns surrounding European sovereign debt increased sharply in early August 2011, causing an "uncertainty shock"in the Eurozone evidenced by major financial turmoil: risk premiums on the interbank market rose dramatically, sovereign debt spreads widened, stock market indices fell sharply and the European stock markets experienced high volatility. This turmoil also affected the expectations of agents, as attested to by the business tendency surveys and bank financing terms. It is therefore likely to have an impact on real activity.

This report proposes an estimate of the effects of this sudden spike in uncertainty on activity in France, based on an analysis of similar events in the past.

First of all, an observation: sudden, exceptional rises in the volatility of the Paris stock market index (CAC 40) are a good indicator of "uncertainty shocks". They allow us to isolate periods where uncertainty rises sharply, generally due to clearly identified events: the Iraq wars, 9/11 attacks, the Russian default, etc. The situation in the summer of 2011 can also be described as an uncertainty shock in the light of this measurement.

Next, the effect of an uncertainty shock is estimated by simulating the reaction of monthly macroeconomic variables (industrial output, interest rates, prices) to this sort of shock. It turns out that everything else being equal, industrial output falls sharply following an exceptional increase in uncertainty. It continues to drop for around a year before gradually climbing again.

The shock that occurred in the Eurozone in summer 2011 seems to have penalised activity at the end of 2011 and should continue to do so in H1 2012. ■

Uncertainty shocks slowing down business

The Eurozone underwent an uncertainty shock in summer 2011

Financial turbulence in the Eurozone

August 2011 was characterised by a sudden shift upwards in financial turbulence in all the world's economies, and more particularly in the Eurozone: following renewed concerns about European sovereign debt, tensions on the interbank markets heightened substantially,(1) Interest rate spreads for servicing European sovereign debt grew sharply, and stock market indices fell considerably. In France as in Germany and the USA, this crisis also led to a very sharp, sudden increase in the volatility of stock market indices in August. In early 2012, stock market volatility returned to more usual levels (see *Graph 1*).

"Volatility shocks" generally lead to sudden rises in uncertainty, which are known as "uncertainty shocks": in a context that is suddenly more uncertain, when one-off events occur (geopolitical crises for example), the frequency and amplitude of stock market fluctuations (both up and down) increase.

An uncertainty shock affects consumption and investment decisions

Economic decisions depend on expectations

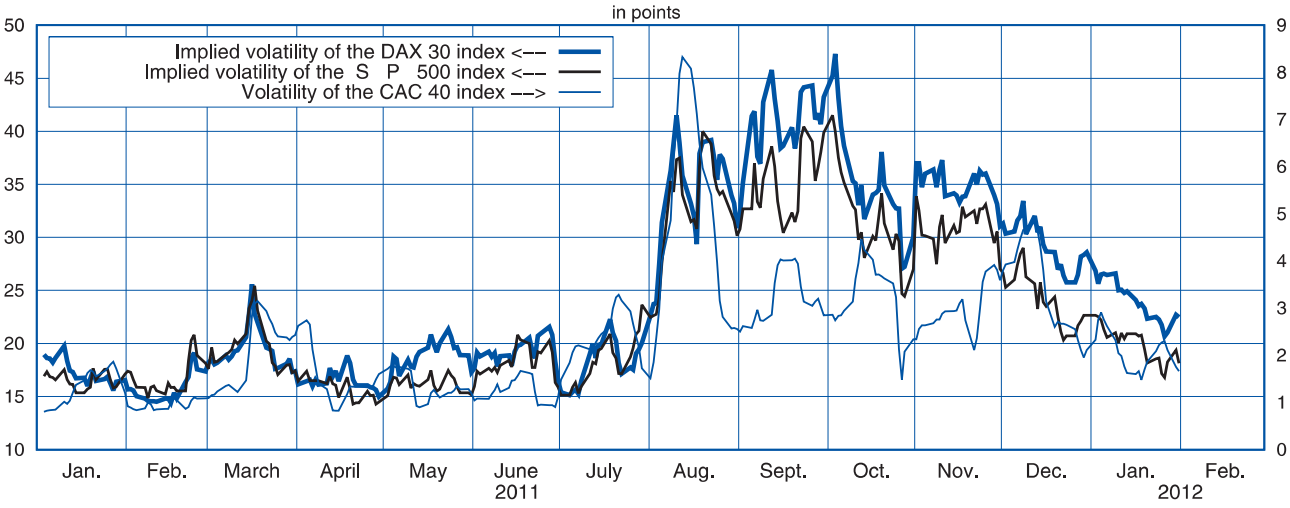
The decisions made by economic agents depend on their assessment of the future situation of the economy as a whole: a household may increase its consumption if it expects prices to rise in the near future; a business may decide to commit to investments if it is expecting strong business. So an uncertainty shock which unsettles the expectations of economic agents may spread to the real economy.

The main channel through which uncertainty shocks spread is corporate investment decisions...

The economic literature has examined the channels of transmission of uncertainty to activity. It has mainly focused on the investment behaviour of companies: in an uncertain environment, they may decide to postpone their investments in order to limit cash-flow and overproduction risks.

(1) The three-month spread between the OIS and Euribor rates, a standard measure of tension on the interbank market, increased by 80% in one month.

1 - Volatility of the DAX 30, S&P 500 and CAC 40 indices



Source: DataInsight, author's calculations

...because investment is irreversible in nature

Investment decisions are irreversible because it is generally difficult to go back on an investment once it has been engaged. Consequently, it is worse for a company to have overinvested due to over-optimism about economic prospects than to have underinvested due to excessive pessimism. In situations of great uncertainty, businesses may therefore scale back their investments (*Arellano et al., 2010*) or postpone them to a later date (*Bloom, 2009*), or even not invest at all. In all these cases the principal effect of an uncertainty shock is therefore underinvestment by companies compared to what they would have decided to do if they had been able to see more clearly into the future.

A rise in uncertainty is thus likely to apply the brakes to economic activity, regardless of whether this period of uncertainty eventually ends positively or negatively. To estimate the effect of an uncertainty shock in France, two steps are required:

- build an uncertainty shock indicator to identify a number of similar shocks in the past;

- on this basis, model and estimate the reaction of the economy to these shocks.

The study is inspired by the work carried out by *Nicholas Bloom* on the subject for the United States (*The Impact of Uncertainty Shock, 2009*).

Volatility peaks in stock market indices are a good indicator of uncertainty shocks

Volatility peaks are rare events that allow us to identify uncertainty shocks

The definition of uncertainty is a question with multiple dimensions which has generated an extensive body of literature. An interesting approach is to use the volatility of the stock market index to build an "uncertainty shock" variable.

The return of tensions in summer 2011 was indeed marked by a sharp increase in the volatility of stock markets.[2] There have only been ten or so precedents over the last twenty years (*see Graph 2*). Additionally, these precedents were very often linked to one-off, identifiable or even exogenous events that may be described as "uncertainty shocks ": the Gulf wars, the 9/11 attacks, etc. So volatility does seem to provide a relevant indicator of such shocks. It also appears to be correlated with other measures of uncertainty (*see Box 1*)

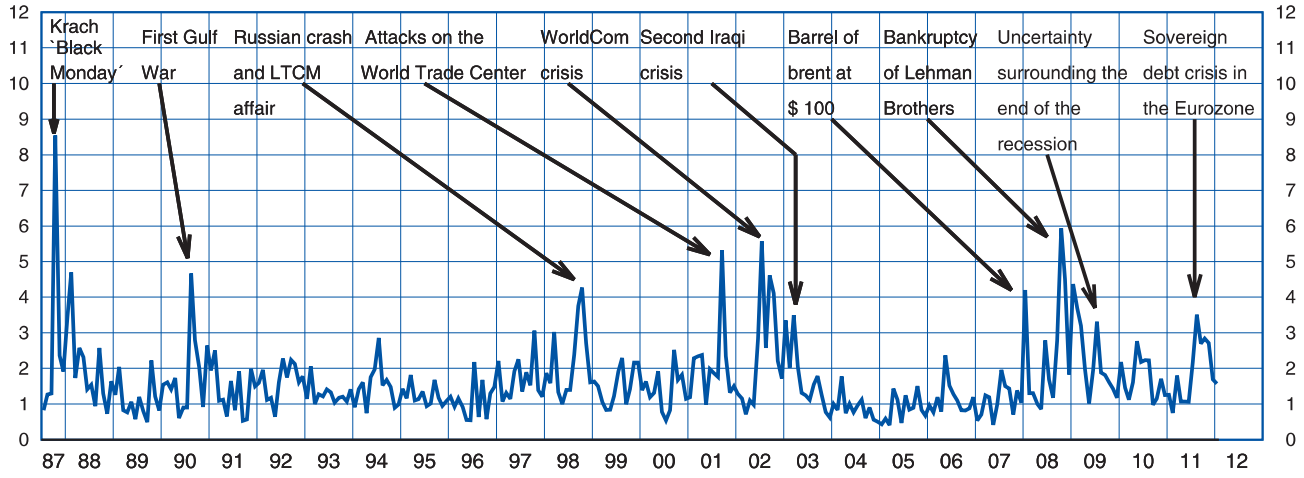
A shock variable takes a value of 1 in the event of a volatility peak, and 0 otherwise

The volatility variable, calculated each month as the monthly variance in the daily series of the reference index (the CAC 40) level as a ratio of the level of the index, is used here. This variable is not intended to quantify the level of uncertainty in the economy, but simply to pinpoint a sudden rise in uncertainty. The assumption is that when the economy is affected by an "uncertainty shock", a significant increase in the volatility of the stock market index is observed.

(2) Unlike *Bloom*, who uses American data, for France we do not have data available about implied volatility. However, this measure is generally well correlated with the observed variance as a ratio of the level of the index, the measure used here. While the shocks identified are international, a variant of our model was nonetheless tested with the implied volatility of the American stock markets (or the VIX index, calculated from the S&P 500 index). This is a volatility index calculated from future options and it is used to estimate the volatility expected by agents (forward-looking variable). The results obtained are very close to these achieved with the variable built here.

Uncertainty shocks slowing down business

2 - Monthly variance of the CAC 40 index as a ratio of the level of the index



Note: Here, volatility is calculated as the ratio of the variance of the index (centred-reduced) to the level of the index.

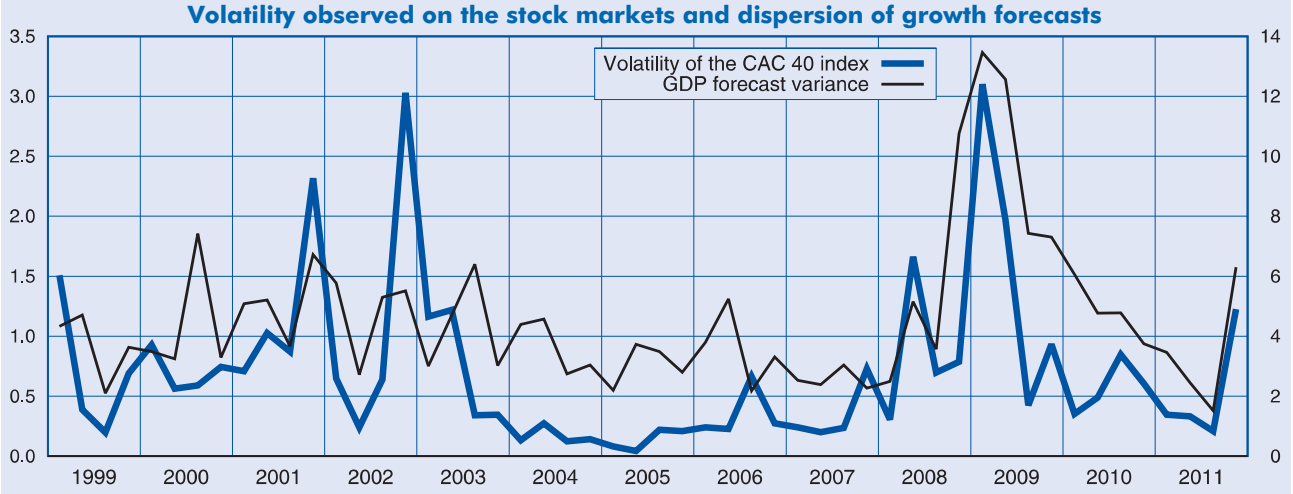
Sources: DataInsight, author's calculations

Box 1 - Volatility peaks are correlated with other uncertainty indicators

Stock market volatility trends are correlated with other indicators which are also likely to provide a measurement of uncertainty. For example, we can use the growth forecast dispersion surveys. A Survey of Professional Forecasters (SPF) is carried out by the European Central Bank (ECB). Each quarter, this survey collects forecasts for inflation, gross domestic product (GDP) and unemployment rates, to different time horizons, from more than 70 economic research institutions in the European Union.

To build another indicator for measuring uncertainty shocks with which uncertainty peaks can be compared, we use the standard deviation of the series of forecasts calculated in the ECB survey. A good correlation is observed between the stock market volatility peaks and the dispersion peaks of growth forecasts. ■

Volatility observed on the stock markets and dispersion of growth forecasts



Sources: DataInsight, BCE, author's calculations

At that point a "shock" binary variable is built, taking a value of 1 when there is an uncertainty shock over the period under consideration, and 0 otherwise. Two conditions are defined for a volatility episode to be considered as an uncertainty shock:

- it exceeds a significance threshold c. This allows us to build a quantitative definition of the exceptional nature of the shock. The threshold c selected corresponds to significance at 5%, considering each observation as independent of the previous ones.(3)

- a similar shock has not occurred over the previous three months. This allows us to identify a shock when the level of volatility is exceptionally high over a period of several months (as was the case in 2008-2009, most notably).

Lastly, the shocks pinpointed under these conditions correspond to precise events which have generally led to a sudden, unexpected rise in uncertainty (*see Table 1 and Box 2*). In particular, the unpredictable nature of each event has been verified.

An uncertainty shock leads to a significant drop in industrial output for several months

An econometric model with monthly data

To model the response of the economy to an uncertainty shock, a "vector autoregresssion" (VAR) model with monthly data is used (*see Box 3*). The use of monthly data is indispensable to capture the instantaneous dynamic of the economy in response to the shock. VAR modelling is used to show the interaction between the macroeconomic magnitudes modelled and hence to estimate the "response functions" of the different VAR variables in reaction to a shock to one of them.The model comprises four endogenous variables: the level of the stock market index, the level of consumer prices, the base interest rate of the Central Bank, and lastly the industrial production index. The volatility shock is introduced as an exogenous variable, i.e. it affects the dynamic of the economy when it occurs, but is not produced endogenously.

We measure the responses of the different economic magnitudes to an uncertainty shock, i.e. when the "shock" variable switches from 0 to 1. They are interpreted as the responses to an "average"uncertainty shock, calculated as the mean of the ten uncertainty shocks identified.

(3) As the selected variable is positive, threshold c has a standard deviation of 1.645.

Table

Uncertainty shocks identified by volatility peaks

Date	Event	Crash
October 1987	"Black Monday"	Financial
August 1990	First Gulf War	Geopolitical
September 1998	Russian crash and LTCM affair	Financial
September 2001	Attacks on the *World Trade Center*	Geopolitical
July 2002	*WorldCom* crisis	Financial
January 2003	Second Iraqi crisis	Geopolitical
January 2008	Barrel of Brent at $100	Oil
October2008	Bankruptcy of *Lehman Brothers*	Financial
July 2009	Uncertainty surrounding the end of the recession	Financial
August 2011	Sovereign debt crisis in the Eurozone	Financial

Box 2 - History of the main uncertainty shocks of the last 25 years

The ten uncertainty shocks identified via stock market volatility (*see Table 1*) correspond to specific events.

- On 19 October 1987, the Dow-Jones index fell by almost 23% after a sharp drop in the European and Asian stock markets (particularly Hong Kong). The reasons for this stock market crash, which by definition was unforeseeable, are not fully agreed on and several factors may have come into play (G7 disagreements on monetary policies, instability in the computerised systems for buying and selling shares, fears surrounding rising interest rates).
- On 2 August 1990, Iraq invaded Kuwait. Iraqi troops had gathered close to the Kuwaiti border on 18 July and the OPEC counties decided to raise the price of the oil barrel from 18 to 21 dollars on 27 July. The unexpected rise in tensions in July and August was still relatively unforeseeable until the end of July.
- On 17 August 1998, Russia announced that the rouble had been devalued and called a moratorium on payments of its foreign debt. This event, which by definition was unexpected, also indirectly caused the near-bankruptcy of American investment fund LTCM.
- On 11 September 2001, the terrorist attack on the Twin Towers brought about a rapid fall in stock market prices, and with it great uncertainty on the financial markets, although there were not any major direct economic consequences.(1) Stock market prices returned to their former level as early as 17 October.
- On 1st July 2002, the share price of the company WorldCom plummeted by 90% after a week without a share listing at the end of June. This event was without a shadow of a doubt unforeseeable, but came as part of the burst of the dotcom bubble and various financial scandals (in particular the Enron affair, revealed in January 2002). The model was thus tested with and without this event in order to ensure that it did not skew the results.
- In January 2003, tensions linked to the prospect of war in Iraq came to a head when many industrialised countries (UK, Spain, Italy, etc.) committed their support to the USA in the event of conflict. The CAC 40 lost just over 800 points between 6 January and 12 March.
- On 3 January 2008, the price of the oil barrel (Brent and WTI) reached $100. The precise event of a broker purchasing a barrel for $100 and the (psychological) uncertainty shock that it caused were not foreseeable but this event occurred during a period of gradual price rises stretching to summer 2008. The model was thus tested with and without this event in order to ensure that it did not skew the results.
- On 15 September 2008, Lehman Brothers filed for bankruptcy, against market expectations which had assumed that the American government and Central Bank would act to avoid the bankruptcy of one of the USA's biggest banking institutions. The 2008-2009 crisis was of a gravity that surely goes much deeper than an uncertainty shock. It was first and foremost a financial and banking crisis which precipitated a worldwide recession. Given the particular nature of the crisis, the model was tested with and without this episode.
- The shock of July 2009 is harder to interpret. The Paris stock market dipped sharply then rose again in July, without there being a precise event to explain this behaviour. But uncertainties surrounding macroeconomic perspectives were particularly high in mid-2009, regarding the end of the recession - or not. This model was tested with and without this shock, without the results changing.
- The crisis in August 2011 was above all linked to the sovereign debt market. Doubts about the credibility of the bailout plan for Greece and uncertainty about the USA debt ceiling at the end of July provoked a sharp increase in risk aversion. This phenomenon was prolonged when Standard & Poor's downgraded the USA's rating on 7 August, and doubts emerged about the stability of European banking institutions. ■

(1) Not taking account of the indirect effects of 9/11 on the economy, for example through the instability in the Middle East and the armed conflicts in Afghanistan and Iraq.

Box 3 - Modelling the spread of an uncertainty shock

A monthly VAR model

Aside from the exogenous uncertainty shock, the VAR model used includes four variables: the CAC 40 level, the consumer price index, the base interest rate of the Central Bank, and the industrial production index.

For the industrial production index (IPI) the decision was made to restrict ourselves to the manufacturing industry, i.e. fields C3-C5 of NAF.[5] The introduction into the model of the level of the stock market index allows differentiation between the effect of an uncertainty shock and that of a variation in stock markets.

All the variables are taken as monthly means and are seasonally adjusted (apart from the interest rate variable), and their logarithm is used in the model. The variables are smoothed using a "real-time" *Hodrick-Prescott* filter.[1]

The VAR modelling assumes that we define an underlying pattern for shock transmission. We assume that an uncertainty shock first affects the financial variables (in this case, the CAC 40 level), then the interest rate and the price level, and then the real economy via industrial production. The variables are therefore put in this order in the VAR model.

For the VAR we use twelve time lags for all the variables except for the exogenous variable, for which only five lags are used. For each VAR model the standard autocorrelation, lag significance and VAR stability tests are performed.

The model is robust to the assumptions

In order to test the robustness of the model a number of variants were used. The model's response was tested with a different smoothing coefficient of the Hodrick-Prescott filter and with different orders of variables. These variants do not show fundamentally different results to those of the basic model. Other variants were also used, in which the uncertainty variable was no longer represented by a binary variable but instead directly by the value of the variance in the daily series of stock market indices. This comes down to making the further assumption that volatility is a relevant measure of uncertainty.

This operation was also performed with the variable representing the implied volatility of the S&P 500 and the DAX 30. As the shocks identified are international, we can consider that we are losing little in the way of information by using an implied volatility index for the American stock market index, rather than a French index - which is not available. These two variants also give analogous results to those presented in this report.

Last, to ensure the robustness of this analysis, our model was also tested with a window of observation reduced to the pre-crisis period (July 1987 - July 2007), and similar results were obtained.

Volatility shocks or sudden stock market declines?

One difficulty of this approach is identifying the shocks when they are correlated with periods in which activity is very often already in decline. So the purpose of this report is to distinguish the effect of an uncertainty shock from the effect of other, habitually studied shocks (monetary, demand-related, etc.). However, it is harder to distinguish the effect of an uncertainty shock from the effect of a sudden fall in the stock market index, for two reasons. The first is that the first consequence of an uncertainty shock is a sudden drop in the stock market index. Information is at the heart of the mechanisms of financial markets: the absence of information about the economic consequences of an unexpected, one-off event causes financial stakeholders to withdraw from their riskiest positions very swiftly. After the 9/11 attacks, for example, the stock market plummeted throughout September solely due to the uncertainty on the financial markets (the New York stock exchange actually returned to its pre-9/11 level by 17 October). The second reason is inherent to the uncertainty calculation selected. If we take as an index the volatility of the stock market index calculated via monthly variance, it is inevitable that sharp drops in the stock market index should be correlated with an increase in volatility.

However, two elements serve to resolve this problem:

- First, the decision to model discrete shocks. This study concerns the effect of exceptional events that generate uncertainty.
- These events have been clearly identified as uncertainty shocks. While some of these events are de facto stock market crashes, they were all unexpected and all caused an increase in uncertainty. ■

(1) To obtain this series, the 2005 base series was retropolated with the aid of the 1990 base series, in order to have data prior to 1990. A variant was also tested with the IPI covering a broader scope, the whole of the industrial field in NAF (BE). The results obtained are very similar.
(6) The smoothed series of observations of a variable by a "real-time"Hodrick-Prescott filter corresponds to a series in which each observation takes the value of the last point in the series of the raw variable, smoothed by a "classical" *Hodrick-Prescott* filter for all previous observations. This avoids the usual side effects of this smoothing method. We select lambda = 14400, the value generally recommended in the literature for monthly data.

Uncertainty shocks slowing down business

What exactly do we measure?

This method does not claim that all the crises it explores can be explained by the sole notion of uncertainty. Many other factors may contribute to the slump in activity during these periods, and they are incidentally very different from each other depending on whether the event is political (like the attacks on the *World Trade Center*) or purely financial (such as the 1987 stock market crash). What this study attempts to underscore is the common point between all these crises, the fact that they have all led to a sudden rise in uncertainty. The question this study answers, then, is that of the specific effect, all else being equal, of an uncertainty shock.

An uncertainty shock significantly affects industrial output in the ensuing months

As the response function of the industrial production index shows (see Graph 3), an uncertainty shock has a significant impact on activity. Indeed, the industrial production index (IPI) falls over the ten months following the shock. At the height of the "uncertainty shock" the IPI is 1% lower than the level it would have been if there had not been a shock. From the 11th month onwards the IPI starts to climb again towards its long-term level, which it reaches at around the 20th month.

After that point the fluctuations do not appear to be significant: although a rebound is observed between the 22nd and the 36th months, the confidence interval remains centred around 0%, i.e. in a zone where the effect of the shock on the industrial production index is absorbed.

Spread of the shock into the economy

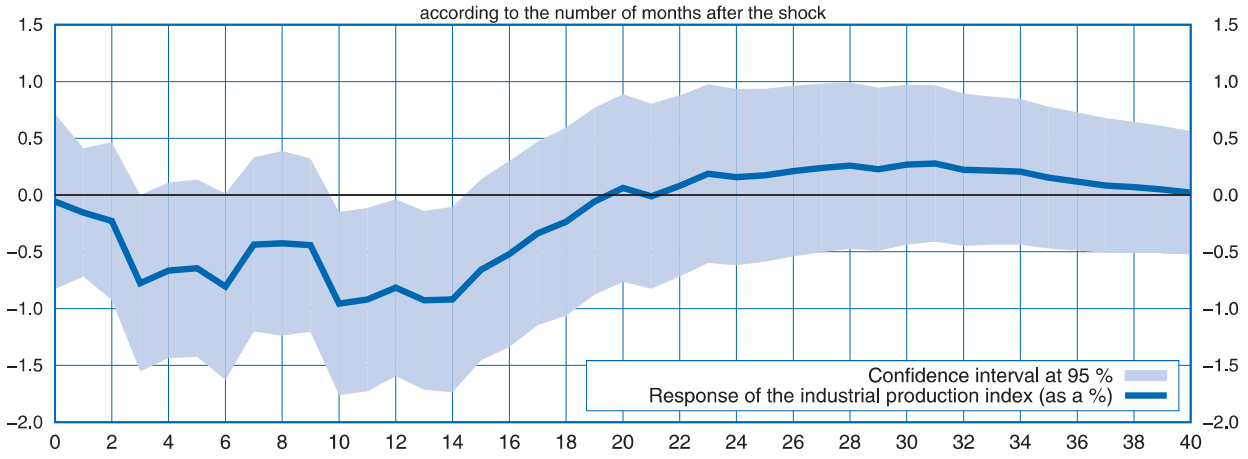
The responses to the uncertainty shock from the other variables used in the VAR (*see Graphs 4a, 4b and 4c*) illustrate the mechanisms that spread the uncertainty shock to industrial activity.

The uncertainty shock first spreads to the economy via a shock to the financing of the economy. The stock market index immediately loses around 10% of its value compared with its pre-shock level. Faced with greater cash-flow risks, companies tend to increase their prices gradually. The effect of the decline in production outweighs inflationary pressure, and the base rate of the Central Bank falls just after the shock.

After a few quarters, the decline in production takes its toll on prices. The fall in inflation combines with the drop in the base rate and with a rebound in the stock market indices when the economic environment becomes less uncertain. In the medium term, production can thus return to its pre-shock level. It should be noted that unlike in the work by *Bloom* (2009) on the American economy, the catch-up effect to make up for lost production just after the shock[7] is not observed with French data.

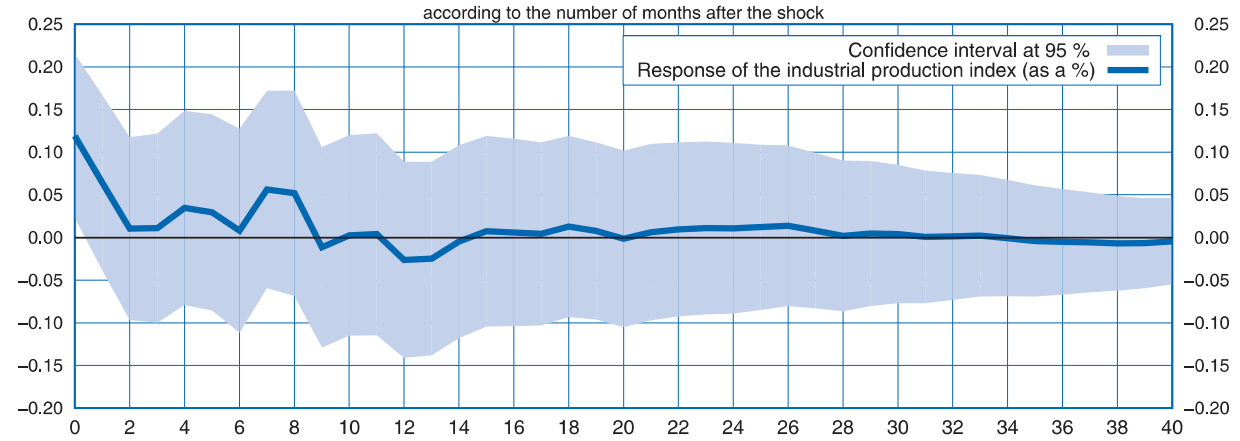
(4) With the American data, this leads to a significant increase in production compared to the pre-shock level, at around the 30th month.

3 - Effect of an uncertainty shock on industrial production



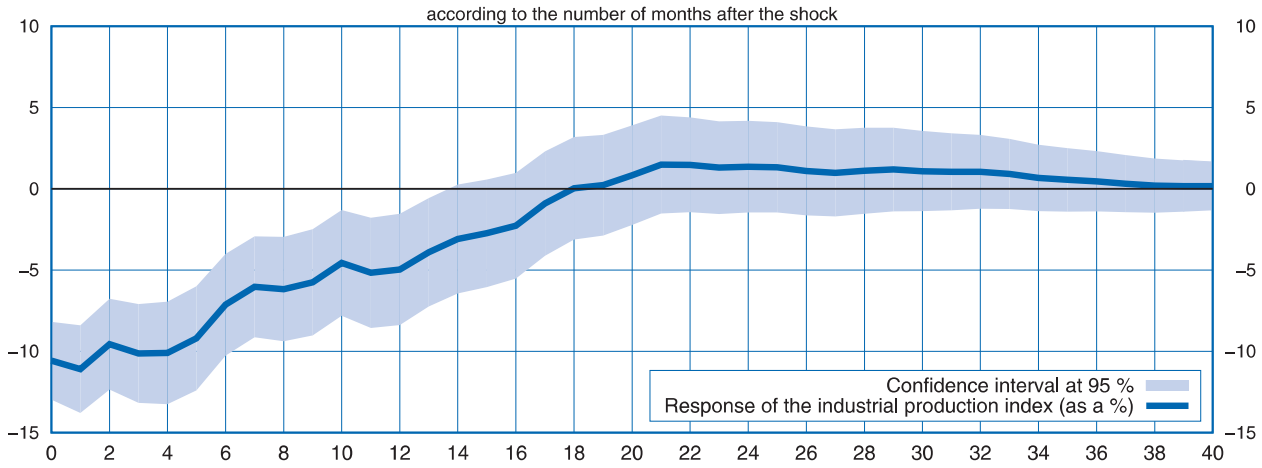
Sources: INSEE, author's calculations

4a - Response as a level of the deviation to its level of inflation



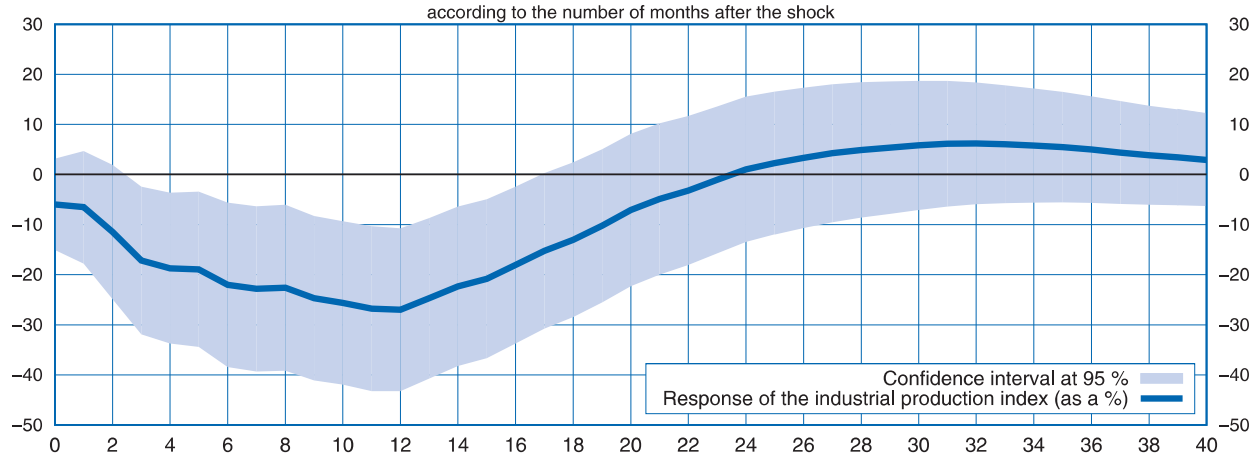
Sources: INSEE, author's calculations

4b - Response as a level of the deviation to its level of the CAC 40



Sources: INSEE, author's calculations

4c - Response of the base rate of the Central Bank



Sources: INSEE, author's calculations

Conclusion

The rise in tensions surrounding sovereign debt in August 2011 led to an uncertainty shock which was visible in the increased volatility of the financial markets. This type of shock generally has a negative impact on activity.

The shock of last August shaved about 1% off industrial production in Q4 2011, and this negative effect may continue through to summer 2012. But in December 2011, the industrial production index (IPI) was 1.5% lower than its long-term level: a large proportion of the weakness of the IPI since August 2011 is thus attributable to this rise in uncertainty.

The mechanism highlighted here is, however, not exclusive, as other factors may have adversely affected activity in H2 2011. First, the European crisis of summer 2011 did not only result in a rise in uncertainty, but also tensions on the interbank market, with financial tensions spreading to the financing terms of private agents. Next, it was accompanied by fiscal consolidation measures in many Eurozone countries, and these measures also took their toll on activity in H2 2011. ■

Bibliography

Arellano C., Bai Y., et Kehoe P., 2010, "Financials Markets and Fluctuations in Incertainly", *Federal Reserve Bank of Minneapolis Research Department Staff Report.*

Bachmann R., Elstner S. et. Sims E.R, 2010, "Uncertainty and Economic Activity: Evidence from Business Survey Data" , NBER, *Working Paper,* n° 16143.

Barlevy B., 2004, "The Cost of Business Cycles Under Endogenous Growth", *The American Economic Review*, vol. 94, n4, pp. 964-990.

Bernanke B.S, 1983, "Nonmonetary Effects of the Financial Crisis in Propagation of the Great Depression" *The American Economic Review*, vol. 73 n3, pp. 257-76.

Bloom N., 2009, "The Impact of Uncertainty Shock", *Econometrica*, vol. 77, n 3, pp. 623-685.

Lawson T., 1985, "Uncertainty and Economic Analysis", *The Economic Journal,* vol. 95, n 380, pp. 909-927.

Leahy J.V et Whited T.M., 1996, "The Effect of Uncertainty on Investment: Some Stylized Facts", *Journal of Money*, Credit and Banking, vol. 28, n 1, pp. 64-83.