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Article

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Uncertainty shock from the Brexit vote decreases investment and GDP in the Euro Area and Germany

By Malte Rieth, Claus Michelsen, and Michele Piffer

The Brexit vote has considerably increased economic uncertainty in Europe and beyond. It will likely affect economic performance and in particular investment in the euro area, which are both already relatively weak. The impact of this uncertainty shock on the euro area and the German economy is estimated with an econometric framework. A counterfactual analysis indicates that the uncertainty associated with the Brexit vote reduces GDP in the model economy for the euro area for more than two years, with a trough of about 0.2 percent after eight months, relative to a situation in which this shock would not have occurred. It also leads to an increase in the unemployment rate and to a mild decline of consumer prices. Investment is estimated to fall by approximately 0.7 percent over the horizon of one year. In Germany, these effects are qualitatively and quantitatively similar. The findings highlight the importance to stimulate investment in the euro area and in Germany, and to minimize uncertainty in the further political process.

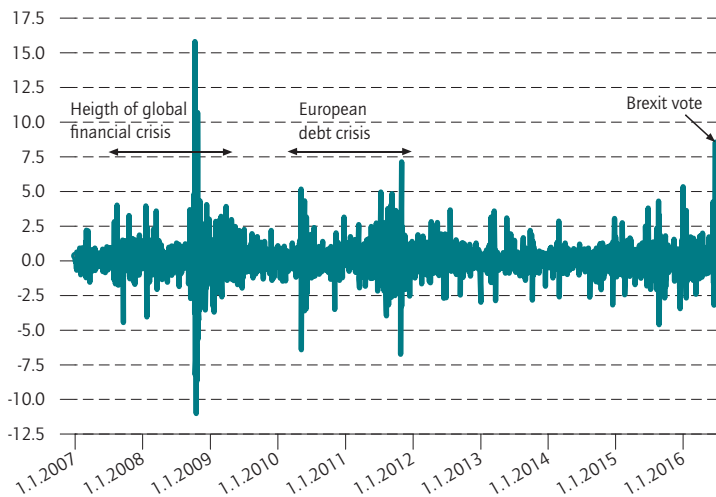
On the night of June 23, 2016, the outcome of the Brexit referendum in the United Kingdom (UK) became public. Since that night, the effects of the Brexit vote have been at the center of a political debate in Europe and beyond. While the vote has already caused a range of political consequences, from an economic point of view one of the main effects associated with the vote is a general increase in uncertainty. As many commentators have argued, the actual consequences of the UK vote are largely unknown.¹ It is not clear how the possible changes in the legal framework related to the Brexit will impact the extensive economic and social ties between the European Union and the UK. For example, when will the UK invoke Article 50 of the Lisbon Treaty? Will this lead to a limitation of the free movement of labor, goods, capital and services? Will the financial sector leave London? Will other EU countries follow with similar referendums? None of these questions are likely to find an answer in the near future.

The following report assesses the economic effects generated by the increased uncertainty related to the unexpected outcome of the Brexit vote for the euro area, with a particular focus on Germany. A counterfactual econometric analysis identifies the uncertainty-related effects of the Brexit vote under the thought-experiment that the economy will not be hit by further economic shocks. This is not a forecasting exercise, but a separation of the effects of uncertainty, abstracting from any other future shocks. While there are many channels through which uncertainty is likely to affect the economy, particular attention is paid to the effects on private investment, a variable highly sensitive to uncertainty and key for long run economic growth.

¹ For example, Rogoff K. (2016): Britain's Democratic Failure. Article on Project Syndicate, June 24.

Figure 1

Overnight change of VStoxx volatility index



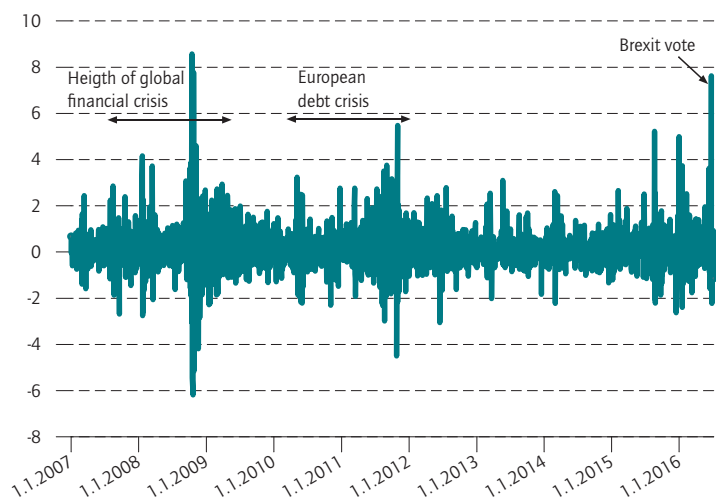
Source: Datastream.

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The Brexit vote triggered the largest overnight VStoxx change since the height of the global financial crisis.

Figure 2

Overnight change of VDax volatility index¹



¹ Vdax-New data is used.

Source: Datastream.

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Compared to the financial crisis, the VDax reacted particularly strongly to the Brexit vote.

The effect of uncertainty on economic activity

The literature has discussed several reasons why uncertainty can affect the economy.² One channel is through a 'wait-and-see' effect. Being uncertain about the future, households might find it optimal to postpone consumption and engage in precautionary savings. Similarly, firms might find it optimal to postpone investment decision until the time in which uncertainty resolves in order to make a more informed decision.³ A second channel focuses on the cost of borrowing. Higher uncertainty is likely to lead lenders to demand higher risk premia. This, in turn, pushes up the cost of borrowing and discourages consumption purchases and investments.⁴ Both channels are thought to particularly affect investment, because investment is often characterized by a slow and costly reversibility and often depends on outside financing.

It is not straightforward to measure uncertainty. Different approaches have been proposed in the literature recently.⁵ One standard measure is option-implied stock market volatility, which approximates implied volatility by using real-time option quotes for stocks. This measure is intended to provide an instantaneous approximation of how much the market thinks a particular stock market index will fluctuate in the next 30 days.

Such volatility measures exist at a daily (or higher) frequency for several of the world's largest stock markets indices, including the Euro Stoxx 50 and the Dax.⁶ Changes in volatility indices can then be used to gauge the change in uncertainty in the countries to which the underlying stock market indices refer. For example, changes in the VStoxx, the volatility index corresponding to the Euro Stoxx 50, can be used to approximate changes in uncertainty in the euro area. Thus volatility indices can also be used to estimate the change in uncertainty that occurred after the Brexit vote, that is, overnight from Thursday, 23 June to Friday 24 June 2016.

The volatility index of both the Euro Stoxx 50 (VStoxx) and the Dax (VDax) spiked on the morning after the Brexit

² For a survey, see Bloom N. (2014): Fluctuations in Uncertainty. *Journal of Economic Perspectives*, 28(2).

³ See Bernanke B. S. (1983): Irreversibility, Uncertainty, and Cyclical Investment. *Quarterly Journal of Economics*, 98(1).

⁴ See Arellano C., Y. Bai, and P. Kehoe (2010): Financial Markets and Fluctuations in Uncertainty, Federal Reserve Bank of Minnesota Research Department Staff Report.

⁵ See Jurado K., Ludvigson S., S. Ng (2015): Measuring uncertainty. *American Economic Review*, 105(3); and Scotti C. (Forthcoming): Surprise and Uncertainty Indexes: Real-Time Aggregation of Real-Activity Macro Surprises. *Journal of Monetary Economics*.

⁶ For further information on the VStoxx see <https://www.stoxx.com/index-details?symbol=V2TX>. As regards the VDax, more precisely the updated index VDax-New is used in the analysis, but referred to as VDax in the following.

vote, indicating a sharp increase in volatility (Figures 1 and 2). The difference between the closing and opening price is 8.6 for the VStoxx and 7.6 for the VDax. Since trading on Thursday closed before the results of the referendum were released, the overnight change to the opening price of Friday is likely to be driven mostly by the outcome of the referendum, as this was the most important economic event in Europe during this short time span. In fact, the overnight changes in both volatility indices are the largest overnight changes since the height of the global financial crisis.

Negative relation between uncertainty and investment

There is a negative relation between uncertainty and business investment. Investment is typically the most sensitive expenditure category of households, governments, and firms to changes in uncertainty. By construction, unconditional correlations do not control for the fact that uncertainty itself might be affected by the level of investment, generating a simultaneous relationship between the two variables. Nevertheless, correlations can still provide insights into the general relationship between aggregate measures of uncertainty and investment.

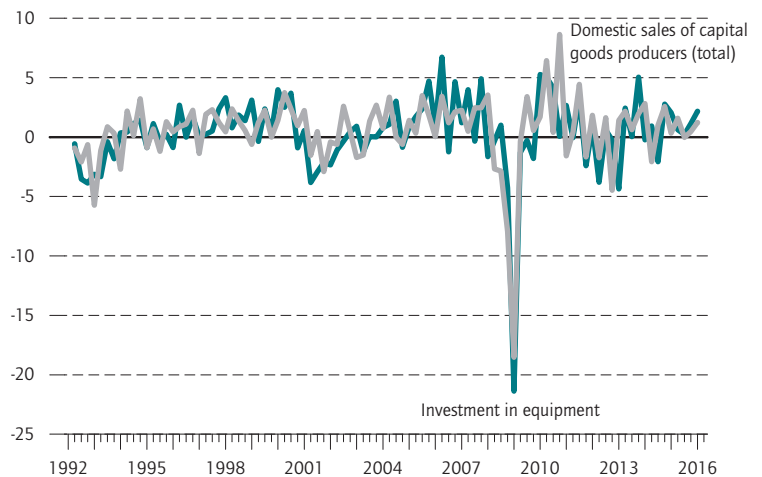
For most countries, detailed information on investment activity is available on a quarterly basis from the national accounts. Gross fixed capital formation includes three categories: investment in buildings (residential, non-residential buildings and civil engineering), equipment (metal products and machinery, transport equipment), and other investment (e.g. software, intellectual property rights). The sub-categories of investment are exposed to changes in uncertainty to different degrees. Residential construction can be expected to be relatively resilient to variation in uncertainty, as it predominantly depends on households' current and expected income. Similarly, long-term research and development projects are likely to be less sensitive to changes in uncertainty as they are typically planned and executed over several years. In contrast, equipment is likely to be mostly affected by uncertainty as it is an important input for the production in the manufacturing industry. If firms are uncertain about the amount of future orders, they might consider postponing or canceling projects that increase production capacities.

Instead of quarterly data from the tables of national accounts, domestic sales of capital goods producers are used in this study. These are available on a monthly basis, which improves the estimation. Domestic sales by these companies are highly correlated with investment in equipment (Figure 3) and often serve as leading indicator to forecast investment activity. Sales are available for several sub-categories of capital goods: i) overall sales of

Figure 3

Investment in equipment and domestic sales of capital goods producers

Quarterly first differences, in billion Euro¹



¹ Real values, seasonally adjusted.

Source: Own calculation based on German federal statistical office.

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Investment in equipment and domestic sales of capital goods producers are highly correlated.

capital goods producers, ii) sales in the NACE-division⁷ *Manufacture of fabricated metal products, except machinery and equipment* (NACE 25), iii) *computer, electronic and optical products* (NACE 26), iv) *machinery and equipment* (NACE 28), v) *motor vehicles, trailers and semi-trailers* (NACE 29) and vi) *other transport equipment* (NACE 30).

Investment in equipment in Germany is lower in times of high economic uncertainty: in periods of high stock market volatility, private firms remain reluctant to buy new equipment, while in periods of low volatility, firms tend to invest more in new machinery, vehicles or electronic devices (Table). Taking a closer look at the different types of capital goods, it becomes obvious that the investment goods sector is hit by economic uncertainty heterogeneously. In particular, it appears that there is a negative relationship between uncertainty and investment in electronic devices, new machinery and metal products, while it plays a less important role for investments in cars and particularly other vehicles (i.e. ships, railroad engines etc.).

⁷ Statistical Classification of Economic Activities in the European Community (Nomenclature statistique des activités économiques dans la Communauté européenne, NACE).

Table

Correlation between stock market volatility and investment

Quarterly, first differences¹

Total private investment	0,0766
Equipment	-0,3333*
Fabricated metal products	-0,3892**
Computer, electronic and optical products	-0,3091**
Machinery and equipment	-0,2992**
Motor vehicles, trailers and semi-trailers	-0,1722*
Other transport equipment	0,1250

¹ Seasonally adjusted data.

Source: Own calculation based on German federal statistical office.

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There is a negative correlation between investment and stock market volatility.

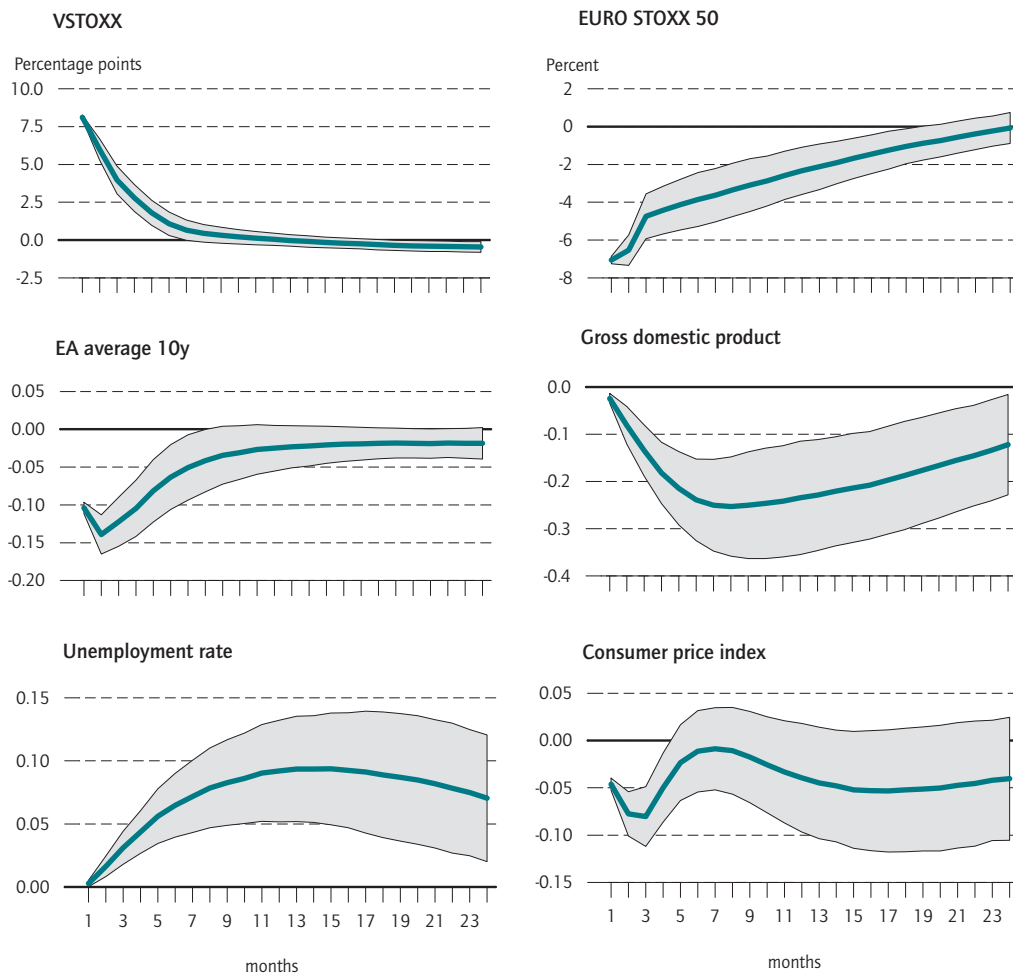
The effects of the uncertainty shock related to the Brexit vote

The descriptive statistics discussed above already indicate that uncertainty related to the outcome of the Brexit referendum could have negative effects on the economies of the euro area countries.⁸ It is possible to quantify these impacts with a structural modeling approach that controls for the simultaneity between uncertainty and other economic variables. Several vector autoregressive

⁸ Compare also Fichtner, F. et al. (2016): Brexit Decision Is Likely to Reduce Growth in the Short Term: DIW Economic Bulletin 26/27. Fichtner et al. study the effect of a Brexit-induced drop in UK growth on German exports to the UK and German GDP growth. In other study, Fichtner et al. (2016). Brexit Decision Puts Strain on German Economy. DIW Economic Bulletin (31).

Figure 4

Effect of Brexit-related uncertainty shock on economic variables in euro area¹



¹ Error bands computed from 500 bootstrapped extractions.

Source: Own calculations.

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There is a long-lasting negative effect on euro area GDP.

Box

Methodology

We use several structural vector autoregressive models which approximate the European economy as a linear system of several macroeconomic variables. The model is written as

$$y_t = c + A_1 y_{t-1} + \dots + A_p y_{t-p} + u_t$$

The variables included in the model for the euro area are the VStoxx, the log of Euro Stoxx 50, the average 10 year Treasury bond yield for the countries of the euro area, the log of the interpolated average GDP, the average unemployment rate and the log of average consumer price index. For Germany, the model likewise includes the VDax, the log of the Dax, the 10 year Bund yield, the log of the interpolated GDP, the unemployment rate and the log of the consumer price index. The endogeneity of variations in uncertainty is addressed using the recursive methodology by Bloom.¹ This approach consists of labeling the uncertainty shock as the only shock that can impact contemporaneously on all variables. The evolution of the variables measuring uncertainty is shown in Figures 1 and 2.

The estimated model is used to perform a counterfactual analysis aimed at separating the effect of the uncertainty related to the unexpected vote for the Brexit. Specifically, a hypothetical uncertainty shock is fed into the model, and it is then analyzed how this shock propagates through the model-economy, holding constant the other exogenous components of the model. That is, the results should be interpreted as under the assumption that no other economic shock will hit the economy. Since Brexit is an

unprecedented event, we approximate it by exploiting observed variations in uncertainty in the period before the Brexit vote of magnitudes comparable to the one observed overnight after the outcome of the referendum.

More precisely, the hypothetical uncertainty shock is scaled such that it increases the volatility index in the model by the same amount by which the index changed overnight after the Brexit vote. For the euro area, the effect of an exogenous increase in the VStoxx by 8.6 points on several euro area financial and macroeconomic variables is modeled. For Germany, an exogenous increase in the VDax by 7.6 points is assumed. This calibration of the shock follows the so-called event study literature that builds on narrow windows around events.² It also relates to the monetary policy literature that estimates impulse responses on monthly data feeding into the model shocks such that the interest rate reacts by the same amount observed at a lower frequency around events of interest.³

The results are discussed by means of impulse response analysis. Each impulse response reports the dynamic effects of the uncertainty shock on the variables in the economic system. Error bands, computed with bootstrap techniques, are used to evaluate whether the point estimates are statistically significantly different from zero.

¹ Bloom N. (2009): The impact of uncertainty shocks. *Econometrica*, 77(3).

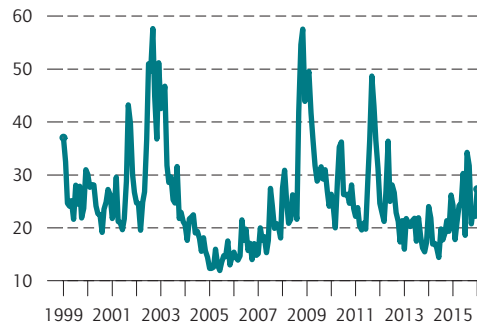
² Gürkaynak R., Sack B., E. Swanson (2005): Do Actions Speak Louder than Words? The Response of Asset Prices to Monetary Policy Actions and Statements. *International Journal of Central Banking*, 1(1).

³ Rogers J. H., Scotti C., and J. H. Wright (2015): Unconventional monetary policy and international risk premia. *International Finance Discussion paper 1172*, Board of Governors of the Federal Reserve System.

Figure 1

VStoxx volatility index

Monthly averages



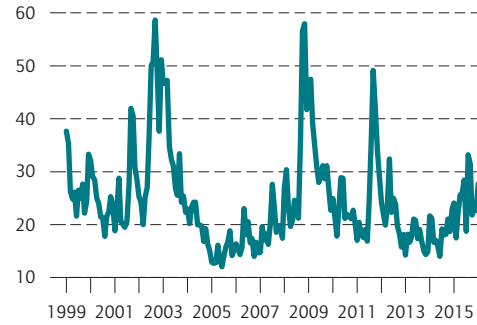
Source: Datastream.

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Figure 2

VDax volatility index¹

Monthly averages



¹ Vdax-New data is used.

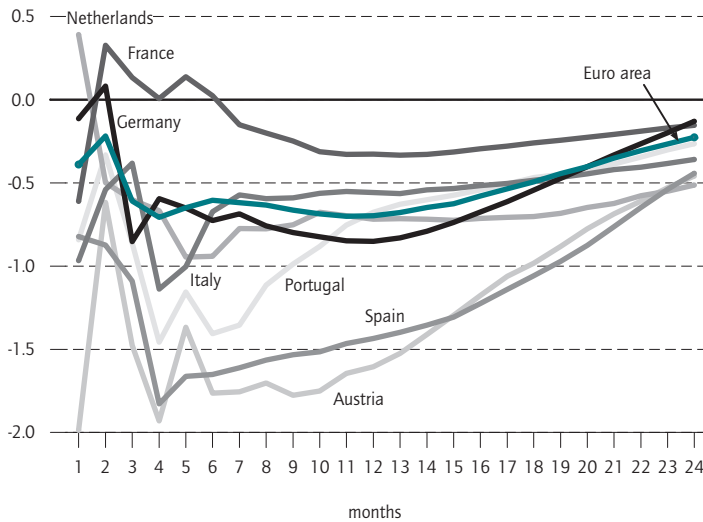
Source: Datastream.

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Figure 5

Effect of Brexit-related uncertainty shock on investment in euro area countries

In percent¹



¹ Point estimates without error bands. Each variable is added one at a time to the baseline VAR model for the euro area.

Source: Own calculations.

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Investment effects differ between countries.

models are used to estimate the effects of a stock market uncertainty shock of the size observed overnight after the Brexit vote (Box).

Investment and GDP decline in the euro area

Model results show that the VStoxx increases by the pre-specified amount on impact, but remains significantly higher for about half a year, before it returns to trend after one year (Figure 4). The increase in uncertainty leads to an immediate drop of stock market prices by seven percent. This effect is relatively long lasting, as the Euro Stoxx 50 recovers only after about two years. The average ten-year rate on euro area government bonds also declines significantly upon impact and fully converges back to trend after one year.

The reaction of GDP and of the unemployment rate in the euro area are even more sluggish. Output gradually falls and reaches a trough of -0.2 percent after eight months. It recovers only relatively slowly, staying below trend for more than two years. The output dynamics are mirrored in the response of the unemployment rate, which peaks after one year. The peak effect is $+0.1$ percentage points relative to the level where the unemployment rate would have been without the uncertainty shock.

Finally, the consumer price index drops significantly for some months by up to 0.1 percent. Afterwards, the response is statistically indistinguishable from zero.

The effects of the uncertainty shock on the level of investment in the euro area as a whole and in selected euro area member countries are qualitatively relatively similar (Figure 5). Euro area investment declines significantly following the shock by about 0.7 percent over a year. In most countries, the trough is reached after approximately four to six months. The response is somewhat slower in France and Germany, where the largest negative effects are reached after about one year. Qualitatively, the results also hold for other countries of the euro area.

Overall, the results suggest that an uncertainty shock equivalent to the overnight change in the VStoxx following the outcome of the referendum in the United Kingdom has substantial and long-lasting effects on investment, GDP and the unemployment rate in the euro area. It also significantly lowers stock market prices and long-term interest rates in the euro area. In contrast, the effects on consumer prices appear more moderate.

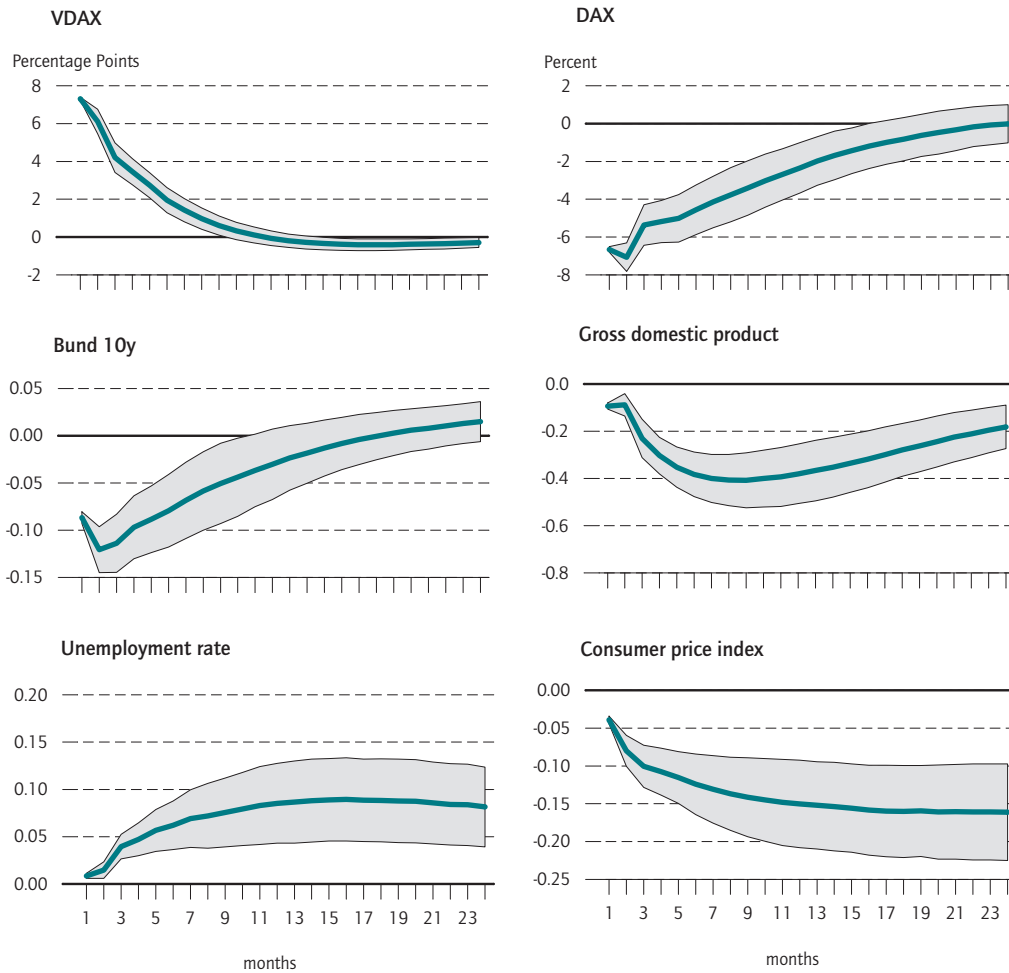
Similar effects on the German economy

According to the model for Germany, the effects of a change in the VDax of the size observed overnight after the Brexit referendum are largely similar to those in the euro area model, both in qualitative and quantitative terms (Figure 6). There is a persistent increase in uncertainty for roughly one year, while stock market prices and long-term interest rates on German government bonds drop below trend for a little more than one year. The unemployment rate increases gradually and does not recover over two years. There are, however, also noteworthy differences between the responses of the German and euro area economies. German output falls more strongly compared to the euro area by up to -0.4 percent. In addition, there is a significant and long-lasting decline in consumer prices.

Compared to the euro area, total investment in Germany contracts more strongly by up to -1.0 percent, reflecting the relatively larger share of the manufacturing sector in Germany compared to the average in the euro area economy (Figure 7). Comparing the dynamics of the various types of investment products shows that fabricated metal products, equipment and computers respond quantitatively similar to total investment. Yet – intuitively – machinery contracts more following the shock. The trough response is twice as large as that of total investment. In contrast, the production of cars and other vehicles is less sensitive to the exogenous increase in uncertainty. Vehicle manufacturers are an important industrial sector in Germany: overall, the industry accounts for

Figure 6

Effect of Brexit-related uncertainty shock on German economy¹



¹ Error bands computed from 500 bootstrapped extractions.
Source: Own calculations.

While most effects are similar to the Euro area, the decline in GDP is stronger.

roughly four percent of total gross value added. Moreover, it is the largest sector of capital goods production. However, vehicles play only a minor role for investment in Germany. New equipment is largely dominated by investment in machinery and other electronic utilities (roughly 71 percent in 2014), while vehicles only account for 29 percent, respectively.

Conclusions

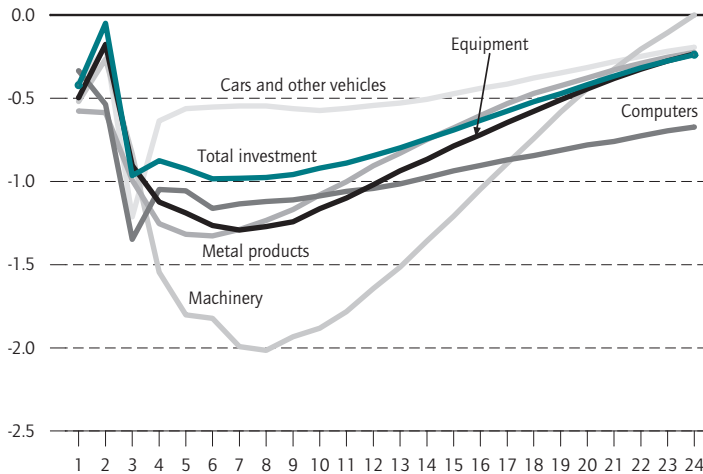
The Brexit vote on June 23 has contributed considerably to economic uncertainty in Europe. There is a large interest in quantifying the effects of the uncertainty that was triggered by the unexpected outcome of the Brexit

referendum. An analysis with a structural model is used to separate the effects of the uncertainty shock that hit the economy on the night of the Brexit vote. The counterfactual analysis, which holds constant all other driving forces of the model economy, shows that the uncertainty shock lowers euro area GDP by about 0.2 percent over the next year, relative to a situation where this shock would not have occurred. Even two years after the shock, GDP is estimated not to have fully recovered. These dynamics are associated with an increase in the unemployment rate by about one tenth of a percentage point. One main driver of the deterioration is investment, which is estimated to decline approximately three times more strongly than GDP – by up to 0.7 percent.

Figure 7

Effect of Brexit-related uncertainty shock on different types of investment in Germany

In percent¹



¹ Point estimates without error bands. Each variable is added one at the time to the baseline VAR model for Germany.

Source: Own calculations.

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Investment in machinery contracts most following the shock.

The effects on the German economy are qualitatively similar to those on the euro area. Yet the decline in GDP and investment is even more pronounced compared to the euro area. In detail, the simulations show, that investments in machinery are affected most. Given the importance of these types of expenditures and the

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persistence of the shock, more needs to be done to stimulate already lackluster investment dynamics in the euro area and Germany.

In this context, it would be beneficial to clarify the relationship between the UK and the European Union, in order to avoid any further uncertainty for firms.⁹ Moreover, politicians should consider to directly stimulating private investment. Already in summer 2015, a high-level commission of experts proposed a set of policies to trigger private investment in Germany. Still, most of these measures are waiting to be implemented.¹⁰ The suggested policies comprise a set of measures to improve the surrounding conditions for private investment. So far, the focus has been on increasing public investment. It is argued that public investment – which has been weak for years – is an important input for private firms in the production process. Thus, increasing public investments should also stimulate private expenditures to expand the capital stock. However, measures that address private investment directly are still pending in an early stage. This concerns for example the tax treatment of private investment or initiatives to increase supply of venture capital.¹¹ Increasing the effort to implement such policies would be desirable to outweigh the negative impulse on investment following the uncertainty shock from the Brexit vote.

⁹ Miethe, J., Pothier, D. (2016). Brexit: What's at Stake for the Financial Sector? DIW Economic Bulletin, (31).

¹⁰ Fratzscher, M. et al. (2015): Abschlussbericht der Expertenkommission zur Stärkung von Investitionen in Deutschland. Bericht der Expertenkommission im Auftrag des Bundesministers für Wirtschaft und Energie.

¹¹ Fratzscher, M., Gornig, M., Schiersch, A. (2016). Weak Corporate Investment Requires Immediate Action. DIW Economic Bulletin, (15).

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