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CHARACTERIZING VERY HIGH UNCERTAINTY EPISODES

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Abstract

This paper uses a two-step approach to characterize the evolution of US macroeconomic and financial variables during episodes of very high uncertainty. First, we identify episodes of very high uncertainty using a regime-switching model. Second, we assess the behavior of macroeconomic and financial variables during these episodes of very high uncertainty. This methodology is analogous to the approach followed by Baele et al. (2013), who study episodes of flights to safety in financial markets. We find that very high uncertainty episodes are associated with a weaker growth performance and sharp declines in stock prices. However, we find that this relation is non-linear in that uncertainty does not seem to matter during periods characterized by medium or low uncertainty.

Keywords: Uncertainty, Markov-switching, Survey data.

JEL Classification Code: C24, D80, E32, E66.

Non-technical summary

The role of uncertainty in the low growth performance of many advanced economies in recent years has received increasing attention among researchers and policy-makers. Macroeconomic theory suggests that uncertainty can have a powerful impact on macroeconomic activity, for example because it may give firms an incentive to delay investment and employment (Bernanke (1983)). Similarly, consumers may postpone their acquisition of durable goods if uncertainty increases (Romer (1990)). Moreover, uncertainty may push up the cost of finance via an increase in risk premia (e.g., Gilchrist et al. (2010)) or have an impact on stock prices as it increases discount rates and hence decreases the net present value of future profitability (Pástor and Veronesi (2012), Bansal and Yaron (2004) and Bekaert et al. (2009)).

In practice, however, measuring uncertainty and capturing its actual impact on macroeconomic variables have proved challenging. An increasing number of empirical studies have addressed this issue in recent years, mainly focusing on the US. Following Bloom (2009), several recent empirical investigations have found a significant counter-cyclical link between uncertainty and macroeconomic activity (see, for example, Baker et al. (2012), Leduc and Liu (2013), IMF (2012) and Denis and Kannan (2013)), although others, such as Knotek and Khan (2011), find only a modest link using data on US households. Changes in uncertainty may have different macroeconomic impacts, depending, for example, on the state of the business cycle or the level of uncertainty. Indeed, our main findings indicate that the role of uncertainty becomes more important when the level of uncertainty in the economy is higher, that is, we find a non-linear impact of uncertainty on macroeconomic and financial variables.

This paper uses a two-step approach to characterize the evolution of macroeconomic and financial variables during episodes of high uncertainty in the US. First, we identify episodes of very high uncertainty using a regime-switching model. Second, we study the behavior of macroeconomic and financial variables during these episodes of very high uncertainty. This approach, which stems from the finance literature, allows us to quantify different macroeconomic effects of uncertainty in three different types of uncertainty episodes - high, medium and low uncertainty periods. In addition, as uncertainty is not directly measurable, we identify these different uncertainty regimes using three alternative measures: the economic policy uncertainty index (Baker et al. (2012)), the implied volatility index on the S&P 500 (VIX index) and a combination of both these measures.

Our key findings are that very high uncertainty episodes are associated with a consistent and significant weakening of economic activity, a decline in inflation, an increase in unemployment and a decline in bond yields and stock prices. Also after controlling for the impact of business cycle conditions, financial and other factors, macroeconomic and financial conditions weaken whenever the economy is in a very high uncertainty episode. Uncertainty matters especially during the relatively rare episodes of very high uncertainty, but does not seem to play a significant role during normal times. High uncertainty seems to have an impact in particular on survey data and regressions based on the Federal Reserve Bank of Philadelphia's Survey of Professional Forecasters show that during very high uncertainty episodes economic agents revise down their expectations of future output. Overall, our results suggest that the exceptionally high levels of (policy) uncertainty may have played an important role in the low growth performance of the US economy in recent years.

1 Introduction

The role of uncertainty in the low growth performance of many advanced economies in recent years has received increasing attention among researchers and policy-makers. Macroeconomic theory suggests that uncertainty can have a powerful impact on macroeconomic activity, for example because it may give firms an incentive to delay investment and employment (Bernanke (1983)). Similarly, consumers may postpone their acquisition of durable goods if uncertainty increases (Romer (1990)). Moreover, uncertainty may push up the cost of finance via an increase in risk premia (e.g. Gilchrist et al. (2010)) or have an impact on stock prices as it increases discount rates and hence decreases the net present value of future profitability (Pástor and Veronesi (2012), Bansal and Yaron (2004) and Bekaert et al. (2009)).

In practice, however, measuring uncertainty and capturing its actual impact on macroeconomic variables have proved challenging. An increasing number of empirical studies have addressed this issue in recent years, mainly focusing on the US. Following Bloom (2009), several recent empirical investigations have found a significant countercyclical link between uncertainty and macroeconomic activity (see, for example, Baker et al. (2012), Leduc and Liu (2013), IMF (2012) and Denis and Kannan (2013)), although others, such as Knotek and Khan (2011), find only a modest relationship using data on US households. While most of the empirical literature uses linear VAR models, there is evidence that uncertainty shocks exert different effects over different phases of the business cycle. Caggiano et al. (2012), for example, find that uncertainty shocks have a larger macroeconomic impact during recessions than during economic upturns. It may thus be appropriate to allow for non-linearities in empirical analyses of uncertainty.

This paper uses a two-step approach to characterize the evolution of macroeconomic and financial variables during episodes of high uncertainty in the US. First, we aim at identifying episodes of very high uncertainty using a regime-switching model. Second, we study the behavior of macroeconomic and financial variables during these episodes of very high uncertainty.

This methodology is analogous to the approach followed by Baele et al. (2013) to identify and characterize episodes of flights to safety in financial markets. An advantage of this approach is that it allows us to account for non-linearities in the relationship between uncertainty and macroeconomic variables. Instead of the uncertainty variable itself, our uncertainty measures are based on the number of days in each month that the economy is in the very high uncertainty regime, i.e. the highest uncertainty regime of the three uncertainty regimes that we distinguish. In other words, our measures of uncertainty increase only when the economy enters a period of very high uncertainty. Finally, as uncertainty is not directly measurable, we identify very high uncertainty regimes using three alternative measures: the economic policy uncertainty index (Baker et al. (2012)), the implied volatility index on the S&P 500 (VIX index) and a combination of both these measures.

2 Why may uncertainty matter?

Economic theory suggests that uncertainty can affect macroeconomic outcomes via several channels. The literature has identified at least three channels through which uncertainty shocks can have an impact on economic activity. First, uncertainty shocks may affect the behavior of firms (Bernanke (1983) and Pindyck (1991)). Uncertainty can have an impact on economic activity as it may give firms an incentive to delay investment and employment decisions. A key concept in this framework is irreversibility. If investment decisions are irreversible, firms must make investment decisions that trade of the extra returns from early commitment against the benefit of having more information by waiting. Bernanke's real options framework captures the notion that when uncertainty is high, the option value of waiting increases as it may be beneficial for firms to wait and acquire more information before deciding to invest in a real asset.

Second, higher uncertainty may induce households to save more. Higher uncertainty about future income may induce consumers to postpone spending, in particular on durable goods. Romer (1990) shows that this was a key driver of the decline in demand during the Great Depression.

Third, higher uncertainty may push up the cost of finance via an increase in risk premia (e.g., Gilchrist et al. (2010)) or have an impact on stock prices as it increases discount rates and thus decreases the net present value of future profitability (Pástor and Veronesi (2012)). Increased uncertainty is thus likely to have a downward impact on asset prices. In addition, higher uncertainty may have an impact on the banking sector's willingness to provide loans and therefore lead to a tightening in credit conditions and depress credit growth.

In addition to these channels, there is recent evidence on how uncertainty plays a role in the transmission of systemic stress to the economy. For example, uncertainty can amplify the impact of financial instability on macroeconomic variables. Hartmann et al. (2012) investigate the links between financial stress and macroeconomic variables using a regime-switching VAR model estimated with bayesian methods. They find that financial shocks have a substantial impact on real variables in high financial stress episodes but a limited impact in normal times. This underlines the fact that an economy may function fundamentally differently in times of systemic financial instability compared with normal times.

Although economic theory identifies clear channels through which high uncertainty may undermine economic performance, the results of empirical work have not been entirely conclusive. An increasing number of empirical studies have addressed this issue in recent years, mainly focusing on the US economy. Following Bloom (2009), several recent empirical investigations have found a strong and significant counter-cyclical link between uncertainty and macroeconomic activity (see, for example, Baker et al. (2012), Leduc and Liu (2013), IMF (2012) and Denis and Kannan (2013)), although others, such as Knotek and Khan (2011), find only a modest link using data on US households. One reason for these somewhat mixed results may be that uncertainty is difficult to measure (see Section 3). In addition, uncertainty is endogenous. Hence, it is difficult to disentangle the impact of other shocks,

such as a demand shock, from the effects of idiosyncratic uncertainty shocks on the profile of economic activity. In addition, there is evidence that macroeconomic policies may have an impact on uncertainty. Bekaert et al. (2013), for example, find that loose monetary policy can decrease risk aversion and uncertainty.

While most of the empirical literature uses linear VAR models, there is evidence that uncertainty shocks exert different effects over different phases of the business cycle. Caggiano et al. (2012), for example, find that uncertainty shocks have a larger macroeconomic impact during recessions than during economic upturns. Non-linearities or asymmetries can occur in various ways. For example, the impact of uncertainty on economic activity may restrain households' decisions to spend more strongly when unemployment is higher. Similarly, increases in uncertainty may have a larger impact on output if the monetary authority is constrained by the zero lower bound in nominal interest rates (Basu and Bundick (2012)). Moreover, the impact of uncertainty shocks on economic activity may be larger during periods when uncertainty is exceptionally high as opposed to periods during which uncertainty is lower. The latter non-linearity is the key hypothesis of this paper. As some underlying level of uncertainty always exists in an economy, this may not necessarily have an important impact on economic growth. That impact may change, however, if uncertainty increases to unusually high levels. This hypothesis implies that we need to use an approach that allows us to study the behavior of macroeconomic and financial variables during different regimes. As there are analogies with the behavior of financial markets during periods of high stress, we follow the approach by Baele et al. (2013) who identify and characterize episodes of flights to safety in financial markets. Flights to safety, defined for financial markets as a sudden increase in appetite for safe assets relative to risky assets, may also be relevant in macroeconomics. During high stress episodes, households and companies may change their economic behavior relative to "normal" times, with implications for macroeconomic relationships. When using the VIX as a dependent variable, the very high uncertainty episodes we identify can be interpreted as flights to safety episodes and therefore our approach permits to study the behavior of macroeconomic variables during such episodes.

The policy implications of better understanding the link between uncertainty and growth may be substantial. Studying this link may help to better understand the reasons for the disappointing growth performance of many advanced economies in recent years. In addition, the impact of macroeconomic stimulus during periods of high uncertainty may be smaller than under normal circumstances because firms behave in a more cautious manner (Bloom (2009) and Bloom et al. (2012)). Thus, if a recession is characterized by a high degree of uncertainty, the response may have to be different from those in other recessions.

3 Measuring uncertainty and data used

A key challenge in the literature on uncertainty relates to its measurement. As uncertainty cannot be directly observed, it is usually measured on the basis of several proxy indicators. In most previous studies, three types of uncertainty measures have been used: financial market indicators, survey-based measures (including forecast dispersion measures)

and media measures based on the number of citations of a specific term (for a recent overview, see Haddow et al. (2013)). Other measures are more microeconomic in nature and are based on various indicators of dispersion at individual company or industry level. As all of these measures have their disadvantages, studies of uncertainty are usually based on a range of indicators.

This paper uses three alternative measures of uncertainty that are available at a daily frequency: the economic policy uncertainty (EPU) index developed by (Baker et al. (2012), the implied volatility index on the S&P 500 (VIX index) and a combination of both these measures. Both measures capture potentially different concepts. Whereas the EPU index aims at capturing uncertainty associated with economic policies, the VIX index reflects market uncertainty associated with future stock price movements and might proxy risk aversion. We use a policy-related uncertainty index as many commentators have argued that the weakness in growth in the US during recent years may have been related to uncertainty about the policy response and political disagreements. We also use a financial market indicator because the implied volatility indices such as the VIX have been among the most widely used uncertainty measures in the literature. By using these two different measures we hope to capture various types of macroeconomic uncertainty. Finally, we also employ a composite indicator as both indicators taken together may provide a useful guide to the general degree of uncertainty in the economy. Other measures of uncertainty, such as those based on forecasters' disagreement, have also been widely used in the literature, but we do not use those here as they are not available at a daily frequency. None of the indicators we use should be seen as a perfect proxy for uncertainty. Taken together, however, they may provide a useful indication of the general degree of uncertainty faced by households and companies. In addition, as the two constituting indicators of uncertainty capture different concepts, using them separately may shed light on the sources of uncertainty.

The daily economic policy uncertainty (EPU) index for the US is a news-based index drawing on newspapers published in the US.[1] These newspapers range from large national papers to small local newspapers across the country. The available data series starts in January 1985. The primary measure for this index is the number of articles that contain at least one term out of the following three categories. The first is "economic" or "economy". The second category is "uncertain" or "uncertainty". The third set is "legislation" or "deficit" or "regulation" or "congress" or "federal reserve" or "white house". As the number of newspapers in the sample has increased over time (from 18 in 1985 to over 1800 by 2008), the index has been normalized by taking daily counts of the total number of relevant newspaper articles and constructing a one-year moving average of this series.

Our second measure of uncertainty, the Chicago Board Options Exchange Market Volatility or VIX index, expresses the implied volatility of the S&P 500 index anticipated on the derivatives market. More specifically, the VIX indicates in percentage points the change to be expected in the next 30 days for the S&P 500 stock market index. The basis for the calculation of this index is provided by S&P 500 option contracts. The VIX is thus a measure of perceived stock market uncertainty by the market in either direction. In

[1]More information on the construction of the economic policy index is available at http://www.policyuncertainty.com/.

addition to using the overall VIX index, it is also possible to decompose this index into a so-called risk aversion and uncertainty component (Bekaert et al. (2013)). We refrain from this option here as we would need to construct a volatility forecasting model for this. The daily VIX index used in this paper is available from January 1990 onwards.

As regards the other data used in the paper, we consider the following macroeconomic variables for the US: industrial production, retail sales, the unemployment rate, CPI inflation, the manufacturing index compiled by the Institute of Supply Management (ISM) and consumer sentiment (i.e., the University of Michigan consumer sentiment index). The ISM manufacturing index is a composite index that monitors employment, production inventories, new orders and supplier deliveries in the manufacturing sector. We also consider three financial variables: stock prices (S&P 500 index), the nominal trade-weighted USD exchange rate and the yield on the 10-year US Treasury bond. All these data are sampled at the monthly frequency.

4 Identifying episodes of very high uncertainty

We consider a univariate regime switching model for the uncertainty variable y_t defined as follows:

$$y_t = \mu(S_t) + \epsilon_t(S_t) \tag{1}$$

where $\epsilon_t|S_t \sim iidN(0, \sigma(S_t))$. The regime generating process is an ergodic Markov chain with a finite number of states $S_t = \{1, ..., M\}$ defined by the following constant transition probabilities:

$$p_{ij} = Pr(S_{t+1} = j|S_t = i)$$

$$\sum_{j=1}^{M} p_{ij} = 1 \quad \forall i, j \epsilon \{1, ..., M\}$$

This mean-variance regime switching model is often estimated for equity returns (see e.g. Perez-Quiros and Timmermann (2001)). Baele et al. (2013) estimate equation (1) with a three-state regime-switching model using as a dependent variable the difference between equity return and the return on a benchmark government bond to identify flight-to-safety episodes. We follow Baele et al. (2013) and estimate equation (1) with three regimes using as a dependent variable each of our uncertainty variables to identify extreme uncertainty episodes.[2] The first regime is an episode with a low level of uncertainty and volatility, while the second regime is an episode of a high level of uncertainty and volatility. The third regime captures the rare episodes of a very elevated level and volatility of uncertainty.[3]

We also consider a bivariate model, which we estimate as follows:

$$x_t = \Phi_c(S_t) + u_t(S_t), \quad u_t|S_t \sim iidN(0, \Sigma(S_t))$$

[2]The model is estimated by quasi maximum likelihood via the Expectation Maximization (EM) algorithm (see, e.g., Hamilton (1990))

[3]We consider a model with a switch in both the mean and the volatility of uncertainty since this specification is considerably preferred by standard information criteria compared with a model that only considers a switch in the intercept.

where the vector x_t contains the daily EPU and daily VIX, i.e. x_t can be rewritten as $x_t = [EPU_t, VIX_t]'$.

Very high uncertainty episodes are infrequent: using the bivariate model (based on both the EPU and the VIX index), the US economy was in a period of very high uncertainty during around 20 per cent of the sample (Table 1). In more detail, Table 1 shows that, as expected, the third regime exhibits the highest mean and variance for the EPU index, the VIX and the bivariate model. This regime can thus be interpreted as the very high uncertainty episode. When using the EPU index, the unconditional probability of being in the third regime is 13.5 per cent. Using the VIX as a measure of uncertainty yields similar results, albeit the unconditional probability of being the third regime is 23.9 per cent and the third regime is more persistent as the transition probability of staying in this regime is 0.979 (compared with 0.693 for the model using the EPU index).

Very high uncertainty episodes have been more frequent during the most recent decade of the sample and especially since 2008. Clearly visible are the peaks following September 2001, the start of the second Gulf war and, more recently, the increases associated with various phases of the global financial crisis and the debt ceiling debate (Figure 1). Noteworthy is the divergence between the EPU index and the VIX towards the end of the sample, suggesting that the high level of uncertainty in recent years may have been associated with uncertainty about economic policies rather than financial market volatility. Figure 2, plotting the daily probability of being in the third regime during the past five years, confirms the recent divergence between both uncertainty measures.

5 Very high uncertainty episodes and the economic and financial environment

As a next step, we study the contemporaneous comovements between the high uncertainty episodes and a number of macroeconomic and financial variables. We consider the following macroeconomic variables: industrial production (monthly change in the log index), retail sales (monthly change in the log index), the unemployment rate (level), inflation (monthly change in the log CPI), ISM manufacturing (monthly change in the log index) and consumer sentiment (monthly change in the log index). We also consider three financial variables: stock prices (monthly change in the log index), exchange rate (monthly change in the log of the nominal trade-weighted USD exchange rate) and the yield on the 10-year US Treasury bond (in level). We regress each of the monthly macroeconomic or financial variables on the number of days per month when the daily probability of being in the third regime is higher than 0.5 and a set of control variables. We therefore estimate the following regression:

$$y_t = \alpha + \beta p_t + \Gamma X_t + u_t \tag{2}$$

Our set of control variables X_t consists of the Aruoba et al. (2009) daily index of business cycle conditions (the ADS index), stock returns (the S&P500 index) as well as the lagged dependent variable y_{t-1}. The ADS index captures the impact of business cycle

conditions, the S&P500 index is a proxy for the impact of financial factors on our variables of interest and the lagged dependent variable captures any omitted other factors that may be relevant. The estimation sample runs from January 1986 to December 2012 when using the EPU index and from January 1991 to December 2012 when using the VIX index and the bivariate model.

A potential caveat of this regression is that it may be affected by endogeneity. Whereas economic theory identifies clear channels through which uncertainty may affect macroeconomic outcomes, in empirical studies the causality of this relationship has been difficult to establish. Although our aim is to study comovements rather than causality, controlling in our regressions for business cycle and financial conditions may help to isolate the impact of uncertainty from other influences such as business cycle or financial conditions. In addition, the timing of the macroeconomic data releases alleviates our concerns about endogeneity to some extent. Indeed, the macroeconomic variables are typically released with a substantial lag, while the uncertainty index we use in regression (1) is available on a timely basis at a daily frequency so that feedback effects are mitigated in equation (2).

Table 2 shows that during very high uncertainty episodes, macroeconomic variables tend to weaken strongly and significantly. More specifically, industrial production, retail sales, inflation as well as business and consumer sentiment are all negatively correlated with uncertainty. All coefficients have the expected signs and are highly significant (except for retail sales) if the economic policy uncertainty index is used. For the VIX index and the bivariate model, the results are broadly similar, although the impact on retail sales is significant in contrast to the coefficients for the confidence indicators. Looking at financial variables, higher uncertainty episodes are associated with large declines in stock prices and bond yields.

Also after controlling for other factors, our results suggest that high uncertainty has a clear impact on our variables of interest, although the coefficient for uncertainty becomes smaller and less significant. In these cases (columns (d) to (f) of Table 2), uncertainty has a significant impact on business and consumer confidence, inflation and on stock prices, but not on the other variables of interest. In addition, for stock prices, the impact of uncertainty is significant and does not depend on the measure of uncertainty used.

To investigate whether the behavior of these macroeconomic and financial variables is different during periods with lower uncertainty, we regress each of these variables on the number of days per month when the daily probability of being in the second regime (i.e., the medium uncertainty regime) is higher than 0.5. Subsequently, we repeat this exercise for the first (i.e., low uncertainty) regime. The results suggest that there is no significant link anymore for any of the macroeconomic or financial variables (Tables 3 and 4). For the EPU index, there is only some evidence of a significant link with industrial production and unemployment during periods of medium-level uncertainty, but that relationship vanishes (and has the wrong sign) once we add our control variables.

As very high uncertainty seems to have an impact in particular on soft data, we investigate this further by focusing on the link between uncertainty and survey data. We use the Survey of Professional Forecasters (SPF) conducted by the Federal Reserve Bank of

Philadelphia, which is a quarterly survey of macroeconomic forecasts in the US. The variables we consider are the quarterly forecasts for real GDP, consumption, (non-residential) investment, industrial production (all in annualized quarterly growth rates), inflation (annual change in the CPI index) as well as the level of the 10-year Treasury bond yield. As control variables we use the ADS index and the S&P500 index. The estimation sample runs from 1991:Q1 to 2012:Q4.

Our results show that very high uncertainty has a significant impact on macroeconomic expectations as measured by the SPF, regardless of the measure of uncertainty (Tables 5 and 6). During very high uncertainty episodes, expectations for output, consumption, investment, inflation and bond yields all drop, whereas they increase for unemployment (although the impact on unemployment is not significant if the VIX index is used). For almost all variables, the impact of uncertainty remains significant also after controlling for business cycle conditions and financial factors, although the size of the coefficients drops as can be expected. Uncertainty mainly affects expectations at the 2-3 quarter horizon, although in some cases expectations for quarters further ahead are also affected. Although the size of the impact cannot be directly compared with those in other studies based on different methodologies, they seem to be in line with other recent empirical studies for the US (e.g. Baker et al. (2012)).

6 Conclusions

In this paper, we have identified episodes of very high uncertainty for the US using a regime-switching model. Focusing on these episodes of very high uncertainty, we have studied the behavior of macroeconomic and financial variables. Based on this two-step approach, we find that very high uncertainty episodes are associated with a consistent and significant weakening of economic activity, a decline in inflation, an increase in unemployment and a decline in bond yields and stock prices. Also after controlling for the impact of business cycle conditions, financial and other factors, macroeconomic and financial conditions weaken whenever the economy is in a very high uncertainty episode. The macroeconomic impact of uncertainty is non-linear. Uncertainty matters during episodes of very high uncertainty, but much less or not at all during periods characterized by medium or low uncertainty. Regressions using the Survey of Professional Forecasters show that during very high uncertainty episodes economic agents revise down their expectations of future output. High uncertainty may thus have played an important role in the weak growth performance of the US economy in recent years.

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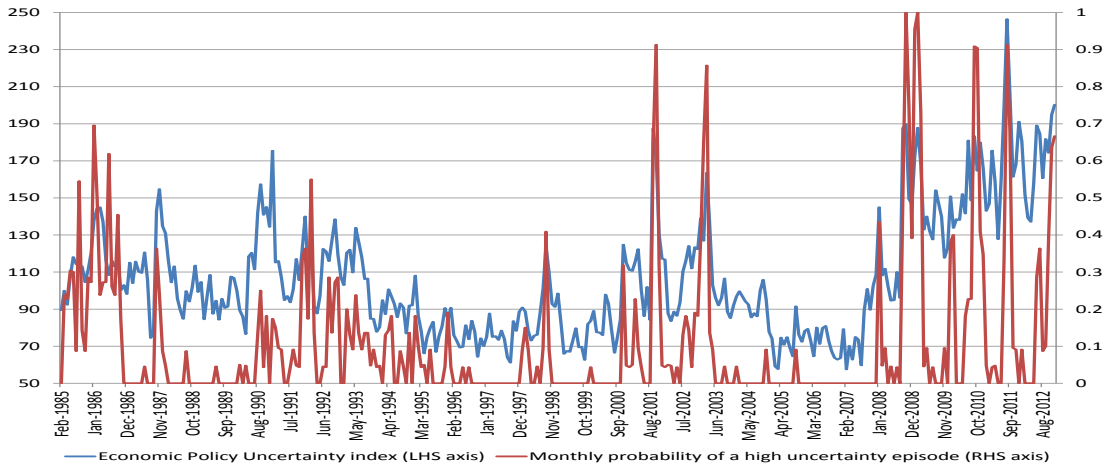
Table 1: Estimation results for a three-state regime-switching model of uncertainty

Panel A: Estimation Results

		μ_1	μ_2	μ_3	σ_1	σ_2	σ_3	p_{33}	$P(S_t = 3)$
	EPU_t	52.753***	111.984***	218.909***	22.788***	43.063***	100.676***	0.693***	13.4%
	VIX_t	13.464***	19.804***	30.935***	1.772***	2.338***	8.346***	0.979***	23.9%
Bivariate	VIX_t	14.264***	21.840***	32.693***	2.210***	2.260***	9.574***	0.953***	21.0%
Model	EPU_t	84.260***	85.821***	167.842***	51.414***	55.493***	105.627***		

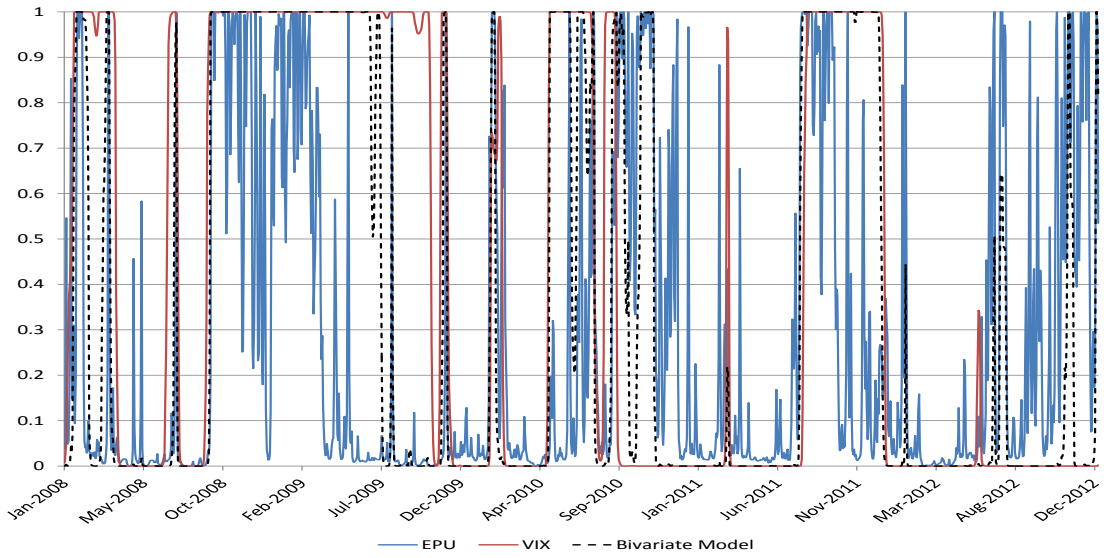
Note: Panel A reports the estimation results for regime switching models. The first two rows show the results for a 3-regime univariate Markov-switching model using alternatively as a dependent variable the economic policy uncertainty (EPU) index from Baker et al. (2012) and the VIX. The last two rows of Panel A instead show the estimation results for a bivariate regime switching model using the EPU and the VIX as a dependent variable. The estimation sample runs from January 1, 1985 to December 31, 2012 for the EPU index and from January 1, 1990 to December 31, 2012 for the VIX and the bivariate model. ***, **, * indicate significance at the 1%, 5% and 10% level, respectively. p_{33} is the transition probability of staying in the third regime and $P(S_t = 3)$ is the unconditional probability of being in the third regime.

Figure 1: Economic Policy Uncertainty index and Monthly probability of very high uncertainty episodes



Note: This figure plots the economic policy uncertainty (EPU) index and the monthly probability of being in a very high uncertainty episode (i.e. the third regime) using the EPU index. The monthly probability corresponds to the number of days per month when the daily probability of being in the third regime is higher than 0.5.

Figure 2: Daily probability of very high uncertainty episodes (2008-2012)



*Note:*This figure plots the probability of being in a very high uncertainty episode (i.e. the third regime) using the EPU index, the VIX index and a bivariate model based on the EPU and VIX from January 1, 2008 to December 31, 2012.

Table 2: Very high uncertainty episodes and the economic environment - Third regime

	EPU_t	VIX_t	BIV_t	EPU_t	VIX_t	BIV_t
	No Controls			Controls		
	(a)	(b)	(c)	(d)	(e)	(f)
Macroeconomic variables						
Industrial Production	-0.745***	-0.282***	-0.454***	0.169	0.222***	0.219***
Retail Sales	-0.444	-0.432***	-0.407**	0.291	-0.129	0.022
Unemployment rate	2.802***	0.138	0.923***	0.705	0.010	0.012
Inflation	-0.330***	-0.120***	-0.189***	-0.246***	-0.073*	-0.117**
ISM Manufacturing	-3.029***	-0.696	-1.089	-1.981*	-0.262	-0.467
Consumer Sentiment	-3.649***	-0.940	-1.038	-2.923*	-0.619	-0.605
Imports	-3.028***	-0.828**	-1.473***	-1.661**	0.015	-0.462
Financial variables						
Stock Prices	-6.099***	-2.956***	-3.848***	-4.751***	-2.181***	-2.889***
Bond Yields	-4.481***	-2.584***	-3.567***	-2.305	-1.716*	-2.414**
Exchange rate	0.607*	0.209	0.348	0.355	0.077	0.166

Note: Columns (a), (b) and (c) reports the coefficients from a regression of the macroeconomic or financial variable on the number of days that the US economy is in a very high uncertainty episode within each month (in per cent). The monthly variable for the very high uncertainty episode is calculated by taking the number of days when the probability of being in the third regime is higher than 50 per cent divided by the total number of days in each month. The macroeconomic variables are industrial production, retail sales, unemployment rate, inflation, ISM manufacturing and consumer sentiment from the University of Michigan survey. The financial variables are stock prices, bond prices and the nominal exchange rate. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively. The full estimation sample runs from 1986:M01 to 2012:M12 for the EPU index and from 1991:M01 to 2012:M12 for the VIX and the bivariate model. The control variables we include in columns (d) to (f) are the ADS index of business cycle conditions, the S&P500 index and the lagged dependent variable.

Table 3: Medium uncertainty episodes and the economic environment - Second Regime

	EPU_t	VIX_t	BIV_t	EPU_t	VIX_t	BIV_t
	No Controls			Controls		
	(a)	(b)	(c)	(d)	(e)	(f)
	Macroeconomic variables					
Industrial Production	-0.247**	0.065	-0.004	0.120*	-0.044	-0.006
Retail Sales	-0.151	0.180	-0.012	0.084	0.087	-0.028
Unemployment rate	2.721***	0.310	-0.560**	-0.020	0.018	0.029
Inflation	0.046	0.025	0.024	0.061	0.018	0.015
ISM Manufacturing	0.484	1.209**	0.432	0.659	1.014*	0.351
Consumer Sentiment	0.405	0.924	-0.018	0.248	0.756	-0.075
Imports	0.353	0.355	0.329	0.940**	0.107	0.286
	Financial variables					
Stock Prices	0.796	1.454***	0.772	0.462	0.670	0.434
Bond Yields	-0.694*	0.006	-0.175	-0.094**	0.054	0.018
Exchange rate	-0.772***	-0.036	-0.031	-0.554**	0.057	0.016

Note: Columns (a), (b) and (c) reports the coefficients from a regression of the macroeconomic or financial variable on the number of days that the US economy is in a second regime (of medium uncertainty) within each month (in per cent). The monthly variable for the medium uncertainty episode is calculated by taking the number of days when the probability of being in the second regime is higher than 50 per cent divided by the total number of days in each month. The macroeconomic variables are industrial production, retail sales, unemployment rate, inflation, ISM manufacturing and consumer sentiment from the University of Michigan survey. The financial variables are stock prices, bond prices and the nominal exchange rate. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively. The full estimation sample runs from 1986:M01 to 2012:M12 for the EPU index and from 1991:M01 to 2012:M12 for the VIX and the bivariate model. The control variables we include in columns (d) to (f) are the ADS index of business cycle conditions, the S&P500 index and the lagged dependent variable.

Table 4: Low uncertainty episodes and the economic environment - First Regime

	EPU_t	VIX_t	BIV_t	EPU_t	VIX_t	BIV_t
	No Controls			Controls		
	(a)	(b)	(c)	(d)	(e)	(f)
Macroeconomic variables						
Industrial Production	0.403***	0.159*	0.215**	-0.146**	-0.111	-0.083*
Retail Sales	0.250	0.173	0.201	-0.151	0.014	0.020
Unemployment rate	-2.715***	-0.412*	-0.020	-0.006	-0.025	-0.032*
Inflation	0.065	0.074**	0.076**	0.024	0.035	0.036
ISM Manufacturing	0.586	-0.536	0.156	0.052	-0.753	-0.125
Consumer Sentiment	0.531	0.151	0.726	0.294	-0.008	0.555*
Imports	0.682*	0.428	0.526*	-0.366	-0.024*	0.023
Financial variables						
Stock Prices	1.355**	0.978*	1.177**	0.388	0.382	0.366
Bond Yields	1.103***	0.971***	1.379*	0.111***	0.004	0.811
Exchange rate	0.322	-0.117	-0.127	0.284	-0.087	-0.063

Note: Columns (a), (b) and (c) reports the coefficients from a regression of the macroeconomic or financial variable on the number of days that the US economy is in a first regime of low uncertainty (in per cent). The monthly variable for the low uncertainty episode is calculated by taking the number of days when the probability of being in the first regime is higher than 50 per cent divided by the total number of days in each month. The macroeconomic variables are industrial production, retail sales, unemployment rate, inflation, ISM manufacturing and consumer sentiment from the University of Michigan survey. The financial variables are stock prices, bond prices and the nominal exchange rate. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively. The full estimation sample runs from 1986:M01 to 2012:M12 for the EPU index and from 1991:M01 to 2012:M12 for the VIX and the bivariate model. The control variables we include in columns (d) to (f) are the ADS index of business cycle conditions, the S&P500 index and the lagged dependent variable.

Table 5: Very high uncertainty episodes and the Survey of Professional Forecasters

		Uncertainty episodes classified based on the EPU index				
		$h=1$	$h=2$	$h=3$	$h=4$	$h=5$
Real GDP	No controls	-5.821***	-3.359***	-1.427***	-0.220	0.255
	Controls	-2.208***	-1.508***	-0.670	0.012	0.106
Consumption	No controls	-4.130***	-2.836***	-1.320***	-0.533*	-0.174
	Controls	-1.061*	-1.243***	-0.397	-0.143	-0.019
Investment	No controls	-17.903***	-13.597***	-8.946***	-4.208***	-1.047
	Controls	-2.794	-2.700	-0.961	1.295	1.697
Industrial Production	No controls	-10.035***	-5.117***	-1.755**	-0.123	1.068*
	Controls	-2.460**	-1.101	0.031	0.650	1.094
Bond yields	No controls	-3.278***	-3.327***	-3.203***	-2.999***	-2.734***
	Controls	-1.744*	-1.808*	-1.760*	-1.634*	-1.435
Unemployment	No controls	4.376***	4.696***	4.810***	4.778***	4.621***
	Controls	4.905***	4.823***	4.696***	4.564***	4.398***
Inflation	No controls	-3.405***	-1.495***	1.223***	-0.904**	-0.646*
	Controls	-2.663***	-1.134**	-0.963**	-0.579	-0.350

Note: This table shows the regression results of equation (2) using the Survey of Professional Forecasters (SPF) by the Federal Reserve Bank of Philadelphia as a dependent variable. We consider the forecasts for the annualized quarterly growth rates of real GDP, private consumption, non-residential investment, industrial production, inflation (annual change in the CPI index) as well as the level of the 10-year Treasury bond yields and the unemployment rate. All forecasts are taken as the mean of the responses for each forecast horizon h={1,2,3,4,5} quarters. The estimation sample runs from 1991:Q1 to 2012:Q4. The probability of being in a very high uncertainty episode corresponds to the number of days between two SPF deadline dates (in per cent) when the daily probability of being in the third regime is higher than 0.5. The control variables are the ADS index (taken as the mean of the ADS index between two SPF deadline dates) and the S&P500 index (taken as the percentage change in the S&P500 index between two SPF deadline dates).

Table 6: Very high uncertainty episodes and the Survey of Professional Forecasters

		Uncertainty episodes based on the VIX				
		$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 5$
Real GDP	No controls	-1.858***	-1.235***	-0.526***	-0.149	0.132
	Controls	-0.399	-0.500**	-0.224	-0.084	0.084
Consumption	No controls	-1.253***	-0.985***	-0.469***	-0.231*	-0.003
	Controls	-0.055	-0.344*	-0.118	-0.093	0.069
Investment	No controls	-7.263***	-5.983***	-4.089***	-2.235***	-0.670
	Controls	-1.924	-2.209**	-1.400**	-0.520	0.140
Industrial Production	No controls	-3.424***	2.305***	-1.161***	-0.538*	0.082
	Controls	-0.549	-0.921**	-0.651**	-0.413	-0.037
Bond yields	No controls	-1.473***	-1.500***	-1.452***	-1.373***	-1.282***
	Controls	-0.876*	-0.907**	-0.889**	-0.845**	-0.791**
Unemployment	No controls	0.386	0.598	0.706	0.746	0.735
	Controls	0.019	0.115	0.160	0.184	0.189
Inflation	No controls	-1.150***	-0.806***	0.830***	-0.761***	-0.673***
	Controls	-0.722**	-0.676***	-0.771***	-0.711***	-0.648***

Note: See Table 5