Assessing uncertainty in Europe and the US: is there a common uncertainty factor?

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Assessing Uncertainty in Europe and the US - Is there a Common Uncertainty Factor?

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This paper is an empirical investigation of uncertainty in the Euro Zone as well as the US. It conducts a factor analysis of uncertainty measures starting in 2001 until the end of 2011. For this purpose I use survey-based data provided by the ECB and the Federal Reserve Bank of Philadelphia as well as the stock market indices VSTOXX and VIX, both measures of implied volatility of stock market movements.

Each measure shows an increase in uncertainty during the last years marked by the financial turmoil. Given the rise in uncertainty, the question arises whether this uncertainty is driven by the same underlying forces. For the Euro Zone, I show that uncertainty can be separated into driving forces of short and long-term uncertainty. In the US there is a sharp distinction between uncertainty that drives stock market and "real" variables on the one hand and inflation (short and long-term) on the other hand. Combing both data sets, factor analysis delivers (1) an international stock market factor, (2) a common European uncertainty factor and (3) an US-inflation uncertainty factor.

JEL-classification: E5, E3
Keywords: monetary policy, uncertainty, survey forecast, forecast disagreement, factor analysis

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1 Introduction

The financial crisis, with its beginning dated roughly around 2008, now turns five. Starting as a subprime mortgage crisis, it evolved into ever expanding dimensions. Therefor the European Central Bank (ECB) as well as the Federal Reserve (Fed) face a multiplicity of challenges.

A great problem central banks face is uncertainty. Additionally, as a consequence of turmoil, market participants might change their usual behavior with the effect of a break up of established transmissions. So, while uncertainty might be a general problem, it becomes of special interest during times of turmoil (González-Páramo 2008).

Market expectations are an important tool to gain insight into the private market assessment of key macro variables. The importance of expectations to control any system or economy properly has been highlighted very early (Kydland and Prescott 1977; Barro and Gordon 1983). A wrong appraisal of expectations could generate serious problems as it may, accidentally, dampen or amplify central bank actions. Since expectations can not be observed directly, they need to be extracted from the data. To get an idea of how market participants expect future values to be, surveys as well as stock market data can be a valuable source of information (ECB 2011). Both indices are forward-looking. Survey measures catch expectations as they explicitly account for the expected values of key variables for different horizons ahead. On the other hand, stock market data covers future expectations as it is one of the main determinants of today's asset values.

This paper aims to extract common global factors that drive the development of uncertainty within the Euro Zone as well as the Unites States (US). This extractions is done with the help of factor analysis, a tool to reduce the complexity of data in order to present it in a more convenient way.

Past works on capturing expectations and identifying uncertainty via stock market or survey based measures can be found, for example, in Galati et al. (2009); Giordani and Söderlind (2003); Söderlind (2008). However, to my knowledge, there is no work which includes the latest developments of the financial crisis. Additionally, with the exception of Geiger et al. (2009), who cover at least European developments, there is no treatment of the Euro Zone or a joint analysis of both regions.

The paper is structured as follows: Section 2 presents general methods of identifying uncertainty. Those measures can be grouped into survey based measures and stock market based measures. Afterwards, those measures are mapped with the data in section 3 and 4. Section 5 covers the factor analysis constricted to the European data set. Section 6 conducts the factor analysis with respect to US data. Finally, section 7 combines

European and US data to perform a global factor analysis with the goal of identifying global uncertainty forces. Section 8 concludes.

2 Measuring Uncertainty

There are several classifications and forms of uncertainty, such as data or parametric uncertainty. For each of those forms, methods have been developed to cope with uncertainty. Most prominent, the approach of Brainard (1967) has become conventional wisdom (for example, Blinder 1998).

Nevertheless, working with uncertainty presumes the identification of uncertainty. Of special interest is thus, the perception of future values by market participants. The importance of expectations for the conduct of monetary policy has been highlighted by several authors, see, e.g., ECB (2006, 2009, 2011). The wrong assessment of market expectations on behalf of the central bank could cause serious problems as it possibly amplifies or dampens her actions in an unexpected manner. Hence, measuring uncertainty means primarily, measuring expectations.

In order to reveal possible uncertainty on behalf of market participants, variables need to be utilized to obtain the required information. Measuring uncertainty is done mainly in two ways. The first of them is based on surveys such as the Survey of Professional Forecasters (SPF) provided by the ECB and FRB of Philadelphia. The second measure relies on stock market data, more precisely on option volatility.

2.1 Measuring Uncertainty via Surveys

Surveys on the perception of the future development of key macro variables have a long tradition in measures of uncertainty (see for example Leduc et al. 2009; Galati et al. 2009). For the Euro area, this survey is provided by the ECB, since 1990 the Federal Reserve Bank of Philadelphia has been conducting this survey for the US, respectively. During this time various changes have occurred. For example, different forecast horizons have been added or dropped. Hence, computable data of the ECB is available only since 2001 whereas US data reaches back till the late sixties.[1]

Depending on the specific form of the questionnaire, different forms of measurement can be deduced. Taking for example the European survey, up to 90 institutions are asked to give their specific perception of the future development of inflation, GDP growth, and unemployment for the next years on a quarterly basis. The relevant forecast horizons

[1] An overview of the European survey is given by Bowles et al. (2007). Respectively, Croushore (1993, 2010) are good manuals for the American survey.

are: inflation for the current year, inflation for the next year, inflation 4 quarters ahead, inflation 8 quarters ahead, and inflation 5 years ahead. Hence horizon one, two, and five are "static" as it can be assumed that a forecast concerning the current year will improve as the year passes by. This does not hold for the forecast horizons 3 and 4. They are constructed as "rolling window". In order to obtain constant forecast data, which is not depended on the inquiry date, only horizon 3, 4 and 5 are taken into account for further analysis. Figure 1 demonstrates the timing using an example vintage of the European survey.

date of survey	current year	next year	1 year rolling	2 year rolling	5 years
2003 Q1	2003	2004	Dec 2003	Dec 2004	2007
2003 Q2	2003	2004	March 2004	March 2005	2007
2003 Q3	2003	2004	June 2004	June 2005	2008
2003 Q4	2003	2004	Sept 2004	Sept 2005	2008

Table 1: Forecast Horizon SPF, ECB

Uncertainty about the development of each variable is typically deduced by its standard deviation (Giordani and Söderlind 2003). Unfortunately, forecast horizon are not coherent. Neither across the US and Euro data nor within one region. This is to some extent due to the specific nature of each variable. Unemployment as well as inflation data, for example, are available on a monthly basis whereas GDP data is only available on a quarterly basis. On the other hand, the US survey takes various variables into account that are not even inquired by the ECB, for example, expectations about real consumption, new housings or corporate profits. To obtain a comparable picture of the US and Euro data, I rely on a subset of each survey. The present data set deals with these difficulties quite well.

2.2 Measuring Uncertainty via Stock Market Volatility

Another way of identifying uncertainty is the use of options. For a call option, only if the current value of the underlying asset exceeds the strike price of the asset the holder of the option will make use of his right, because only in this case the value of the option is positive. Otherwise, if the current price falls below the strike price the value of the option is zero as it merely guarantees the holder to buy the underlying at a higher price than the market price. Thus, the price of an option is open ended in one direction as it rises with the underlying asset, but it is chopped off at the bottom as it can not be

worth less than zero. This effect is even more developed if more than one price change is allowed (Hull 2009; Neely 2005).

Why Higher Volatility Leads to a Higher Option Price

Any option is worthless, if the underlying asset's price does not change. No agent needs to buy an option which gives him the right to buy or sell the underlying asset at a certain price if there will be no possible price change in the future at all. If price changes occur according to some public formula, again, the respective option would be worthless as everybody would merely calculate the future price of the underlying asset.

Hence, an option attains its value due to the uncertainty of future price developments. Supposing two call options for two different underlyings with a different variance but the same mean and an equally distributed probability of future states, both options can not be worth less than zero. Therefore, the option with the higher variance must gain a higher price as it offers a potentially greater payoff with the same downside risk.

Implied Volatility

The volatility at one point in time is not observable. Of course, it can be estimated using past observations. However, in reality, most market participants make use of the so-called *implicit* volatility. The Black-Scholes formula determines the price of an option as a function of its strike price, the underlying asset value, the risk-free interest rate, the time to expiry, and its variance (Black and Scholes 1972, 1973). Except for the variance, σ, all variables are observable. Hence, one can calculate the volatility which is necessary to match the current market price of the option. In contrast to historical volatilities, implied volatilities are forward-looking, they include expectations and assumptions of market participants about future stock movements. For the further work, I use the implicit volatility index VSTOXX for the European market and the VIX for the US market.

3 Uncertainty measured by survey data

3.1 European Survey Data

This section provides an illustration of the survey data of the European as well as the American survey of professional forecasters.

A closer look at the European survey data reveals that all variables show more or less the same pattern during the last decade and especially during the beginning of the

financial crisis around 2008 with the fall of Lehman Brothers. The standard deviations of all three variables (GDP, inflation and unemployment) have become larger during the financial crisis, whereas they have been relatively low in the years before. This holds – even though to a different extent – for all forecast horizons. An exception is the long term (5 years) forecast of unemployment which was relatively high even in the years before 2008 and, compared to other forecast horizons, did not really recover in the years after the peak. Figure 1 captures these developments for the forecast horizons rolling 1 year ($1y$), rolling two years ($2y$), and the 5 years long term perspective (l).

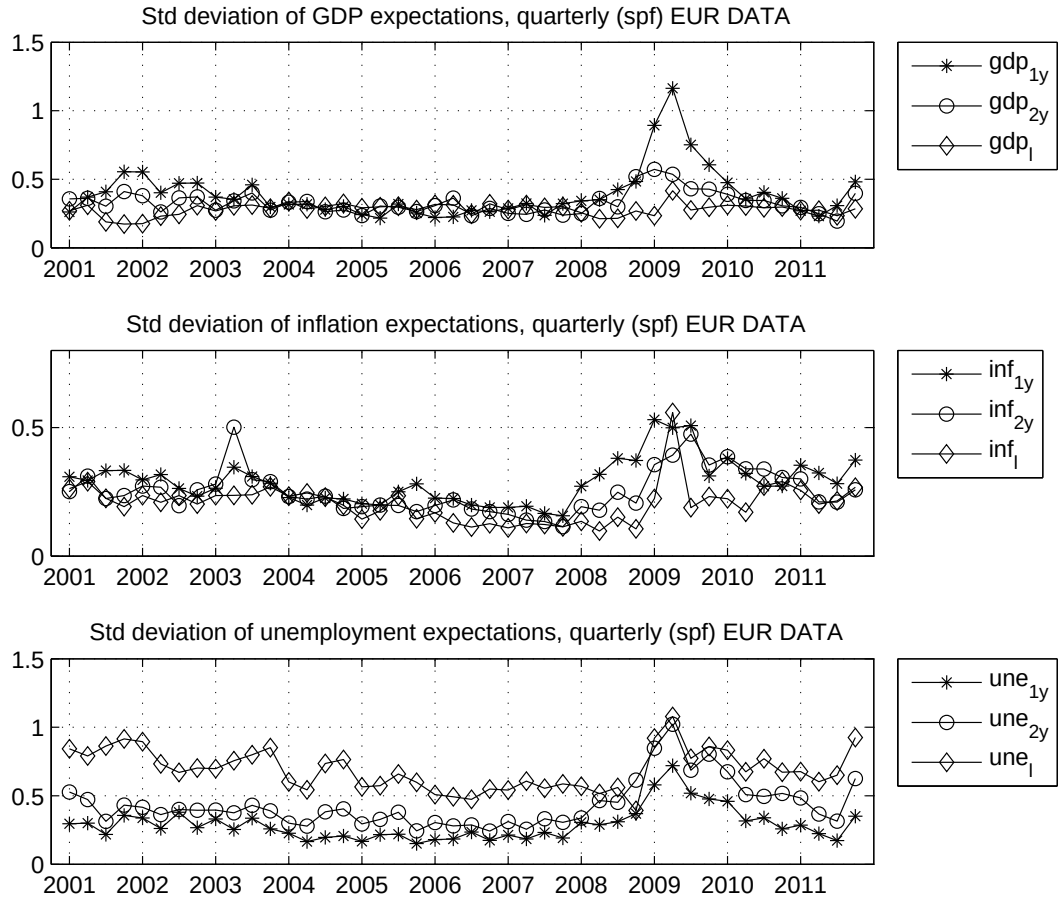

Figure 1: Std Deviation GDP, Inflation, Unemployment

Interpreting a high standard deviation as a high degree of uncertainty, I conclude that uncertainty has been on an all-time high during the financial crisis only slowly recovering

during the most recent years with values close to the pre-crisis level. This holds for every variable of the SPF.

Interestingly, while one would expect long-term expectations to be more sluggish than short-term forecasts, this fact holds only for the GDP series. As can be seen in the second panel of Figure 1, the opposite is true for inflation expectations. Long-term uncertainty (marked by diamonds) is relatively high compared to short-term uncertainty (marked by asterisks).

It is important to notice that Figure 1 depicts standard deviations. Hence, one can not conclude that short-term expectations of, say, inflation are low or lower than long-term expectations. A high standard deviation reflects a severe divergence, whereas a low standard deviation reflects a consonant appraisal of future rates among forecasters. A possible interpretation for the high standard deviation during 2009 can be found in Geiger and Sauter (2009) and Geiger et al. (2009). The rising standard deviation could thus be the consequence of a break up between different camps of agents who follow different approaches in predicting future developments. Those camps are nearly congruent in calm times but break apart if things start shaking. The first camp consists of agents who can be called "monetary believers". They form expectations with a focus on the monetary development. According to this position, the immense liquidity provision on behalf of the ECB will lead into a rising inflation rate in the long run.

On the other hand, there is a second camp whose supporters focus their assessment on "real" factors such as capital utilization or GDP growth. In their opinion, despite the liquidity rush, the poor output development delivers no reason for inflationary pressure in the future.

Despite the acceleration of uncertainty, measured by the standard deviation of forecasts, the mean forecast shows a different picture; see Figure 2. While short-term expectations vary to some extent during the crisis, long-term expectations are well anchored. This is true for GDP growth as well as for inflation. It is important to look at both measures, standard deviation and mean. A constant mean is in line with a high standard deviation where extrema net each other out.

The constantly low mean of long-term expectations on inflation is striking. Given that inflation is the main goal of the ECB and anchoring inflation expectations one of her most precious achievements, one could attest the ECB a well done job. This anchoring of long term expectations is even more impressive, given the beginning of the first cycle of quantitative easing in fall 2008 with already high inflation expectations and the beginning slowdown of the European economy.

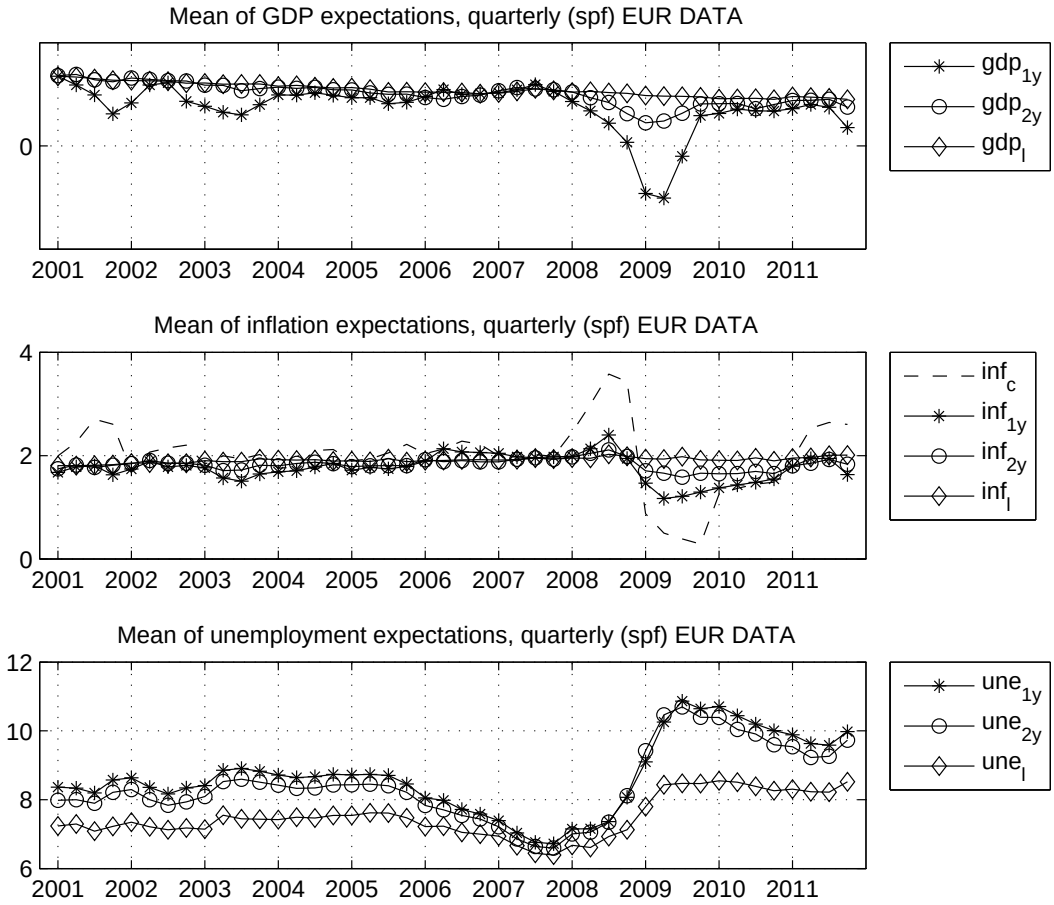

Figure 2: Mean GDP, Inflation, Unemployment

Interestingly, unemployment shows some kind of a wave shape for all horizons. The relative low expectations shifted upwards during the crisis but did not recover completely afterwards – they have undergone a level shift.[2]

3.2 US Survey Data

For the US, Figure 3 and Figure 4 plot standard deviation and mean of real GDP, inflation, and unemployment. The notation originates from the raw data set: The abbreviation (6) denotes the four quarter ahead forecast, the abbreviation 10 the ten years ahead forecast, respectively.

Interpreting the US data is more difficult than the European data as the picture is less uniform. Of course, one can identify the financial crisis, but even this outstanding event is less obvious in the US data.

Standard deviation of real GDP growth expectations is marked by three significant humps. The first hump is a heightened uncertainty due to the recession lasting from March 2001 till November 2001, followed by the second hump in 2003 corresponding to the corporate scandals and the beginning Iraq war. The last, most significant hike starts 2007 with the beginning of the financial crisis. During all these periods, uncertainty about the ten year outlook remains quite low.

Inflation uncertainty seems to be rather erratic. Short and long-term uncertainty perform a slow acceleration starting around 2006. Albeit very speculative, this acceleration could be due to the change of the chairman of the Federal Reserve (Bernanke succeeding Greenspan).

Even though one can identify a peak of uncertainty during 2009, it is more or less "one of many" humps regarding those last years. However, one important aspect is the different scale of inflation uncertainty compared to the European figures. During the crisis, US values are nearly twice the Europeans ones.

Taking into account the mean values, plotted in Figure 4, it looks like deflationary scares such as 2003 and around 2009 come along with heightened uncertainty. Nevertheless, long-term expectations of inflation as well as real GDP seem to be well anchored. Unemployment shows the same "wave" pattern as in Europe with uncertainty not fully recovering to the pre-crisis level and a significant higher mean forecast.

[2] This is of course plausible as unemployment is measured in levels, whereas GDP and inflation are growth figures.

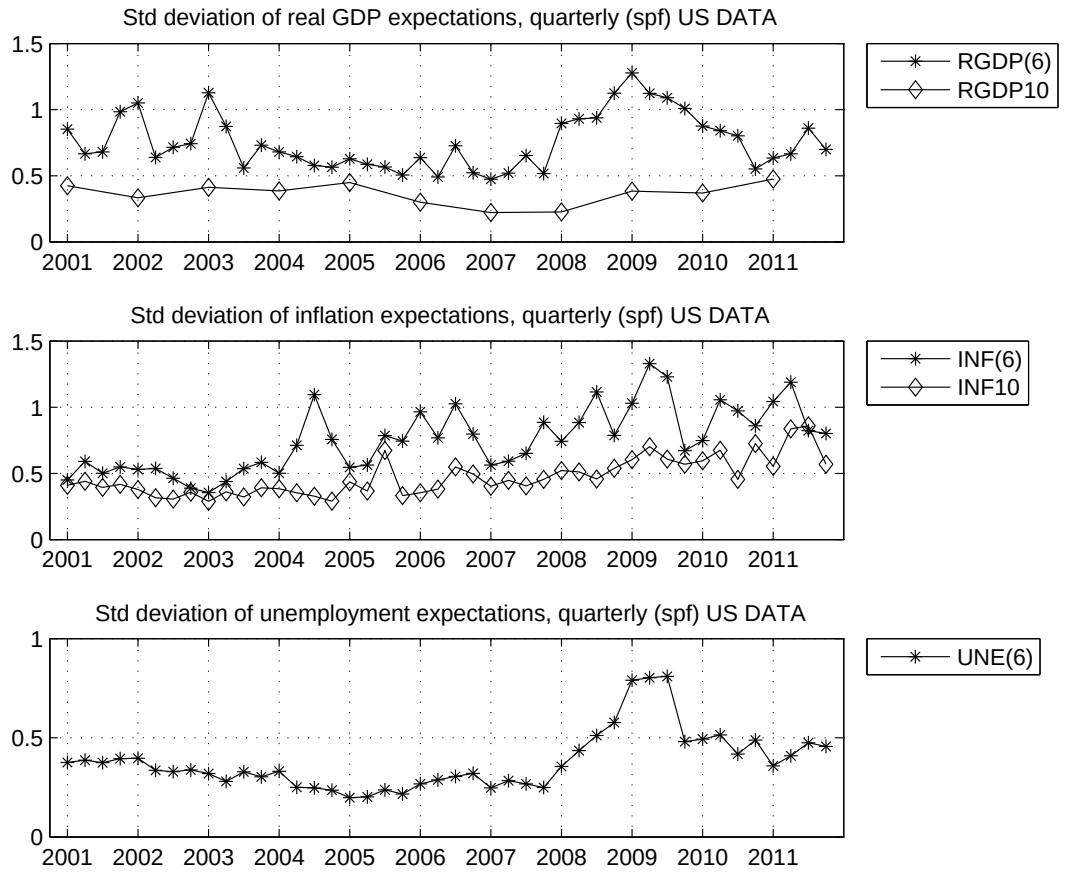

Figure 3: Standard deviation of real GDP, inflation, and unemployment, US

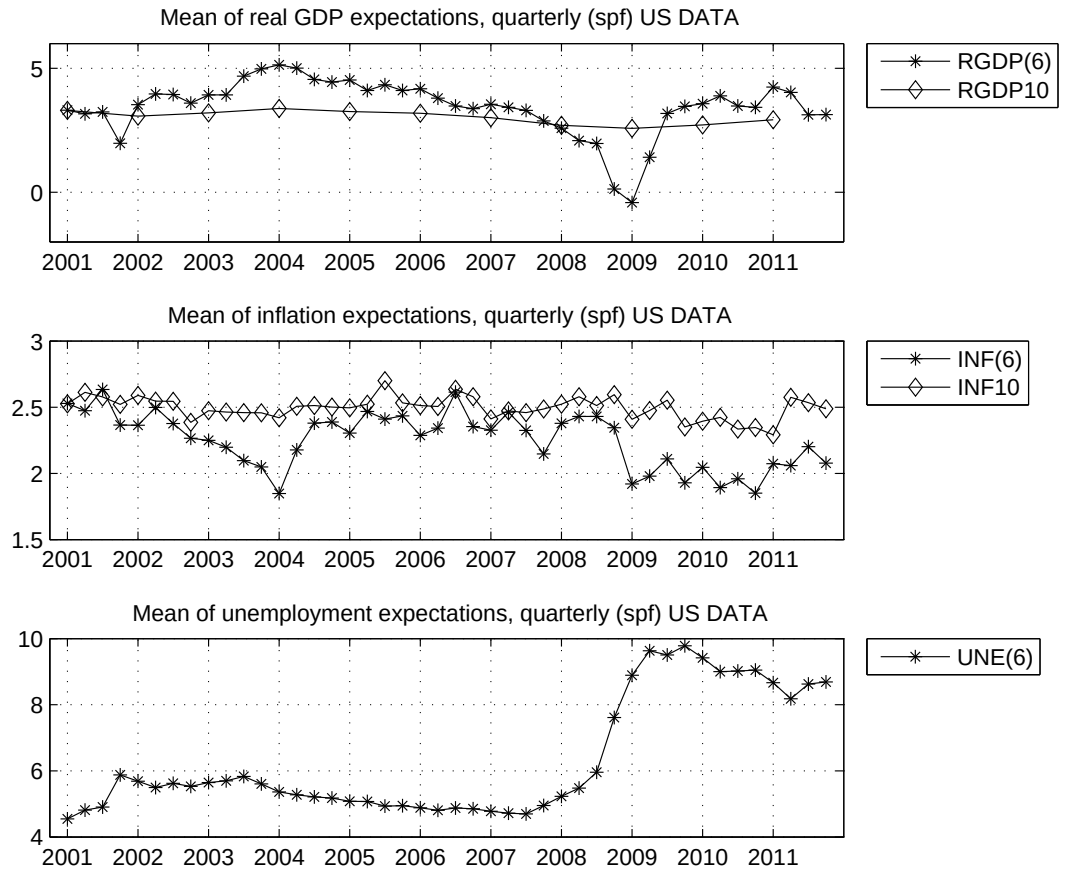

Figure 4: Mean of real GDP, inflation, and unemployment, US

3.3 Comparison

For convenience, Figure 5 depicts US and EU data in one common plot. As can be seen, GDP standard deviation in the US data is always greater than the European values. This holds for the short and long-term perspective. However, a higher standard deviation can also be attributed to generally higher values of US GDP growth expectations. Hence, one should rather focus on the pattern then the absolute values. Concerning this, the – compared to the US – steep acceleration of European uncertainty during the financial crisis becomes evident. Long-term uncertainty remains low and less volatile in both regions.

Inflation values till mid-2003 are very close. This changes at the beginning of 2004 with a general acceleration of uncertainty in the US, while European values remain on a very low path. Only during the recent crisis those values have been risen but also rebounded quite quickly.

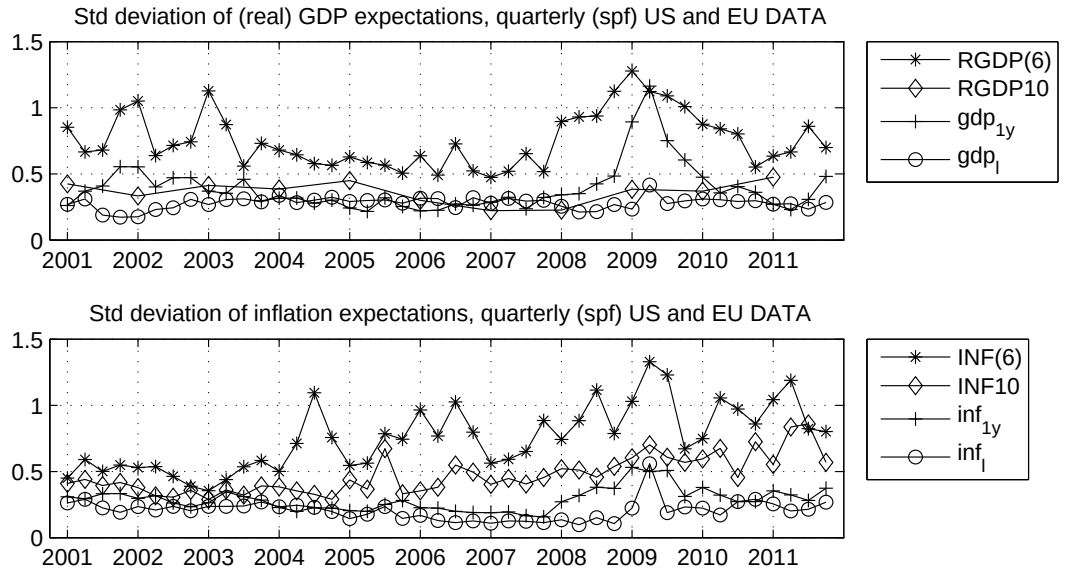

Figure 5: Standard deviation of (real) GDP and inflation, US and EU

4 Uncertainty in US and EU Stock Market Indices

Figure 6 captures the VSTOXX and VIX developments, that is, the implied volatility measure for the European and the US stock market, respectively. The picture corresponds to the findings of the survey measures. What strikes most is the nearly perfect synchronized course of both measures which already indicates a strong connection and interrelation of the European and American stock market. A common global driver of uncertainty seems to be very plausible.

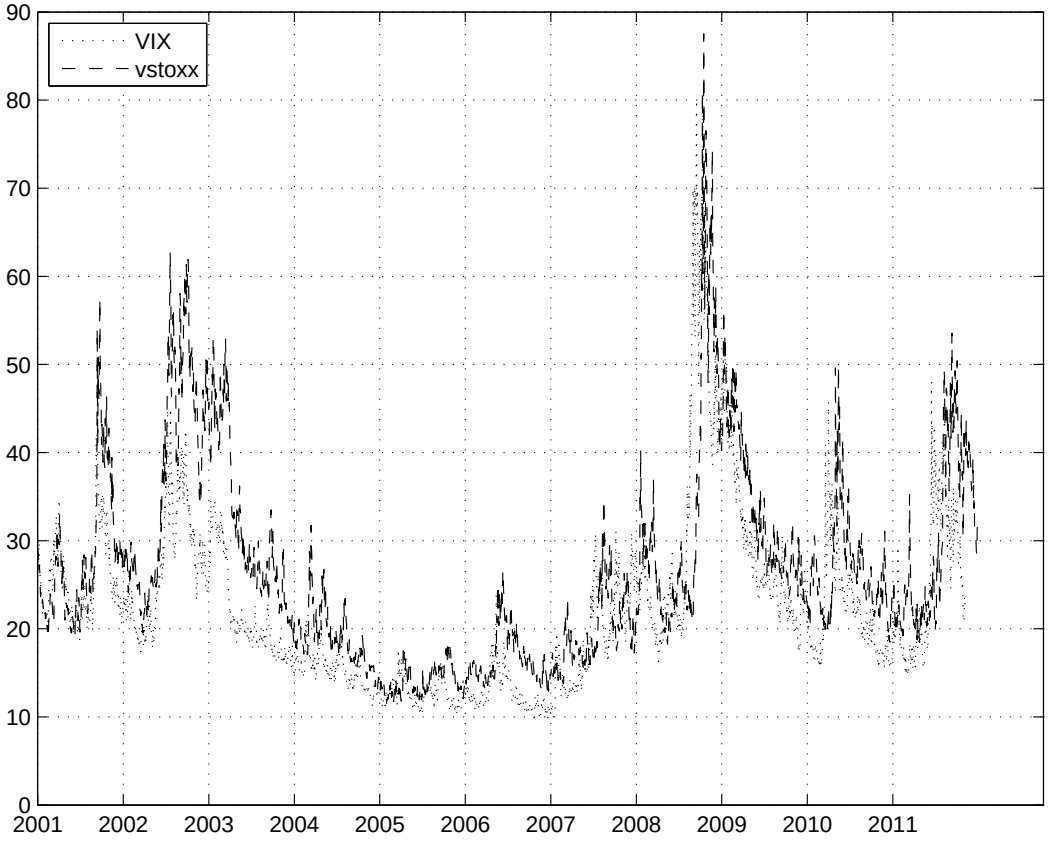

Figure 6: VIX (US), vstoxx (EU), daily

Compared to the survey measure, the stock market measure is more sensitive to unforeseen shocks. This may have various reasons. On the hand, this is simply due to the fact that stock prices can and do change much faster than nearly every other economic variable. They react immediately on incoming news which would fall into oblivion if contracts could only be made on a quarterly basis. On the other hand, this may be merely

owed to a technical issue. Stock market data is available on a daily basis. By squeezing stock market data into a quarterly scheme, a smoother and less volatile picture is achieved, which corresponds quite well to the survey based graphs presented above.

With the VIX and VSTOXX on hand, it is easy to recap past developments of the last 10 years. Some crucial events are the first peak at the end of 2001 which is owed to the terror attacks of September 11$^{\text{th}}$. The following hump mid-2002 corresponds to the corporate scandals in the US, followed by a little bit smaller hump associated with the Iraq invasion in the first quarter of 2003 (Bekaert et al. 2010). Interestingly, during those events uncertainty in the Euro Area was even higher than in the US.[3]

The second major group of events starts around 2008 with the collapse of Bear Stearns followed by the second-to-none rise and fall in uncertainty due to the financial crisis and the following (unconventional) measures undertaken by the Fed and the ECB. The last humps, around mid 2010 and 2011 are owed to the so called Euro crisis reflecting the risk of default in various European countries, most notably Greece.

These volatility index movements can be found in the survey data only to a very limited extend. The reasons have been mentioned above. However, the rise due to the financial crisis is also represented in the survey measures. Other peaks, such as those around 2003 (corporate scandals and Iraq), are only very hard to detect in the survey data. This is not astonishing or counterfactual as both measures, volatility index as well as survey data, measure uncertainty but from a different perspective and data basis. Survey measures display uncertainty about growth, inflation, and unemployment; option volatility displays uncertainty about the stock market, which of course itself is dependent on other underlying factors. Hence, not only the event *per se* is crucial but also the central banks reaction and its further implications for macro variables.

5 Factor Analysis of Euro Data

In what follows, I first conduct a factor analysis of the European data and afterwards the US data. The purpose is, to evaluate region specific factors and patterns. I will show that uncertainty in Europe follows different patterns and forces than in the US. In a third step, I combine both data sets to evaluate whether there exists something

[3] One has to be careful in interpreting the VIX and VSTOXX as a solely uncertainty measure. Bekaert et al. (2010) show how this measure can be decomposed into two components, namely, risk aversion and uncertainty. This is due to the fact that both indices are stock market based, and thus also harbor information about risk (aversion). However, this does not alter the findings above as the volatility index is at least a good proxy for uncertainty.

like a region independent, hence, common world uncertainty factor or if uncertainty is somehow region driven.

Both measures – standard deviation and the volatility index – account for uncertainty. As has been shown in the previous chapters, given that they show the same ups and downs, stock market as well as survey based data seems to follow a common factor. It appears that the common driving force behind these measures is some kind of "general uncertainty". This uncertainty can become visible with he help of factor analysis.

In general, factor analysis is a tool to reduce the complexity of a given data set. It is utilized to extract a common, latent factor from the data such that movements in various different variables can be explained by fewer factors, making a representation and interpretation more convenient.

For the Euro area, my data set consists of variables taken from the SPF and the VSTOXX; they are listed in Table 2. The last column gives the abbreviations used for further analysis.

Stock market data	VSTOXX	$vstoxx$
Survey Data	GDP 1 year rolling	gdp_1
	GDP 5 years ahead	gdp_5
	Inflation 1 year rolling	inf_1
	Inflation 5 years ahead	inf_5
	Unemployment 1 year rolling	une_1
	Unemployment 5 years ahead	une_5

Table 2: Data Set FA, EUR

The Kaiser-Meyer-Olkin (KMO) criterion value is 0.75, "middling"[4]. All individual measures of sampling adequacy (MSA) are at least greater than 0.6 and most of them larger than 0.7. The only exception is the standard deviation of long-term GDP growth, which is 0.22. Nevertheless, and for the sake of completeness, I keep this variable. In order to find the right number of underlying driving factors, I follow Kaiser and Rice (1974) and assume as many factors, as eigenvalues greater one. Two eigenvalues can be identified which fulfill this criterion, hence, two common factors should be extracted.

[4] Kaiser and Rice (1974) proposed a scale of sampling adequacy, according to values greater 0.5 are said to be "miserable", greater 0.6 "mediocre", greater 0.7 "middling", greater 0.8 "meritorious", and greater 0.9 "marvelous". Values smaller than 0.5 are "unacceptable".

Variable	Factor 1	Factor 2
$vstoxx$	0.6718	-
gdp_1	0.9144	-
gdp_5	-	0.4964
inf_1	0.8537	-
inf_5	-	0.9718
une_1	0.9656	-
une_5	-	0.5307

Table 3: Loadings EUR, Promax rotation (cropped)

Table 3 lists the respective factor loadings of the two factors. The loadings are generated using *promax* rotation with power 10.[5] All values absolutely smaller than 0.4 have been removed. The loadings are also plotted in Figure 7.

The *promax* rotation, opposed to the *varimax* rotation, is oblique. Hence, the extracted factors are not orthogonal and thus not independent from each other. Using promax, the loadings can also not be interpreted as correlations which is the case using varimax rotation.

As can be seen very clearly even from Table 3, there is a distinction between long term and short term expectations. All short term variables (gdp_1, inf_1 and une_1), as well as the volatility index ($vstoxx$) are loaded by Factor 1. Opposed to that, long-term forecasts (gdp_5, inf_5 and une_5) are loaded solely by Factor 2.

This loading patten is in line with an economic interpretation of a separation between short and long-term drivers of uncertainty.[6] Uncertainty about short-term inflation development depends mainly on temporary shocks whereas uncertainty about inflation development far in the future depends on the variance of permanent shocks (Ball et al. 1990).

However, the influence of the long-term factor is not as clear as it is for the short-term figures. The more or less strict distinction of short and long-term drivers only holds for inflation. Long-term unemployment as well as GDP growth are driven less intensive by this second component. Long-term GDP growth is a difficult variable. It is little loaded by Factor 2 and even less by Factor 1. Additionally, it exhibits a high specific variance

[5] The varimax method delivers a very similar picture. For interpretation and presentation, however, promax seems to be more appropriate in this case as it highlights the specific loadings more clearly.

[6] See, for example, Caporale and Kontonikas (2006); Caporale et al. (2010) where the authors distinguish between the development of short-run and steady-state/long-run/structural inflation uncertainty for different European countries.

of approximately 0.82 which indicates that gdp_5 is only to a very limited amount driven by common factors.

Figure 7 shows Factor 1, which I declare as the short term uncertainty on the horizontal axis. Long term uncertainty is plotted as Factor 2 on the vertical axis. The results of the conducted factor analysis support the distinction in the literature between drivers of short and long-term uncertainty.

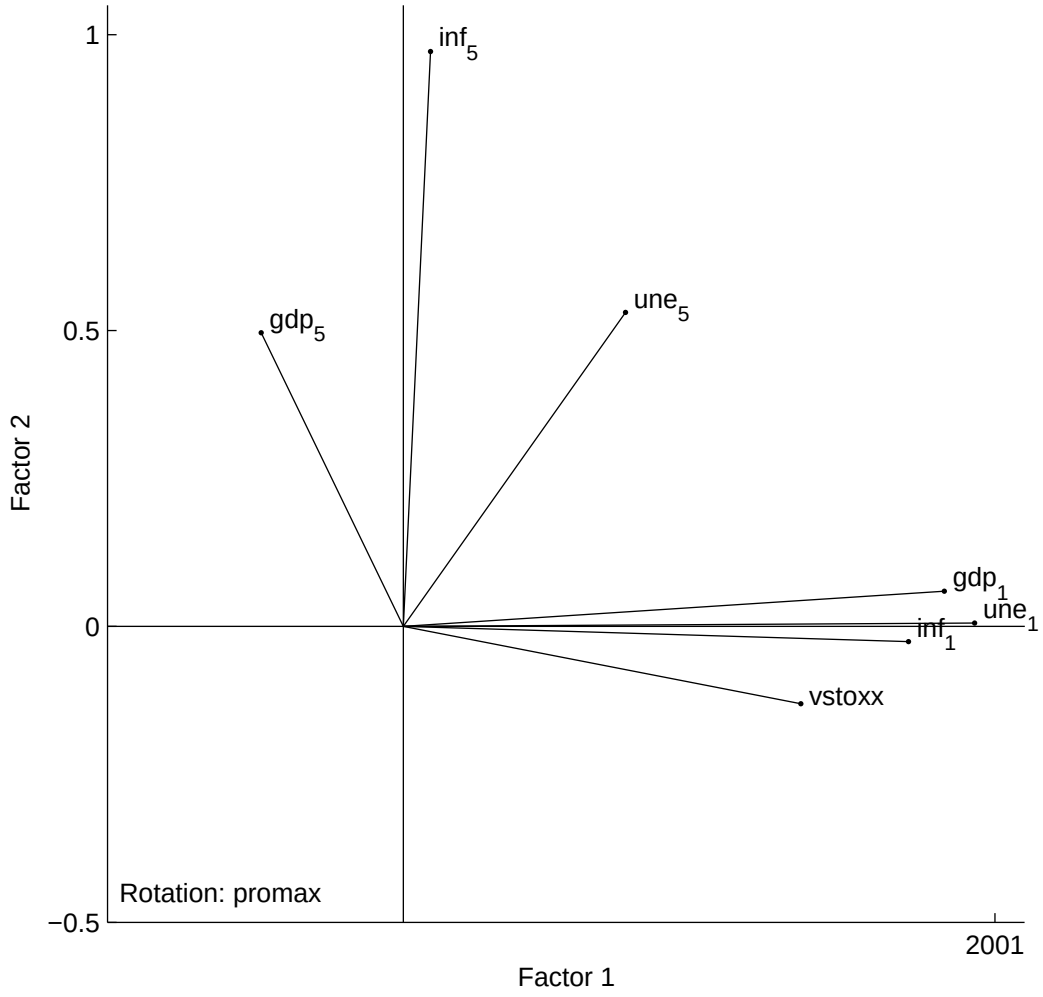

Figure 7: Loadings EU, promax rotation

6 Factor Analysis of US Data

Analogously to the European analysis, the US data set is constituted by the SPF provided by the Federal Reserve Bank of Philadelphia and the VIX provided by the Chicago Board Options Exchange (CBOE). Unfortunately – with the exception of inflation – for the most variables the US survey only offers three horizons: 4 quarters ahead, annual average current year and annual average next year. For factor analysis, I use the data shown in Table 4. Except for the standard deviation of long-term inflation expectations, all variables are the standard deviation of short-term forecasts, hence, the whole data set covers rather short-term uncertainty.

Stock market data	VIX	VIX
Survey Data	Inflation 1 year rolling	$CPI(6)$
	Inflation 10 years ahead	$CPI10$
	Real Consumption 1 year rolling	$RCONSUM(6)$
	Real GDP 1 year rolling	$RGDP(6)$
	Unemployment 1 year rolling	$UNEMP(6)$

Table 4: Data Set US

I conduct the *varimax* rotation which is an orthogonal rotation. The extracted factors are thus independent from each other. Nevertheless, the results using *promax* are comparable.

The KMO offers a value of 0.75 which is according to Kaiser and Rice (1974) "middling". All MSA values are at least larger than 0.5, hence "acceptable". Further, two eigenvalues larger then one can be identified which calls for two factors to be extracted. The loadings are given in Table 5 where all values smaller than 0.17 have been removed for convenience.

According to Table 5, stock market volatility, real consumption and real GDP are solitary loaded by Factor 1. Inflation uncertainty – short and long-term – are loaded solitary by Factor 2. Unemployment uncertainty seems to be nearly equally dependent on both factors.

Analogous to the Euro area, stock market and short-run GDP uncertainty are loaded by one common factor which also drives real consumption. Also, short-run uncertainty concerning unemployment is driven by this factor to some extent. Opposed to the European data, short-run unemployment uncertainty is also driven by a second factor. This

Variable	Factor 1	Factor 2
VIX	0.8195	-
$CPI(6)$	-	0.7793
$CPI10$	-	0.7661
$RCONSUM(6)$	0.8484	-
$RGDP(6)$	0.8877	-
$UNEMP(6)$	0.7244	0.6256

Table 5: Loadings US, varimax rotation (cropped)

was not the case for the Euro area, where I discriminated between a short and long-term prospects.

Most importantly, the strong distinction between short and long-term uncertainty of inflation expectations can not be found in the US data. Both inflation horizons are loaded by the same factor. Hence, the distinction made for the European data, which was encouraged by the literature (Caporale and Kontonikas 2006; Caporale et al. 2010) can not be approved for the US data with the use of factor analysis. Moreover, as varimax is an orthogonal rotation, that is, both factors are independent from each other, there is a strong difference between long and short-term inflation uncertainty on the one hand and (nearly) all other variables on the other hand.

To conclude, for the Euro area there is a distinction concerning the loadings between long-term and short-term uncertainty especially for inflation but also GDP and unemployment which is also reinforced by the existing literature. The US factor analysis suggests no distinction between long and short-term uncertainty about inflation. Much more there is a "classical" distinction between uncertainty about monetary values – no matter what time aspect – and "real" variables including stock market uncertainty.

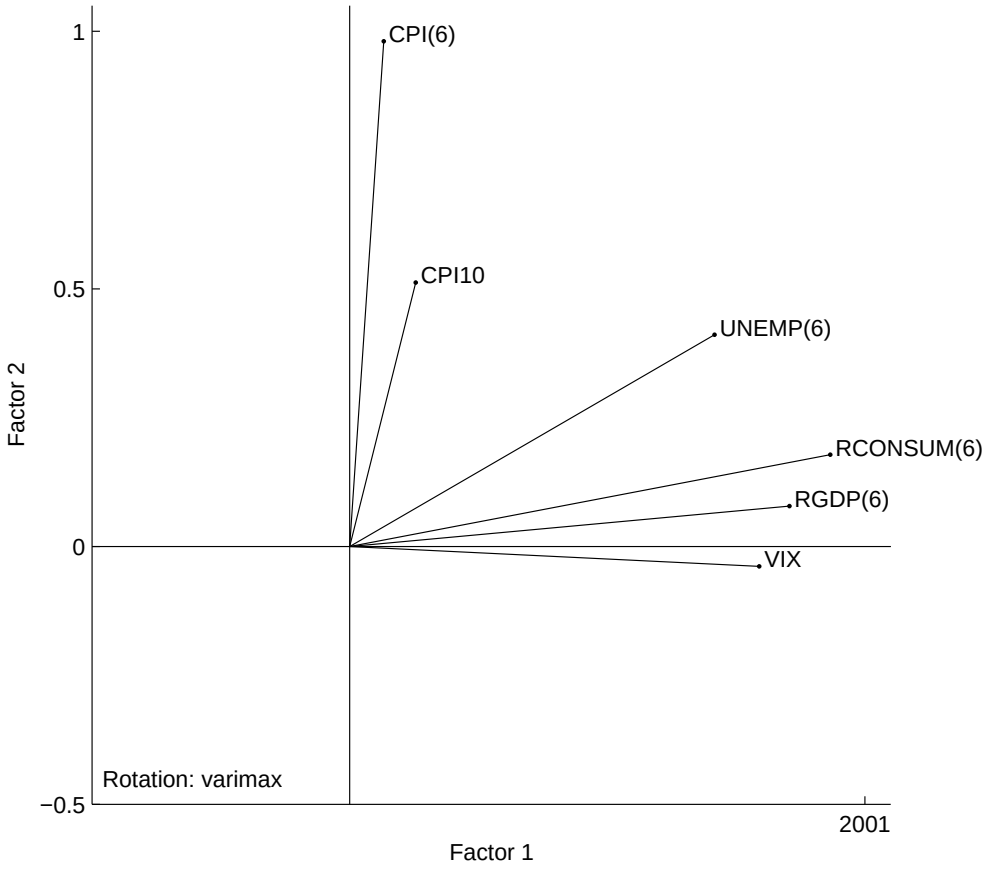

Figure 8: Loadings US, varimax rotation

7 Is Uncertainty Driven by the Same Latent Factors in US and the Euro zone

After both regions have been analyzed separately, now a global factor analysis is conducted. The goal is to identify whether Europe and the United States obey one common factor in terms of uncertainty or if uncertainty is region driven. If there exists something like a "global US-Euro uncertainty" this would also give evidence for a common, strongly connected market in which for example GDP growth can no longer be treated as an independent, region or country-specific variable.

For the global factor analysis, both data sets are combined. Due to the poor MSA value of US unemployment and long term European GDP growth, I have dropped those values. The remaining eleven variables exhibit an MSA value at least greater than 0.5 and are listed in Table 6. The overall KMO criterion is 0.8, "meritorious".

Stock market data	VSTOXX	$vstoxx$
	VIX	VIX
Survey Data US	Inflation 1 year rolling	$CPI(6)$
	Inflation 10 years ahead	$CPI10$
	Real Consumption 1 year rolling	$RCONSUM(6)$
	Real GDP 1 year rolling	$RGDP(6)$
Survey Data EUR	GDP 1 year rolling	gdp_1
	Inflation 1 year rolling	inf_1
	Inflation 5 years ahead	inf_5
	Unemployment 1 year rolling	une_1
	Unemployment 5 years ahead	une_5

Table 6: Data Set FA, US & EUR

The analysis with the help of the eigenvalue criterion suggests three common factors loading uncertainty in the US and Europe. The loadings produced by *varimax* rotation are listed in Table 7 and Figure 9. The upper panel shows US, the lower panel Euro Zone loadings. Figure 7 captures all values from both regions. For clarity, Figure 8 displays only those values greater than 0.3. The last column always displays the specific variance.

I declare Factor 1 as "international stock market uncertainty factor". The highest loadings on this factor are given by the US and European Stock market indices VIX and $vstoxx$. Both loadings are greater than 0,9. Additionally, the specific variances are

Variable	Factor 1	Factor 2	Factor 3	specific variance
VIX	0.9839	0.1462	0.0743	0.0050
$CPI(6)$	-0.0342	0.0853	0.9604	0.0692
$CPI(10)$	0.1603	0.0814	0.6227	0.5799
$RCONSUM(6)$	0.6467	0.3967	0.2188	0.3766
$RGDP(6)$	0.6500	0.4849	0.1714	0.3130
$vstoxx$	0.9183	0.1896	-0.0201	0.1203
gdp_1	0.4527	0.7947	0.2532	0.0994
inf_1	0.4771	0.6165	0.3886	0.2414
inf_5	0.0878	0.6633	0.0712	0.5472
une_1	0.4747	0.7869	0.2754	0.0796
une_5	0.1337	0.7917	-0.0927	0.3467

Table 7: Loadings US & EUR, Varimax rotation

Variable	Factor 1	Factor 2	Factor 3	specific variance
VIX	0.9839	-	-	0.0050
$CPI(6)$	-	-	0.9604	0.0692
$CPI(10)$	-	-	0.6227	0.5799
$RCONSUM(6)$	0.6467	0.3967	-	0.3766
$RGDP(6)$	0.6500	0.4849	-	0.3130
$vstoxx$	0.9183	-	-	0.1203
gdp_1	0.4527	0.7947	-	0.0994
inf_1	0.4771	0.6165	0.3886	0.2414
inf_5	-	0.6633	-	0.5472
une_1	0.4747	0.7869	-	0.0796
une_5	-	0.7917	-	0.3467

Table 8: Loadings US & EUR, Varimax rotation (cropped)

very small. A specific variance of zero would indicate that the respective variable is solely driven by the common factors. I return to the other variables loaded by Factor 1 later.

Factor 2 is the "European uncertainty factor". Besides the stock market index, all other European variables no matter if long or short-term are loaded by this latent force. Especially uncertainty about GDP and unemployment is compared to inflation higher loaded by this factor. I would thus refine the factor as "European *real* variables uncertainty factor".

Factor 3 is a "US inflation uncertainty factor" as it especially loads the uncertainty concerning short and long-term US inflation and hardly anything else.

Despite those strict mono-causal explanations, there are several connections. For example, Factor 1 is not only loaded by stock market data but – to a smaller extent – also by US real variables $RGDP(6)$ and $RCONSUM(6)$. Hence, uncertainty concerning the stock market is somehow connected to uncertainty about the real development of the US economy and to a smaller extent short-term European developments.

Furthermore, most of the variables loaded mainly by Factor 2 also account for Factor 1, though to a smaller amount. Interestingly, this holds especially for the short-term variables gdp_1, inf_1 and une_1. Uncertainty about long-term developments in Europe are not driven by "US uncertainty". On the other hand, Factor 2 also drives uncertainty about short-term US developments. Hence, there is a connection in terms of uncertainty between the US and Europe, but rather on a short-term basis. Uncertainty about the expected long-term development, however, is not; it is region driven.

Factor 3 should be refined into 'US *short-term* inflation uncertainty factor". Given the data set, short-term inflation uncertainty reveals the second highest loading of the data set. It also confirms the previous finding (see Table 5), whereas US inflation is independent of any other variable. However, long-term inflation uncertainty ($CPI10$) must be taken critical as it also shows a high specific variance of nearly 60%. But in fact, this third factor also loads European short-term inflation uncertainty which again indicates a strong connection between both economic regions.

The previous pattern of a short–long distinction for the European data and a real–monetary distinction of the US data fades. This is particularly true for the European analysis. As before, the US data still provides a distinction between real (Factor 1) and monetary values (Factor 2) which reminds of the classical dichotomy. On the other hand, the sharp distinction between short and long-term uncertainty of the European data can not be found for the global factor analysis. All values are loaded by the same factor, Factor 2, no matter their forecast horizon.

Reasons for these findings may arise out of the differences between the leading policy actors of both regions. When compared to the Federal Reserve System, the ECB is a young institution. Taken the classical dichotomy literally, the US have achieved a *long-run* situation with an independency of monetary and real variables, a distinction which does not yet hold for the European economies.

Additionally, the Fed only in charge of price stability and not mandated to promote maximum employment and moderate long-term interest rates. Hence, the different uncertainty forces of real and monetary values could originate from the threefold mandate

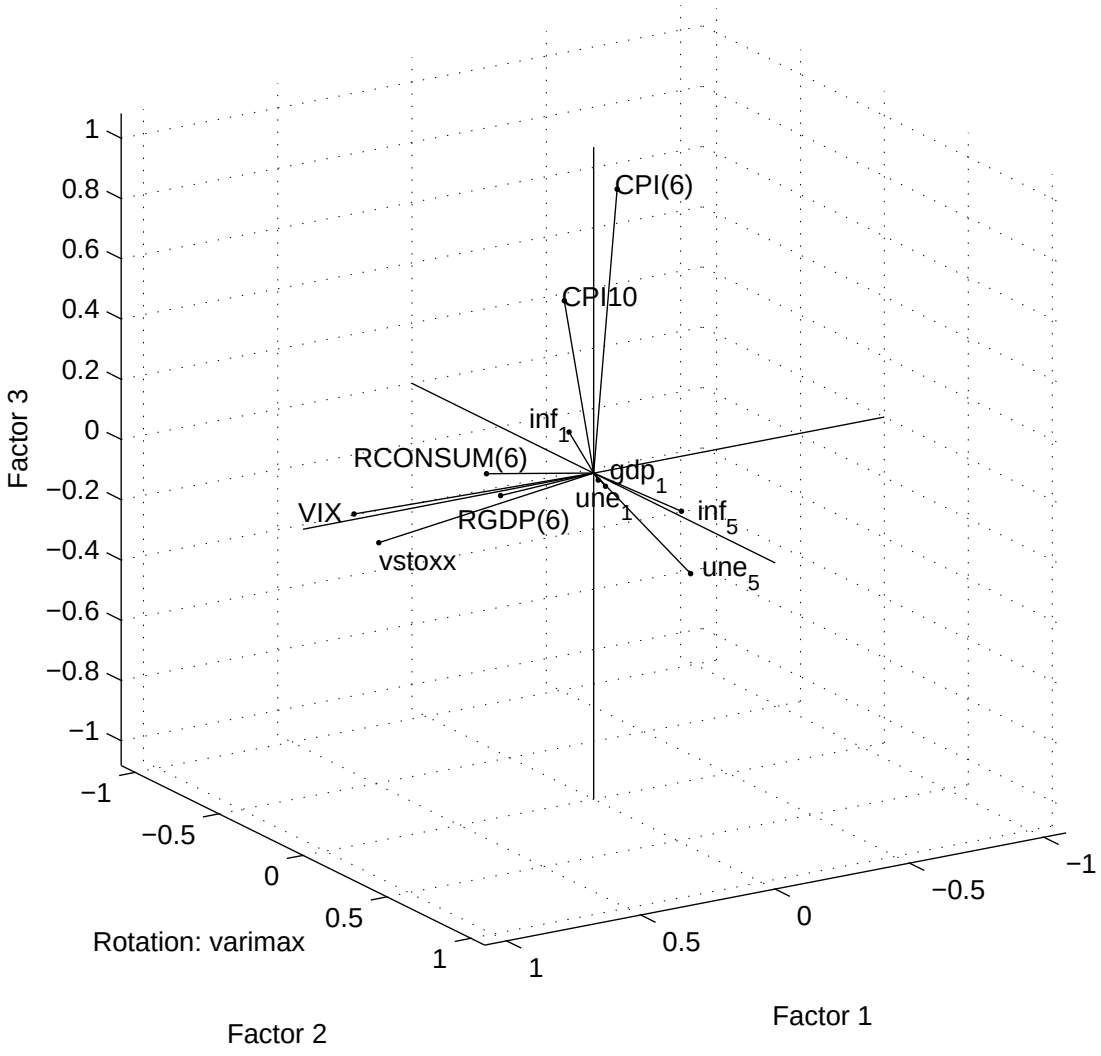

Figure 9: Loadings US and EU, varimax rotation

of the Fed whereas the common European factor indicates the unique price stability goal of the ECB. If so, one must admit that the public obviously does not believe in a control of the stock market on behalf of the ECB and thus uncertainty concerning the stock market is driven by a non-European, hence American, force.

8 Conclusion

This paper attempted an exploration of uncertainty during the last decade with the help of an explanatory factor analysis. Using data from the Survey of Professional Forecasters (US and Europe) and stock market volatility measured by the VIX/VSTOXX indices, the US as well as the Euro Zone have first been investigated separately and later on jointly.

The European survey data indicates low uncertainty during the pre-crisis years, as measured by the standard deviation of forecasts. All variables show an acceleration of uncertainty during the crisis over nearly all forecast horizons. Nevertheless, mean expectations remain nearly constant or at least quickly return to their pre-crisis values. For the US survey data, an acceleration of inflation uncertainty can be found, starting around 2006. This is true for short and long-term expectations. Additionally, deflationary tendencies seem to promote a rise in uncertainty. Stock market data shows a nearly perfect synchronized run of both economic regions.

For the Euro Zone, factor analysis shows a clear separation between uncertainty concerning short-term forecasts and uncertainty concerning long-term forecasts. This holds more or less for all variables taken into account and is especially pronounced for inflation expectations. This finding is in line with other research whereby short-term inflation uncertainty is driven by temporary shocks and long-term uncertainty by permanent shocks. According to my findings, this result can be assigned to a lesser amount also to other variables such as GDP growth or unemployment expectations.

In contrast to the European findings of a short and long-term factor, US factor analysis delivers a rather "classical" distinction between "real" and "monetary" factors. On the one hand, there is a factor that drives short and long-term inflation uncertainty while, on the other hand, uncertainty concerning stock market movements as well as real consumption and GDP growth are governed by a different factor. Unemployment seems to be somewhat in-between.

Combining both data sets yields three distinct factors which load the uncertainty measures. Firstly there exists an international stock market uncertainty factor which loads especially the VIX and VSTOXX and to a smaller extent real US variables. Secondly

an European uncertainty factor can be identified, loading mainly European uncertainty measures disregarding the forecast horizon. Thirdly, as the US analysis already revealed, US short and long-term inflation uncertainty follows a distinct common factor which only to a very limited amount affects also Euro inflation uncertainty. Reasons for these patterns may be found in the different policy mandates as well as the unequal age of the monetary institutions here and abroad.

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