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ASSESSING UNCERTAINTY IN EUROPE AND THE US - IS THERE A COMMON FACTOR?

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This paper aims an empirical investigation of uncertainty in the Euro Zone as well as the US. For this purpose I conduct a factor analysis of uncertainty measures starting in 2001 until the end of 2011. 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 factors. For the Euro Zone, I show that uncertainty can be separated into factors 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. Combining 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: C1, E3, E5, E6
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 2007/2008, 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 about the effect of their policy. While uncertainty might be a general problem, it becomes of special interest during times of turmoil. During those periods, market participants might change their usual behavior with the effect of a break up of established transmissions (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 expectations about future developments 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 an explanatory factor analysis to identifying common but invisible latent factors.

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) or Geiger et al. (2009). However, to my best knowledge, with the exception of the last mentioned, there is no work dealing with uncertainty which includes the latest developments of the financial crisis.

This work is the first, conducting a factor analysis which includes the financial crisis as well as US and European data. Since now, there has been no joint analysis on uncertainty concerning this time span, covering both regions.

The paper is structured as follows: Section 2 presents general methods of identifying and measuring uncertainty. Those measures can be grouped into survey based measures and stock market based measures. Those measures are mapped with the data in Section 3. Section 4 covers the factor analysis, starting with a short introduction of explanatory factor analysis. Subsequently, factor analysis is firstly constricted to the European data set and secondly to the US data set. Thirdly, the European and US data are combined in order to perform a global factor analysis with the goal of identifying global uncertainty forces. Section 5 concludes the paper and summarizes the findings.

2 Measuring Uncertainty

Dealing 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). A 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. Most prominent this was demonstrated by Brainard (1967) for which *Brainard conservatism* has become conventional wisdom (Blinder 1998).

Measuring uncertainty means primarily, measuring expectations. This is done mainly in two ways. The first group of measures is based on surveys such as the Survey of Professional Forecasters (SPF) provided by the ECB and FRB of Philadelphia. The second group consists of financial market-based measures which rely, for example, on stock market data, inflation-linked bonds, or swap rates.

Although surveys deliver *direct* information on inflation expectations compared to financial market data, they have several shortcomings. As mentioned by Giordani and Söderlind (2003) and Croushore (1993), there is no guarantee that the respondents give their *best* estimate. Also *tactical games* or the *fear of consequences* could lead to biased or exaggerated answers. This source of error is tried to be reduced by making the publication of the survey anonymous. However, this anonymity may reduces the risk of "wrong" forecasts and encourages the respondent to report what she really believes, it also gives rise to less precise forecasts as the respondent can not be held accountable for her predictions. Additionally, due to the low investigation frequency of surveys, ranging from monthly up to biannually reports, they can not reflect behavioral changes properly. In the end, they suffer from well known problems with the design of questionnaires (Galati et al. 2009).

On other hand, uncertainty measures derived from financial data are predominantly based on information given by stock volatility, more precisely on option volatility. As these data are available in high frequency, changes in behavior can be examined quite well. Due to the fact that this is an indirect measure, deduced from stock market data, there is a potential risk of swapping of information. Despite this shortfall, volatility indices are a good proxy for uncertainty and are well used in academic literature (Bekaert et al. 2010).

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, Mankiw et al. 2003; 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]

Uncertainty about the development of each variable is typically deduced by its standard deviation (Giordani and Söderlind 2003). Unfortunately, surveys 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. However, the present data set deals with these difficulties quite well.

2.2 Measuring Uncertainty via Stock Market Volatility

Stock market measures to identify uncertainty make use of options. For a call option, only if the current value of the underlying asset (S_t) exceeds the strike price of the asset (X), the options goes into the money; otherwise, the value of the option is zero. Hence, the value of a call option at expiry is $(S_T - X) \vee 0$. Therefore, 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.

As any foreseen price change would make an option obsolete, options attain their value due to the uncertainty surrounding future price developments. Due to the fact that a call

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

option can not be worth less than zero, options with a higher variance of the underlying must, compared to options with a lower variance of the underlying, gain a higher price as they offer a potentially greater payoff while at the same time bear the same downside risk (Hull 2009; Neely 2005).

The volatility of an option 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 (Black and Scholes 1972, 1973) for a call option,

$$C = S_0 N(d_1) - Xe^{-rT} N(d_2) \quad \text{with.} \tag{2.1}$$

$$d_1 = \frac{ln(S_0/X) + (r + \sigma^2/2)T}{\sigma\sqrt{T}}, \tag{2.2}$$

$$d_2 = \frac{ln(S_0/X) + (r - \sigma^2/2)T}{\sigma\sqrt{T}}, \tag{2.3}$$

determines the price of the option (C), as a function of its strike price (X), the underlying asset value (S), the risk-free interest rate (r), the time to expiry (T), the cumulative normal density function ($N(\cdot)$), and its variance (σ^2). Except for the variance, σ^2, all variables are observable such that the volatility which is necessary to match the current market price of the option can be calculates easily. 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 Empirical evidence of uncertainty measures

3.1 Survey measures

European Survey Data

The European survey data is taken from the Survey of Professional Forecasters which is provided by the ECB. Table 1 lists the variables taken into account, the last column gives the abbreviations used in the following.[2]

[2] The SPF is conducted on a quarterly basis. If questions are constructed as a *rolling window*, survey date and forecast horizon are of a constant relation. For example, if the survey data is 2009q1, the rolling 1 year ahead forecast is for 2010q1, if the survey is conducted 2009q2, the forecast is for 2010q2. On the other hand, no rolling window forecasts are of no constant relation. If, for example,

GDP 1 year ahead (rolling)	gdp_1
GDP 2 years ahead (rolling)	gdp_2
GDP 5 years ahead	gdp_5
Inflation current year	inf_c
Inflation 1 year ahead (rolling)	inf_1
Inflation 2 years ahead (rolling)	inf_2
Inflation 5 years ahead	inf_5
Unemployment 1 year ahead (rolling)	une_1
Unemployment 1 years ahead (rolling)	une_2
Unemployment 5 years ahead	une_5

Table 1: Survey Data, EUR

A closer look at the European survey data reveals that all variables show more or less the same pattern during the last decade, especially at the beginning of the financial crisis 2007 and its intensification 2008 with the fall of Lehman Brothers. As can be seen in Figure 1, the standard deviations of all three considered 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. 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.

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.

Interestingly, long-term GDP uncertainty remains quite low during the crisis, Only short-term uncertainty hikes during the year 2009. Never-the-less, all horizons recover back to their pre-crisis levels.

Opposed to that, inflation uncertainty offers a rise in all considered horizons during the crisis. Long-run inflation expectations reflect the ability of the central bank to anchor expectations, the picture of accelerating rates, no matter their time-aspect, but especially long-term, has raised the question whether inflation expectations are really well anchored

the survey date is 2009q1, the 5 year ahead forecast is for the year 2014; If the survey date is 2009q2, the forecast remains for the year 2014.

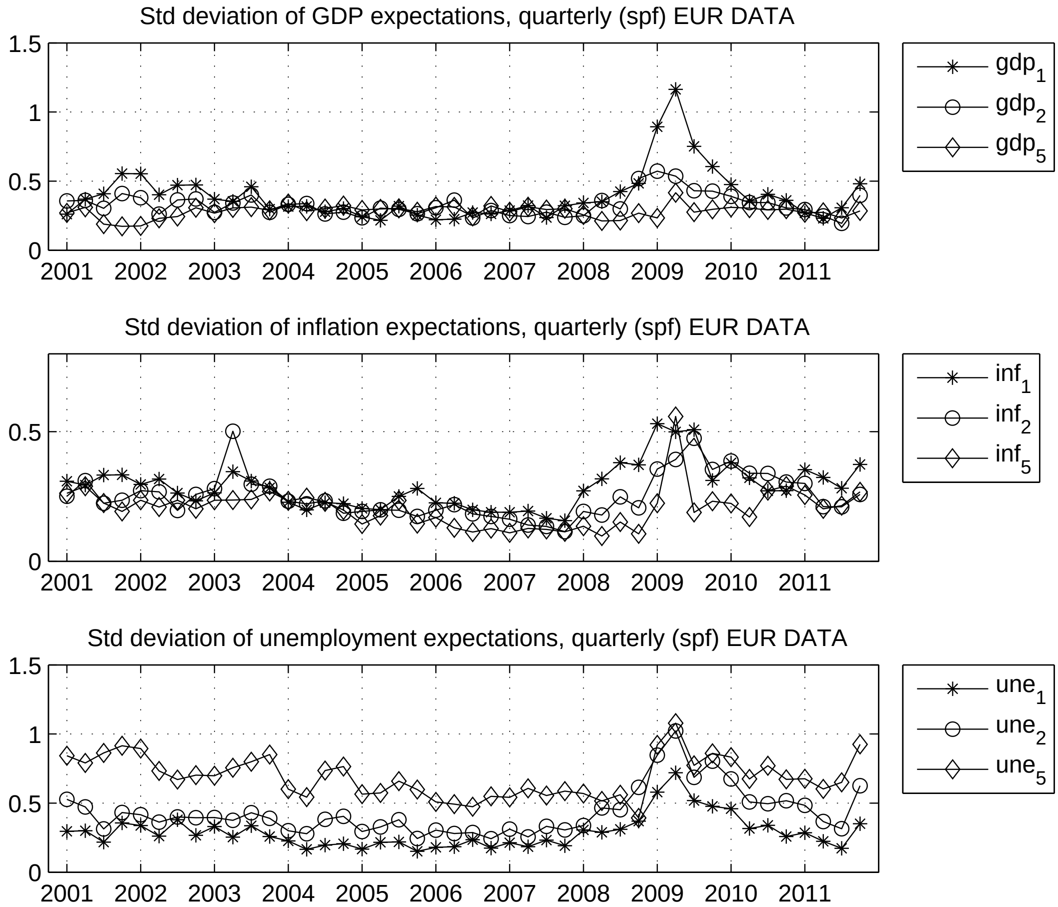

Figure 1: Std Deviation of GDP, Inflation, Unemployment, EUR

in the Euro zone, see, for example, Gerlach et al. (2011) This thought is fostered as the dispersion of expectations has not been recovered totally since its peak 2009.

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.

Unemployment uncertainty has also been risen during the crisis no matter the time aspect. However, the acceleration was very moderate and uncertainty has nearly recovered the years after with a slight rise during the most recent quarters of 2011.

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 during the crisis, long-term expectations of GDP growth and inflation remain nearly unchanged. This finding is not in contradiction to the standard deviation findings; a constant mean is in line with a high standard deviation where extrema net each other out.

US Survey Data

Figure 3 and 4 plot standard deviation and mean of the variables listed in Table 2.[3]

RGDP 1 year ahead (rolling)	$RGDP_1$
TGDP 10 years ahead	$RGDP_{10}$
Inflation 1 year ahead (rolling)	CPI_1
Inflation 10 years ahead	CPI_{10}
Unemployment 1 year ahead (rolling)	UNE_1

Table 2: Survey Data, US

Interpreting the US data is more difficult than the European data as the picture is less uniform. Even an outstanding event, such as the financial crisis, is less obvious in the US data and can only hardly be detected.

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

[3] For better discrimination, US values are abbreviated with capital letters and the acronym for inflation is CPI.

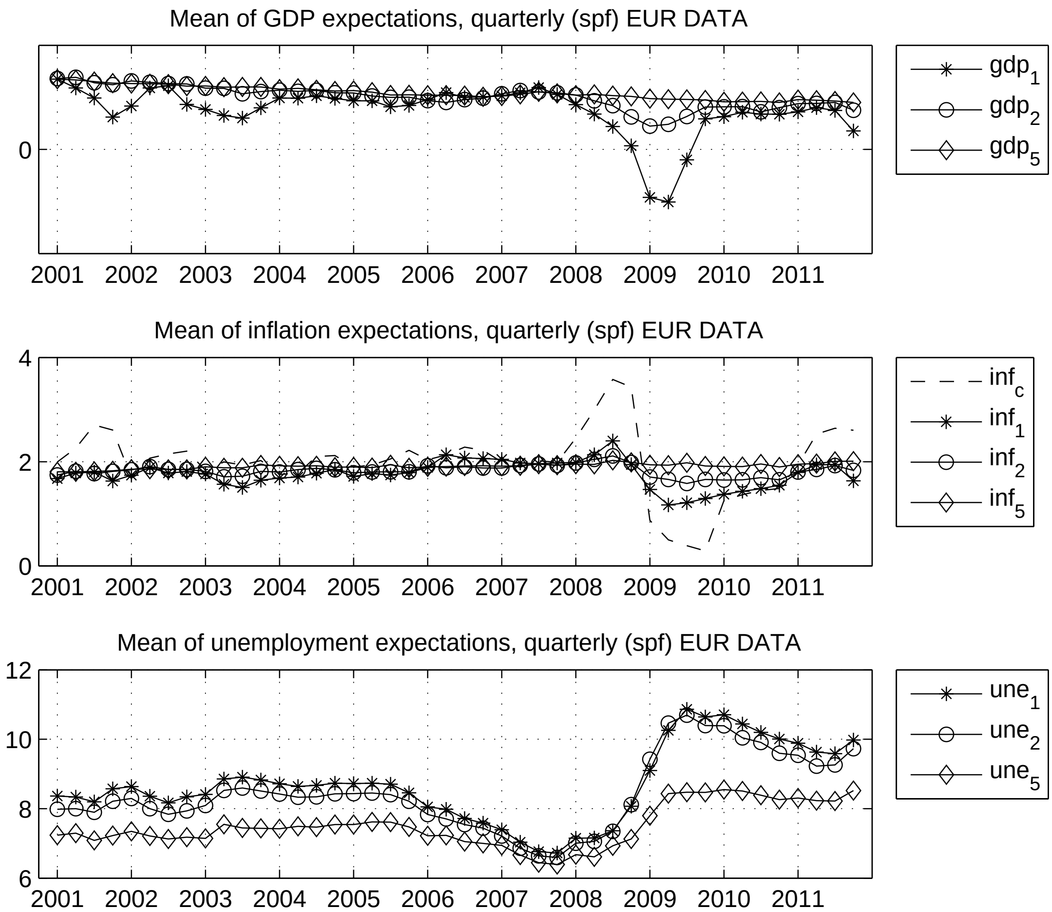

Figure 2: Mean of GDP, Inflation, Unemployment, EUR

2007 with the beginning of the financial crisis. During all these periods, uncertainty about the ten year outlook remains quite low and only short-term variations occur.

Inflation uncertainty seems to be rather erratic. Short and long-term uncertainty perform a slow acceleration starting already 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.

Unemployment uncertainty rises vis-à-vis the evolving financial turmoil and has still not yet recovered to the pre-crisis level.

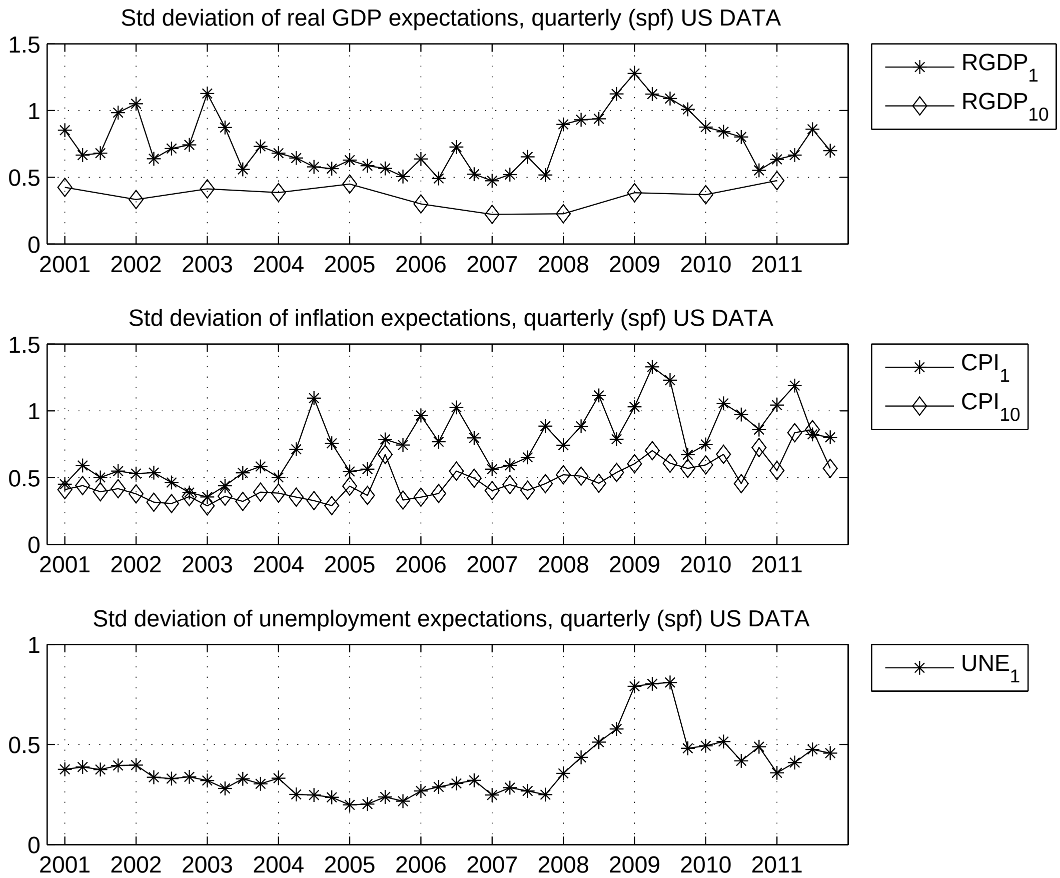

Figure 3: Standard deviation of real GDP, inflation, and unemployment, US

Taking into account the mean values, plotted in Figure 4, the drop of expectations regarding real GDP growth becomes obvious. The bottom is hit at the first quarter of 2009, the same time when uncertainty hits the ceiling. However, the mean recovers fast till it reaches pre-crisis levels in 2011, which was also true for real GDP uncertainty in Figure 3.

Comparing mean and standard deviation, 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, mean and standard deviation remain quite constant during the years.

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.

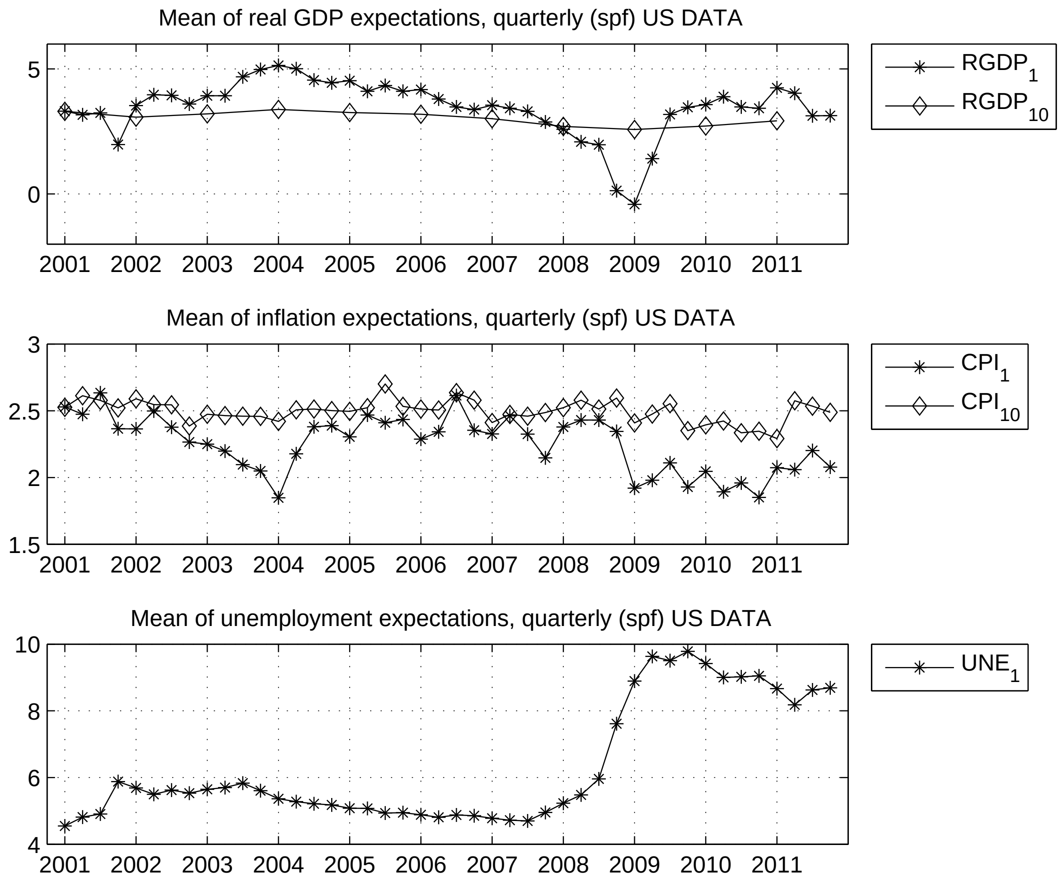

Figure 4: Mean of real GDP, inflation, and unemployment, US

3.2 Stock Market Indices

Figure 5 captures the implied volatility for the European and the US stock market, measured by the VIX and VSTOXX. Both indices are calculated as a weighted average of options on the S&P 500 and the EURO STOXX 50, respectively. The higher its value, the higher the expected variance of the underlying which serves as an indicator of uncertainty.

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 uncertainty concerning the European and American stock market.

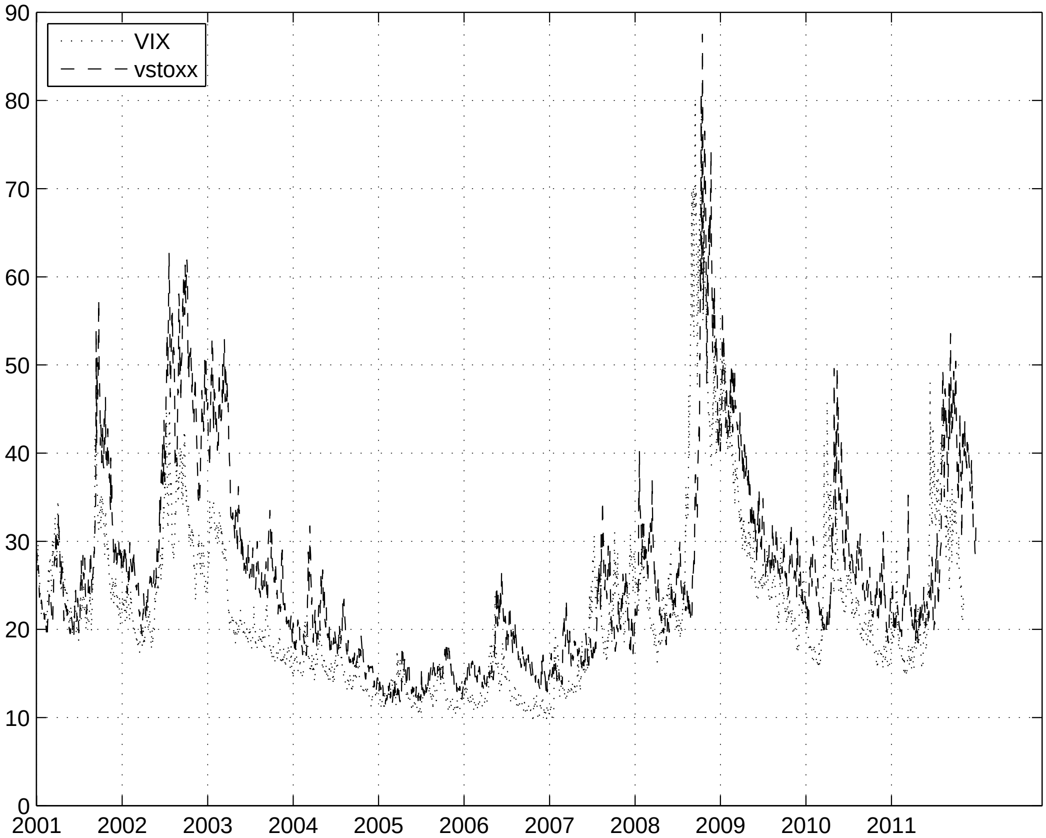

Figure 5: VIX (US), vstoxx (EU), daily

Compared to the survey measure, the stock market measure is more sensitive to unforeseen shocks. This is due to several reasons. Most important, stock prices 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. 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 developments of the past 10 years. Some crucial events are the first peak at the end of 2001 which is owed to the terror attacks of 9/11. The mid-2002 hump corresponds to the US corporate scandals (Enron, WorldCom, AOL, etc.) on the basis of which the Sarbanes-Oxley Act was passed. The following little hump can be 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.

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.

4 Factor Analysis

4.1 Short Introduction into the General Method

Factor analysis is a tool to reduce the complexity of a given data set. The aim is to identify a number of factors which contribute in interpreting and presenting the original data in a more convenient. Those extracted factors are not direct observable. They only become visible by utilizing the covariance or correlation matrix of the original data set.[4]

Factor analysis presumes a theoretical model, where each variable, y_j $(j = 1, \dots, m)$, is a linear combination of the underlying factors, f_k $(k = 1, \dots, p)$ and some residual component, e_j. Each factor is loaded with λ, in which λ_{jk} is the weight of the k-th factor on the j-th variable. This relationship is written as

$$y_j = \lambda_{jk} f_k + e_j, \tag{4.1}$$

which is equivalent to the matrix notation

$$y = \Lambda f + e, \tag{4.2}$$

4 The general method of factor analysis can be found in several textbooks. For the rest of this section I rely mainly on Rinne (2000).

with $y' = (y_1, \ldots, y_m)$, $f' = (f_1; \ldots; f_p)$, and $e' = (e_1, \ldots, e_m)$. The respective loadings are summarized according to

$$\Lambda := \begin{pmatrix} \lambda_{1,1} & \cdots & \lambda_{1,p} \\ \vdots & \ddots & \vdots \\ \lambda_{m,1} & \cdots & \lambda_{m,p} \end{pmatrix}. \tag{4.3}$$

As the aim of factor analysis is the reduction of the complexity of the original data, it must hold that $p < m$, i.e., the number of factors is less than the number of variables of interest.

Under the assumption that, (1) the error terms are independent of each other, have zero mean and constant variance and (2) the unobservable factors are independent from each other, have zero mean and a constant variance of 1, the covariance structure of the hypothetical model can be calculated. The variance of y_j is

$$Var(y_j) = \sum_{k=1}^{p} \lambda_{jk}^2 Var(f_k) + Var(e_j) = 1 \tag{4.4}$$

$$= \sum_{k=1}^{p} \lambda_{jk}^2 + \sigma_j^2 \tag{4.5}$$

The first part on the right-hand-side of equation (4.5) is called *communality* of variable y_j. A convenient writing is $h_j^2 := \sum_{k=1}^{p} \lambda_{jk}^2$. It is the part of a variance of each variable, which is explained by the common factors. For two common factors the communality would be given as $h_j^2 = \lambda_{j1}^2 + \lambda_{j2}^2$, where the first part is attached to the first common factor and the second part to the second common factor, respectively. The sum of all communalities, no matter the variable, is defined as $h^2 := \sum_{j=1}^{m} h_j^2$.

The second part of equation (4.5) is called *specific variance*. It accounts for the part of variance which is not explained by the common factors, hence, which is factor specific. If in the hypothetic model of equation (4.1) y_j could be fully explained by $\lambda_{jk} f_k$, hence the common factors, the error term and thus the variance would equal zero.

For each two variables the covariance can be calculated such that

$$Cov(y_j, y_i) = \sum_{k=1}^{p} \lambda_{ik}\lambda_{jk}, \quad (j \neq i) \tag{4.6}$$

$$= \Lambda\Lambda' \tag{4.7}$$

Combining equation (4.5) and (4.6), the correlation matrix R of the original data becomes

$$R = \Lambda\Lambda' + \Psi \tag{4.8}$$

with Ψ representing the specific variance on its diagonal elements and all off-diagonal elements zero.

Equation (4.8) is said to be the *theoretical variance covariance matrix*. In order to remove specific variances, $R_h = R - \Psi = \Lambda\Lambda'$ is calculated. The reduced correlation matrix R_h contains the communalities on its diagonal and the correlations coefficients on the off-diagonal positions.

Finding the right loadings in R_h is equivalent to a factorization of R_h. However, the solution is not trivial, there may exist multiple solutions.

Determining the loadings of the factors I will use the maximum-likelihood method. The number of extracted factors is deduced via the Kaiser criterion (Kaiser 1970; Kaiser and Rice 1974). For $m = p$ no further information would be generated and no reduction of the data complexity is achieved. Thus, as an upper bound it must hold $p < m$. If the eigenvalue of a factor is greater than one, it explains more of the total variation than any other single variable. Vice versa, if the eigenvalue is smaller than one, the factor explains less than any single variable. Subsequently, as a lower bound, as many factors as eigenvalues larger than one should be taken into account. In general, one would choose as many factors as eigenvalues greater one, which is, according to Kaiser (1970), called, the *natural* number of factors. However, an increase in the number of factors does not substantially affect the value of major factors. In any case, these criteria can only serve as a guideline. To find the right number of factors there should always be an economic reasoning; either ex ante or ex post (Kaiser 1970).

As any orthogonal or oblique rotation of the factor loadings is done with the help of a transformation matrix P, such that

$$R = (LP)(LP)' + \Psi \tag{4.9}$$

$$= LPP'L' + \Psi \tag{4.10}$$

$$= LL' + \Psi \tag{4.11}$$

rotation enables the researcher to draw a picture of the data, which fits best according to the purpose of his research goal. Due to the fact that the factors as well as their respective loadings are rotated, the initial equation (4.8) is not violated, but only represented in a different, more convenient, way. Among others, the most prominent orthogonal rotation form is *varimax*, the most prominent oblique rotation form is *promax*. For an oblique transformation the extracted factors are not independent from each other and can be interpreted as correlations which is the case using varimax rotation; I will make use of both methods.[5]

4.2 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 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 of uncertainty is some kind of general, macroeconomic uncertainty. This latent but not direct observable force can become visible with he help of factor analysis.

For the Euro area, my data set consists of variables taken from the SPF and the VSTOXX; they are listed in Table 3. The last column gives the abbreviations used for further analysis. All variables are taken from 2001q1 till 2011q4.

The Kaiser-Meyer-Olkin (KMO) criterion value is 0.75, which is according to Kaiser and Rice (1974) "middeling".[6] 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.

The Eigenvalues are listed in Table 4. To find the right number of underlying driving factors, I follow Kaiser and Rice (1974) and assume as many factors, as eigenvalues

[5] It should be mentioned, that factor analysis offers a lot of space in terms of execution and interpretation. This is true for finding the right number of factors, as there is no compulsory rule, when to chose which rotation method and if so, to which amount a rotations should be conducted. All these degrees of freedom should not be mistaken for "data manipulation". However, it should rather be taken as an advantage of this method, to illustrate the data in a convenient way which helps the author to make his idea more conspicuous. As Steve Jobs would say: Its not a bug, its a feature.

[6] 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".

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 3: Data Set FA, EUR

greater one. Two eigenvalues can be identified which fulfill this criterion, hence, two common factors are extracted.

Eigenvalues
4.05
1.34
0.70
0.46
0.22
0.15
0.07

Table 4: Eigenvalues FA, EUR

Table 5 lists the respective factor loadings of the two factors as well as the Communality and the specific variance, i.e., the uniqueness. The loadings are generated using *Promax* rotation.[7] For a better representation all factor loadings absolutely smaller than 0.25 have been removed from the table. Column 4 and 5 comprise the communality and uniqueness no matter their value. The loadings are also plotted in Figure 6.

As can be seen very clearly even from Table 5, 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 highly loaded by Factor 1. Opposed to that, long-term forecasts (gdp_5, inf_5 and une_5) are loaded predominately by Factor 2.

This loading patten is in line with an economic interpretation of a separation between short and long-term drivers of uncertainty, see, for example, Caporale and Kontonikas

7 The varimax-method delivers a very similar picture. For interpretation and presentation, however, promax seems to be more appropriate as it highlights the specific loadings more clearly.

Variable	Factor 1	Factor 2	Communality	Uniqueness
$vstoxx$	0.6584	-	0.4467	0.6269
gdp_1	0.9095	-	0.8327	0.1012
gdp_5	-	0.4780	0.2727	0.8252
inf_1	0.8445	-	0.7133	0.2944
inf_5	-	0.9718	0.9032	0.0050
une_1	0.9572	-	0.9168	0.0616
une_5	0.4017	0.5225	0.4344	0.3612

Table 5: Loadings EUR, Promax rotation (cropped)

(2006); Caporale et al. (2010) where the authors distinguish between the development of short-run and long-run inflation uncertainty for different European countries. Ball et al. (1990) reason that, 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.

Uncertainty about future development of a variable and anchored expectations are just two sides of the same coin. Low uncertainty can be put on a level with well anchored expectations and vice versa. Hence, as uncertainty is driven by two latent forces one could also say that expectations are anchored in two different ways, depending on there future horizon. This reasoning is also supported by the findings of Figure 1. The standard deviation of long-term expectations seems to be decoupled from short-term movements. This holds especially under turbulent times such as the financial crisis where the standard deviation of long-term expectations remains quite low compared to short-term movements, which is equivalent to well anchored long-term expectations and at least less anchored short term expectations.

This pattern, deduced from factor analysis and Figure 1 is especially pronounced for inflation uncertainty, hence, anchoring of inflation expectation. According to Figure 1, this finding should also hold for GDP growth; But factor analysis does not support this view as long-term GDP growth has only a weak loading of 0.47. However, due to the poor MSA value and the high specific variance of long-term GDP growth uncertainty (0.83), factor analysis is not meaningful enough for gdp_5 and I rely rather on the graphical standard deviation representation. Unemployment, neither from Figure 1, nor factor analysis can be put in this sharp distinction. Long-term uncertainty seems to follow its own force till 2007 and co-moves with short-term uncertainty from then on. This view is supported by the factor analysis which extracts one factor for short-term unemployment uncertainty with a high loading of 0.95, but an additional second driving forces of long-term unemployment uncertainty. Hence, while short-term uncertainty is driven by one force, long-term uncertainty is nearly equally driven by two forces.

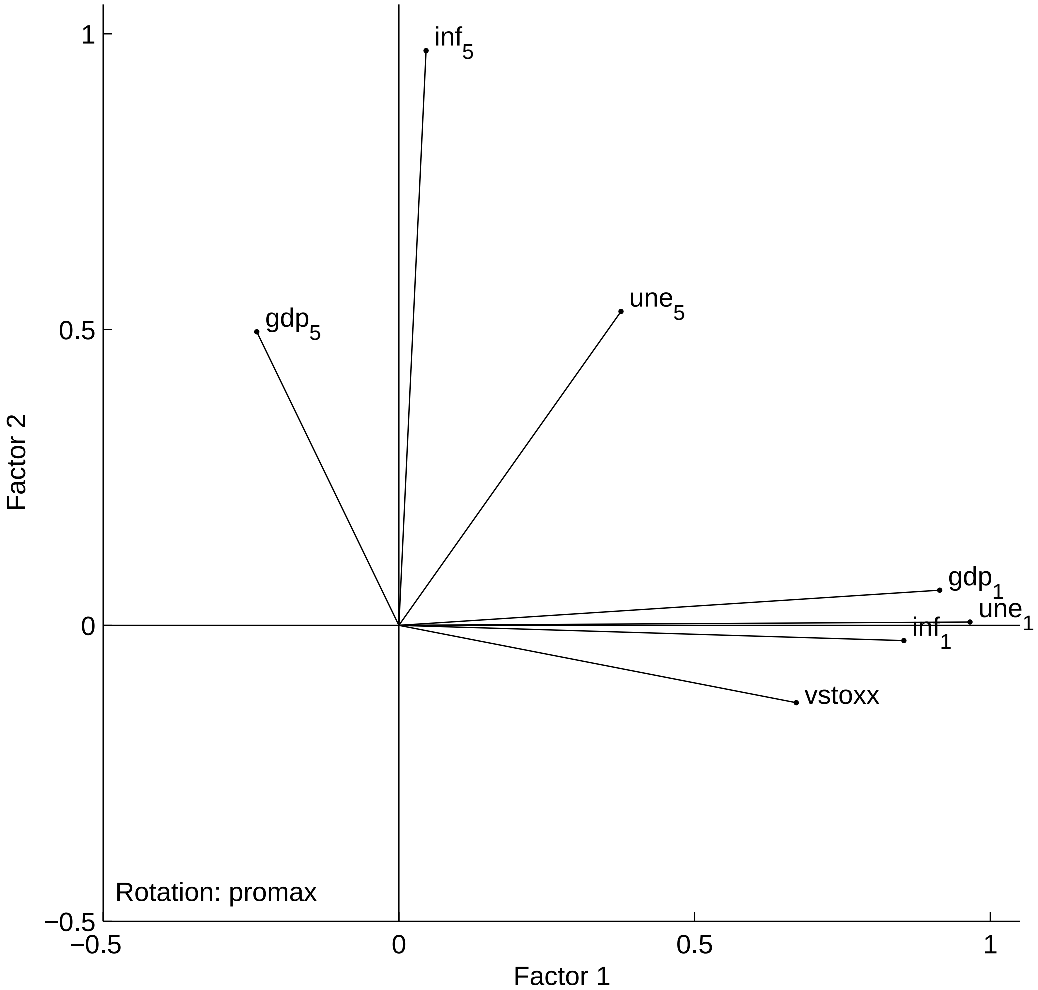

Figure 6: Loadings EUR, promax rotation

Figure 6 shows Factor 1, which I declare as 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. This holds especially for inflation uncertainty and only to a less amount for GDP growth and unemployment uncertainty.

4.3 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 6. Except for the standard deviation of long-term inflation expectations, which is a ten year forecast, all variables are the standard deviation of 4 quarters ahead forecast.

Stock market data	VIX	VIX
	Inflation 1 year rolling	CPI_1
	Inflation 10 years ahead	CPI_{10}
Survey Data	Real Consumption 1 year rolling	$RCONSUM_1$
	Real GDP 1 year rolling	$RGDP_1$
	Unemployment 1 year rolling	$UNEMP_1$

Table 6: Data Set FA, US

The KMO criterion offers a value of 0.75 for the given data set which is according to Kaiser and Rice (1974) “middling”. All MSA values are at least larger than 0.5, hence “acceptable”. The eigenvalues are given in Table 4. Again, two eigenvalues larger then one can be identified (3.47 and 1.46), thus, factor analysis is conducted with the assumption of two factors.

The loadings are given in Table 7 where all values smaller than 0.17 have been removed for convenience. I conduced the orthogonal varimax rotation, the extracted factors are thus independent from each other. Nevertheless, the results using promax are comparable. As before, the last two columns give the communality and uniqueness, respectively.

According to Table 7, stock market volatility, real consumption and real GDP are solitary loaded by Factor 1. Inflation uncertainty – short and long-term – is 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.

Variable	Factor 1	Factor 2	Communality	Uniqueness
VIX	0.8195	-	0.6774	0.3226
CPI_1	-	0.7793	0.6115	0.3885
CPI_{10}	-	0.7661	0.6059	0.3941
$RCONSUM_1$	0.8484	-	0.7317	0.2683
$RGDP_1$	0.8877	-	0.8164	0.1836
$UNEMP_1$	0.7244	0.6256	0.9162	0.0838

Table 7: Loadings US, varimax rotation (cropped)

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 which explains for both variables around 60% of the variation. Hence, the distinction made for the European data, which was encouraged by the literature, 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.

With the exception of unemployment uncertainty, US data offers a distinction between *real* and *nominal* values which reminds of the "classical dichotomy". As the volatility index is based on the stock market and stock prices are based indirectly on real developments, the VIX fits very well into this categorization. This situation is also given in Figure 7, where Factor 1 on the horizontal axes is plotted against Factor 2 on the vertical axes. Very clearly one can see, how all real values gather around the horizontal axes while opposed to that CPI_1 and CPI_{10} have a vertical orientation. Finally, unemployment is right in the middle.

To conclude the region specific analysis, a very different picture is offered, depending on the region of interest. For the Euro area a distinction concerning the loadings between long-term and short-term uncertainty can be identified which especially holds for inflation uncertainty and, though less, for GDP growth and unemployment uncertainty. These findings are also reinforced by the existing literature. The US factor analysis suggests no distinction between long and short-term uncertainty on inflation. Much more there is a classical distinction between uncertainty about monetary values – no matter their time aspect – and real variables including stock market uncertainty.

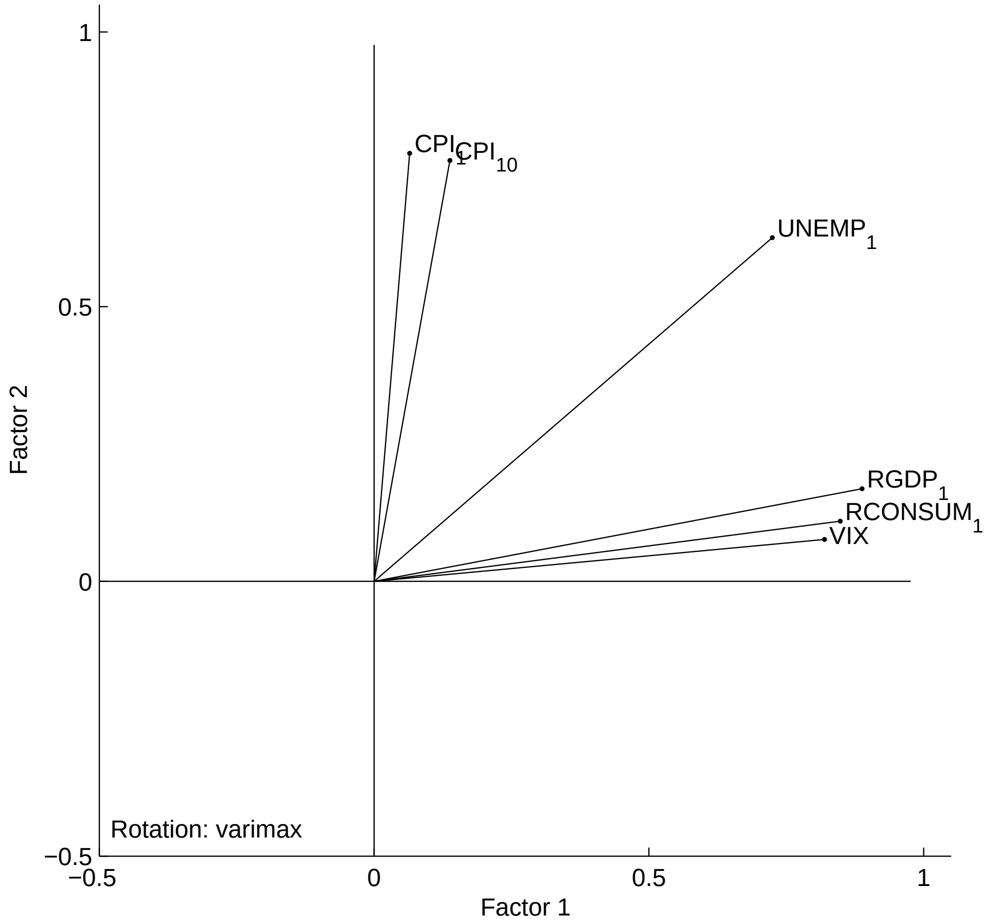

Figure 7: Loadings US, varimax rotation

4.4 Combined Factor Analysis of US and European data

After both regions have been analyzed separately, in what follows a global factor analysis is conducted which covers both data sets. 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 factor, this would also give evidence for a common, strongly connected market in which developments can no longer be treated as independent from each other.

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 8. The overall KMO criterion is 0.8, which is according to Kaiser and Rice (1974) "meritorious".

Stock market data	VSTOXX	$vstoxx$
	VIX	VIX
Survey Data US	Inflation 1 year rolling	CPI_1
	Inflation 10 years ahead	CPI_{10}
	Real Consumption 1 year rolling	$RCONSUM_1$
	Real GDP 1 year rolling	$RGDP_1$
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 8: Data Set FA, US & EUR

The eigenvalue criterion suggests three common factors loading uncertainty in the US and Europe. Loadings, communality and uniqueness produced by *varimax* rotation are listed in Table 9 and presented graphically in Figure 8. The upper panel of Table 9 shows US, the lower panel Euro Zone values. For an easier interpretation, Table 10 dismisses all loadings with a value less than 0.3. US values are written in capital letters, European values are written in lowercases to give a more convenient reading.

What can be seen in Table 10 is that, despite other connections, there is strong connection between the European and US volatility index. Factor 1 loads both of them very high with values larger than 0.9. This factor accounts for more than 99% of the US stock market uncertainty and nearly 90% of the European stock market uncertainty.

Variable	Factor 1	Factor 2	Factor 3	Communality	Uniqueness
VIX	0.9839	0.1462	0.0743	0.9950	0.0050
CPI_1	-0.0342	0.0853	0.9604	0.9308	0.0692
CPI_{10}	0.1603	0.0814	0.6227	0.4201	0.5799
$RCONSUM_1$	0.6467	0.3967	0.2188	0.6234	0.3766
$RGDP_1$	0.6500	0.4849	0.1714	0.6870	0.3130
$vstoxx$	0.9183	0.1896	-0.0201	0.8797	0.1203
gdp_1	0.4527	0.7947	0.2532	0.9006	0.0994
inf_1	0.4771	0.6165	0.3886	0.7586	0.2414
inf_5	0.0878	0.6633	0.0712	0.4528	0.5472
une_1	0.4747	0.7869	0.2754	0.9204	0.0796
une_5	0.1337	0.7917	-0.0927	0.6533	0.3467

Table 9: Loadings US & EUR, Varimax rotation

Variable	Factor 1	Factor 2	Factor 3	Communality	Uniqueness
VIX	0.9839	-	-	0.9950	0.0050
CPI_1	-	-	0.9604	0.9308	0.0692
CPI_{10}	-	-	0.6227	0.4201	0.5799
$RCONSUM_1$	0.6467	0.3967	-	0.6234	0.3766
$RGDP_1$	0.6500	0.4849	-	0.6870	0.3130
$vstoxx$	0.9183	-	-	0.8797	0.1203
gdp_1	0.4527	0.7947	-	0.9006	0.0994
inf_1	0.4771	0.6165	0.3886	0.7586	0.2414
inf_5	-	0.6633	-	0.4528	0.5472
une_1	0.4747	0.7869	-	0.9204	0.0796
une_5	-	0.7917	-	0.6533	0.3467

Table 10: Loadings US & EUR, Varimax rotation (cropped)

Accordingly both variables exhibit a specific variance (uniqueness) close to zero. A specific variance of zero would indicate that the respective variable is solely driven by the common factors. Given this result, I declare Factor 1 as the “international stock market uncertainty factor”

Factor 2 is the “European uncertainty factor”. Besides the stock market index, all European variables no matter their time horizon 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 loads to a high amount US inflation uncertainty and to a less extend short-term European inflation uncertainty. However, long-term US uncertainty also shows a high amount of uniqueness. I declare Factor 3 as the "US inflation uncertainty factor".

Despite those 'first-look' explanations, there are several connections between variables and factors. Factor 1 not only loads stock market data but – to a smaller extent – also US real variables $RGDP_1$ and $RCONSUM_1$ and to even less extent European short-term variables gdp_1, inf_1 and une_1. That is, uncertainty concerning the stock market here and abroad is also connected to uncertainty about the real development of the US and European economy. Due to the amount of the respective loading and the affected variables, I would reason that, uncertainty on behalf of the development of the US economy also dominates uncertainty about the short term-development of the European economy.

The opposite picture gives Factor 2. As Factor 1 was high on US and low on European values, Factor 2 is high on European and low on US values. This finding confirms the previous separation between a US and a European uncertainty facto and shows the strong connection of the European an the US economy at least for the short-term horizon.

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 7), whereas US inflation is independent of any other variable.

The previous pattern of a short–long distinction for the European data and a real–monetary distinction of the US data fades as both data sets are combined. This is particularly true for the European analysis. As before, the US data still provides a distinction between a real factor and a monetary factor 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.

Interpreting these findings must be done with caution. The different pattern reflects differences between both economic regions. Those differences can arise out of the different cultural or institutional backgrounds. However, from an monetary policy perspective, 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. Additionally, the Fed is only in charge of price stability and not mandated to promote maximum employment and moderate long-term interest rates. Hence, the

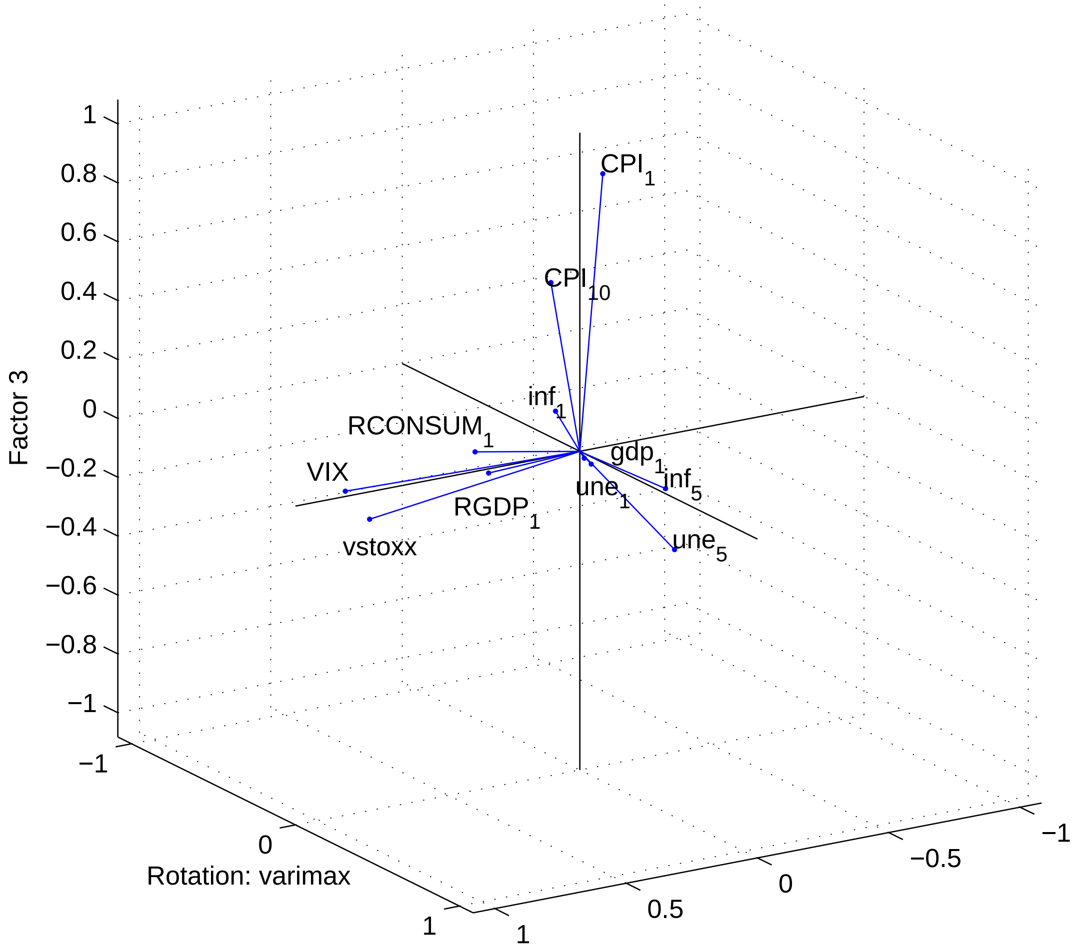

Figure 8: Loadings US & EU, varimax rotation

different uncertainty forces of real and monetary values could originate from the threefold mandate 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.

5 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 long distinction, US factor analysis delivers a rather “classical” picture of a “real” and a “monetary” factor. 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.

References

Ball, L., S. G. Cecchetti, and R. J. Gordon (1990): "Inflation and Uncertainty at Short and Long Horizons," *Brookings Papers on Economic Activity*, 1990, 215–254.

Barro, R. J. and D. B. Gordon (1983): "A Positive Theory of Monetary Policy in a Natural Rate Model." *Journal of Political Economy*, 91, 589 – 610.

Bekaert, G., M. Hoerova, and M. L. Duca (2010): "Risk, Uncertainty and Monetary Policy," NBER Working Papers 16397, National Bureau of Economic Research, Inc.

Black, F. and M. S. Scholes (1972): "The Valuation of Option Contracts and a Test of Market Efficiency." *Journal of Finance*, 27, 399 – 417.

——— (1973): "The Pricing of Options and Corporate Liabilities." *Journal of Political Economy*, 81, 637 – 654.

Blinder, A. S. (1998): *Central banking in theory and practice*, MIT Press, 4. ed.

Bowles, C., R. Friz, V. Genre, G. Kenny, A. Meyler, and T. Rautanen (2007): "The ECB survey of professionla forcasters (SPF) - A review after eight years experience," Occasional Paper Series 59, ECB.

Brainard, W. (1967): "Uncertainty and the effectivness of policy," *American Economic Review*, 57, 411–425.

Caporale, G. M. and A. Kontonikas (2006): "The Euro and Inflation Uncertainty in the European Monetary Union," CESifo Working Paper Series 1842, CESifo Group Munich.

Caporale, G. M., L. Onorante, and P. Paesani (2010): "Inflation and inflation uncertainty in the euro area," Working Paper Series 1229, European Central Bank.

Croushore, D. (1993): "Introducing: the survey of professional forecasters," *Business Review*, 3–15.

——— (2010): "Philadelphia Fed forecasting surveys: their value for research," *Business Review*, 1–11.

ECB (2006): "Measures of inflation expectations in the euro area," *Monthly Bulletin*, 7, 59–68.

——— (2009): "Expectations and the conduct of monetary policy," *Monthly Bulletin*, 5, 75–90.

——— (2011): "Inflation Expectations in the euro area: a review of recent developments," *Monthly Bulletin*, 2, 73–86.

Galati, G., S. Poelhekke, and C. Zhou (2009): "Did the crisis affect inflation expectations?" DNB Working Papers 222, Netherlands Central Bank, Research Department.

Geiger, F. and O. Sauter (2009): "Deflationary vs. Inflationary Expectations - A New-Keynesian Perspective with Heterogeneous Agents and Monetary Believes," Diskussionspapiere aus dem Institut für Volkswirtschaftslehre der Universität Hohenheim 312/2009, Department of Economics, University of Hohenheim, Germany.

Geiger, F., O. Sauter, and K. D. Schmid (2009): "The Camp View of Inflation Forecasts," Diskussionspapiere aus dem Institut für Volkswirtschaftslehre der Universität Hohenheim 320/2009, Department of Economics, University of Hohenheim, Germany.

Gerlach, P., P. Hördahl, and R. Moessner (2011): "Inflation expectations and the great recession," *BIS Quarterly Review*, 39–51.

Giordani, P. and P. Söderlind (2003): "Inflation forecast uncertainty," *European Economic Review*, 47, 1037–1059.

González-Páramo, J. (2008): "The financial market crisis, uncertainty and policy responses," Speech held at IE Business School Annual Alumni Conference, Madrid.

Hull, J. C. (2009): *Options, futures and other derivatives*, Pearson Education.

Kaiser, H. F. (1970): "A second generation little jiffy," *Psychometrika*, 35, 401–415.

Kaiser, H. F. and J. Rice (1974): "Little Jiffy, Mark IV," *Educational and Psychological Measurement*, 34, 111–117.

Kydland, F. E. and E. C. Prescott (1977): "Rules Rather than Discretion: The Inconsistency of Optimal Plans," *The Journal of Political Economy*, 85, 473–491.

Leduc, S., G. Rudebusch, and J. Weidner (2009): "Disagreement about the Inflation Outlook," *FRBSF Economic Letter*, 5.

Mankiw, N. G., R. Reis, and J. Wolfers (2003): “Disagreement about inflation expectations,” Working Paper 9796, Nationla Bureau of Economic Research (NBER).

Neely, C. J. (2005): “Using Implied Volatility to Measure Uncertainty About Interest Rates,” *Federal Reserve Bank of St. Louis Review*, 87, 407–425.

Rinne, H. (2000): *Statistische Analyse multivariater Daten*, Oldenbourg.

Söderlind, P. (2008): “Inflation Risk Premia and Survey Evidence on Macroeconomic Uncertainty,” Working paper series 2008-12, Department of Economics, University of St. Gallen.

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46-2012	Julian P. Christ and Ralf Rukwid	INNOVATIONSPOTENTIALE IN BADEN-WÜRTTEMBERG: BRANCHENSPEZIFISCHE FORSCHUNGS- UND ENTWICKLUNGSAKTIVITÄT, REGIONALES PATENTAUFKOMMEN UND BESCHÄFTIGUNGSSTRUKTUR	IK
47-2012	Oliver Sauter	ASSESSING UNCERTAINTY IN EUROPE AND THE US - IS THERE A COMMON FACTOR?	ECO