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## A Critical Look at Measures of Macroeconomic Uncertainty

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*Department of Economics*

# A Critical Look at Measures of Macroeconomic Uncertainty

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## A CRITICAL LOOK AT MEASURES OF MACROECONOMIC UNCERTAINTY

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# A Critical Look at Measures of Macroeconomic Uncertainty

David Kjellberg and Erik Post <sup>\*†</sup>

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## Abstract

This paper takes a critical look at available proxies of uncertainty. Two questions are addressed: (i) How do we evaluate proxies given that subjective uncertainty is inherently unobservable? (ii) Is there such a thing as a general macroeconomic uncertainty? Using correlations, some narrative evidence and a factor analysis we find that disagreement and stock market volatility proxies seem to be valid measures of uncertainty whereas probability forecast measures are not. This result is reinforced when we use our proxies in standard macroeconomic applications where uncertainty is supposed to matter. Uncertainty is positively correlated with the absolute value of the GDP-gap.

**Keywords:** Uncertainty, Macroeconomics, Survey Data

**JEL classification:** C42, C82

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# 1 Introduction

Uncertainty is a crucial element in modern macroeconomic theories and policy analyses. Since we cannot directly observe uncertainty we must use proxies in economic applications. It is therefore surprising that few studies have taken a critical look at available proxies of macroeconomic uncertainty to discern which are more appropriate than others as measures of uncertainty. In the few studies that exist, some preferred proxy is usually assumed to be the correct measure of uncertainty, and other proxies are evaluated by comparison with this preferred proxy. Such a procedure requires that we *know* a measure of uncertainty that is correct, and no such measure has been established for certain.

In this paper we offer an alternative narrative methodology that does not take a stand, *ex ante*, on a preferred proxy. Instead, we subject all available proxies to a test where we study if they react as expected to exogenous shocks to uncertainty. Also, we argue that although different proxies of uncertainty are connected to different macroeconomic variables, they should under reasonable assumptions be positively correlated. We investigate if this is the case empirically. Moreover, given that uncertainty could vary substantially across different variables, we ask the question if different types of uncertainty share a common factor.

The most commonly used proxy of uncertainty in applied work is some proxy of *stock market volatility* (e.g. Romer (1990) and Hassler (1996)). This proxy is usually employed without due motivation or reference to why stock market volatility would be appropriate. In this paper we also consider uncertainty proxies derived from surveys, targeted both at professional forecasters and the general public. These proxies are *disagreement proxies*, as they reflect the disparity of individual point forecasts. The ability of such disagreement proxies to capture aggregate uncertainty has been discussed in some papers (Zarnowitz and Lambros (1987) and Giordani and Söderlind (2003) *inter alia*). The general conclusion seems to be that disagreement proxies have reasonable properties as measures of uncertainty, and they have been used extensively; see e.g. Bomberger (1996) and Sepulveda (2003) who also provide further references. Lastly, we also consider *probability forecast proxies* obtained from professional forecasters who assign probabilities to interval outcomes of key variables. From a theoretical point of view this type of proxy is appealing since an approximation of the entire probability distribution is used to construct the uncertainty proxy.

We also try to evaluate the effects of uncertainty on aggregate consumption and residential investment. This can provide some further evidence on the usefulness of available proxies. We also study the co-movement of various uncertainty proxies

with the business cycle.

The results can be summarized as follows. The (implied) volatility proxy behaves as expected since it increases with exogenous events such as terrorist attacks and outbreaks of war, and decreases at presidential election outcome dates. The disagreement proxies also increase in response to events of conflict and financial crisis. Surprisingly, the probability forecast proxies do not react in any systematic way to these events. This finding is of special importance since the probability forecast proxies have been posited as "true" uncertainty and used to evaluate other proxies (e.g. in Zarnowitz and Lambros (1987)). In the light of our results, such a supposition is dubious. The correlation table for all available proxies indicates that various disagreement proxies are positively correlated. Also, there are some indications that volatility and probability forecast proxies are co-moving. Using factor analysis we find only one common factor across different variable proxies of uncertainty. This could be interpreted as there being only one fundamental factor of uncertainty that shows up in most proxies. When we use proxies of uncertainty in standard macroeconomic applications where uncertainty is supposed to matter, we find that all proxies generally have the expected effects, except the probability forecast proxies. This could be interpreted as further evidence of the inability of the probability forecast proxies to pick up uncertainty. Finally, we look at the evolution of proxies in relation to the business cycle. We find that uncertainty seems to be higher the further we are from the normal level of real activity in the economy.

The paper is organized as follows. In section 2 we introduce the concept of uncertainty within a simple model. The model is used to derive some properties of uncertainty which are considered in the subsequent analysis. Section 3 describes the different proxies considered. Section 4 attempts to evaluate uncertainty proxies based on some narrative evidence. Section 5 uses factor analysis to extract common factors across different proxies. Section 6 includes proxies of uncertainty in standard macroeconomic applications and examines how uncertainty co-moves with the business cycle. Section 7 concludes.

## 2 A model motivation

The aim of this section is to give some structure to the way we think about macro-economic uncertainty. We will discuss under what circumstances different types of uncertainty are related, and present a simple VAR model to illustrate how uncertainty in different variables will co-move under reasonable assumptions. For each variable, uncertainty is defined as its *expected* variance.

Consider a model economy that can be described by a trivariate VAR in GDP growth ( $y$ ), inflation ( $\pi$ ) and interest rates ( $i$ ). The first equation is an aggregate demand relation; the second can be said to represent supply and the third describes monetary policy. This model can compactly be written in matrix form as

$$AX_{t+1} = C + B(L)X_t + \varepsilon_{t+1}, \quad (1)$$

with  $X_t = \begin{bmatrix} y_t & \pi_t & i_t \end{bmatrix}'$ ,  $\varepsilon_t = \begin{bmatrix} \varepsilon_{1,t} & \varepsilon_{2,t} & \varepsilon_{3,t} \end{bmatrix}'$ .  $\varepsilon_t$  is interpreted as the vector of *structural*, unobserved, shocks to the economy.

Also, make the standard assumption that

$$Cov_t(\varepsilon_{t+1}) = E_t(\varepsilon_{t+1}\varepsilon_{t+1}') = \begin{bmatrix} \sigma_{1,t+1}^2 & 0 & 0 \\ 0 & \sigma_{2,t+1}^2 & 0 \\ 0 & 0 & \sigma_{3,t+1}^2 \end{bmatrix}, \quad (2)$$

indicating that the structural shocks are orthogonal to each other and has conditional expected variances  $\sigma_{t+1}^2 = \begin{bmatrix} \sigma_{1,t+1}^2 & \sigma_{2,t+1}^2 & \sigma_{3,t+1}^2 \end{bmatrix}'$ . Note that we allow for structural variances to be time-variant. Rewrite equation (1) in its reduced form by pre-multiplying by  $A^{-1}$ . We then get

$$\begin{aligned} A^{-1}AX_{t+1} &= A^{-1}C + A^{-1}B(L)X_t + A^{-1}\varepsilon_{t+1} \\ X_{t+1} &= D + G(L)X_t + e_{t+1} \end{aligned} \quad (3)$$

where  $e_{t+1}$  are the *reduced* form residuals obtained by estimation. These observed residuals are linear combinations of the structural shocks  $\varepsilon_{t+1}$ . Redefine  $A^{-1} = F$  and write the residuals explicitly as

$$e_{t+1} = F\varepsilon_{t+1}. \quad (4)$$

The coefficients in  $F$  capture the structural contemporaneous relations between the variables in the VAR and the structural shocks. In general all elements of  $F$  will be non-zero so that the variance covariance matrix of the reduced form residuals

$\Omega_{t+1} \neq 0$  for all elements. The general expression for  $\Omega_{t+1}$  becomes

$$\Omega_{t+1} = E_t \left( e_{t+1} e'_{t+1} \right) = E_t \left( F \varepsilon_{t+1} \varepsilon'_{t+1} F' \right). \quad (5)$$

The variances of the variables, the diagonal elements in  $\Omega_{t+1}$ , can be expanded as

$$Var_t(y_{t+1}) = f_{11}^2 \sigma_{1,t+1}^2 + f_{12}^2 \sigma_{2,t+1}^2 + f_{13}^2 \sigma_{3,t+1}^2, \quad (6)$$

$$Var_t(\pi_{t+1}) = f_{21}^2 \sigma_{1,t+1}^2 + f_{22}^2 \sigma_{2,t+1}^2 + f_{23}^2 \sigma_{3,t+1}^2, \quad (7)$$

$$Var_t(i_{t+1}) = f_{31}^2 \sigma_{1,t+1}^2 + f_{32}^2 \sigma_{2,t+1}^2 + f_{33}^2 \sigma_{3,t+1}^2, \quad (8)$$

where we see that the variance of each variable is a linear combination of *all* structural shock variances,  $\sigma_{t+1}^2$ . This implies that an increase in any element of  $\sigma_{t+1}^2$  will increase uncertainty of all variables. This occurs because of the contemporaneous relations through the  $F$ -matrix.

**Proposition 1** *All proxies of uncertainty are expected to move in the same direction to large exogenous shocks to uncertainty.*

Proposition 1 forms the basis for the narrative approach in section 4.1 where we evaluate available proxies of uncertainty by examining how they react to events which a priori should be expected to increase or decrease uncertainty.

In order to make statements about the possible correlations between  $Var_t(y_{t+1})$ ,  $Var_t(\pi_{t+1})$ , and  $Var_t(i_{t+1})$ , we need to consider the correlations of  $\sigma_{t+1}^2$ . According to expressions (6)-(8), with positive correlations between the elements of  $\sigma_{t+1}^2$ , the variances  $Var_t(y_{t+1})$ ,  $Var_t(\pi_{t+1})$ , and  $Var_t(i_{t+1})$ , will also be positively correlated. In fact, even if  $\sigma_{t+1}^2$  are uncorrelated, we will still have positive correlations between  $Var_t(y_{t+1})$ ,  $Var_t(\pi_{t+1})$ , and  $Var_t(i_{t+1})$  provided that the off-diagonal elements in  $F$  differ from zero. Imagine that uncertainty about the demand shock,  $\sigma_{1,t+1}^2$ , suddenly increases and  $\sigma_{2,t+1}^2$  and  $\sigma_{3,t+1}^2$  are unchanged. Since all expected variable variances contain  $\sigma_{1,t+1}^2$  the correlations between the variances should be positive.<sup>1 2</sup> This result is summarized in a second proposition.

**Proposition 2** *If structural shock variances,  $\sigma_{t+1}^2$ , are non-negatively correlated and at least one structural shock has contemporaneous effects on all variables in the economy, then uncertainty about all variables will be positively correlated.*

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<sup>1</sup>However, the correlations might be very small, but nevertheless positive. The size of the relation depends on the coefficients in  $F$  and the relative size of structural shock variances.

<sup>2</sup>Alternatively, if we assume the Choleski decomposition with  $f_{12} = f_{13} = f_{23} = 0$ , which is commonly done in the monetary policy literature, then all variables will share the  $\sigma_{2,t+1}^2$  component and still *positive* correlation will result.



This proposition indicates that the expected variance of any relevant macroeconomic variable should in theory reflect a conception of general macroeconomic uncertainty, as it includes several or all elements of  $\sigma_{t+1}^2$ . In section 4.2 we study the correlation table of all available proxies to see if this expected result holds.

The model suggests that we could have as many underlying factors of uncertainty as the number of variables. But it may be the case that, e.g.,  $\sigma_{1,t+1}^2$  varies where  $\sigma_{2,t+1}^2$  and  $\sigma_{3,t+1}^2$  are relatively stable. To investigate how many factors that drive uncertainty we will perform a factor analysis on the expected macroeconomic variable variances in section 5.

### 3 Uncertainty proxies

Both expected levels and expected distributions are unobservable in the sense that they are only available in the minds of the agents of the economy. While we can usually observe the outcome of a variable to evaluate expected levels; the expected distributions (i.e. uncertainty) have the disadvantage that there is no *ex post* observation of the actual conditional distribution. We exclude more complex methods of estimating the whole expected distribution, and focus on easily interpreted proxies of uncertainty that can be expressed by a single number, their expected variances.<sup>3</sup>

The data is in monthly or quarterly frequency for the US from 1980 to 2005. For several proxies we cannot find data as far back as 1980, which means we have to settle for what can be obtained. The proxies connected to the financial markets, i.e. the volatility proxies, are available for higher frequencies but for comparison purposes we use the monthly and quarterly versions of these proxies as well.

The acronyms are constructed according to the following logic. The first letter of the acronym denotes the type of proxy method: "D" for disagreement, "P" for probability forecast, and "V" for volatility. For the disagreement proxies we have two additional subgroups, proxies belonging to the quantitative Survey of Professional Forecasters and proxies belonging to the qualitative Michigan Consumer Survey. Thus, after "D", the next letter denotes the subgroup: "S" for the Survey of Professional Forecasters and "M" for the Michigan Consumer Survey. The last letter for all acronyms denotes the variable connected to each specific proxy. Table 1 illustrates the logic of the acronym constructions. See Tables 2 and 3 for a description of data and data handling.

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<sup>3</sup>The interested reader can consult Aguilar and Hördahl (1999) for a description on how to derive the full distribution of expectations through option pricing.

Table 1: Construction of acronyms for uncertainty proxies

First letter	Second letter	Third letter
D ( <b>D</b> isagreement)	S ( <b>S</b> urvey of Prof. Forecasters)	7 variables, see Table 3
	M ( <b>M</b> ichigan Consumer Survey)	8 variables, see Table 2
V ( <b>V</b> olatility)	O ( <b>I</b> mplied, based on <b>O</b> ption prices)	See Table 2
	H ( <b>H</b> istorical)	See Table 2
P ( <b>P</b> robability forecast)	Y ( <b>R</b> ead GDP % change)	See Table 3
	I ( <b>I</b> nflation)	See Table 3

Table 2: Acronyms and descriptions of uncertainty proxies

Acronym	Description	Sample
DMB	Business conditions during coming 12 months	1980m1-2005m6
DMF	Financial situation in 12 months	1980m1-2005m6
DMH	Buying conditions for houses	1980m1-2005m6
DMR	Expected change in interest rates the coming 12 months	1980m1-2005m6
DML	Buying conditions for large goods	1980m1-2005m6
DMD	Expected change in real family income the next years	1980m1-2005m6
DMU	Expected change in unemployment the coming 12 months	1980m1-2005m6
DMV	Buying conditions for vehicles	1980m1-2005m6
VH	Historical volatility, rolling 1-year standard deviation	1980m1-2005m12
VO	Implied volatility, monthly averages on daily OEX index	1986m1-2005m12

Note: Proxies derived from the Michigan Consumer Survey and Volatilities, monthly data

### 3.1 Stock market volatility proxies

A commonly used proxy for uncertainty is stock market volatility, which describes the variability of stock market returns. The typical volatility proxy for a stock market is the standard deviation, or variance, of stock index returns. Stock market volatility is an example of a market based proxy of uncertainty.

We use two different stock market volatilities, historical (VH) and implied volatilities (VO). The historical volatility is a moving standard deviation for a certain time span. In this paper we have included the monthly and quarterly frequencies for historical volatility of the S&P 500 index during the last 12 months, based on daily index returns. We have also included the implied stock market volatility, derived from prices of stock index options, in the form of an implied volatility index known as the VIX.<sup>4</sup> Implied volatility can therefore be considered a more forward looking proxy than historical volatility.

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<sup>4</sup>Supplied by the Chicago Board Options Exchange (CBOE)

Table 3: Acronyms and descriptions of uncertainty proxies, cont'd

Acronym	Description	Sample
DSP	Expected %-change in corporate profits 4 quarters ahead	1980q1-2005q4
DSI	Expected CPI-inflation 4 quarters ahead	1981q3-2005q4
DSH	Expected %-change in new housing starts 4 quarters ahead	1980q1-2005q4
DSC	Expected %-change in real consumption 4 quarters ahead	1981q3-2005q4
DSY	Expected %-change in real GDP 4 quarters ahead	1981q3-2005q4
DSR	Expected T-Bill interest rate 4 quarters ahead	1981q3-2005q4
DSU	Expected unemployment rate 4 quarters ahead	1980q1-2005q4
PY	Probability distribution for changes in real GDP next year, sa	1992q1-2005q4
PI	Probability distribution for inflation next year, sa	1992q1-2005q4

Note: Proxies derived from the Survey of Professional Forecasters, quarterly data

### 3.2 Disagreement proxies

Another type of proxy for uncertainty is the disagreement proxy as derived from survey responses. This proxy typically observes the cross-sectional standard deviation across individual point forecasts. It is important to recognize that this is a simple proxy of uncertainty as it only reflects the average disparity of the individuals' expected means of the distribution.

The disagreement proxies are of two different types. The first type consists of disagreement estimates based on quantitative point forecasts. These proxies all come from the Survey of Professional Forecasters and include disagreement about inflation (DSI), corporate profits (DSP), housing starts (DSH), real GDP (DSY), real consumption (DSC), T-bill rate (DSR), and the unemployment rate (DSU).

The second type of disagreement proxies is based on qualitative survey data. The data are presented as proportions of respondents who believe a variable will go up, down, or stay the same.<sup>5</sup> To derive proxies of uncertainty we follow Lyhagen (2001). By letting the proportions be parameters in a multinomial distribution we can calculate a variance to serve as a proxy of uncertainty. Let  $P_u$  denote the proportion of respondents who answer "Up", and  $P_d$  denote those who answer "Down". The sum of variances of these proportions becomes  $(1 - P_u)P_u + (1 - P_d)P_d$ . This variance proxy imply that if one of these proportions is equal to unity there is no uncertainty, and if both proportions equal 0.5 uncertainty is at its maximum.

The qualitative proxies of disagreement used in this paper are all derived from the Michigan Consumer Survey and include disagreement about business conditions (DMB), financial situation (DMF), buying conditions for houses (DMH), borrowing rate (DMR), buying conditions for large goods (DML), real family income (DMD),

<sup>5</sup>Or equivalently: "better", "same" or "worse".

unemployment rate (DMU), and buying conditions for vehicles (DMV).

### 3.3 Probability forecast proxies

The theoretically most appealing type of uncertainty proxy in this paper is what Sepulveda (2003) refers to as the *probability forecast proxy*. It is appealing because not only does it take into account disagreement but also the average individual forecast distribution. The Survey of Professional Forecasters includes a section in its questionnaire where the respondents are asked to state their expected probability over intervals of GDP growth and inflation for the next year. This yields a histogram representation of each forecaster's expected distribution at a certain point in time, making it possible to derive an average distribution of expectations.

In deriving the probability forecast proxies we follow Sepulveda (2003) as we first calculate each forecasters mean and standard deviation of the expectations at  $t$ . Then we simply take the average of the mean and the standard deviation, across all forecasters, to get both the average mean and the average standard deviation. Our derivation is a bit different from what is used in Sepulveda (2003), as we acknowledge the seasonality in the series and use a seasonal dummy approach to adjust for this pattern. The reason for seasonality is the declining forecast horizon as the forecaster approaches the forecast period. In other words, the forecaster obtain more and more information as he or she approaches the forecast period starting date and this is taken into account in deriving the proxy.

We include the derived expected variance of both real GDP growth and inflation (PY and PI).

## 4 Do uncertainty proxies measure uncertainty?

As stated in Proposition 1 we expect appropriate proxies to respond to exogenous shocks to uncertainty. Also, referring to Proposition 2 we have reasons to believe that uncertainty in all macroeconomic variables should be positively correlated.

### 4.1 Narratives

In order to evaluate alternative uncertainty proxies we rely on the idea that an appropriate uncertainty proxy should react to an unforeseen event that is thought to either increase or decrease uncertainty exogenously. The advantage of this approach is that we need not to assume that e.g. probability forecast proxies are the true uncertainty measures and proceed to evaluate other proxies based on their affinity with this type of proxy. Instead we assume that uncertainty proxies should increase with some unforeseen and exogenous events at certain dates, if not they cannot be said to measure uncertainty well. This narrative approach relies on identifying dates, corresponding to months or quarters, where uncertainty increased or decreased.<sup>6</sup>

For comparison purposes we restrict our attention to the time period 1987-2005 for which all but the probability forecast proxies are available. The choice of dates is subjective by nature but we have carefully applied the following criteria. *First*, the event should be such that when it occurs, it more or less instantaneously brings about a change of uncertainty in a particular direction. *Second*, it should be exogenous to the variable subjected to the test. We construct three sets of dummy variables. One is a dummy variable for military conflicts, *CONFLICT*, that includes two terrorist attacks and one military conflict. These episodes are also included in Chen and Siems (2004), where the authors study how returns of stocks have evolved during periods of military conflicts. One is a financial dummy, *FINCRISIS*, that includes two financial crises, and one is a dummy for regular US presidential elections, *ELECTION*, that includes five events. The episodes and dates are displayed in Table 4.

To most people the terrorist attacks on September 11 2001 should constitute an event that must have raised uncertainty instantaneously. Bartram, Brown, and Hund (2005) find evidence of an increase in the systematic component of risk and

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<sup>6</sup>In this paper we use an identification strategy by choosing dates that should represent *shocks to uncertainty*. An alternative, but much more difficult, strategy would be to measure *the arrival rate and signal quality of incoming information*. The more information we acquire and the better the information is, the less uncertain we are. Imagine a person reporting a probability forecast distribution of the weather tomorrow and then moving into a room without windows and no contact with the outside world. After a few days a new probability forecast distribution is reported. Supposedly, the mean is unchanged but the variance of the distribution has increased!

Table 4: Periods of shocks to uncertainty

<i>CONFLICT</i>		<i>FINCRISIS</i>		<i>ELECTION</i>
Aug 2 1990	Iraq invasion	Oct 19 1987	Black Monday	Nov 8 1988
Feb 26 1993	WTC bombing			Nov 3 1992
		March 10 2000	Dot Com crash	Nov 5 1996
Sep 11 2001	Terror attacks			Jan 6 2001
				Nov 2 2004

Bloom (2006) documents a dramatic increase in the number of times the wording "uncertainty" was used in the FOMC meetings right after the 9/11 attacks. These findings support the idea that uncertainty increased sharply with the 9/11 terrorist attacks.

The financial crises episodes in October 1987 and March 2000 are endogenous to the volatility proxies and therefore in these regressions only included as controls. For the other proxies no such problem should exist and we expect that all proxies should increase with these events as people were likely to become uncertain about the future performance of the economy given such large disruptions of the stock market.<sup>7</sup>

The presidential election outcomes are different from the other episodes. Although the presidential elections occur on regular dates, the *outcome* is unknown beforehand. When the outcome of the election becomes known, this implies a reduction of uncertainty, satisfying our first criterion of selection.<sup>8</sup> Also, the outcomes of presidential elections can be said to comply with our second criterion, exogeneity, since uncertainty does not affect the date of resolved uncertainty.

To test whether proxies of uncertainty have reacted as they are expected to do to these types of events we run the following regression for each of the considered uncertainty proxies ( $UP_t$ ),

$$UP_t = c + \beta_{LAG}UP_{t-1} + \beta_C CONFLICT + \beta_F FINCRISIS + \beta_E ELECTION + \varepsilon_t, \quad (9)$$

<sup>7</sup>As was put by Fed Governor Phillips (1997): "Such episodes [stock market crashes] are generally accompanied by dramatic increases in uncertainty".

<sup>8</sup>Election polls might of course indicate how uncertain the outcome is. This issue is ignored in this analysis and the negative shocks to uncertainty at the resolve of uncertainty are treated equally across elections.

where one lag of the proxy is included to purge the series of a predictable autoregressive component in the evolution of proxies.<sup>9</sup> We expect  $\beta_C$  and  $\beta_F$  to be positive and  $\beta_E$  to be negative.<sup>10</sup>

Table 5 indicates that we seem to have been quite successful in identifying dates when uncertainty *increased*, *CONFLICT* and *FINCRISIS*. The presidential election dummy, on the other hand, does not come in significant in any of the regressions. However, if we look at *daily* data of VO (implied volatility) in Figure 1, it is clear that for all elections except year 2000 the volatility *decreased* the day after the election. For the 2000 election, the volatility *increased* the day after the election, but we should note that the election outcome was not known at that time. The day after the decisive meeting in Congress on January 6 2001, volatility *decreased*. Also, VO exhibits a highly significant and positive sign on *CONFLICT*. These findings support the use of VO as a suitable proxy of uncertainty.

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<sup>9</sup>For quarterly measures the dummies are lagged one period to be sure to pick up the effect of the event at the time of the survey.

<sup>10</sup>The estimated parameters for the dummy variables will simply tell us if the unpredictable component in the proxy is significantly different from non-dummy periods.

Table 5: Dummy regression results

<i>UP</i>	<i>CONFLICT</i>	<i>FINCRISIS</i>	<i>ELECTION</i>	Old R2	New R2	Obs
DMB	-**	+***	-	0.76	0.77	222
DMF	+	-	-	0.18	0.17	222
DMD	+	+	+	0.01	0.01	222
DMU	+	+	+	0.59	0.54	222
DML	+*	+**	+	0.75	0.75	222
DMV	+*	+***	-	0.64	0.66	222
DMH	+*	+	-	0.73	0.73	222
DMR	+	-	+	0.80	0.80	222
VO	+***	(+***)	-	0.76	0.82	222
VH	+	(+***)	+	0.89	0.91	222
DSY	+	+**	-	0.06	0.13	74
DSC	+***	+**	+	0.13	0.28	74
DSP	+	-	+	0.34	0.30	74
DSU	+***	-	-	0.29	0.39	74
DSH	+***	+	-	0.22	0.31	74
DSI	+**	+	+	0.19	0.22	74
DSR	+	-	-	0.17	0.19	74
PY	-	+	+	0.08	0.07	55
PI	+	+	-	-0.02	-0.06	55

Note: The table only presents the sign of the estimated coefficients, as the size is not comparable across proxies. Old R2 is the r-square of the regression of equation 9, excluding the dummies. New R2 is the r-square when including the dummies. Obs is the number of observations. \*, \*\* and \*\*\* denote 10, 5 and 1 percent significance levels.



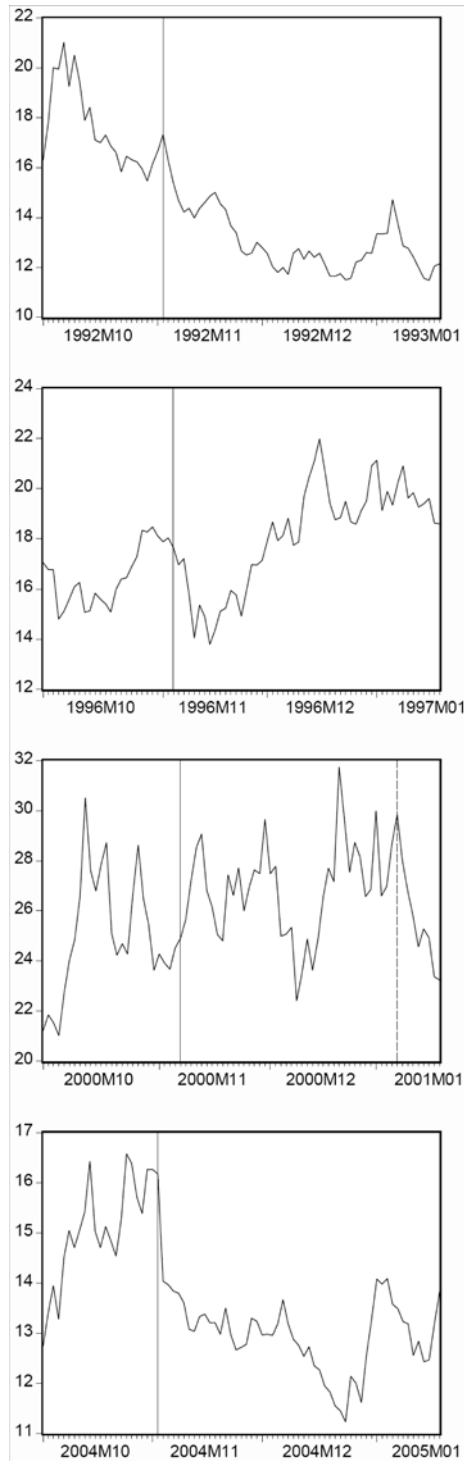


Figure 1: Daily implied volatility (VO) around US presidential elections 1992-2004  
 Note: The solid line indicates the election date (11/3/1992, 11/5/1996, 11/7/2000 and 11/2/2004).  
 The dashed line indicates the certification of the electoral vote in Congress 1/6/2001)

For the Michigan consumer survey proxies it is the proxy DMV, disagreement concerning buying condition for vehicles, that seems to be the best indicator by reference to its positive and significant estimates to both *CONFLICT* and *FINCRISIS*, as well as some increase in the adjusted R-squared when the dummies are included. For the survey of professional forecaster DSC, disagreement concerning real consumption, seems to be the most appropriate proxy of uncertainty with highly significant coefficient estimates for both *CONFLICT* and *FINCRISIS* and a large increase in the adjusted R-squared.

The probability forecast proxies, PY and PI, do not pick up any changes in uncertainty at the dummy dates. This is surprising given that these proxies are often believed to be more refined proxies of uncertainty. A possible reason could be that the sample period is somewhat shorter than for the other proxies. Nevertheless, this finding casts some doubt on the usefulness of these proxies of uncertainty.

Thus, the narrative evidence indicates that most survey based proxies and the volatility proxies have reacted as expected to exogenous shocks to uncertainty, while the probability forecast proxies show strikingly weak responses to these shocks.

## 4.2 Correlations

The Pearson's correlation coefficients between all considered proxies are illustrated in Figure 2.

	DMB	DMD	DMF	DMH	DMR	DML	DMU	DMV	DSP	DSH	DSC	DSY	DSR	DSI	DSU	PI	PY	VH	VO
DMB	1	0,30*	0,02	0,01	0,07	0,14	0,48*	-0,03	0,15	-0,27*	-0,14	-0,08	0,03	-0,12	-0,40*	0,08	-0,07	-0,09	-0,20
DMD	0,30*	1	-0,43*	-0,18	-0,36*	-0,45*	-0,03	-0,36*	-0,14	-0,47*	-0,24	-0,24	-0,22	-0,21	-0,52*	-0,02	0,01	-0,29*	-0,11
DMF	0,02	-0,43*	1	0,24	0,47*	0,75*	0,39*	0,55*	0,45*	0,70*	0,37*	0,46*	0,51*	0,49*	0,58*	0,10	-0,13	-0,10	-0,23
DMH	0,01	-0,18	0,24	1	0,18	0,35*	-0,03	0,60*	0,13	0,32*	0,05	0,21	0,24	0,36*	0,27*	-0,06	0,18	0,07	0,09
DMR	0,07	-0,36*	0,47*	0,18	1	0,66*	0,12	0,39*	0,23	0,46*	0,38*	0,39*	0,28*	0,24	0,49*	0,19	0,07	0,23	0,25
DML	0,14	-0,45*	0,75*	0,35*	0,66*	1	0,53*	0,62*	0,52*	0,63*	0,33*	0,45*	0,50*	0,47*	0,56*	0,20	-0,03	0,09	0,01
DMU	0,48*	-0,03	0,39*	-0,03	0,12	0,53*	1	0,09	0,52*	0,23	0,09	0,16	0,34*	0,29*	0,10	0,21	-0,03	-0,19	-0,30*
DMV	-0,03	-0,36*	0,55*	0,60*	0,39*	0,62*	0,09	1	0,12	0,55*	0,12	0,24	0,36*	0,38*	0,41*	-0,31	-0,34	-0,08	-0,22
DSP	0,15	-0,14	0,45*	0,13	0,23	0,52*	0,52*	0,12	1	0,43*	0,30*	0,37*	0,41*	0,39*	0,33*	0,34	0,21	0,04	0,03
DSH	-0,27*	-0,47*	0,70*	0,32*	0,46*	0,63*	0,23	0,55*	0,43*	1	0,56*	0,66*	0,72*	0,72*	0,69*	0,28	0,29	0,05	-0,07
DSC	-0,14	-0,24	0,37*	0,05	0,38*	0,33*	0,09	0,12	0,30*	0,56*	1	0,75*	0,46*	0,50*	0,59*	0,20	0,33	0,20	0,34*
DSY	-0,08	-0,24	0,46*	0,21	0,39*	0,45*	0,16	0,24	0,37*	0,66*	0,75*	1	0,68*	0,72*	0,65*	0,32	0,42*	0,21	0,44*
DSR	0,03	-0,22	0,51*	0,24	0,28*	0,50*	0,34*	0,36*	0,41*	0,72*	0,46*	0,68*	1	0,69*	0,52*	0,22	0,26	-0,01	0,02
DSI	-0,12	-0,21	0,49*	0,36*	0,24	0,47*	0,29*	0,38*	0,39*	0,72*	0,50*	0,72*	0,69*	1	0,60*	0,12	0,06	-0,06	-0,10
DSU	-0,40*	-0,52*	0,58*	0,27*	0,49*	0,56*	0,10	0,41*	0,33*	0,69*	0,59*	0,65*	0,52*	0,60*	1	0,06	0,09	0,20	0,30*
PI	0,08	-0,02	0,10	-0,06	0,19	0,20	0,21	-0,31	0,34	0,28	0,20	0,32	0,22	0,12	0,06	1	0,71*	0,30	0,31
PY	-0,07	0,01	-0,13	0,18	0,07	-0,03	-0,03	-0,34	0,21	0,29	0,33	0,42*	0,26	0,06	0,09	0,71*	1	0,47*	0,47*
VH	-0,09	-0,29*	-0,10	0,07	0,23	0,09	-0,19	-0,08	0,04	0,05	0,20	0,21	-0,01	-0,06	0,20	0,30	0,47*	1	0,80*
VO	-0,20	-0,11	-0,23	0,09	0,25	0,01	-0,30*	-0,22	0,03	-0,07	0,34*	0,44*	0,02	-0,10	0,30*	0,31	0,47*	0,80*	1

Figure 2: Correlations of all uncertainty proxies

Note: Numbers are Pearson correlation coefficients, with stars indicating that the estimate is significantly different from zero at the 1 percent significance level. The grey boxes show three groups of uncertainty proxies that have mainly positive intercorrelations within each group.

Indeed, a large share of the correlations are positive. Out of 190 correlations, 84 are significantly positive at the one percent level, as indicated by \*. Only eleven correlations are significantly negative. Generally, the disagreement proxies from the Michigan Consumer Survey and the Survey of Professional Forecasters survey data show rather high and significant correlations, both within and between groups. There are two exceptions. DMD, disagreement concerning real family income, is predominantly negatively correlated with the other proxies with eight out of 19 correlations being significantly negative. DMB, disagreement about the business conditions, is positively correlated with DMD and negatively correlated with a few other proxies. The results here thus indicate that DMD and DMB do not capture the same phenomenon as the other proxies.

The correlation coefficients between the disagreement proxies and the other proxies are mostly insignificant. Only six out of 64 correlations are significant at the one percent level. This result is very different from the positive relation between probability forecast proxies and disagreement proxies found in Zarnowitz and Lambros (1987). The reason for this finding could be that the sample periods are non-overlapping, and that we address the problem of different forecast horizons as explained above. The non-disagreement proxies, the volatility and probability forecast proxies, exhibit significant and positive correlation with each other.

Thus, within the groups of proxies, indicated by shaded areas, the correlation table supports both Proposition 1 and 2. As expected, we see positive correlations across variable-specific uncertainty proxies. However, the two groups seem to give different answers to how uncertainty varies over time.

## 5 Factor analysis

In section 2 we concluded that any proxy of uncertainty could be driven by many underlying factors, or sources of uncertainty. In this section we investigate how many underlying common factors that are suggested by the data reduction technique known as factor analysis.<sup>11</sup> For a complete description of factor analysis see Sharma (1996) and Johnson (1998). Factor analysis is performed on each of the subgroups constituted by the Michigan Consumer Survey and the Survey of Professional Forecasters. Common factors are searched for across variables, using the same proxy type, to avoid problems of mixing different types of proxies. For the probability forecast proxies and volatilities, there are only two proxies of each and no factor analysis is conducted.

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<sup>11</sup>*Entia non sunt multiplicanda praeter necessitatem!*

The purpose of factor analysis is to search for underlying latent factors that explain co-movements in different variables. The number of common factors can in general be as many as the number of variables less one. The factor analysis provides us with some useful results. *First*, it can help us identify which proxies that are more closely connected to any common factors, and which proxies that are more idiosyncratic. *Second*, it turns out that we detect and compute only one common factor for each subgroup, and we interpret this factor as some general macroeconomic uncertainty. *Third*, this common factor will be used for applications in section 6. Below, these steps are described in more detail.

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is used to determine the appropriateness of performing factor analysis on the data. No formal statistical test is available, but an overall KMO-value of 0.60 is the recommended minimum value.<sup>12</sup> We also restrict individual KMO-proxies to be above 0.50 for inclusion in the common factor extraction. If any proxy is below 0.50 this proxy is excluded. We rerun the KMO-test until all separate proxies are above 0.50 so that all idiosyncratic proxies are excluded.<sup>13</sup> For Michigan Consumer Survey proxies we must first disqualify DMU, disagreement concerning unemployment, and then DMB, disagreement about business conditions, because of individual KMO-values lower than 0.50. Referring to Table 5 the narrative evidence also indicates that DMU and DMB are weak proxies for uncertainty. For the Survey of Professional Forecasters proxies we find strong results for the KMO test with no values below 0.80. Overall, the average KMO-value is 0.74 for the Michigan Consumer Survey group and 0.86 for the Survey of Professional Forecasters group after exclusion of DMU and DMB which indicates that the remaining proxies are well suited for factor analysis. All variables with their respective KMO-values and average KMO-values for the two subgroups are displayed in Table 6.

Next we estimate factor models, one for each subgroup, by principal axis factoring (PAF) to determine how many factors that are suggested by this formal procedure.<sup>14</sup> The eigenvalues of the sample covariance or correlation matrix measures the strength of the factors in explaining the total variance in all variables. According to the often employed larger-than-one-eigenvalue criterion as well as a screeplot analysis there is exactly one common factor each for the Michigan Consumer Survey and the Survey

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<sup>12</sup>A KMO-value of below 0.50 is deemed "unacceptable", 0.50-0.59 "miserable", 0.60-0.69 "mediocre", 0.70-0.79 "middling", 0.80-0.89 "meritorious and 0.90-1.00 "marvellous". (see Sharma (1996) p. 116)

<sup>13</sup>Referring to the model in section 2 these excluded proxies can be seen as representing those variables in the economy that do not enter endogenously in the VAR.

<sup>14</sup>Alternative methods such as Iterated Principal Factors and Maximum Likelihood give very similar results.

Table 6: Kaiser-Meyer-Olkin values for sampling adequacy

Uncertainty proxy	KMO
DMF	0.78
DMH	0.66
DMR	0.74
DML	0.71
DMD	0.90
DMV	0.75
Michigan Consumer Survey average	0.74
DSP	0.86
DSI	0.86
DSH	0.81
DSC	0.96
DSY	0.89
DSR	0.92
DSU	0.80
Survey of Professional Forecasters' average	0.86

of Professional Forecasters subgroups. The eigenvalues above zero are displayed in Table 7. That we can only detect one common factor for each subgroup indicates that there is one prime driver of uncertainty common to all proxies, which can be interpreted as some general macroeconomic uncertainty.

Table 7: Eigenvalues for the number of common factors

Factors	Michigan Consumer Survey	Survey of Professional Forecasters
1	2.36	4.04
2	0.42	0.30
3	0.04	0.07

With one factor for each subgroup we take a look at the factor loadings of each proxy. It turns out that for the Michigan Consumer Survey subgroup, DMD, the disagreement about future real family income, is negatively related to the common factor but all others positively. DMD was also considered a weak proxy of uncertainty judging from the narrative evidence in Table 5. That DMD has the lowest communality indicates that the negative loading for this factor is significant but small. Also, DMD seems quite closely related to DMB, according to the correlation coefficient reported in 2, and is somewhat guilty by association to DMB. Thus, although formally not disqualified, DMD must be considered a weak proxy for uncertainty. DML, which refers to disagreement about buying conditions for large goods, has the highest communality with the common factor and DMD the lowest. DML also seemed to be a adequate proxy by looking at Table 5. For the Survey of

Professional Forecasters proxies all the factor loadings are positive. DSY, disagreement concerning real GDP, has the highest communality and DSP, disagreement concerning corporate profits, the lowest. The narrative evidence in Table 5 also indicate that DSY is a better proxy than DSP.

Lastly, to get an estimate of the underlying factor we need to *score* the data to produce an estimate of the latent common factor. The scoring coefficients help form the weights put on each variable so we can produce an estimate of the underlying factor at time  $t$ . We interpret this factor as an estimate of general macroeconomic uncertainty. The factor loadings, variance contributions and the scoring coefficients, using the regression method, are reported in Table 8.<sup>15</sup>

Table 8: Loadings, variance decompositions and scoring coefficients

	Factor loading	Communality	Uniqueness	Scoring coeff.
Michigan Consumer Survey				
DMF	0.65	0.42	0.58	0.15
DMH	0.47	0.23	0.77	0.11
DMR	0.57	0.32	0.68	0.11
DML	0.85	0.73	0.27	0.47
DMD	-0.36	0.13	0.87	-0.06
DMV	0.73	0.53	0.47	0.27
Survey of Professional Forecasters				
DSP	0.46	0.21	0.79	0.05
DSI	0.82	0.67	0.33	0.17
DSH	0.84	0.71	0.29	0.25
DSC	0.72	0.52	0.48	0.11
DSY	0.87	0.76	0.24	0.31
DSR	0.79	0.62	0.38	0.14
DSU	0.74	0.55	0.45	0.11

The computed factors are weighted combinations of the included proxies. The common factor for the Survey of Professional Forecasters proxies (SFactor) contains all the Survey of Professional Forecasters proxies, but DSY, real GDP disagreement, contribute with the lions share followed by DSH, disagreement concerning buying conditions for houses, and DSI, CPI-inflation disagreement. The common factor for the Michigan Consumer Survey proxies (MFactor) contains all proxies but DMU and DMB and assigns the largest weight on DML, disagreement concerning buying conditions for large goods, followed by DMV and DMF.

In this section we have reduced our survey based disagreement proxies of uncertainty from 15 (eight from the Michigan Consumer Survey and seven from the

<sup>15</sup>The alternative Bartlett scoring method yields nearly identical results.

Survey of Professional Forecasters) to two, MFactor and SFactor. In the process we have excluded those few proxies that are considered to be most idiosyncratic (DMU and DMB) and assigned larger weights on those that are closely connected to the others. Thus, we believe that these two factors could be reasonable conceptions of the general macroeconomic uncertainty in the economy as captured by disagreement.

## 6 Extensions

The correlation table, the narrative evidence, and the factor analysis helped us to evaluate uncertainty proxies. In this section we look closer at how uncertainty proxies co-move with the business cycle and thereafter we study if uncertainty matters for aggregate consumption and residential investment. We use our factors for the Michigan consumer survey group (MFactor) and the survey of professional forecasters (SFactor) along with volatility proxies (VO and VH) and probability forecast proxies (PY and PI).

### 6.1 Co-movements with the business cycle

The relation between business cycles and uncertainty is left mostly unexplored in the previous literature. Some papers relating macroeconomic uncertainty to the business cycle are Ball (1992) and Shields, Olekalns, Henry, and Brooks (2005). Ball (1992) analyzes the relation between inflation and inflation uncertainty and argues that higher inflation should raise inflation uncertainty. Shields, Olekalns, Henry, and Brooks (2005) find that uncertainty about inflation and output increases with shocks to output and inflation. We provide some empirical evidence on the co-movement of uncertainty with the business cycle in general by comparing the time series evolution of uncertainty proxies with the real GDP-gap.

The plots of proxies of uncertainty and the business cycle is shown in Figure 3.<sup>16</sup> From looking at the co-movements of the business cycle and the proxies it appears as if uncertainty seems to be higher the further away we are from the "normal" state of the economy. From looking at the official NBER business cycle dates it appears as if uncertainty has been higher at the turn of the business cycle moving away from a recession.<sup>17</sup> For the probability forecast measures PY and PI, these findings are not as clear.

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<sup>16</sup>The business cycle measure is obtained by standard Hodrick–Prescott (HP) filtering of the log real output with smoothing weight set to 1600. The Michigan Consumer Survey measures and volatility measures have been converted from monthly to quarterly by averaging.

<sup>17</sup>Peak-Through: January 1980–July 1980, July 1981–November 1982, July 1990–March 1991, March 2001–November 2001. Source: [www.nber.org/cycles.html](http://www.nber.org/cycles.html)

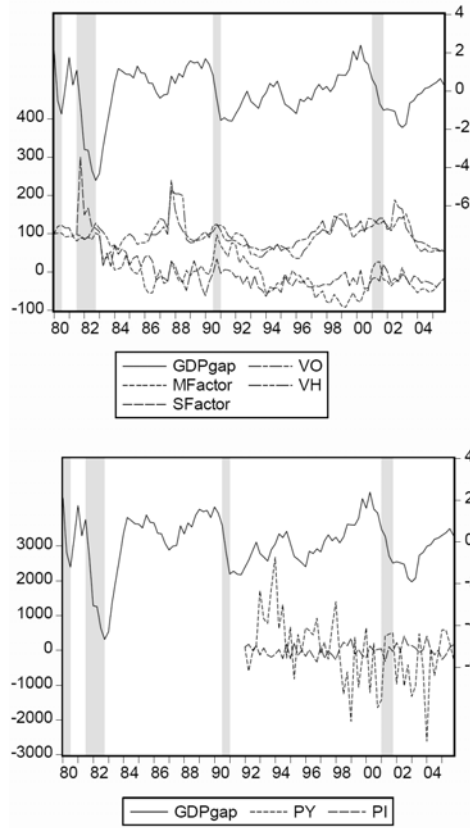


Figure 3: The Business Cycle and Uncertainty Proxies 1980-2005

Note: Displayed are the GDP HP-filtered business cycle (RHS) and selected uncertainty proxies (LHS). MFactor, SFactor, VO and VH have been normalized to 100 at their respective first observation. NBER peak to recession periods are displayed as shaded areas and cover the following peak-through periods: January 1980-July 1980, July 1981-November 1982, July 1990-March 1991, and March 2001-November 2001. Source: [www.nber.org/cycles.html](http://www.nber.org/cycles.html)



To further explore the relation between the business cycle and uncertainty Table 9 shows the correlations of the absolute value of the GDP-gap and uncertainty proxies.<sup>18</sup> All uncertainty proxies have positive correlation coefficients, especially the survey based proxies, SFactor and MFactor, show strong correlations.

Table 9: Correlations of uncertainty proxies with the business cycle

$UP$	$Corr(UP,  GDPgap )$
MFactor	0.44
SFactor	0.49
VO	0.26
VH	0.15
PY	0.33
PI	0.20

## 6.2 Precautionary savings

Next, we estimate Euler equations following Campbell and Mankiw (1991), which allow for precautionary savings effects on consumption,  $\Delta c_t$ , through an uncertainty proxy,  $UP_t$ ,

$$\Delta c_t = \alpha + \beta_1 r_{t-1} + \beta_2 \Delta y d_{t-1} + \gamma_c UP_{t-1} + \varepsilon_t. \quad (10)$$

The log change in disposable income,  $(\Delta y d_t)$ , is added to control for hand-to-mouth behaviour of consumers. When we estimate equation (10) the uncertainty proxy, the real interest rate ( $r$ ), and the disposable income must be instrumented due to time aggregation issues. Our instruments are lagged values of  $\Delta c$ ,  $\Delta y d$ ,  $r$  and  $UP$ .<sup>19</sup>

The precautionary savings effect would show up as a significantly positive  $\gamma_c$ , meaning that high uncertainty would lead to consumption being postponed into the future. It might seem counter-intuitive to expect a positive effect on  $\Delta c_t$  from  $UP_{t-1}$ , but as the contemporaneous consumption level decreases from higher uncertainty, the change in consumption to the next period increases *ceteris paribus*.

The results from our two stage least squares regressions, shown in Table 10, indicate mixed results for our set of uncertainty proxies. The Survey of Professional Forecasters factor (SFactor) is significant at the five percent level. The Michigan Consumer Survey disagreement factor (MFactor) is negative, but insignificant. The VO and VH volatility proxies show no significant effects. For the probability forecast

<sup>18</sup>The GDP-gap is measured as the absolute real percentage deviation of GDP from its HP-trend (w=1600).

<sup>19</sup>See Hall (1988) for further motivation. The lag structure follows Hall (1988) and Campbell and Mankiw (1991).

Table 10: Estimates of the consumption Euler equation

	$r$	$\Delta yd$	$UP$	R2	Obs
MFactor	0.028 (0.83)	0.236 (1.02)	-0.166 (-1.13)	-0.07	97
SFactor	-0.018 (-0.57)	0.298 (1.59)	0.308** (2.58)	-0.02	91
VO	-0.016 (-0.67)	0.268 (1.26)	0.010 (1.03)	-0.03	73
VH	-0.007 (-0.25)	0.439*** (2.84)	0.021 (-0.59)	-0.28	97
PY	-0.009 (-0.28)	0.043 (0.18)	-0.016 (-0.69)	-0.12	53
PI	-0.012 (-0.55)	-0.096 (-0.43)	-0.037* (-1.69)	-0.16	53

Note: \*, \*\* and \*\*\* denote 10, 5 and 1 percent significance levels.

measures PY and PI, the estimates are negative, with the one for PI significant at the ten percent level.

### 6.3 Residential investment

Finally, following Downing and Wallace (2005) we study how uncertainty influences the decision to invest in residential housing. Uncertainty is expected to decrease investment, due to the increased value-to-wait when uncertainty is high. See Bernanke (1983) on uncertainty and the irreversibility of investment.

For all qualified proxies we estimate an extension of the model in Downing and Wallace (2005) adding  $UP_t$ ,

$$\begin{aligned}
Starts_t = & \beta_0 + \beta_1 HR_t + \beta_2 TR_t + \beta_4 HRvol_t + \beta_5 TRvol_t \\
& + \gamma_r UP_t + controls + \varepsilon_t,
\end{aligned} \tag{11}$$

where  $Starts_t$  is the number of housing starts for quarter  $t$ .  $HR_t$  is housing returns;  $TR_t$  is the T-bill rate;  $HRvol_t$  is the historical volatility of housing returns and  $TRvol_t$  is the volatility on the T-bill rate. The *controls* are the spread between the thirty year and the ten year bond yields and a set of seasonal dummies. The estimation technique is adapted to the dependent variable being an integer count variable. In particular we use the Poisson based estimation technique as described in Greene (2003).

Downing and Wallace (2005) uses  $HRvol_t$  as their only proxy of uncertainty but we find that the reported negative sign for this proxy is unstable over subperiods.

The results when adding uncertainty proxies are shown in Table 11. The sign on the uncertainty proxy is negative and significant for all but the probability forecast proxies PY and PI. This is further support for survey proxies of uncertainty (except PY and PI), given that uncertainty should decrease the number of housing starts.

Table 11: Estimates of the residential investment decision

	<i>HR</i>	<i>TR</i>	<i>HRvol</i>	<i>TRvol</i>	<i>UP</i>	R2	Obs
MFactor	0,016*** (5,6)	-0,029*** (-6,33)	0,019 (1,64)	0,055** (2,16)	-0,137*** (-6,06)	0,87	102
SFactor	0,025*** (6,7)	-0,033*** (-6,87)	-0,0001 (-0,01)	-0,03 (-1,14)	-0,059** (-2,45)	0,81	98
VO	0,024*** (5,32)	-0,049*** (-11,63)	-0,019 (-1,03)	-0,103*** (-4,38)	-0,005*** (-3,01)	0,82	80
VH	0,027*** (7,69)	-0,036*** (-8,99)	-0,016 (-0,99)	-0,04 (-1,55)	-0,012* (-1,68)	0,8	104
PY	0,016*** (3,29)	-0,031*** (-4,52)	0,032** (2,00)	-0,074*** (-2,89)	0,031 (-0,22)	0,81	56
PI	0,016*** (3,2)	-0,030*** (-3,99)	0,031* (1,84)	-0,078*** (-3,30)	0,192 (0,93)	0,81	56

Note: \*, \*\* and \*\*\* denote 10, 5 and 1 percent significance levels.

## 7 Conclusions

The main purpose of this paper is to evaluate available proxies of uncertainty. Using a simple VAR-model of the economy we derive two propositions. The first proposition states that different proxies of uncertainty should react with the same sign to large exogenous shocks to uncertainty. The second states that different uncertainty proxies should, under reasonable assumptions, be positively correlated. We use these criteria to evaluate proxies of uncertainty. To apply the first criterion we identify dates that should increase or decrease uncertainty. To apply the second, we use correlation analysis. Also, using factor analysis we investigate how many factors of uncertainty that are common across different proxies. Finally, we include proxies of uncertainty in standard macroeconomic applications where uncertainty is supposed to matter.

We show that stock market volatility proxies behave as expected when there are exogenous shocks to uncertainty and also matter for residential investment. Therefore, we find some support for the use of volatility proxies as indicators of uncertainty. This is especially true for the implied volatility proxy derived from option prices.

A notable finding in this paper is the weak support for the probability forecast proxies as indicators of uncertainty. The narrative evidence gives little indication that this type of proxy is picking up uncertainty. Moreover, in applications where uncertainty could matter, these proxies do not add any explanatory power.

The disagreement proxies pick up exogenous shocks to uncertainty and also matter for economical decisions. The strongest support is given to the use of disagreement proxies based on quantitative surveys. Zarnowitz and Lambros (1987) and Giordani and Söderlind (2003) also claim that disagreement proxies are viable proxies for true uncertainty. However, the crucial assumption made by Zarnowitz and Lambros (1987) to draw this conclusion is that true uncertainty is equal to the probability forecast variance. Our paper indicates that such a supposition is incorrect. Giordani and Söderlind (2003) instead use an asset pricing model to evaluate disagreement proxies but have the same problem since they rely on time series model proxies of uncertainty as the true measure of uncertainty.

From the correlation between proxies of uncertainty we find that there are two independent groups. One group consists of the survey disagreement proxies; the other consists of the probability forecast and stock market volatility proxies. Within groups most proxies are positively correlated. This result is reinforced by factor analysis through which we find that all proxies from the Survey of Professional Forecasters and most proxies from the Michigan Consumer Survey are tied together by exactly one common factor for each survey. By the factor analysis we are able to compute common factors, supposedly representing uncertainty, that drive the different proxies. These factors are taken to be indicators of general macroeconomic uncertainty.

We also find that proxies of uncertainty are positively correlated with the absolute value of a business cycle measure. The further away from a "normal" state of the economy we are, the higher the uncertainty. The co-movement of uncertainty and the state of the economy could be an important factor in the business cycle, as well as in policy making, and has previously remained undetected in the literature.

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