The Relation Between Macroeconomic Uncertainty And The Expected Performance of the Economy

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Preliminary Version, Comments welcome[†]

First version : May 2003   This version: April 2004

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Mayo 2003

Abstract

By using data from surveys of expectations, it is shown that macroeconomic uncertainty, measured by the standard deviation of the expected output growth, the expected unemployment rate, and the expected inflation rate, is negatively related to the expected performance of the economy, proxied by the expected growth rate of output. That is, forward-looking agents are more uncertain about the future development of output, unemployment, and inflation when the growth rate of output is expected to fall, and they are less uncertain when this growth rate is expected to increase. The findings indicate that macroeconomic polices would have asymmetric effects on output depending upon how economic agents expect the economy to perform in the near future.

1 Introduction

This paper represents an empirical attempt at studying the factors that may affect macroeconomic uncertainty. I hypothesize that economic agents are more uncertain about the evolution of output growth, unemployment, and inflation when they expect a feeble economy.

To test this hypothesis, I build series for the standard deviation of expected output growth, expected unemployment, and the expected inflation rate from surveys of expectations. I use them as proxies for macroeconomic uncertainty.

A total of ten different series of uncertainty coming from three distinct surveys are generated, and regressed on the expected growth rate of real GDP. With only one exception, the message from every series is the same: a foreseen weakening of the economy, measured by the expected growth rate of output, raises the level of uncertainty about the future performance of output, unemployment, and inflation. Indeed, it is estimated that a 1-percent fall in the expected growth rate of real GDP, raises macroeconomic uncertainty by about 15-percent to 22-percent, depending upon the survey being studied.

I argue that these results must be taken into account by the policymaker when designing macroeconomic policies because higher uncertainty during expected downturns will make any policy aimed at pushing up aggregate activity less effective.

The findings call for more research on models that could deliver them endogenously. Indeed, even though uncertainty is hardly missing from any macroeconomic model nowadays, the treatment of it in the literature is unidirectional. An exogenous random shock hits the economy, directly through aggregate supply or aggregate demand or indirectly

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through the interest rate, but no feedback channel is allowed or studied.

At the empirical level, economists have long investigated the effects of uncertainty on variables like consumption, investment, and inflation, but few attempts have been made to detect what variables, if any, may affect uncertainty. One of the exceptions is Mankiw, Reis and Wolfers (2003) who study the dispersion (disagreement) among inflation forecasts. They find that inflation positively affects disagreement, but their series do not show a clear relationship with real activity.[1]

As mentioned above, I do find a relationship between uncertainty and expected real activity. Not only of inflation uncertainty, but also of output and unemployment uncertainty.

The paper continues (section 2) with a brief description of how macroeconomic uncertainty is usually estimated. Section 3 describes the surveys used in the study. Section 4 delineates the empirical measures of uncertainty used in the estimation. Section 5 explains the econometric model and techniques utilized. Section 6 presents the results. Section 7 explains the importance of the findings for policy makers. Section 8 concludes.

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[1]The measure they used for real activity is the output gap

2 Estimating Uncertainty in Economics

The empirical estimation of uncertainty has been entirely concentrated on measuring inflation uncertainty. Two main avenues have been followed to obtain those measures. One approach, which I refer as the Model Based Approach, is to use realized values of the variable to elicit econometric or statistical estimations of the variability of it. This measure of variability is then used as a proxy for uncertainty.

In an early study Okun (1971) studies the correlation between the level and the standard deviation of inflation, across seventeen OECD countries to see if economies with higher levels of inflation consistently have higher inflation variability. Later, Logue and Willett (1976), use regression analysis to find a strong relation between the variability of inflation and the average rate of the price change for forty-one countries during the period 1958-1970.

The development of new econometric techniques, such as ARCH, allowed authors to measure uncertainty by estimating the conditional variance of the variable under analysis, typically the inflation rate. There is an ample literature in this area, but the classical study is Engle (1982) who developed the ARCH technique, and applied it to analyze the variability of inflation in the United Kingdom.

However, rather than measuring uncertainty, the model based approach really measures volatility. The former is a feature that forward-looking agents face when confronting any decision, the latter is a characteristic of the data once uncertainty has been solved. The other path that has been followed in the empirical literature, and that I refer to as the Survey Based Approach, is to estimate uncertainty from surveys of economic

expectations. The common route taken is to obtain the standard deviation (or the variance) of the point forecasts, of the variable under analysis, made at a point in time by several different forecasters. This variability, which is actually a measure of the disagreement among the forecasters (see Bomberger,1996), is used as a proxy for uncertainty. Among the several studies using this approach are Hayford (2000), and Mankiw, Reis, and Wolfers (2003).[2]

Zarnowitz and Lambros (ZL) (1987) state that the main assumption required for the validity of using disagreement as a proxy for uncertainty is that the interpersonal dispersion measure be a good approximation to the dispersion of intrapersonal predictive probabilities held by the same individual. Using the Survey of Professional Forecasters (SPF).[3] they obtain a direct measure of inflation uncertainty. Since this survey asks not only for point forecasts of inflation, but also requires forecasters to assign a probability to different intervals where the inflation rate may realized next period, a direct measure of uncertainty can be retrieved from the standard deviation (or the variance) around those probability forecasts. This variance would tell us how uncertain is the forecaster around his point forecast. In ZL words: "how diffuse is his distribution".

Lahiri, Teigland, and Zaporowski (1988) use this measure to study the effect of inflation uncertainty on interest rates, finding that the former has not significant effect upon the real interest rate.

Using survey data to estimate uncertainty has both benefits and costs. Among the former is that this better represents what economic agents were really perceiving at the time

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[2]They argue that disagreement is important by itself. They do not use it as a proxy for uncertainty.

[3]A brief explanation of this survey is given in section 3

they made decisions. How sure or unsure were they about the future path of the main economic variables is something we can directly obtain from surveys of expectations. Hence, if these surveys reflect the market's perceptions, then the level of uncertainty in the market about the future realization of the most important macroeconomic variables can be acquired from them. The main drawback is that disagreement may not be a good proxy for uncertainty, that is the ZL assumption may not be met. Here the evidence is not conclusive. There are as many studies supporting its use (see for instance Bomberger (1996), and Giordani and Söderlind (2003), as there are opposing it (Zarnowitz and Lambros (1987) is one example).

In this paper, I follow the survey based approach, and the two proxies for uncertainty within this approach are used. That is, I use disagreement and the measure of uncertainty coming from the probability forecast in the SPF, in order to obtain series of macroeconomic uncertainty. The latter measure allows me to disregard to certain extent the drawback mentioned above.

3   The Data

3.1   The Surveys

Two, and sometimes three, different surveys are used to construct the variables that are explained below, the Livingston Survey, the Survey of Professional Forecasters, and in one case, the Survey of Consumers from the University of Michigan.

3.1.1 The Livingston Survey (LS)

Originally conducted by the late Journalist Joseph A. Livingston, and currently being carried out by the Federal Reserve Bank of Philadelphia,[4] the LS asks , every June and December, economists in the financial, nonfinancial, academic, and labor sector for their forecasts for a set of more than eighteen economic variables for the end of the current month, six months ahead, twelve months ahead, and lately ten years ahead for some variables. It covers the period between June of 1946 and the present.[5]

In this study I use six month ahead forecasts for real GDP (RGDP), the Consumer Price Index, and the Unemployment Rate for the the period 1971-2002.[6]

3.1.2 The Survey of Professional Forecasters (SPF)

First conducted jointly by the American Statistical Association (ASA) and the National Bureau of Economic Research (NBER), the ASA-NBER Economic Outlook Survey began to be administered by the Philadelphia FED in 1990, which changed the name to the Survey of Professional Forecasters, which truly reflects the nature of the survey participants.

Conducted every quarter, the survey asks professional forecasters, that is, those who forecast as part of their job, to provide their forecasts for more than twenty-five economic variables for the next six quarters and for the current and the next calendar year. In addition, the questionnaire also asks for three probability variables; the probability

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[4]For a brief history of the survey see Croushore (1997)

[5]Early data seem to be unreliable. See Carlson (1977)

[6]1971 is the earliest year with real GDP forecasts

that the percent change in real/nominal GDP falls in a particular range in the current and following quarter, the probability that the percent change in the price index for GDP falls in a particular range during the current and following period, and the probability of a decline in real GDP in the current quarter and the following four quarters.[7]

The variables I use in this study are: the one quarter ahead forecasts of RGDP, the consumer price index, and the unemployment rate. In addition, the three probability variables are exploited. Thus, both point and probability projections are used for the period 1968-2002.

3.1.3 The Michigan Survey of Consumers (MSC)

Conducted every month by the Survey Research Center at the University of Michigan, as its name indicates, it is a survey of consumer expectations about economic and financial conditions. In a broad sense, the survey asks participants for their expectations about financial conditions in the household and prices and income in the whole economy. Based on the information collected, the Survey Research Center constructs the Index of Consumer Sentiment, and the Index of Consumer Expectations.

I slightly modify the index of consumer expectations to obtain what I call the index of economic expectations. The purpose of this is to obtain an index where all the variables have the same forecasting period.[8]

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[7]For a detailed explanation of this survey, see Croushore (1993)

[8]Details are given in appendix B

4   The Empirical Measures of Uncertainty

I examine what are arguably the three most important macroeconomic variables: output growth, the unemployment rate , and the inflation rate. To this end, I construct measures of output uncertainty, unemployment uncertainty, and inflation uncertainty as explained below.

4.1   Output Uncertainty $(U_t(E_t[g_{t+1}]))$

Using data from three separate surveys, I construct two different measures of output uncertainty. The first is a measure of dispersion, also known as the level of disagreement among respondents at any given point in time. The second is a direct estimation of the uncertainty surrounding the expected growth rate of RGDP obtained from the probability of RGDP variable in the SPF. This measure was first put forward by ZL (1987), and I will refer to it as uncertainty in the ZL sense.

4.1.1   Point Forecasts (Disagreement)

By using point forecast data for the expected value of RGDP from both the LS and the SPF, I construct a measure of disagreement. Utilizing the data as summarized in table 1 (see appendix A), the following measure of dispersion is constructed at time t for the j (j=LS, SPF) survey.

$$U_t^j(E_t[g_{t+1}^j]) = [\frac{1}{N_t} \sum_{i=1}^{N_t}(E_t[g_{i,t+1}^j] - E_t[g_{t+1}^j])^2]^{1/2},$$

where

$$E_t[g_{t+1}^j] = \frac{1}{N_t} \sum_{i=1}^{N_t} E_t[g_{i,t+1}^j],$$

and

$$E_t[g_{i,t+1}^j] = log(E_t[RGDP_{i,t+1}^j]/E_t[RGDP_{it}^j]) \times 100.$$

Time $t+1$ represents the forecasting period in the particular survey, and i $(i = 1, ..., N_t)$ represent respondents.

As can be seen, $U_t^j(E_t[g_{t+1}^j])$ is nothing else than the standard deviation around the expected growth rate of RGDP, $E_t[g_{t+1}^j]$.

A similar measure is built from the MSC's data. Here, I slightly modify the well-known Index of Consumer Expectations (ICE) with the purpose of obtaining an index where the expectational period is the same. Indeed , the ICE is based on the answer to three different questions where for two of them the forecasting period is twelve months and for the other it is five years. I, eliminate the question associated with the five-year projection period. I will refer to this new index as the index of economic expectations (IEE_{t+1}). It is built using the same procedure as the ICE (see appendix B for details). A value for the IEE_{t+1}, $IEE_{i,t+1}$, is calculated for each respondent i $(i = 1, ..., N_t)$ at every month t. Then, the mean and the dispersion measures around the change in the index are obtained as follows,

$$IEE_{t+1} = \frac{1}{N} \sum_{i=1}^{N} IEE_{i,t+1}$$

$$U_t^{sc} = [\frac{1}{N} \sum_{i=1}^{N} (IEE_{i,t+1} - IEE_{t+1})^2]^{1/2}$$

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4.1.2 Probability Forecasts (Uncertainty in the ZL sense)

In the SPF, survey participants are asked, among several queries, to provide their estimated probabilities for l different given intervals ($l = 1, ..., L_t$) for the growth rate of RGDP for the forecasting period.

At all periods, both the upper and lower intervals are open, and therefore an assumption needs to be made about the end points for those outermost intervals. Here I follow the same procedure used by Lahiri, Teigland, and Zaporowski (1998) when they analyze inflation uncertainty, which is to assume that the outmost intervals have the same length as the rest.

At every time t, each individual i ($i = 1, ..., N_t$) is asked to assign a probability to each one of the L_t intervals. Let that probability be $P_{it}(g_{l,t+1})$,[9] and denoting the midpoint of the interval by $\overline{g}_{l,t+1}$, it is possible to calculate the implicit expected growth rate of RGDP, that is the mean of individual i's probability distribution at time t, and the level of uncertainty surrounding it for every respondent in the survey as

$$E_t[g_{i,t+1}] = \sum_{l=1}^{L_t} P_{it}(g_{l,t+1}) \cdot \overline{g}_{l,t+1},$$

and

$$u_{it} = [\sum_{l=1}^{L_t} (\overline{g}_{l,t+1} - E_t[g_{i,t+1}])^2 \cdot P_{it}(g_{l,t+1})]^{1/2}$$

Based on these, I can then calculate the expected growth rate of RGDP at time t, $E_t[G_{t+1}]$, and the level of uncertainty attached to it, $U_t(E_t[G_{t+1}])$ as follows: [10]

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[9]For example, an individual assigning $P_{it}(g_{l,t+1}) = 0.2$ to the l= 2.0-2.9 interval, is saying that he believes there is a 20% chance that the growth rate of RGDP would be between 2.0% and 2.9%.

[10]G_{t+1} will be used to represent the expected growth rate obtained from the probability forecast.

$$E_t[G_{t+1}] = \frac{1}{N_t} \sum_{i=1}^{N_t} E_t[g_{i,t+1}],$$

and

$$U_t(E_t[G_{t+1}]) = \frac{1}{N_t} \sum_{i=1}^{N_t} u_{it}.$$

The former is an average at time t of the expected growth rate by each survey participant. The latter is the average of the standard deviation appended to each one of the $E_t(G_{t+1})$s, and hence represents the level of uncertainty of the market around the expected growth rate of output.

Another piece of information that can be obtained from the probability forecasts in the SPF is the Probability of Decline variable.[11] One of the tasks forecasters have to answer, is to assign the probability of a decline in real GDP in the quarter following the quarter in which the survey is taken. Using this variable, which I denote by $Prob_{it}(D)$, I obtain the mean and the level of disagreement around it using the procedure described in part 4.1.1).

4.2 Unemployment Uncertainty $(U_t(E_t[Unem_{t+1}]))$

Available survey data on expected unemployment rates is composed only of point forecasts. Using data from the j-th survey ($j = LS, SPF$), a measure of disagreement is constructed around the mean of the expected unemployment rate at time t, as follows:

$$U_t^j(E_t[Unem_{t+1}^j]) = [\frac{1}{N_t} \sum_{i=1}^{N_t} (E_t[Unem_{i,t+1}^j] - E_t[Unem_{t+1}^j])^2]^{1/2},$$

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[11]This variable is also known in the press as the Anxious Index

with

$$E_t[Unem^j_{t+1}] = \frac{1}{N_t} \sum_{i=1}^{N_t} E_t[Unem^j_{i,t+1}]$$

being the mean expected unemployment rate for the forecasting period at time t, constructed from the expected rate, $E_t[Unem^j_{it+1}]$, given by everyone of the i participants $(i = 1, ..., N_t)$ in the j-th survey in that particular period (see table 2 on appendix A).

4.3 Inflation Uncertainty $(U_t(E_t[\pi_{t+1}]))$

As is the case with output data, it is possible to obtain both point and probabi-lity forecasts for inflation expectations. I use the two of them to build measures of uncertainty.

4.3.1 Point Forecasts (Disagreement)

Let the i-th forecaster's $(i = 1, ..., N_t)$ expected inflation rate for the relevant fore-casting period, made at time t, in the j-th survey $(j = LS, SPF)$, be $E_t[\pi^j_{i,t+1}]$. By using this, I construct the following measure of dispersion:

$$U^j_t(E_t[\pi^j_{t+1}]) = [\frac{1}{N_t} \sum_{i=1}^{N_t} (E_t[\pi^j_{i,t+1}] - E_t[\pi^j_{t+1}])^2]^{1/2},$$

around the expected inflation rate at time t:

$$E_t[\pi^j_{t+1}] = \frac{1}{N_t} \sum_{i=1}^{N_t} E_t[\pi^j_{i,t+1}].$$

4.3.2 Probability Forecasts (Uncertainty in the ZL sense)

Participants in the SPF are also asked to attach probabilities to various intervals for the inflation rate for the following quarter.

Let the i-th respondent $(i = 1, ... N_t)$ assign the probability $P_{it}(\pi_{l,t+1})$ to each of the L_t intervals , and denoting $\overline{\pi}_{l,t+1}$ as the midpoint of the l-th interval $(l = 1, ..., L_t)$, I can use the same procedure followed to obtain output uncertainty to retrieve measures of the mean and variance of the distribution associated with expected inflation at time t. Indeed,

$$E_t[\pi_{i,t+1}] = \sum_{l=1}^{L_t} P_{it}(\pi_{l,t+1}) \cdot \overline{\pi}_{l,t+1}$$

is the implicit expected inflation rate perceived by the i-th respondent, and

$$u_{it}(E_t[\pi_{i,t+1}]) = [\sum_{l=1}^{L_t} (\overline{\pi}_{l,t+1} - E_t[\pi_{i,t+1}])^2 \cdot P_{it}(\pi_{l,t+1})]^{1/2}$$

is the standard deviation, or a sign of the diffuseness associated with the distribution of $E_t[\pi_{i,t+1}]$. Hence,

$$U_t(E_t[\Pi_{t+1}]) = \frac{1}{N_t} \sum_{i=1}^{N_t} u_{it}(E_t[\pi_{i,t+1}])$$

represents the average level of uncertainty the market perceives about the expected rate of inflation, $E_t[\Pi_{t+1}]$.[12]

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[12]Although not needed explicitly, the expected rate of inflation can be calculated as $E_t[\Pi_{t+1}] = \frac{1}{N_t} \sum_{i=1}^{n_t} E_t[\pi_{i,t+1}]$

5 The Econometric Model and Techniques

In order to investigate the relation, if any, between the expected performance of the economy, as measured by the expected growth rate of output, and the level of uncertainty market participants perceive, I fit the following general equation:

$$U_t^j(E_t[y_{t+1}]) = \gamma_0 + \sum_{l=1}^{L} \gamma_l \, U_{t-l}^j(E_t[y_{t+1}]) + \phi E_t[x_{t+1}] + \varepsilon_t \tag{1}$$

where, $U_t^j(E_t[y_{t+1}])$ represents the level of uncertainty, U_t^j at time t for the j-th survey, associated with $E_t[y_{t+1}]$, which can describe the expected growth rate of output from both point forecasts and probability forecasts $(E_t[g_{t+1}], E_t[G_{t+1}])$, the expected unemployment rate $(E_t[Unem_{t+1}])$, the expected inflation rate $(E_t[\pi_{t+1}])$, the probability of decline in RGDP $(Prob_t(D))$, or the index of economic expectations (IEE_{t+1}). Equation 1 allows for several lags of the LHS variable with the purpose of detecting any persistence in the uncertainty process. $E_t[x_{t+1}]$ represents the expected growth rate, at time t, of the different output measures coming from the three surveys that were mentioned in section 4. That is, x_{t+1} takes the values of g_{t+1}, G_{t+1}, $Prob_t(D)$, or the IEE_{t+1}.[13] The data are seasonally adjusted by using a difference from moving average additive procedure, and then detrended by using the Hodrick-Prescott filter.[14]

Depending upon the results of diagnostic tests, the model in equation 1 is estimated using either Least Squares(LS) or Maximum Likelihood (ML). The lag structure was chosen by minimizing the Akaike information criteria (AIC).

To detect serial correlation, the Breusch-Godfrey LM statistic is used in conjunction

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[13]For a summary of the uncertainty measures, see table 4 on appendix A

[14]Using dummies to take care of seasonality, and linearly detrending the data do not alter the results.

with visual inspection of the correlogram of the residuals. Since seasonality may produce autocorrelation at the seasonal lag, the number of lags to test is set equal to the number of forecasting periods in a year ,in the particular data set, plus one. For instance, in the SPF, which is a quarterly survey, the number of lags being tested is $l=5$. Heteroskedasticity is pinpointed by using both the White test, and Engle's ARCH LM test, and by visual inspection of the correlogram of squared residuals. To test for model misspecification, the Ramsey RESET test with 3 fitted terms is employed.

When serial correlation is found, the errors are allowed to take the following form

$$\varepsilon_t = \sum_{i=1}^{n} \varphi_i \varepsilon_{t-i} + e_t \tag{2}$$

If Engle's LM test displays signs of a heteroskedastic process, equation 1 is estimated by allowing a GARCH(p,q) process for the conditional variance as follows.

$$\varepsilon_t = \sqrt{h_t e_t} \qquad h_t = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j h_{t-j} \tag{3}$$

Finally, if the White test reveals the presence of heteroskedasticity of unknown form, heteroskedasticity-consistent standard errors are used and reported.

6 Results

6.1 Output Uncertainty

Table 5 presents the results of the estimation. The second column shows the fin-dings from the LS. The variable under analysis is the 6-month expected growth rate of RGDP, $E_t[g_{t+1}]$. The level of disagreement about it, measured by the standard deviation, is the proxy for output uncertainty, $U_t(E_t[g_{t+1}])$, which is regressed on two lags of it and $E_t[g_{t+1}]$, which represents the expected performance of the economy. Only lag 1 turned out to be significant at conventional levels. As the ARCH-LM test indicates, there is evidence of an ARCH type process for the variance. Visual inspection of the squared residuals correlogram indicates that a GARCH process would be appropriate. A GARCH(3,1) process to model the variance gives the minimum AIC (see appendix). Although, not very reliable in small samples, the Jarque-Bera statistic of 0.64 indicates that normality in the errors cannot be rejected.

The results in table 5 are those obtained after allowing the GARCH process for the conditional variance. With the exception of the F-Test , the diagnostic tests shown there correspond to the values obtained before allowing for the GARCH procedure, and thus show the need for corrective measures.

As can be seen, uncertainty about the expected performance of the economy shows persistence. This does not contradict what we would expect from rational forward-looking agents. Since uncertainty is related to future events , past values of it should not help in explaining it today. However, since the disagreement proxy is used here, it is entirely consistent with a rational agent to observe persistence in the disagreement process. It would indicate that the factors , others than $E[g_{t+1}]$, that made individuals disagree six months ago are still present today.

<div align="center">**Table 5: Output Uncertainty**</div>

	Livingston Survey	SPF: Point Forecasts	SPF: Probability of Decline	Michigan Survey of Consumers	SPF: Probability Forecasts
Constant	-0.0045	0.0020	-3.6449***	-0.0073	0.0927***
	(0.0142)	(0.0048)	(0.6122)	(0.1701)	(0.0212)
U_{t-1}	0.2656**	0.2797***	0.1849*	0.5338***	—
	(0.1220)	(0.0797)	(0.0959)	(0.0525)	
U_{t-2}	—	—	-0.1651**	—	—
			(0.0825)		
$E_t(x_{t+1})$	-0.0890***	-0.0738**	0.2111***	-0.0041	-0.0320***
	(0.0170)	(0.0325)	(0.0366)	(0.01831)	(0.0075)
F-statistic (prob)	5.5121 (0.0000)	2.3293(0.0275)	27.142(0.0000)	58.9057(0.0000)	1.1922(0.3192)
B-G LM[a] (prob)	0.7924(0.8512)	12.972(0.0236)	9.0699(0.1063)	17.6095(0.1729)	9.8808(0.1297)
White Test (prob)	1.4581(0.9178)	33.534(0.0000)	19.936(0.0181)	43.326(0.0000)	8.0195(0.0181)
ARCH LM (prob)	13.6398(0.0034)	49.216(0.0000)	5.2677(0.3840)	17.609(0.1729)	30.608(0.0000)
n	63	85	85	300	85

[a]Breusch-Godfrey test for serial correlation

*: significant at the 10% level. **: significant at the 5% level. ***: significant at the 1% level. Numbers in parenthesis are standard errors, except for the probability of decline and Michigan columns, which are heteroskedasticity-consistent standard errors.

The estimated coefficient on $E[g_{t+1}]$, tells us that a one percent increase in the 6-month ahead forecast of the growth rate of RGDP decreases the level of uncertainty by 0.089

points. To better understand the real magnitude of that change, I obtain a crude measure of the relative importance of that value. Comparing the 0.0089 against the mean of the series, 0.5849, it is possible to conclude that a one point decrease in $E[g_{t+1}]$ would generate an increase in uncertainty of about 15 percent.

Similar results are obtained from the point forecasts in the SPF, there is persistence in the dispersion series and a negative relationship between $E[g_{t+1}]$, which here is the 1-quarter ahead forecast of the growth rate of RGDP, and the level of uncertainty about it, $U_t(E[g_{t+1}])$. A one point increase in $E[g_{t+1}]$ would decrease uncertainty about the expected performance of the economy by 22 percent when compared with its mean in the series.

As the diagnostic tests indicate, a correction to account for conditional heteroskedasticity should be made. The best fit is reached with a GARCH(1,3) process, and the results presented are those attained after applying the corrective procedure.

The third column deals with the uncertainty around the probability of decline, $Prob_t(D)$. This probability is the weight that individuals put on the event: RGDP declining the quarter following the one in which the survey is taken. In this case $E_t[X_{t+1}]$ represents this probability. The White test indicates for the presence of heteroskedasticity in the data. Since it is of unknown form, White heteroskedastic consistent standard errors are reported. The minimum AIC value is obtained when allowing 2 lags of the dependent variable in equation 1. Again, persistence resides in the data, and this time it is more accentuated by lasting for two periods. The positive number on $E_t[x_{t+1}]$ implies that an increase in the probability of decline ,$Prob_t(D)$, that is, a foreseen decrease in RGDP

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raises the level of uncertainty about it.

The fourth column shows the findings from the Michigan survey of consumers for the monthly index of economic expectations, IEE_{t+1}, mentioned in part 4. Uncertainty around the index , $U_t(IEE_{t+1})$ is regressed on its past twelve values, and on the value of the index. Once more, lagged uncertainty -albeit only 1 lag- helps to explain its value today. Although, the estimator on IEE_{t+1} does show an inverse relation with the level of uncertainty about it, it is not significant at conventional levels. The standard errors presented there are heteroskedasticity-consistent standard errors to account for heteroskedastic errors as the White test indicates.

Finally, the fifth column exhibits the results for what I believe is the star and most reliable of the surveys, the probability forecasts in the SPF. Here the dependent variable is a direct measure of the uncertainty perceived by the individual about its 1-quarter ahead forecast of the growth rate of RGDP, $E_t[G_{t+1}]$, and this forecast is the one used as the explanatory variable.

None of the lagged values of uncertainty is significant at conventional levels. This is what should be expected from a forward-looking agent. The ARCH LM test hints that conditional heteroskedasticity is found in the series. To correct for it, an ARCH(4) process for the conditional variance is used in the estimation (see appendix C for details). This does not change the results qualitatively or quantitatively in a significant way, it only improves the accuracy of the estimation. The results shown in table 5 are the ones obtained after correcting for the problem.

The findings tell the same story, a fall in the expected growth rate of RGDP raises the

level of uncertainty by 0.0284 points. This is a 3.5 percent increase when compared with the mean value of the series.

It then seems to be clear, from analyzing the different measures of uncertainty arising from the three surveys, that when agents expect the growth rate of output to decrease during the near future , they are more uncertain than when this rate is expected to increase.

6.2   Unemployment Uncertainty

With the purpose of detecting whether the previous findings also apply to other macroeconomic variables, I investigate whether the expected performance of output also affects the uncertainty agents perceive about the unemployment rate. To this end, I regress the disagreement measure around the expected unemployment rate, $U_t(E_t[Unem_{t+1}])$ for both the LS and the SPF, against the expected growth rate of real GDP, $E_t[g_{t+1}]$, coming from the same surveys. As before, the lagged measure of disagreement around the expected unemployment rate is used to measure the degree of persistence in the series.

Table 6 shows the results. In both cases, persistence appears in the data. Interestingly, the level of uncertainty one period ago does not help to predict it today. It is a two period lag , in the case of the LS, and three and four lags for the SPF, the relevant lags for predicting unemployment uncertainty. Since the LS is applied twice a year, June and December, the finding would indicate that the level of uncertainty today depends upon the level of unemployment uncertainty during the same survey period one year ago, which could be a result of some seasonal pattern on hirings. A similar explanation could hold for the SPF.

Table 6: Unemployment Uncertainty

	Livingston Survey	Survey of Professional Forecasters
$Constant$	-0.0000	-0.0007
	(0.0102)	(0.0036)
U_{t-2}	0.1820*	—
	(0.0982)	
U_{t-3}	—	0.2253**
		(0.0889)
U_{t-4}	—	0.0956
		(0.0906)
$E_t(x_{t+1})$	-0.0798***	-0.0922***
	(0.0118)	(0.0209)
F-statistic (prob)	24.112 (0.0000)	9.0874 (0.0000)
B-G LM (prob)	0.6352(0.8883)	3.8521 (0.5708)
White Test (prob)	1.9640 (0.8540)	7.5430(0.5807)
ARCH LM (prob)	0.6132(0.7359)	6.3159(0.2766)
n	63	85

*: significant at the 10% level. **: significant at the 5% level. ***: significant at the 1% level.

Numbers in parenthesis are standard errors

In both cases the data exhibit a negative relationship between the expected performance of the economy and unemployment uncertainty. Even though the change in uncertainty when $E_t[g_{t+1}]$ changes by one point is similar, when compared with their respective series means, they depart from each other significantly. While the change in unemployment

uncertainty in the LS represents a change of 0.24 percent with respect to its mean, the change in the SPF denotes a shift in uncertainty of 46 percent respect to its mean. Therefore, both measures of uncertainty deliver the same message, an increment in the expected growth rate of RGDP pushes unemployment uncertainty down, and vice versa.

6.3   Inflation Uncertainty

In the two previous sub-sections I have used only estimators for real variables. I want now to know whether the inverse relationship found there can be extended to a nominal variable. To this purpose, I regress the measure of uncertainty about the expected inflation rate, $U_t(E_t[\pi_{t+1}])$, against the expected growth rate of real GDP obtained from the LS, and the SPF for its two type of projections. As before, persistence is analyzed by including lags of the dependent variable.

The second column shows the findings for the LS. Even though the one lag value of $U_t(\cdot)$ is significant, there still remains some indication of serial correlation as hinted by the Breusch-Godfrey test. Indeed allowing a one lag period in the error term greatly improves the fit of the equation in terms of the AIC, and the adjusted R-squared. The results shown in table 7 incorporate this correction.

The estimated parameter on $E_t[g_{t+1}]$ indicates that an increase in the expected growth rate of output of one point tends to decrease uncertainty by about 15 percent when compared with the mean of the inflation uncertainty series.

The next column presents the findings from the point forecast portion of the SPF. Here persistence does not play a role in the inflation uncertainty path. Both the White test and the ARCH-LM test indicate heteroskedasticity. Visual inspection of the correlogram of squared residuals hints at the presence of conditional heteroskedasticity. Indeed, an ARCH(3) process for the variance is found to describe it well (see appendix C)

Table 7: Inflation Uncertainty

	Livingston Survey	SPF:Point Forecasts	SPF: Probability Forecasts
Constant	0.0054	-0.0091	0.04524**
	(0.0138)	(0.0145)	(0.0198)
U_{t-1}	0.4695***	—	—
	(0.1065)	—	
$E_t(x_{t+1})$	-0.0955***	-0.2321***	-0.0225***
	(0.0212)	(0.0762)	(0.0075)
F-statistic (prob)	16.687 (0.0000)	2.4258(0.0424)	1.2340(0.2981)
B-G LM (prob)	6.4547(0.0396)	3.5266(0.6193)	4.8404(0.4356)
White Test (prob)	2.9530(0.7072)	9.5238(0.0085)	4.1047(0.1284)
ARCH LM (prob)	2.9141(0.4050)	10.236(0.0688)	18.427(0.0024)
n	63	85	85

* significant at the 10% level. **: significant at the 5% level. ***: significant at the 1% level.

Numbers in parenthesis are standard errors, except for the last column which are Bollerslev-Wooldrige robust standard errors

The estimation also shows an inverse significant relationship between inflation uncertainty and expected output growth. A one percent decrease in $E_t[g_{t+1}]$ raises inflation uncertainty by about 32 percent when compared with its mean.

Finally, the probability forecasts in the SPF gives a similar story. First , and as expected, no persistence is present in the data, that is history does not play any role in determining today's level of inflation uncertainty. It can be seen that an improvement in the expected performance of the economy, measured by output growth, is translated into

a fall in inflation uncertainty of about 3 percent when compared with its mean value. The ARCH-LM test hints at the presence of conditional heteroskedasticity. Visual inspection of the correlogram of the squared residuals manifests that a GARCH(3,1) process for the conditional variance should be indicated. Indeed, allowing for it improves the fit as evidenced by a smaller AIC (see appendix C). Since the errors do not seem to be normal after the correction, quasi-maximum likelihood is used and Bollerslev-Wooldrige robust standard errors are reported.

7 The Importance of the Findings

People being more uncertain when expecting the economy to deteriorate, is likely to alter the effects of macroeconomic policies, and thus policy design should be adapted.

On the monetary side , this would imply that in order to achieve the same effect on output, monetary policy needs to be more aggressive when agents are expecting output to decline than when they expect it to increase. Indeed, higher uncertainty during the downside would make economic agents to hold back consumption and investment decisions, and therefore delaying, at best, the efficacy of monetary policy.[15]

Furthermore, Cover (1992), and De Long and Summers (1988) document that positive monetary shocks have smaller effects on output than negative monetary innovations. This could be explained by higher uncertainty during the downturn than during the expansion.

On the fiscal side, policies aimed at affecting aggregate demand through consumption, tax policy for instance, may also confront a different response from the economy, depending upon the expected growth rate of output. When households expect output growth to fall, the higher level of uncertainty associated with it would make them postpone consumption decisions. For instance, and aside from Ricardian considerations, a 1-percent increase in the tax rate on income may caused aggregate demand to fall, but a 1-percent decrease in that rate may not affect aggregate activity at all if households

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[15]Theoretically, one needs a concave marginal revenue product of capital on the innovation affecting output to obtain a negative link between uncertainty and investment. Leahy and Whited (1996) find this link empirically.

expect output to fall in the near future.

Thus, the economic authority needs to account for this pattern of uncertainty overtime when designing macroeconomic polices. That is, it needs to be aware that because of it, macroeconomic policies are likely to result in asymmetric effects on output.

8 Conclusions

Different forms of uncertainty are incorporated in most macroeconomic models nowadays as an exogenous unidirectional variable. Uncertainty affects all the variables in the model, but it is not affected by any of them.

This study represents an empirical attempt to show that uncertainty about the main macroeconomic variables is also affected by the expected performance of the variables it affects. That is, uncertainty seems to be not only a right hand side variable but also a left hand side one.

I have measured macroeconomic uncertainty through the standard deviation associated with the expected value of output growth, the unemployment rate, and the inflation rate respectively. Ten different series of uncertainty coming from three different surveys of expectations are generated. I use not only the disagreement proxy for uncertainty but also a direct measure of it, which can be obtained from data from the SPF.

With only the exception of the Michigan survey, in every series the message is the same: A foreseen weakening of the economy, measured by the expected growth rate of RGDP, raises the level of uncertainty about the future performance of output growth, unemployment, and inflation. Hence, forward-looking agents behold higher levels of macroeconomic uncertainty when the expected growth rate of output falls, and lower levels of uncertainty when the expected growth rate rises.

The findings shown here, may have substantial effects on the design of macroeconomic policy. For instance, the same change in the target for the federal funds rate may cause lower effects on output during a contraction of economic activity than during an

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expansion because the higher level of uncertainty may eventually hold back spending and investment decisions.

It could also be argued that the asymmetric effects of monetary policy reported by Cover (1992) for the U.S. economy may not only be the result of prices being sticky downwards, as the Keynesian view would argue, but also to higher levels of uncertainty during downturns.

The findings in this study are only an attempt to acquire some light on an area that is in need of more theoretical and empirical research. Why people feel more uncertain during the downturn than during the expansion phase of the business cycle is a question that needs to be answered.[16]

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[16]In work in progress, Sepúlveda-Umanzor (2004) finds that a simple RBC model augmented to include variable capacity utilization, can generate asymmetry in the response of output to symmetric innovations. This generates a negatively skewed distribution of output. This would explain why we observe more dispersion in forecasts on expected downturns.

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Appendix

A Data

Table 1: Output Uncertainty

	Livingston Survey (LS)	Survey of Professional Forecasters (SPF)	Michigan Survey of Consumers (MSC)
Original Variable	Expected Real GDP (RGDP)[a]	(1)Expected RGDP[a] (2) Probability of RGDP[b] (3) Probability of Decline[c]	(1) Expected household financial condition (2)Expected country's economic condition
Constructed Variable	Implicit expected growth rate of RGDP	Implicit expected growth rate of RGDP	Index of Economic Expectations
Uncertainty Measure	Disagreement	(1) Disagreement (2) Uncertainty in ZL sense	Disagreement
Forecasting Period	6-month ahead forecast	1-quarter ahead forecast	12-month ahead forecast
Periodicity	Semi-annual	Quarterly	*Monthly*
Period	$1971:06-2002:06$	$1981:03-2002:03$	$1978:01-2002:12$

[a]Prior to 1992: Real GNP

[b]Refers to the probability that the percentage change in RGDP falls in a particular range. Prior to 1992: RGNP

[c]Refers to the probability of a decline in RGDP during the next quarter. Prior to 1992: RGNP

Table 2: Unemployment Uncertainty

	Livingston Survey (LS)	Survey of Professional Forecasters (SPF)
Original Variable	Expected Unemployment Rate	Expected Unemployment Rate
Uncertainty Measure	Disagreement	Disagreement
Forecasting Period	6-month ahead forecast	1-quarter ahead forecast
Periodicity	Semi-annual	Quarterly
Period	$1971:06-2002:06$	$1981:03-2002:03$

Table 3: Inflation Uncertainty

	Livingston Survey (LS)	Survey of Professional Forecasters (SPF)
Original Variable	Expected CPI	(1)Expected CPI (2) Probability of Inflation
Constructed Variable	Implicit expected inflation rate	Implicit expected inflation rate
Uncertainty Measure	Disagreement	(1) Disagreement (2) Uncertainty in the ZL sense
Forecasting Period	6-month ahead forecast	1-quarter ahead forecast
Periodicity	Semi-annual	Quarterly
Period	$1971:06-2002:06$	$1981:03-2002:03$

Table 4: Summary of Uncertainty Measures

Uncertainty around	Livingston Survey (LS)	Survey of Professional Forecasters (SPF)	Survey of Consumers
Output	$U_t^{LS}(E_t[g_{t+1}^{LS}])$	$(1)U_t^{SPF}(E_t[g_{t+1}^{SPF}])$ $(2)U_t^{SPF}(E_t[G_{t+1}^{SPF}])$ $(3)U_t^{SPF}(Prob(D))$	$U_t^{MSC}(IEE_{t+1})$
Unemployment	$U_t^{LS}(E_t[Unem_{t+1}^{LS}])$	$U_t^{SPF}(E_t[Unem_{t+1}^{SPF}])$	n/a
Inflation	$U_t^{LS}(E_t[\pi_{t+1}^{LS}])$	$(1)U_t^{SPF}(E_t[\pi_{t+1}^{SPF}])$ $(2)U_t^{SPF}(E_t[\Pi_{t+1}^{SPF}])$	n/a

B The Index of Economic Expectations(IEE_{t+1})

As hinted in the body of the paper, the IEE is built from a slight modification of the Index of Consumer Expectations (ICE). The codebook of the Survey of Consumers from the Survey Research Center at the University of Michigan describes how the ICE is constructed.

The ICE is calculated as

$$ICE = \frac{X_2 + X_3 + X_4}{4.1134} + n$$

where , the Xs corresponds to three particular questions in the survey.[17] As the codebook states, the relative scores of the 3 component questions (X_2 to X_4) are used in the equation and are defined as the percent giving favorable replies minus the percent giving unfavorable replies, plus 100. The denominator of the formula is the 1966 base period

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[17]See the Codebook for details on the questions

total for the three questions, and the added constant n is used to correct for sample design changes from the 1950s. Prior to December 1981, $n = 2.7$; for December 1981 and after, $n = 2.0$.

X_2 and X_3 correspond to questions asking respondents about expectations one year ahead, while X_4 asks for a 5-year forecasting period. Because of this discrepancy in the projection period, I drop the X_4 question to end up with an index where the components have the same forecasting period.

The IEE_{t+1} is then

$$IEE_{t+1} = \frac{X_2 + X_3}{1.455} + n$$

where the denominator represents the 1966 base period total for the two questions.

C Error term corrections

C.1 Output uncertainty

C.1.1 Livingston Survey

Variance equation

$$h_t = 0.0042 + 0.3865\varepsilon^2_{t-1} + 0.2575h_{t-1} + 0.6417h_{t-2} - 0.4935h_{t-3}$$
$$(0.0031) \quad (0.2767) \quad (0.3053) \quad (0.1707) \quad (0.2289)$$

$AIC = -1.1148 \qquad Log\ likelihood = 42.5612 \qquad Jarque - Bera(Prob) = 0.6405(0.7259)$

C.1.2 SPF: Point forecasts

Variance equation

$$h_t = 0.0002 - 0.1273\varepsilon^2_{t-1} - 0.0867\varepsilon^2_{t-2} + 0.2716\varepsilon^2_{t-3} + 0.8170h_{t-1}$$
$$(0.0002) \quad (0.0674) \quad (0.0395) \quad (0.1019) \quad (0.1045)$$

$AIC = -2.2677 \qquad Log\ likelihood = 101.9781 \qquad Jarque - Bera(Prob) = 2.5038(0.2859)$

C.1.3 SPF: Prob. forecasts

Variance equation

$$h_t = 0.0052 + 0.2044\varepsilon^2_{t-1} + 0.0165\varepsilon^2_{t-2} - 0.0024\varepsilon^2_{t-3} + 0.5331\varepsilon^2_{t-4}$$
$$(0.0040) \quad (0.2090) \quad (0.1266) \quad (0.0500) \quad (0.1973)$$

$AIC = -1.1586 \qquad Log\ likelihood = 56.2428 \qquad Jarque - Bera(Prob) = 1.2911(0.5243)$

C.2 Inflation uncertainty

C.2.1 Livingston Survey

Equation for the error term

$$\varepsilon_t = -0.3297\varepsilon_{t-1} + e_t$$
$$(0.1430)$$

C.2.2 SPF: Point forecasts

Variance Equation

$$h_t = 0.0054 + 0.6718\varepsilon_{t-1}^2 + 0.1022\varepsilon_{t-2}^2 + 0.2166\varepsilon_{t-3}^2$$
$$(0.0032) \qquad (0.2882) \qquad (0.1466) \qquad (0.0997)$$

$AIC = -0.6769 \qquad Log\ likelihood = 34.769 \qquad Jarque - Bera(Prob) = 2.7246(0.2560)$

C.2.3 SPF: Prob. forecasts

Variance Equation

$$h_t = 0.0002 + 0.3398\varepsilon_{t-1}^2 - 0.2683\varepsilon_{t-2}^2 + 0.5508\varepsilon_{t-3}^2 + 0.5009h_{t-1}$$
$$(0.0005) \qquad (0.1456) \qquad (0.1179) \qquad (0.2150) \qquad (0.0957)$$

$AIC = -1.2980 \qquad Log\ likelihood = 62.1656 \qquad Jarque - Bera(Prob) = 9.1376(0.0103)$

D Figures

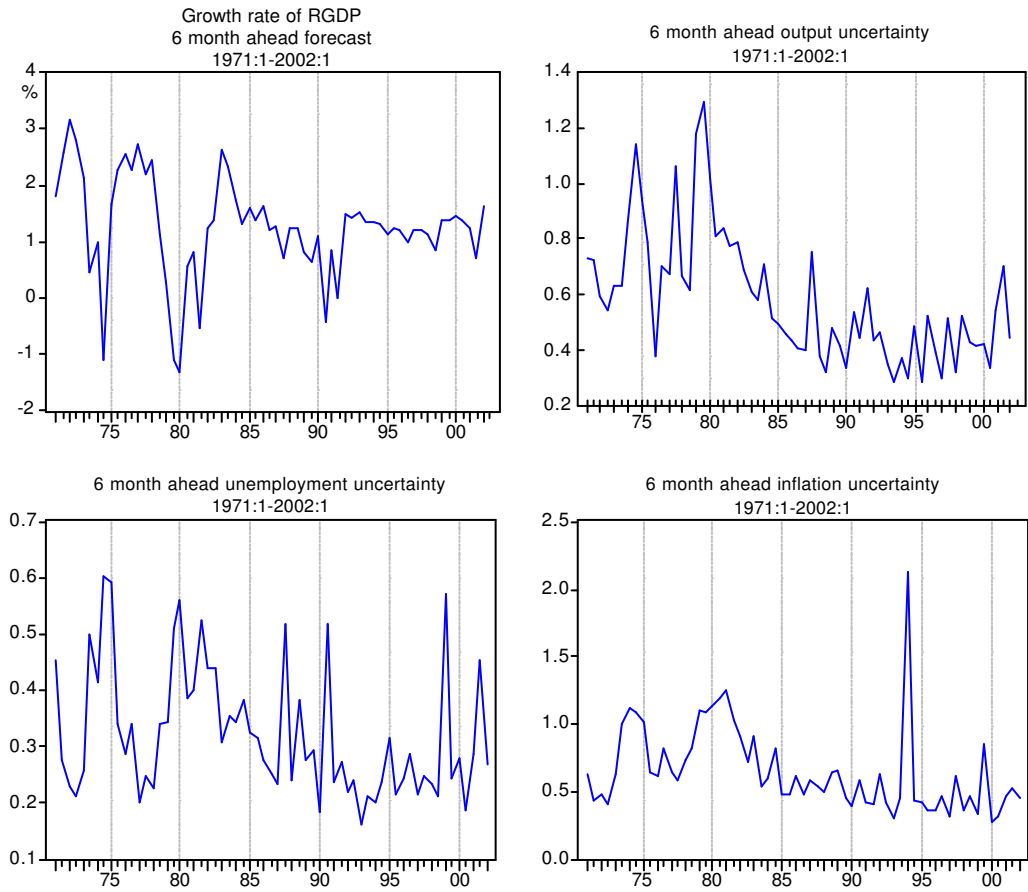Figure 1: Uncertainty in the Livingston Survey

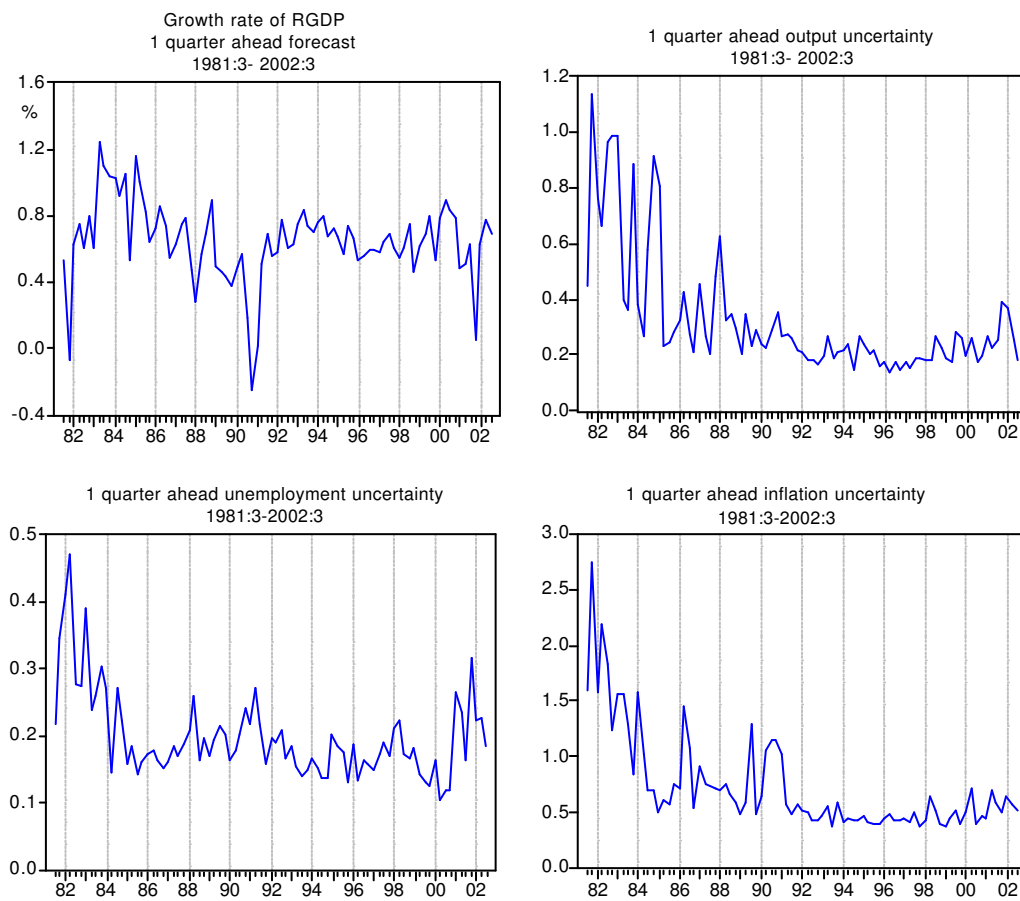Figure 2: Uncertainty in the Survey of Professional Forecasters, point forecasts

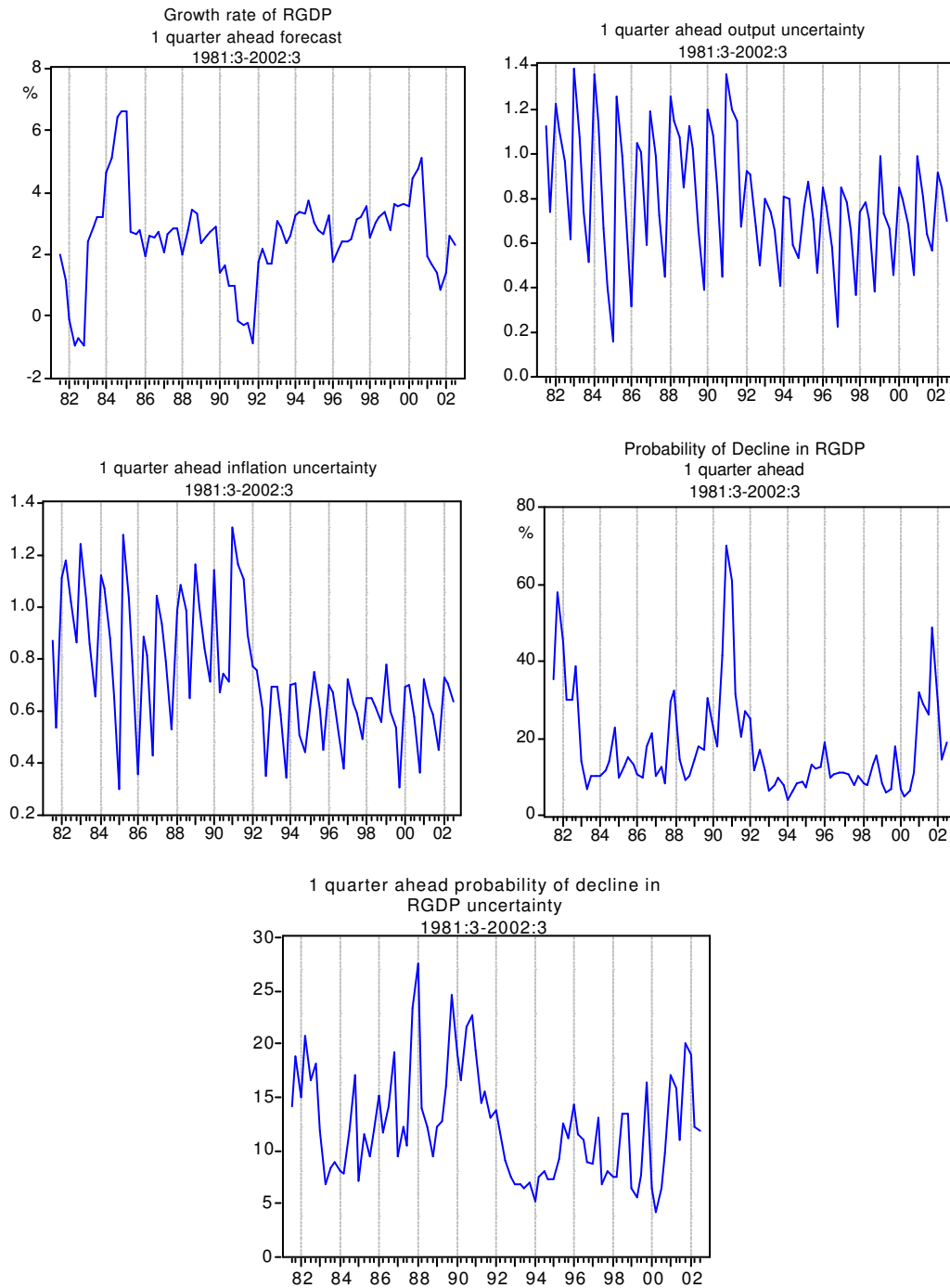Figure 3: Uncertainty in the Survey of Professional Forecasters, probability forecasts

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Figure 4: Uncertainty in the Michigan Survey of Consumers

Index of economic expectations
1978:01-2002:12

12 month ahead IEE uncertainty
1978:01-2002:12