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Uncertainty and Monetary Policy

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[FIRST DRAFT]

Abstract: This work analyses how the Bank of England and the Czech National Bank communicate uncertainty in their discussion of the setting of a forward-looking monetary policy. The aim of the analysis is to test whether information about uncertainty in the monetary policy minutes helps to explain the interest rate settings

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1. Introduction

There has been a growing interest in uncertainty in monetary policy-making, and in the communication of monetary policy. Central banks in particular (notably the ECB, the Bank of England and the US Fed) have sponsored research into model uncertainty.[1] Attention has also been paid to the uncertainty faced by markets, which has raised the importance of transparency on the part of the central bank (e. g. Eusepi, 2005). The main conclusion is that central bank transparency renders 'the optimal policy rule robust to expectational mistakes, even in the plausible case where the economic agents face other sources of uncertainty about the economic environment. On the other end, lack of transparency can lead to a welfare-reducing outcome where self-fulfilling expectations destabilize the economic system' (Eusepi, 2005, p. 22). Similarly Mishkin (2004) argues that inflation targeting in particular is made more effective by transparency. Yet there have been dissenting voices on the unambiguous benefits of transparency, as Geraats (2002) shows in her survey article. Where there is uncertainty on the part of the central bank, transparency which communicates that uncertainty may make monetary policy less effective. This issue is most relevant where this uncertainty is understood as being distinct from quantifiable risk, i.e. as reflecting the need for decision-makers to go beyond any one model and exercise judgement (Dow 2003).

Recognizing the importance of the uncertainty faced by the monetary authorities, a large part of the theoretical literature has sought to derive models of optimal monetary policy (i.e. to derive optimal Taylor-type rules) in the presence of uncertainty. The majority of the results adhere to the Brainard (1967) principle of *conservative* or *gradualism,* that is if a central bank is unsure about the magnitude and the nature of the economic effect on change in its instrument, it should change that instrument less than it would were it sure. Within a Taylor rule context, the theoretical literature[2] has suggested two ways in which uncertainty should be handled: first uncertainty lowers the weights on output gap and inflation but does not have a direct effect on the interest rate. Second uncertainty regarding one variable (e.g. inflation) should increase the weight put on the other (e.g. output gap).[3] Using data for the US, Martin and Milas (2009) find support for these theoretical predictions.

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1 Uncertainty as to the preferred model on which policy is to be based
2 see e.g. Peersman and Smets (1999), Walsh (2003) Swanson (2004)
3 There are two exceptions to this rule: the first applies in the case of imperfect or low credibility. The second case applies when the there is uncertainty surrounding the degree of inflation persistence. In both cases policymakers may find optimal to act more vigorously than it would have been optimal in a no-uncertainty scenario.

Recently, a new literature has been emerging which takes the issue of central bank communication seriously. This literature is based on the view that monetary policy consists not just of an interest rate decision and its communication, but also of communicating the analysis of the central bank, its expectations, and the confidence with which these are held. This wider communication is effected through press conferences and texts, as well as different measures such as the central banks' fan charts. Thus Cobham (2003) and Dow *et al.* (2009) have provided a textual analysis of UK monetary policy committee minutes, while Rosa and Verga (2005a, 2005b) have analysed ECB press conference transcripts.

The methodology that we apply in this article builds on Dow *et al.* (2009) and Rosa and Verga (2005a). We will analyze the semantic context of the minutes of the Monetary Policy Committee (MPC) of the Bank of England and of the Bank Board (BB) of the Czech National Bank; more specifically we contextualize the use of the word 'uncertainty' so that we can build a glossary to translate the language used in the minutes into quantitative variables. This should allow us to capture the degree of uncertainty surrounding the meetings. Moreover, the index would capture the weight and the context in which the policymakers refer to the concept of uncertainty.

Our analysis allows comparison with previous research on other central banks; by studying the language used by central banks with respect to uncertainty in a way where the banks can be compared. Hence our aim is twofold: first we aim to derive indicators reflecting the uncertainty faced by the policymakers in their considerations.[4]

Second, after having constructed the 'uncertainty' indexes, we investigate whether they have any particular role in the settings of monetary policy. The aim of the paper is to link the textual analysis to the actual policy implementation; therefore, we estimate a Taylor rule model in which the coefficients on inflation and output gap are functions of our measures and uncertainty.

The remainder of the paper is structured as follows. The next section present the context of uncertainty in which central banks operate, Section 3 presents the methodology used to construct the uncertainty indexes, Section 4 contains the econometric methodology, Section 5 discusses the results and Section 6 concludes.

2. Nature of uncertainty in monetary policy

[4] For the preliminary theoretical foundation see Dow *et al.* (2005)

Monetary policy operates in conditions of uncertainty about the future and also in terms of a potential asymmetry between the knowledge of the monetary authority and market participants.

Dow *et al.* (2007, 2009) define three sources of uncertainty; first is global uncertainty, which is consequence of the stochastic nature of the economic environment. This comprises also uncertainty about the state of the economy, since there is imperfect information derived from the availability of data and the quality of the data themselves; some economic indicators are unobservable (e.g. the NAIRU, the potential output and the equilibrium rate of interest). Moreover the nature and the persistence of the shock are frequently unknown.

The second type of uncertainty is model uncertainty; even in a deterministic world, there would be the possibility that our limited knowledge would not allow us to reach a single trusted model. It would ease analysis of the problem if somehow the knowledge base of the central bank could be represented by a single definable and describable entity. However, policy decisions are usually taken by committee, whose members have a diverse background, each with their own views on how the economy works and what may happen. Even though in a formal context central banks may have a formal model that they use in forecasting and explanation, they at the very least augment it with a range of other models, so there can be no exact exposition of the opinion forming process. Uncertainty about the appropriate model is also a matter of fact of actual policy decisions. As Levin and Williams (2003, p.946) remind us "each member of the monetary policy committee holds a particular view of the behavior of the economy represented by a macro model".

A third type of uncertainty is signal uncertainty. Monetary policy is conducted not only via a change in the short term interest rate, but also on the analysis and the motivation behind that particular value. This component is, probably, of central importance for a successful monetary policy, since the interest rate has little impact on future inflation and economic activity. As Svensson (2005) highlights, a successful policy maker is able to control private sectors' expectations. These expectations have a direct impact on the yield curve and on the long-term interest rate, which in turn will determine the path of current and future consumption and investment. Thus, since central bank communication leaves room for interpretation, agents will be engaged in judgment which is uncertain in nature and asymmetric, working against central bank transparency.

Central banks are likely to have better resources to form a view than most others. While they will have a good understanding of the limitations of their knowledge outsiders will neither know what that knowledge is nor the degree of certainty with which it is held. The ability to communicate is also imperfect and there is a clear incentive to be clear rather than complete in putting the message across. There is further interdependence between the monetary authority's knowledge, and uncertainty, and those of the private sector, in that each forms expectations of what the other is likely to do both in the light of their own knowledge and their understanding of the other. As Issing (2005) reminds us ‘data are often not self-explanatory, as their information content changes depending on the way they are communicated by the sender’ (p.67).

Moreover since the information provided by the central bank on its decision making process is both quantitative and discursive, information uncertainty has both quantifiable and non quantifiable aspects.

Although institutionalised procedures ultimately result in specific interest rate decisions, they are nevertheless open to different interpretations by market participants. It is this context which sets the scene for current debates on the transparency of central bank policies (e.g. Geraats 2002). The challenge for a policy committed to transparency consists in ensuring adequate transparency of the form and content of decision procedures for revealing the collective judgement of the decision-making body as well as sometimes revealing difference of opinion.[5] This form of transparency should make it more likely that market behaviour is conditioned by the same expectations as the Central Bank, helping to improve the policy makers’ ability to predict. But it also facilitates a closer anticipation of future decisions if the past decision process is well understood. Hence, these signals play a central role in monetary policy. The channels through which these signals are formed, are therefore of key importance in the success of the enterprise.
Therefore central banks under investigation here follow an inflation targeting strategy; they all make decisions by committee and publish minutes that reveal internal differences of opinion. This comparative study will allow some assessment as to which is the more effective framework for communication.

3. Methodology

It is difficult to measure uncertainty as it is not directly observable. Much of the academic literature focuses on the theoretical aspect of uncertainty that the Central Bank faces and on the practical issues of the uncertainty surrounding the Central Bank forecasts for inflation and output growth. A notable exception is the work by Rosa and Verga (2005a, 2005b). Analysing the ECB President’s monthly conference, they build an index which gives ‘summary statistics of the ECB Governing Council view about both the future prospect of inflation and real activity in the Euro area’. On the most basic level, a simple count of uses of the terms ‘uncertain’ and ‘uncertainty’ can be taken as an ordinal indicator of how much uncertainty the central bank was experiencing.

[5] Geraats (2002) makes it clear that there is a range is aspects over which central banks try to be transparent.

Our focus is on the Bank of England and on the Czech National Bank language on uncertainty in such a way as to allow some comparison with the previous studies. This should shed some light on the implications of the framework differences between the monetary authorities for communication about uncertainty, and how that relates to monetary policy decisions. Here the committee is treated as a single entity (i.e. voice) rather than a collection of individuals and a plurality of voices.

More specifically, we analyse the frequencies of the term 'uncertainty', studying how they are used in the minutes of the monetary policy committees without imposing our own interpretations. Since our focus is on how the MPC communicates its uncertainty we follow Dow *et al.* (2009) and we consider all word forms arising from the word stems 'uncertain'. This allows us to derive frequencies f(U) which represent the number of times the respective set of expression U is instanced in a given MPC/EB/BB minute in a substantive way that reflects their assessment of uncertainty inherent in the given economic situation. To arrive at frequency counts that can be regarded as substantive in the sense described, raw counts of U occurrences have to be subjected to a preliminary step of analysis that removes instances that merely arise as part of a conditional consideration in the minutes.

For the Bank of England we expand the database of Dow *et al.* (2009) from September 1997 to December 2007 and for the CNB our sample starts on January 1998 providing us with 124 and 120 observations, respectively. We have further recorded the length of each minute as a word count, to be able to control for possible change in length during particular months[6].

Figures 1 and 4 in Appendix I plot the index of uncertainty for the Bank of England and the CNB, respectively. At a first glance we notice that there is not a discernible pattern emerging, this is in line with the results of Dow *et al.* (2008, p.) where the uncertainty measure was found to follow a white noise process which is 'highly compatible with the presence of significant signal uncertainty in the MPC communications'.

The derived frequency of uncertainty, f(U), is then classified according to the nature of the uncertainty described. Here we consider only two different subcategories: references to uncertainty on domestic inflation and uncertainty on economic/output activity/growth, which are factors which could be considered to be of relevance when monetary policy decisions are taken. Data for the UK are plot in Figures 2 and 3 and in Figures 5 and 6 for the CNB.

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[6] We disregard cover pages and annexes. For more details on the Bank of England see Dow *et al.* (2009).

4. Empirical specification

Our empirical analysis is based on the well-known Taylor rule (Taylor, 1993). It is widely accepted that the behaviour of the interest rate can be described by the following policy rule:

$$i_t = \alpha_c + \alpha_\pi E_t \pi_{t+1} + \alpha_y y_t$$

Where α_c is a constant, i_t is the policy rate at time *t*, $E_t \pi_{t+1}$ is the expected level of inflation and y_t is the output gap. Allowing for interest rate smoothing, the above equation can be rewritten as:

$$i_t = (1-\gamma_1)\alpha_c + \gamma_1 i_{t-1} + (1-\gamma_1)\{\alpha_\pi E_t \pi_{t+1} + \alpha_y y_t\} \qquad (1)$$

Following the theoretical literature and Martin and Milas (2008) we know that the parameters, α_π and α_y are functions of uncertainty underlining the model and the state of the economy so that in presence of uncertainty the above equation can be rewritten as:

$$i_t = (1-\gamma_i)a_c + \gamma_1 i_{t-1} + (1-\gamma_1)\{(a_\pi + a_\pi^{unc} u_t)E_t \pi_{t+1} + (a_y + a_y^{unc} u_t) y_t\} \qquad (2)$$

Where *u* is the measure of uncertainty descried in the previous section.
This method allows us to test whether the response to uncertainty as communicated in the central bank minutes are reflected in the behaviour of the policy makers that is whether uncertainty impact positively (or negatively) interest rate changes. If the predictions of the theoretical literature are correct then we should expect $\gamma_{\pi,y}^{unc}$ to take a value smaller than zero.

Our second empirical specification considers the two sub sets of uncertainty: inflation uncertainty and output uncertainty. Our second specification is therefore given by:

$$i_t = (1-\gamma_i)a_c + \gamma_1 i_{t-1} + (1-\gamma_1)\{\alpha_\pi^\pi E_t \pi_{t+1} + \alpha_y^y y_t\} \qquad (3)$$

Where $\alpha_\pi^\pi = a_\pi + a_\pi^{\pi-unc} unc^\pi + a_\pi^{y-unc} unc^y$ and $\alpha_y^y = a_y + a_y^{\pi-unc} unc^\pi + a_y^{y-unc} unc^y$. We define unc^π and unc^y as the inflation and output uncertainty, respectively. As state previously, the literature makes clear prediction of how an optimal policy should be set. If increased uncertainty leads to a more passive response to a variable and strengthen the response to the other we should expect $\gamma_{\pi}^{\pi-unc} < 0$, $\gamma_{\pi}^{y-unc} > 0$ and $\gamma_{y}^{\pi-unc} > 0$, $\gamma_{y}^{y-unc} < 0$.

5. Empirical results

We use monthly data from 1997:9 to 2007:12 and 1998:1 to 2007:12 for the Bank of England and the CNB respetively. We use this sample period since we wanted to exclude from our analysis, the financial crisis, when monetary authorities were mainly focused on restoring financial stability and preventing the collapse of the financial system, rather than focusing on the more traditional objectives of inflation and output stabilization. For the interest rate we use the end of the month official bank rate, the inflation is the percentage annual change in the retail price index for the UK and the consumer price index for the Czech Republic. The output gap is measured using the industrial production data detrended using the Hodrick-Prescott filter.

Results from the generalized method of moments (GMM) are presented in Tables 1 through 4.[7] Column (i) in Table 1 and 3 presents the traditional Taylor rule without explicit regard to uncertainty as in Equation (1).

We find that the reaction to a one percentage increase in output gap, increases the interest rate by 1.61 percent, while a similar change in inflation increases the policy rate by 1.86 percent.

Column (ii) in Table 1 shows the Taylor rule for the UK where the parameters are allowed to be function of our measure of uncertainty. We find that uncertainty enters significantly and with the expected sign on the inflation weight. The estimation confirms the prediction that the reaction of interest rate to the inflation is weaker when there is more uncertainty.

The results presented above are of interest, but they do not shed any light on which ‘type’ of uncertainty matters. The theoretical literature suggests that in presence of uncertainty an optimal monetary policy should respond by decreasing the weight on inflation when there is uncertainty surrounding this indicator, but it should increase the weight on the other variables (in our case output). To test this hypothesis we use our measure of inflation and output uncertainty. Results are presented in Table 2. The estimated coefficients of inflation and output are very similar to the original Taylor rule; interestingly, we observe that only output uncertainty is significant and of the expected sign: positively related to inflation and negatively to the output gap.

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[7] The instruments used are lagged variables and a constant. We experimented with various specifications allowing for various lags and leads; in the end the model with current level of output and 3-three months ahead performed best.

It is not straightforward to give a clear interpretation of the results; there are two possible explanations. First, our sample period refers to the great moderation, where inflation was relatively low and stable and the central bank had a good control of private sector's inflation expectations. Hence, inflation uncertainty did not pose a serious threat. Second, since its independence, the Bank of England has always made clear its strong commitment to fight inflation. Hence, it is possible that the uncertainty surrounding inflation was not strong enough to alter the preferred weight that the bank attached to inflation.

Finally we compare our results to a conventional empirical measure of uncertainty; we estimate a Phillips curve and an aggregate demand equation allowing the error terms to follow a GARCH (1,1) process. The implied volatilities recovered from these models are then used to re-estimate Equation (3). Results are in Table 2 columns (i) and (ii); they show that both types of volatilities have an impact on inflation but not on output.

Looking at the CNB results we notice the strong statistically significant weight attached to inflation. For each percentage move in inflation our estimate suggests a 2.2 percentage change in the nominal interest rate; this result is justifiable with the strong disinflationary programme at the beginning of the nineties.

Column (ii) in Table 3 provides the estimates of the role of uncertainty in monetary policy. The coefficient has the expected sign and it is significant at the conventional statistical level. The Brainard principle, that policymakers that face uncertainty should be more *conservative*, fully applies here. Moving now to Table 4 and the impact that inflation and output uncertainty had, we first notice that only the inflation component is statistically significant, similarly to what we estimate in the case of no uncertainty. The level of the coefficient is very similar, and the uncertainty surrounding inflation is negative as expected. However, the coefficient of output uncertainty is of opposite sign.

6. Conclusions

In this paper we have analysed the frequencies of the use of the term 'uncertainty', studying how they are used in the minutes of the monetary policy committees of the bank of England and the Czech National Bank. We have then estimated the impact of uncertainty on monetary policy using the traditional Taylor rule framework. We have found clear evidence that monetary policy has been affected by uncertainty and that these effects are generally consistent with the predictions of the theoretical literature.

Our work can be extended in a number of ways. This framework can be applied to other countries to test whether there is a clear pattern in the response of monetary policy to uncertainty and whether banks following an inflation targeting strategy behave differently from a non those that adopt other strategies.

It would also be of interest to analyse the impact of financial market uncertainty and investigate if asset price uncertainty has had any impacts on the monetary policy.

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Appendix I

Figure 1. UK uncertainty

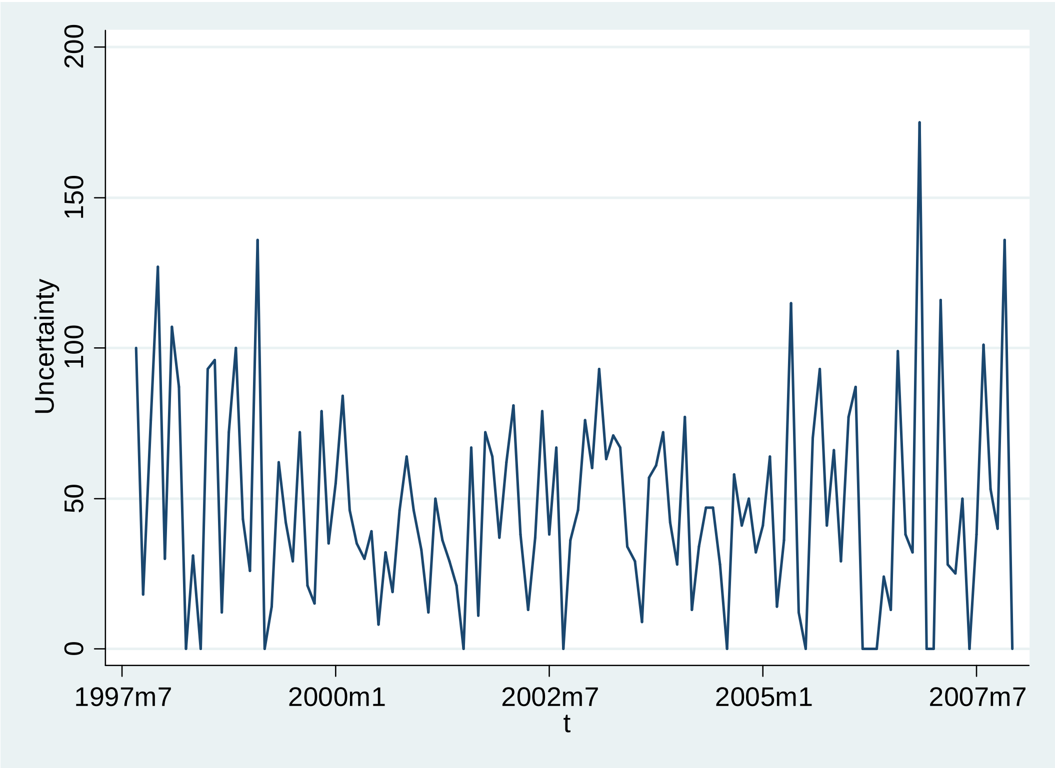


Figure 2. UK inflation uncertainty

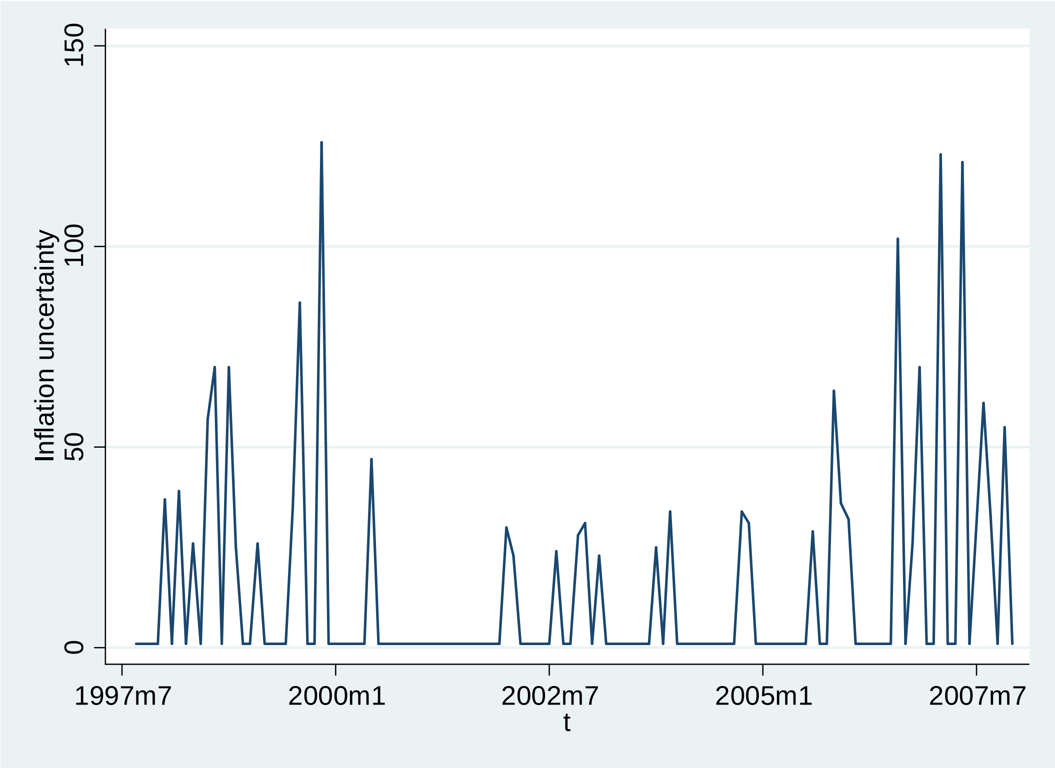


Figure 3. UK output uncertainty

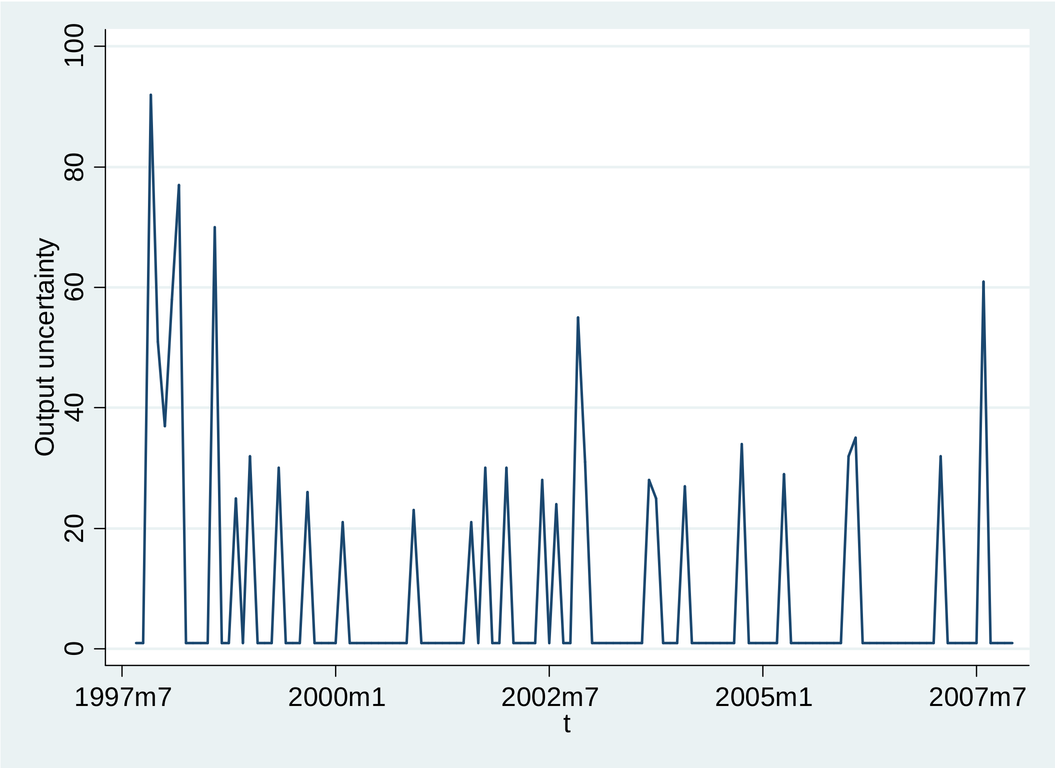


Figure 4. CNB uncertainty

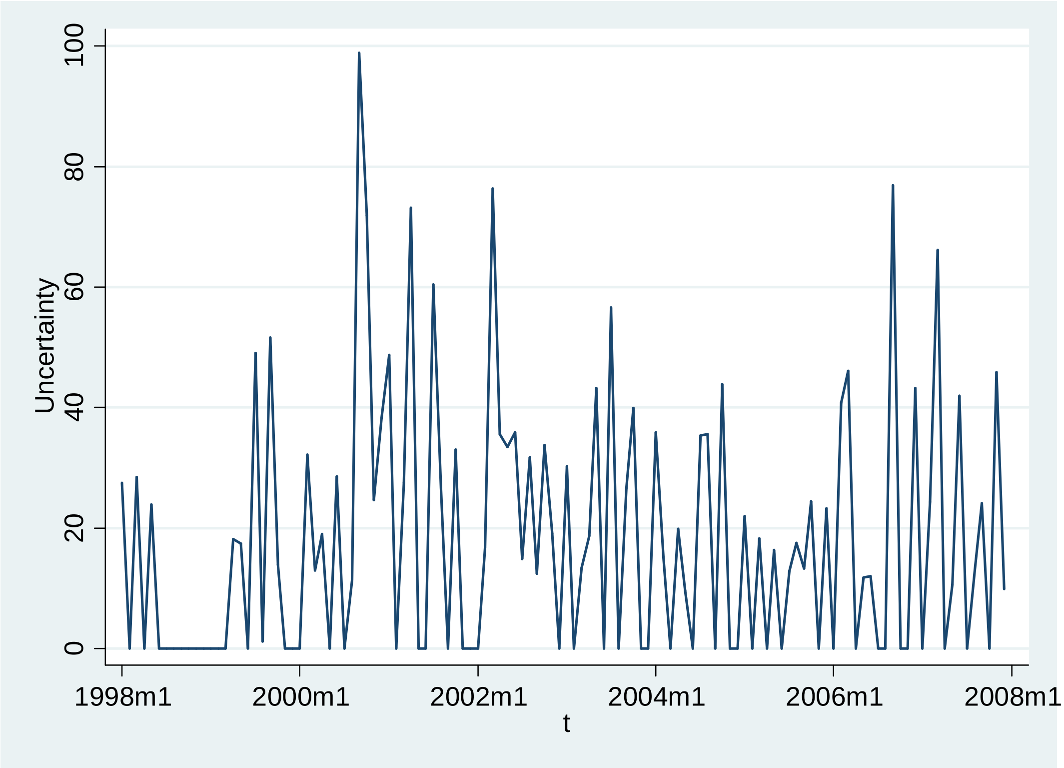


Figure 5. CNB inflation uncertainty

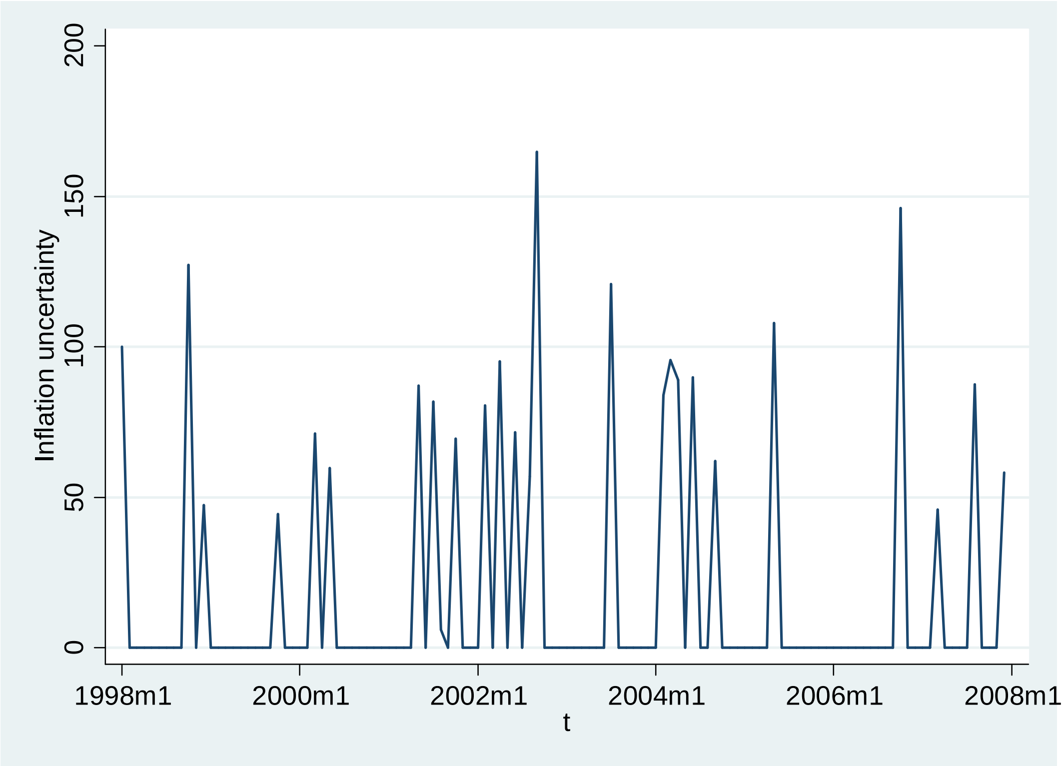
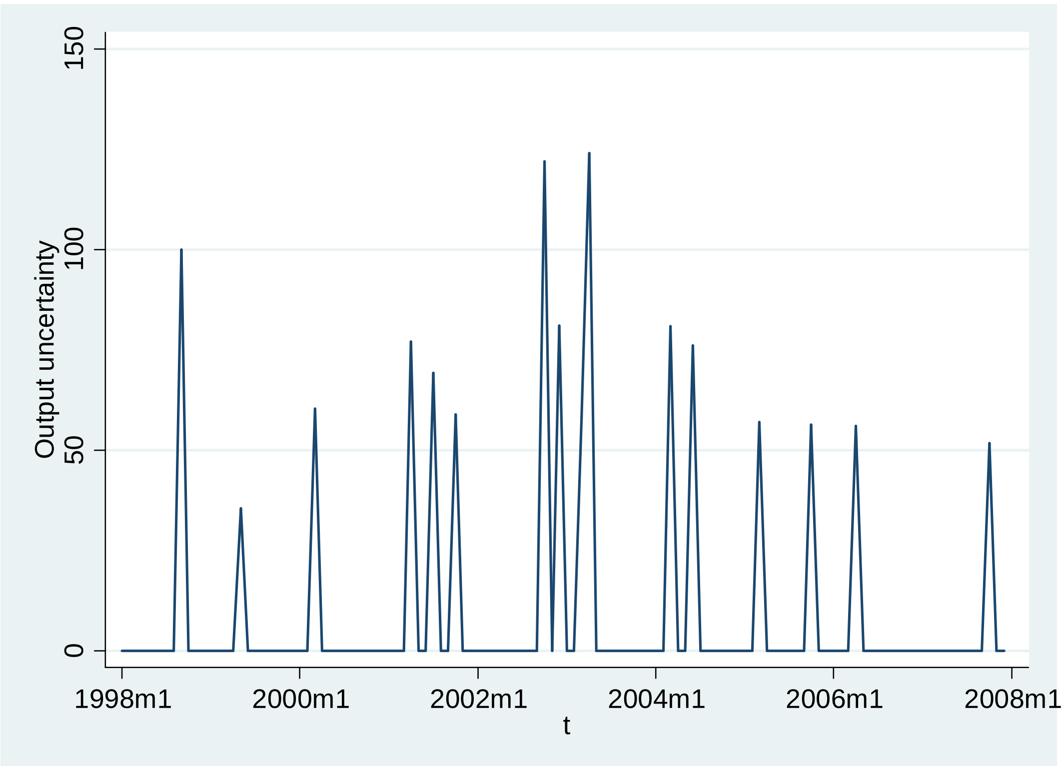


Figure 6. CNB output uncertainty



Appendix II

Table 1: Estimates Model 1 and 2

	Taylor rule	Taylor rule with uncertainty	
	(i)	(ii)	(iii)
			$\gamma_i^{unc} = 0$
α_c	3.257 ***	4.033 ***	4.033 **
γ_i	0.966 ***	0.918***	0.944 ***
α_π	1.861 ***	2.928 ***	1.216 ***
α_π^{unc}		-0.061 **	-0.013 **
α_y	1.619 ***	- 0.650	-0.007
α_y^{unc}		0.044 *	
Adj R^2	0.98	0.95	0.97
s.e.	0.115	0.184	0.128
J-stats	0.76	0.84	0.12

Notes: The estimates refer to the two-step GMM estimators. The weight matrix and the variance-covariance matrix corresponding to the parameter estimates is heteroskedasticity- and autocorrelation-consistent using the Newey-West kernel.
*, **, *** indicate the level of significance of 10%, 5% and 1% respectively. J-stats is the p-value that the system is not overidentified.

Table 2: Estimates Model 3

	Taylor rule with uncertainty	Taylor rule with GARCH uncertainty	
	(i)	(ii)	(iii)
α_c	2.923 ***	3.751 ***	3.364 ***
γ_i	0.965 ***	0.951 ***	0.951 ***
α_π	1.843 ***	2.274 ***	1.211 ***
$\alpha_\pi^{\pi-unc}$	-0.003	-0.305 ***	-0.265 ***
α_π^{y-unc}	0.028 ***	0.007	0.026 ***
α_y	1.434 ***	3.034	0.805 ***
$\alpha_y^{\pi-unc}$	0.044 ***	-0.156	
α_y^{y-unc}	-0.075 ***	-0.014	
Adj R^2	0.98	0.98	0.98
s.e.	0.148	0.118	0.111
J-stats	0.80	0.26	0.12

Notes: The estimates refer to the two-step GMM estimators. The weight matrix and the variance-covariance matrix corresponding to the parameter estimates is heteroskedasticity- and autocorrelation-consistent using the Newey-West kernel.
*, **, *** indicate the level of significance of 10%, 5% and 1% respectively. J-stats is the p-value that the system is not overidentified.

Table 3: Estimates Model 1 and 2

	Taylor rule	**Taylor rule with uncertainty**
	(i)	(iii)
		$\gamma_i^{unc} = 0$
α_c	4.955 ***	4.602 ***
γ_i	0.979 ***	0.959 ***
α_π	2.262 ***	2.681 **
α_π^{unc}		-0.070 **
α_y	0.3179	1.143 **
α_y^{unc}		-0.066 ***
Adj R^2	0.98	0.98
s.e.	0.341	0.39
J-stats	0.85	0.84

Notes: The estimates refer to the two-step GMM estimators. The weight matrix and the variance-covariance matrix corresponding to the parameter estimates is heteroskedasticity- and autocorrelation-consistent using the Newey-West kernel.
*, **, *** indicate the level of significance of 10%, 5% and 1% respectively. J-stats is the p-value that the system is not overidentified.

Table 4: Estimates Model 3

	Taylor rule with uncertainty	**Taylor rule with uncertainty**
α_c	0.942 ***	0.946 ***
γ_i	3.779 ***	3.651 ***
α_π	2.130 **	2.173 **
$\alpha_\pi^{\pi-unc}$	-0.031 *	-0.031 **
α_π^{y-unc}	-0.025 **	-0.027 **
α_y	-0.21611	-0.246
$\alpha_y^{\pi-unc}$	-0.00814	
α_y^{y-unc}	0.002292	
Adj R^2	0.97	0.97
s.e.	0.409	0.386
J-stats	0.73	0.73

Notes: The estimates refer to the two-step GMM estimators. The weight matrix and the variance-covariance matrix corresponding to the parameter estimates is heteroskedasticity- and autocorrelation-consistent using the Newey-West kernel.
*, **, *** indicate the level of significance of 10%, 5% and 1% respectively. J-stats is the p-value that the system is not overidentified.