Optimal Central Bank transparency

van der Cruijsen, C.A.B.; Eijffinger, S.C.W.; Hoogduin, L.H.

Published in:
Journal of International Money and Finance

Publication date:
2010

Document Version
Early version, also known as pre-print

Journal of International Money and Finance xxx (2010) 1–26

Contents lists available at ScienceDirect

Journal of International Money and Finance

journal homepage: www.elsevier.com/locate/jimf

Optimal central bank transparency☆

Carin A.B. van der Cruijsen [a,*], Sylvester C.W. Eijffinger [b,c,d], Lex H. Hoogduin [a,e]

[a] De Nederlandsche Bank, PO Box 98, 1000 AB, Amsterdam, The Netherlands
[b] CentER and European Banking Center, Tilburg University, P.O. Box 90153, 5000 LE, Tilburg, The Netherlands
[c] RSM Erasmus University, Rotterdam, The Netherlands
[d] CEPR, United Kingdom
[e] University of Amsterdam, Amsterdam, The Netherlands

JELclassification:
E31
E52
E58

Keywords:
Central bank transparency
Monetary policy
Inflation persistence

A B S T R A C T

Should central banks increase their degree of transparency any further? We show that there is likely to be an optimal intermediate degree of central bank transparency. Up to this optimum more transparency is desirable: it improves the quality of private sector inflation forecasts. But beyond the optimum people might: (1) start to attach too much weight to the conditionality of their forecasts, and/or (2) get confused by the large and increasing amount of information they receive. This deteriorates the (perceived) quality of private sector inflation forecasts. As a result, inflation is set in a more backward looking manner resulting in higher inflation persistence. By using a large scale panel data set on the transparency of central banks we find empirical support for an optimal intermediate degree of transparency at which inflation persistence is minimized. Our results indicate that while several central banks would benefit from further transparency increases, some already have reached the optimal level.

1. Introduction

Only a few decades ago monetary policy making was veiled in secrecy. In 1986 Goodfriend, summarized the arguments for secrecy that were used by the US Federal Reserve (Fed) in the Merrill

☆ Views expressed are our own and do not necessarily reflect those of the institutions we are affiliated with.

* Corresponding author. Tel.: +31 (20) 524 1961; fax: +31 (20) 524 2506.
E-mail addresses: c.a.b.van.der.cruijsen@dnb.nl (C.A.B. van der Cruijsen), s.c.w.eijffinger@uvt.nl (S.C.W. Eijffinger), l.h.hoogduin@dnb.nl (L.H. Hoogduin).

0261-5606/$ – see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jimonfin.2010.06.003

versus FOMC court case. It encouraged further research on the desirability of secrecy because the theoretical arguments were inconclusive. Nowadays, central banks have made several steps towards transparent monetary policy regimes and they pay a lot of attention to day-to-day communication with the financial markets and the public at large.

Central banks are likely to continue their transparency enhancing practices. Last year, the executive board of the Swedish Riksbank decided that voting records will be published at the same time as the monetary policy decision and not with a delay of a few weeks. A quite recent step of the Fed has been to increase and expand the content of the disclosed economic forecasts of the Federal Reserve Board members and the Reserve Bank presidents. Bernanke's comments on this move point out that these transparency changes:

> "…*represent just one more step on the road toward greater transparency at the Federal Reserve*." (Bernanke, November 14th 2007).

Not only is transparency used as a tool for independent central banks to be held accountable, it is often argued that transparency is also desirable from an economic point of view. Policymakers and researchers have discussed the possible economic effects of central bank transparency. Theoretically, the debate on the desirability of transparency is a continuing story, although the more recent literature yields outcomes in favor of more transparency. Most empirical studies conclude that previous transparency enhancements have been desirable from an economic standpoint. For example, they have resulted in improved anticipation of monetary policy and better anchored inflation expectations (van der Cruijsen and Demertzis, 2007). For a recent overview of the transparency literature we refer to van der Cruijsen and Eijffinger (2010b).

We investigate whether it is desirable for central banks to increase their degree of transparency any further. We use two theoretical arguments in the transparency debate (uncertainty and confusion/information overload) to substantiate our case for the presence of an optimal intermediate degree of transparency. To our knowledge the empirical research on an optimal degree of central bank transparency has just started and focusses on analyzing the effects of particular aspects of transparency instead of the overall level. It shows us that most forms of transparency lead to better economic outcomes while some forms do not. Therefore it seems to be optimal to have an intermediate degree of transparency by limiting some forms of transparency. For example, Ehrmann and Fratzscher (2009b) demonstrate that limiting the communication in the week before Federal Open Market Committee meetings is a useful way to prevent market volatility and speculation. While the previous theoretical literature makes a case for or against *one particular* form of transparency, e.g. the publication of the goals of the central bank or the central bank's forecasts of inflation, our analysis is about the optimal degree of *overall* monetary policy transparency.

We relate central bank transparency to the quality of private sector forecasts. At low degrees of transparency, more information provision (e.g. about the complexity of monetary policy making and the conditionality of policy and economic forecasts) might be desirable because it could improve the private sector's forecasts of inflation. However, at some degree of transparency more transparency might be detrimental because it could worsen these forecasts. We argue that for two reasons this is likely to hold.

The first reason is that a lot of transparency could lead to *uncertainty*. By providing too much information, people start to focus too much on the complexity of monetary policy making and the uncertainty surrounding forecasts. While the actual quality of their forecasts might not be affected, agents perceive the quality of their forecasts to be worse.

The second reason is that a high degree of transparency could lead to an *information overload* and *confusion*. The assumption that individuals are capable to absorb, understand, and weigh all the information that the central bank provides is probably too strong. Although some degree of transparency might help clarify matters, it is likely that a large amount of information disclosure would result in an information overload and confusion. At some level of transparency agents can not see the forest for the trees, which is detrimental for the quality of their inflation forecasts.

Since the (perceived) quality of inflation forecasts is difficult to measure we use inflation persistence instead. Price setters are more inclined to determine price increases based on past inflation when they can not rely on their forecasts of future inflation. We use a New Keynesian model to illustrate that the

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

higher the degree of backward lookingness of price setting is, the more persistent inflation is, which is detrimental for the society's welfare. There is an optimal degree of central bank transparency at which inflation persistence is minimized. For central banks it is relevant to have more insight in inflation persistence: the speed with which inflation reacts to shocks hitting the economy. For central bankers it is easier to perform monetary policy when inflation persistence is low, because then steering inflation expectations is relatively effective and inflation can be brought in line with the target relatively quickly.

Theoretically both the uncertainty – and the confusion/information overload – argument support the idea of an optimal intermediate degree of transparency. We can test this hypothesis empirically by relating transparency to inflation persistence. By allowing for a quadratic relationship between central bank transparency and inflation persistence we build further on the research of Dincer and Eichengreen (2007), who find a negative relationship between central bank transparency and inflation persistence. We find empirical support for our hypothesis by using their panel data set on the transparency of 100 central banks. Our finding that an intermediate degree of transparency (so neither full secrecy nor complete transparency) is optimal is robust to various settings. Given the nature of the data, however, it is difficult to be certain about the exact optimal degree of transparency. First, transparency is difficult to measure. Constructed indices are necessarily subjective in their choice of which aspects of transparency to include and how to weigh these components. Second, our empirical analysis has to be performed using transparency values that are observed in practice. Our baseline regressions lead to an optimum of 6, whereas theoretically it could be somewhere between 0 and 15. We have some reason to believe that the actual optimal degree of transparency might be higher. Low degrees of transparency are observed more often. The average degree of transparency in the sample is about 4 and very high transparency scores are not observed at all (13.5 is the highest value in our data set). A regression with only OECD countries results in an optimal degree of 7.5. The optimum is likely to be central bank-specific, which makes sense since the information processing capacity of its public differs too. Despite uncertainty about the exact optimum, our results do point out that while several central banks (especially those of developing countries) are likely to benefit from further transparency increases, there is a transparency level at which more public information is detrimental. Central banks would be wise to not become completely transparent.

First we will expound our theoretical case for an optimal intermediate degree of central bank transparency (Section 2). We discuss all *possible* empirical relationships between central bank transparency and inflation persistence one might observe in practice, including our hypothesis: the optimal transparency regime. Then, in Section 3, we talk through our empirical analysis and present the *actual* empirical relationship we find. Last, we conclude in Section 4.

2. Optimal central bank transparency: theory

In this theoretical section, we first summarize the related literature on optimal degrees of transparency in Section 2.1. Then, we discuss our case for an optimal intermediate degree of transparency in four steps in Section 2.2.

2.1. Related theoretical literature

A lot of theoretical research has been conducted on the desirability of central bank transparency from an economic viewpoint. Findings both in favor and against transparency exist. Van der Cruijsen and Eijffinger (2010b) give an overview of this literature and show there is a tendency of the more recent work to favor most, although not all, forms of central bank transparency. Here we briefly discuss research that points at the desirability of an *intermediate* degree of transparency.

Jensen (2002) shows that, within a forward looking model, some intermediate degree of transparency may be optimal. In his New Keynesian model it is easier for the public to distill the intentions of the central bank when it is transparent about the control errors. Inflation expectations and, as a result, inflation become more responsive to the central bank's monetary policy. This will most likely result in more attention of the central bank to inflation, which is beneficial for a central bank that faces a low degree of credibility but could be undesirable for a relatively credible central bank. In case of transparency, stabilizing output costs more in terms of inflation. The trade-off between credibility (and

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

the related degree of inflation) and the flexibility to stabilize output determines which amount of transparency is optimal.[1]

Another argument in favor of limiting the degree of central bank transparency is provided by Morris and Shin (2002) who show that a lot of public information might be harmful as it crowds out private information. In their model, economic agents have an incentive to match the underlying economic fundamentals, about which they can have both private and public information, and they want to coordinate their actions with other agents (no value added from an aggregate point of view). The coordination motive might lead agents to put more weight on the public signal than is justified by the level of its precision. As a result, the damage caused by noise in the public information (worsening the forecasts of economic fundamentals and as a result the actions taken) might be higher. However, Svensson (2006) argues that for empirically reasonable parameter values, more public information is desirable in the Morris and Shin (2002) model. The only exception is when: (1) each agent puts more weight on the coordination motive than on the motive to bring actions in line with economic fundamentals, and (2) the noise in the public signal is at least eight times higher than the noise of the private signal. This is unlikely because central banks spend a lot of resources on collecting and interpreting data.

In contrast, by introducing costs in the Morris and Shin framework Demertzis and Hoeberichts (2007) show that, for reasonable parameter values, more transparency is not always desirable. When it is costly for the private sector to process information, more public information reduces the incentives for the private sector to gather their own private information.

With a model in which public information is endogenous, Morris and Shin (2005) point again at the possible negative effects of public information. Providing a lot of information to steer market expectations might be undesirable because it could lower the informativeness of financial markets and prices and, therefore, worsen public information.

Several researchers argue, in contrast to Morris and Shin (2002), that coordination is useful from an aggregate viewpoint. But even then, maximum transparency need not be optimal. This is for example shown by Walsh (2007), who models that a reduction of price dispersion is desirable. His analysis shows that increased precision of central bank's forecasts of *cost* disturbances (or lower persistence of these shocks) increases the optimal degree of economic transparency. More transparency makes it easier for the private sector to distinguish between supply and demand shocks. It then becomes easier to neutralize demand shocks without destabilizing inflation and output. In addition, the detrimental effect of more transparency about the central bank's signal of supply shocks, the increase of the volatility of private sector inflation expectations and through it inflation, is lower when the central bank's forecasts of the supply shocks are more accurate. In contrast, the optimal level of transparency turns out to be higher when the errors of the central bank's forecasts of demand disturbances are larger (or these disturbances become more persistent) because transparency can prevent forecast errors to spill over to affect inflation.

Gosselin et al. (2007) allow for intermediate degrees of transparency and include uncertainty about the precision of information (fog) in their model. In the intermediate transparency case the central bank publishes its interest rate to steer market expectations. It can use the interest rate to mitigate (exploit) the common knowledge effect when it harms (enhances) social welfare. In the full transparency case the central bank communicates all its information and the interest rate loses its role as a strategic signal. When the central bank's fog is large, full transparency is optimal. When its fog is thin or even absent, partial transparency is better because the central bank keeps its ability to manipulate private sector expectations in an optimal way. These results are independent of the particular social welfare function and hold whether the private sector operates in fog or not.

Dale et al. (2008) show that the disclosure of *certain* information (e.g. the inflation target of the central bank) is helpful because it improves private sector expectations. However, like Morris and Shin (2002), the communication of *uncertain* information (e.g. inflation forecasts) might be detrimental because agents could put too much weight on it. The mechanism underlying this result is different than

[1] If instead the central bank would reveal its preferences for output directly, then expectations do not react to central bank's actions and the central bank would remain flexible to stabilize output.

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

in Morris and Shin (2002). When the central bank communicates its forecasts of inflation, the private sector uses it in combination with its own forecasts to form inflation expectations. The private sector has to estimate the relative quality of the forecasts to weigh these forecasts accordingly. The more uncertain the forecasts of the central bank are, the higher the risk that mistakes in determining the weights result in poorer private sector expectations compared to the no-communication case. When the central bank communicates certain information (its inflation target), the private sector forecasts are of relatively high quality (compared to a situation without central bank communication) and the risk that additional, uncertain, information works as a source of distraction is therefore higher.

Cukierman (2007) probes the limits of central bank transparency both by looking at its feasibility and its desirability. He argues that for central bankers it is not *feasible* to be transparent about everything because of their limited knowledge about how the economy works. For example, because it is hard to measure the output gap it is difficult to be transparent about it. Even when abstaining from these feasibility constraints, Cukierman (2007) argues that it is not *desirable* for a central bank to be transparent about everything. For example, using a variant of the Diamond and Dybvig (1983) model of bank runs, the immediate disclosure of private information about threats to financial stability turns out to be undesirable.

2.2. A case for an optimal intermediate degree of transparency

Our research embroiders on this search for the optimal degree of transparency. Our hypothesis is that neither secrecy nor complete transparency is optimal, but some intermediate degree is to be preferred. Fig. 1 summarizes the steps we take to underpin this hypothesis.

We start our case for an optimal degree of transparency by relating the degree of central bank transparency (T) to the quality of private sector inflation forecasts (QF). By using two arguments in the transparency debate, uncertainty and confusion/information overload, we point out that there is likely to be an optimal degree of central bank transparency at which the (perceived) quality of inflation forecasts is optimized. Note that we analyze the desirability of central bank transparency in general, whereas previous theoretical research has focussed on one or a couple of particular aspect of transparency (see van der Cruijsen and Eijffinger, 2010b). Next, we argue why the (perceived) quality of inflation forecasts affects the degree to which inflation is formed in a backward looking way (b). As a third step, we point out that the higher b is the more persistent inflation is. This is illustrated with a standard New Keynesian model. The last step is then to relate this inflation persistence measure (B) – which is relatively easy to measure – to the degree of transparency.[2] We show that although there are five different types of transparency regimes possible, our argumentation leads to the hypothesis that there exists an optimal transparency regime: an intermediate degree of transparency at which inflation persistence is minimized. A low degree of inflation persistence is desirable for the central bank. The lower inflation persistence is, the easier it is to bring inflation back to target by steering inflation expectations. Next, we will discuss our steps one by one in more detail.

2.2.1. Step 1: transparency and the (perceived) quality of forecasts

We present two arguments why there might be a link between central bank transparency and the quality of inflation forecasts of the private sector: the uncertainty-argument and the confusion/information overload-argument.

The extent to which a central bank achieves its goals is very important for its credibility. For a central bank it is therefore helpful to explain the conditionality of its monetary policy steps and outcomes. Otherwise deviations from the central bank's announced goals or policy path might harm its reputation. Issing (2005) stresses that communication is not that simple: the central bank needs to find a balance between the need to be clear and the need to convey the complexity and conditionality of

[2] It is more difficult to relate central bank transparency to the (perceived) quality of inflation forecasts. Although data on the *actual* quality of inflation forecasts could be constructed for at least a selection of countries, it will be hard to measure the *perceived* quality of forecasts. Therefore, we link transparency to inflation persistence, which is relatively easy to measure and of direct interest to central bankers.

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

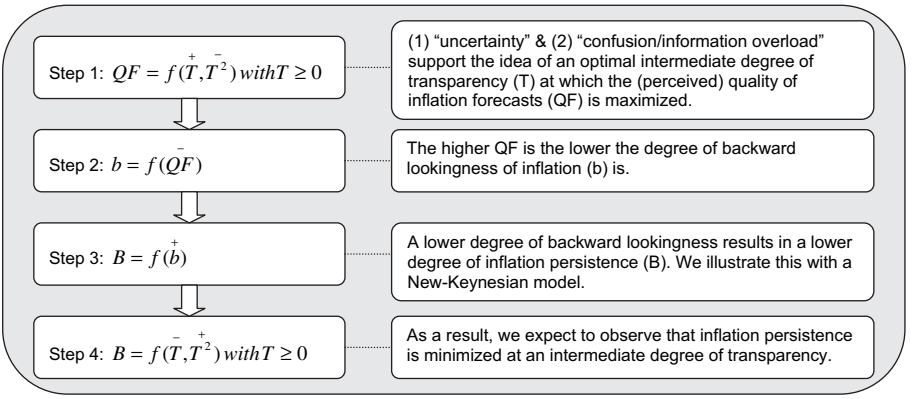

Fig. 1. A case for optimal transparency: theoretical underpinning.

monetary policy making. The central bank faces uncertainty about various things, e.g. shocks hitting the economy, how well its own model explains reality and how effective it is in influencing inflation expectations (Woodford, 2003). Issing (2005) argues that a good communication strategy would be to use clear wording to explain complex facts but not provide the illusion that the world is certain.

The first argument we use to establish our case for the presence an optimal degree of transparency is what we call the *uncertainty argument*. At low levels of transparency, the private sector does not have a solid basis for making inflation forecasts. Up to the optimal degree of transparency, more central bank transparency is likely to result in better insight into future inflation and its conditionality and to improve the quality of the forecasts of private agents. However, beyond the optimal degree of transparency, additional transparency is undesirable. A lot of information on the conditionality might lead people to focus too much on this conditionality which reduces the perceived quality of their forecasts.

Another argument why there is likely to be an optimal degree of central bank transparency is the *confusion/information overload argument*. At low levels of transparency, additional information provision by the central bank might be a helpful tool for the private sector to improve the quality of their inflation forecasts. However, at some degree of transparency additional transparency (defined as providing additional information) is likely to cause confusion instead of clarity. While first steps towards more transparency result in public information that is relatively easy to understand (e.g. an inflation target), later transparency steps often consider information that is more difficult to comprehend (e.g. confidence bands surrounding forecasts). With a lot of information communicated it will become unrealistic to assume that individuals are capable to absorb, understand and weigh all this information. They are likely to suffer from an overload of information. The resulting confusion worsens the quality of their inflation forecasts. Previous research supports this confusion/information overload argument.

The idea that a share of the population forms inflation expectations in a bounded rational way is supported by the outcomes of a survey among 1800 Dutch households by van der Cruijsen and Eijffinger (2010a). For example, several respondents report inflation expectations that are very unlikely (e.g. 80%) which casts doubt on their understanding of the concept of inflation. Most respondents already suffer from an information overload, indicated by the fact that their knowledge about the transparency practices of the European Central Bank (ECB) is lacking or even incorrect. This supports the idea of limited processing capability (in line with Sims, 2003). [3]

Deviations of behavior from full rationality are found by behavioral economics research. Psychological factors might affect the formation of inflation expectations. For example, people often disregard

[3] Alternatively, it could be that, although the information is freely available, it does not reach the public (either because of disinterest on the side of the public or not enough effort on the side of the central bank).

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

new information that is not in line with their previous beliefs (Rabin, 1998: 26). This would make the gradual adjustment towards the rational value of inflation expectations slower as people are slower to adapt their beliefs. In addition, people might suffer from a *confirmation bias*: they interpret information in such a way that their prior beliefs are confirmed. This *belief perseverance* also explains slow adjustments of inflation expectations. Economic agents interpret information differently because of their dissimilar views on the environment (Babcock and Loewenstein, 1997). For quantitative perceptions both memory and psychological factors are relevant (Del Giovane et al., 2008). Cestari et al. (2008) show that recalling prices correctly is hard, especially when a person perceives inflation to be higher and more persistent. Heuristics make it easier to perform complex tasks but they may lead people to make large mistakes (Tversky and Kahneman, 1974). An overload of information could lead people to, unconsciously, rely more on these heuristics. Assuming learning agents, at some point more public information might reduce the learning speed, because people have to process more (confusing instead of clarifying) information. An information overload is therefore likely to result in worse inflation forecasts.

The "sticky-information"-model of Mankiw and Reis (2002) encompasses the idea that macroeconomic information spreads slowly through the population. Mankiw and Reis (2002) mention two reasons why only a share of price setters updates its prices: 1) the costs of acquiring information, and 2) the costs of re-optimization. Those that do adjust their prices realize that not everybody does so and this awareness will limit the size of their adjustment. In this model expectations are formed in a rational way, but this does not happen so often. We believe that at a low degree of transparency, more transparency could lead to a reduction of the costs of acquiring information. But if transparency becomes too high it becomes more difficult to interpret all the provided information correctly which instead raises the costs of distilling useful information. Assuming the resources spend on gathering useful information remain constant, then the higher information costs worsen the inflation forecasts. Zbaracki et al. (2004) show that these costs of gathering and processing information are much more relevant when deciding whether to change prices than the costs of making new price lists.

Another explanation for inflation persistence is given by Amato and Laubach (2003). They show that when not all price setters are optimizing but some have rule-of-thumb behavior (e.g. in Gali et al., 2001) then there is endogenous inflation persistence. Some agents have limited capacity to form rational expectations. These rule-of-thumbers imitate the behavior of all agents one period earlier. Depending on the random optimization costs price setters either behave optimally or as a rule-of-thumber. The higher the number of rule-of-thumbers the higher inflation persistence will be. We argue that too much transparency could result in an information overload, therefore higher optimization costs, which would lead to a larger share of rule-of-thumb price setters and eventually in higher inflation persistence.

Roberts (1998) analyzes survey inflation expectations data and finds support for an intermediate degree of rationality: inflation expectations are neither formed in a purely rational way nor by only using lagged inflation. Two models fit the data. The first is a "partly adaptive model" where a share of the population forms inflation expectations by looking at lagged inflation, while others form expectations in a rational way. In the second model Roberts assumes "habit persistence" in inflation expectations. Inflation expectations are described as "stubborn" in the sense that they adjust only gradually towards the rational value. Professional forecasters might be hesitant to change their forecasts of inflation for two reasons. First, they could be afraid to look foolish when making large adjustments in their forecasts in response to new information. Therefore, they would prefer smaller adjustments. Second, they might want to make forecast that do not differ that much from those of other professionals. This would result in backward looking behavior, as forecasters would base their forecasts partly on the previously published forecasts of other professionals. These forecasts of professionals are likely to affect the inflation expectations of, e.g., households. Carroll (2001) shows that the inflation expectations of the public at large follow those of professional forecasters with a lag.

Let us now relate these findings to central bank transparency. When agents care about coordination with other agents (argued by Morris and Shin, 2002 too) then they are more likely to respond to new information by the central bank not only when they believe it would improve the quality of their inflation forecasts but also when they believe other forecasters will look at the *same* information. This behavior would increases the likelihood that they adjust their expectations in a similar way. Now

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

assume that the central bank becomes very transparent. In that case a lot of information is produced and for agents it is more difficult to know which kind of information other forecasters will pick up. In this information overload situation they might be more induced to have a higher degree of backward looking expectations formation since it is difficult to form good quality inflation forecasts and to predict the inflation forecasts of other agents. Agents are more hesitant to react to news because they are not sure whether their forecast will remain close to those of other agents. In addition, with a lot of public information it is more easy to pick up the wrong information and to make mistakes, which makes people careful to put too much weight on inflation forecasts. Furthermore, it will be more difficult to process all the information. The gradual adjustment process towards the rational value of inflation expectations that Roberts (1998) describes, is then likely to take longer. Alternatively, referring to Roberts' "partly adaptive model", the share of people forming inflation expectations by looking at lagged inflation is probably higher in case of an information overload because the quality of the inflation forecasts is worse.

One example of a case in which transparency might have led to more confusion and uncertainty is transparency about the ECB's "Two Pillar Strategy". This strategy puts an important role on (1) money and (2) a broadly based judgement of future price developments and risks to price stability at an Euro area level. According to common used transparency measures more information provision results in a higher degree of transparency. The fact that the ECB communicates it follows a two-pillar strategy is transparency enhancing (e.g. Eijffinger and Geraats, 2006). However, in reality it need not be that more information leads to more clarity. De Haan et al. (2005: 16–25) argue that the unclear and changing weights of the pillars may confuse people. The conclusion of a 2003 evaluation of the ECB's monetary policy strategy was that, although it was helpful internally as a framework for analysis and debate, it was difficult to communicate externally.[4] This is confirmed by the research presented by van der Cruijsen and Eijffinger (2010a). A share of 1/6 of Dutch households members feel interest rate decisions are not made in a clear fashion. This share is even up to 1/2 for those respondents that can be qualified as "economic experts".[5] An unclear strategy results into a worse quality of the inflation forecasts of the public via more confusion.

Another example is the publication of inflation fan charts by the Bank of England. By showing how uncertain it actually is about future inflation in a graph, people might not only start to put too much weight to the uncertainty of central banks, but they might also get confused. As a response the actual and perceived quality of their own forecast might deteriorate.

As a last example we would like to mention the Financial Stability Reports. They are often so long that readers can not see the forest for the trees. Therefore it might be difficult to grasp a clear measure and it might be easy to make mistakes when weighing all the included information. Also it is more easy to interpret information incorrectly and in line with previous believes. This is detrimental for the private sector forecasts.

Ehrmann and Fratzscher (2009a) support the idea that too much transparency might cause confusion. In contrast to transparency about different points of views about the economic outlook, transparency about committee members' disagreement about monetary policy worsens the extent to which monetary policy decisions are anticipated.

In general, note that the stream of information is likely to be larger - and thereby the risk of information overload higher – when a central bank communicates on relatively a lot of aspects of its monetary policy making process and in a relatively detailed manner. Eijffinger and Geraats (2006) distinguish between political, economic, procedural, policy, and operational transparency. Central banks can get a score between 0 and 3 on each aspect depending on the amount of information given. It seems reasonable to assume that a higher transparency score goes along with a larger information stream.

[4] See the ECB press release of 8 May 2003: "The ECB's monetary policy strategy" for more details. The evaluation led to improved external communication (e.g. the introductory statement of the President at the press conference after monetary policy meetings).

[5] Two different expert-definitions are used: (1) respondents with very good economic knowledge (self-assessment) and (2) respondents that deal with economic, financial or monetary matters on a daily basis.

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

2.2.2. Step 2: the (perceived) quality of forecasts and the degree of backward lookingness of inflation

If price setters are unable to forecast inflation very well and perceive their forecast to be poor, they are likely to set prices by putting much weight to something they are certain about, namely inflation in the past. The lower the (perceived) quality of the inflation forecasts is, the larger the degree to which inflation will be set in a backward looking manner (either by lowering the frequency of price updating behavior of all agents or by increasing the share of rule-of-thumbers). Note that even a change in the *perceived* quality of private sector forecasts is enough to shift the degree of backward lookingness. When people start to realize that the central bank is uncertain about future policy outcomes the *actual* quality of their inflation forecasts need not change, but it does change the *perceived* quality of their forecasts, which is relevant for price-setting behavior.

2.2.3. Step 3: the degree of backward lookingness of inflation and inflation persistence

The higher the degree of backward lookingness, the more persistent inflation will be. We illustrate this with a standard hybrid New Keynesian model:

$$x_t = E_t(x_{t+1}) - \alpha(i_t - E_t(\pi_{t+1})) \quad a > 0 \tag{1}$$

$$\pi_t = (1-b)E_t(\pi_{t+1}) + b(\pi_{t-1}) + cx_t + e_t \quad e_t \sim idd\left(0, \sigma^2\right); 0 \le b \le 1, \tag{2}$$

where x is the output gap, i is the nominal interest rate, π is the inflation rate, b measures the degree to which inflation formation is backward looking, t is the time indicator, E is the expectations operator and e is and exogenous shock to inflation. Equation (1) is the forward looking IS-curve. When $b = 0$ equation (2) is the traditional New Keynesian Phillips curve *without* endogenous inflation persistence (the term $b(\pi_{t-1})$ drops out). Instead when $b > 0$ we get a modified version of the New Keynesian Phillips curve *with* endogenous inflation persistence. The higher b is, the higher the endogenous inflation persistence will be.

In addition to endogenous inflation persistence ($b > 0$), it is possible to add exogenous inflation persistence to the model by making the shock to inflation (e_t) persistent ($e_t = \rho e_{t-1}$). Then even when inflation is fully forward looking ($b = 0$), it is possible to have inflation persistence. In case $b > 0$, the persistence resulting from price shocks is even higher. In addition to the exogenous persistence these shocks create (via e_t), they cause additional endogenous inflation persistence (via $b(\pi_{t-1})$). Assuming persistent shocks would only amplify the difference in inflation persistence between the cases $b = 0$ and $b > 0$ but not change the qualitative insight that the higher b is, the higher inflation persistence is.

The central bank is minimizing the following loss function when determining its monetary policy:

$$V_t = E_t \sum_{i=0}^{\infty} \beta^i \left\{ \pi_{t+i}^2 + \lambda x_{t+i}^2 \right\}. \tag{3}$$

Here V_t is the expected loss of the central bank, β is the discount factor and λ measures the central bank's preference for output stabilization relative to its preference for price stability. Note that the choice of this loss function can be justified by referring to a representative agent maximizing expected utility (with a slight modification, see Woodford, 2003).

Inflation persistence is lower when inflation is less backward looking (b is lower). A lower degree of backward lookingness leads to a lower expected loss for the central bank. For the central bank it then becomes easier to bring inflation faster and better in line with its inflation goal via the management of inflation expectations. The output costs of reducing inflation will be lower resulting in a better inflation output trade-off. For the central bank more insight into the Phillips curve is relevant since it provides information about the effectiveness of its policy. As Yellen (2007) argues, it would improve central banks' inflation forecasts and help them get more understanding of which policy they should follow.

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

2.2.4. Step 4: linking central bank transparency to inflation persistence

Both uncertainty and confusion/information overload suggest the presence of an optimal intermediate amount of central bank transparency at which inflation persistence is minimized. Each theory can be expressed by one equation that relates central bank transparency (T) to inflation persistence (B):

$$B_1 = j_1 T + h_1 T^2 + Z \quad T \geqq 0 \tag{4}$$

$$B_2 = j_2 T + h_2 T^2 + Z \quad T \geqq 0. \tag{5}$$

In equations (4) and (5) Z is a vector of control variables. Both arguments are in favor of an optimal degree of central bank transparency and imply the presence of a parabola ($j_n < 0$ and $h_n > 0$). We still expect to observe a parabola ($\sum_{n=1}^{n=2} \alpha_n j_n < 0$ and $\sum_{n=1}^{n=2} \alpha_n h_n > 0$) when we weigh these ($n$) theories according to their relevance (α_n) to get the overall relationship between central bank transparency and inflation persistence:

$$B = jT + hT^2 + Z,$$

$$\text{with } T \geqq 0; j = \sum_{n=1}^{n=2} \alpha_n j_n; h = \sum_{n=1}^{n=2} \alpha_n h_n; \text{ and } \sum_{n=1}^{n=2} \alpha_n = 1. \tag{6}$$

In equation (6) B is an index of inflation persistence, T is an index of transparency, Z is a vector of control variables. On the basis of the values of the coefficients for h and j, we can distinguish five possible transparency regimes:

I) *Secrecy* ($h \geq 0; j > 0$ or $h > 0; j \geq 0$). In this case complete secrecy results in the lowest degree of inflation persistence.
II) *Optimal transparency* ($h > 0; j < 0$). This is our hypothesis.
III) *Maximum transparency* ($h \leq 0; j < 0$ or $h < 0; j \leq 0$). Here more transparency is always better.
IV) *One low and one high transparency equilibrium* ($h < 0; j > 0$).
V) *Transparency is irrelevant* ($h = 0; j = 0$). In this case transparency is not related to inflation persistence.

Table 1 and Fig. 2 give an overview of the various transparency regimes that result from different values for h and j.

Now that we know the possible empirical relationships between central bank transparency and inflation persistence we can turn to the data and investigate for which transparency regime there is empirical support.

3. Empirical analysis

Several researchers have investigated the economic effects of central bank transparency. Some of this work relates transparency to inflation persistence. For example, van der Cruijsen and Demertzis (2007), using the transparency data of Eijffinger and Geraats (2006), show that countries with a higher degree of central bank transparency have lower inflation persistence. This result is obtained by rearranging the persistence measures obtained for several countries by Levin et al. (2004). Dincer and Eichengreen (2007) have extended the transparency data set of Eijffinger and Geraats (2006). Using this data set, they confirm the negative relationship between transparency and inflation persistence. We build further on this empirical research by investigating the presence of a quadratic relationship between transparency and inflation persistence and by including several control variables inspired by micro studies on inflation persistence.[6]

[6] Note that Dincer and Eichengreen (2007) use two control factors (openness and financial depth). In reaction to an earlier draft of this paper (CEPR Discussion Paper No. 6889) they have elaborated their persistence analysis (Dincer and Eichengreen, 2009) and included as controls also: openness*exchange rate dummy, political stability and regulatory quality. However, the controls they include either do not significantly relate to inflation persistence or have a coefficient of about zero. Therefore, their analysis might suffer from an omitted variable bias.

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

Table 1
Transparency regimes.

j/h	0	+	–
0	Irrelevance	Secrecy	Maximum transparency
+	Secrecy	Secrecy	Two equilibria
–	Maximum transparency	Optimal transparency	Maximum transparency

3.1. Transparency data

For this analysis we use the transparency data set of Dincer and Eichengreen (2007), who construct transparency indices similar to Eijffinger and Geraats (2006). Dincer and Eichengreen (2007) have extended the data set of Eijffinger and Geraats (2006) in two ways: (1) the sample is extended to 100 countries instead of 9, and (2) the data period is broadened to 1998–2005. We realize that transparency indices are only crude measures of the actual amount of information communicated. However, in the empirical literature on the impact of central bank transparency it is common to work with transparency indices because more reliable and detailed measures of the amount of information communicated are not available. Furthermore, it seems reasonable to assume a positive correlation between the transparency score and the amount of information communicated. Fig. 3 gives an overview of the data.

Although theoretically possible values lie between 0 and 15, in practice the highest degree of transparency observed is 13.5. Comparing continents, the central banks of Europe turn out to be the most transparent, closely followed by the central banks of Oceania. African central banks on average have the lowest degree of transparency. The transparency of Asian central banks is a bit higher. The

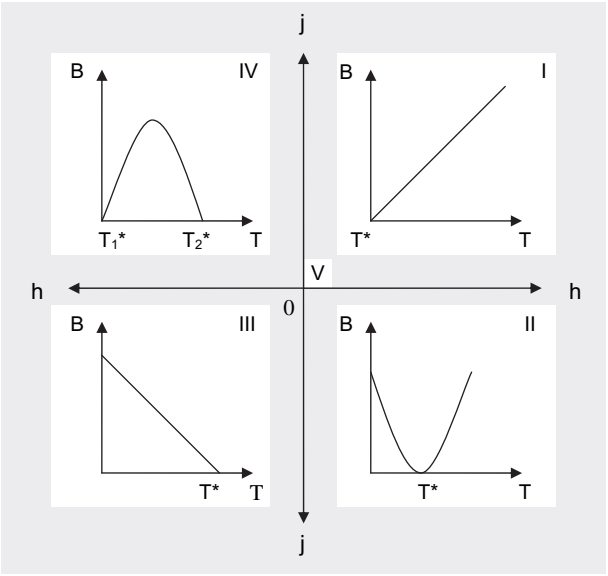

Fig. 2. Various transparency regimes.
Note: this figure gives an overview of the various transparency regimes that result from different settings of j and h in equation (6). B is the index for inflation persistence, T is the index for transparency and T* is the optimal degree of transparency at which inflation persistence is minimized. Five different transparency regimes are possible: I) The secrecy regime ($h \geq 0; j > 0$ or $h > 0; j \geq 0$), II) The optimal transparency regime ($h > 0; j < 0$), III) The maximum transparency regime ($h \leq 0; j < 0$ or $h < 0; j \leq 0$), IV) Two optimal degrees of transparency: one low (T_1^*) and one high (T_2^*) ($h < 0; j > 0$), V) Transparency is irrelevant ($h = 0; j = 0$). We have simplified graph I and III by drawing straight lines. Note however that this holds only when $h = 0$. Instead when $h \neq 0$, these lines have curvature. We did not plot regime V (it would be a horizontal line).

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

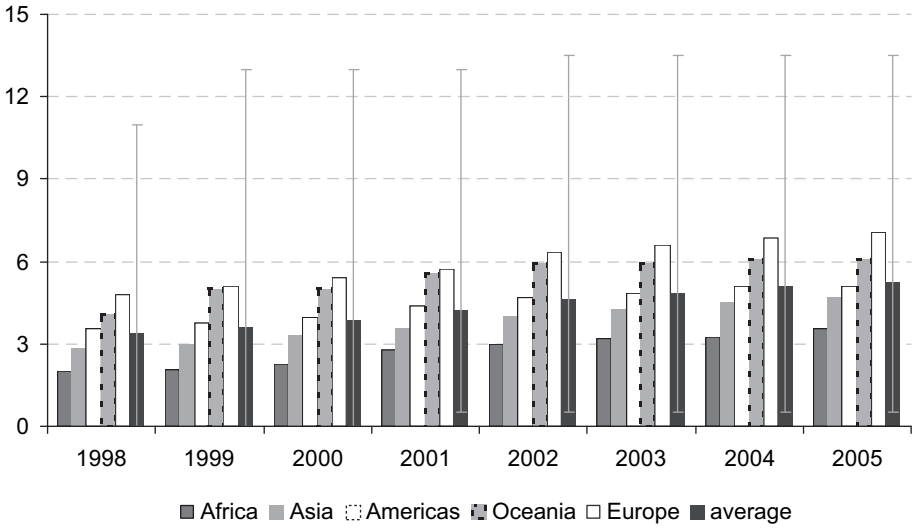

Fig. 3. Central Bank Transparency.
Source: This figure is based on the transparency data of Dincer and Eichengreen (2007). The gray line provides the range of observed values.

transparency scores of the central banks of American countries lie between those of relatively transparent and relatively intransparent continents. In general, the level of transparency has risen over time. Only for a few countries we observe a, temporary, decrease in transparency. The range of observed degrees of transparency is broad. For example, in 2005 the central banks of Aruba and Bangladesh obtained a transparency score of 0.5, close to the minimum, while the Reserve Bank of New Zealand (with a score of 13.5) received a score that was close to the maximum. We utilize both the country and the time dimension of this transparency data set. For more details on the transparency data we refer to Appendix A.1.

3.2. Inflation data

In addition to transparency data we construct inflation persistence measures by utilizing CPI inflation data. The inflation data (q.o.q. annualized inflation rate, for more details see Appendix A.2) we use is from the International Financial Statistics (IFS) database, which is a product of the International Monetary Fund (IMF).

What we are interested in is the degree of inflation persistence. Inflation persistence is the speed with which inflation moves back towards its equilibrium level after shocks occur. When inflation persistence is low this adjustment process occurs faster. For central banks it is interesting to know how inflation responds to shocks hitting the economy. If a central bank wants to follow a preemptive monetary policy strategy, insight in the reaction of inflation to changing monetary conditions is needed.

In the literature inflation persistence is measured in several ways. Marques (2004) provides a useful overview of the various methods at hand. An often used measure of inflation persistence, which we will use too, is the *sum of the autoregressive coefficients:* $\rho = \sum_{j=1}^{p} \beta_j$ which can be obtained by estimating inflation (π) on its lags:

$$\pi_t = \alpha + \sum_{j=1}^{p} \beta_j \pi_{t-j} + \varepsilon_t \tag{7}$$

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

Other examples of measures that also give an estimate of the average speed with which inflation returns to its equilibrium level after a shock has occurred are the *largest autoregressive root* (e.g. Stock, 2001) and the *half-life*. Critique on the largest autoregressive root is the fact that it does not summarize the impulse response function well, as its shape depends on all the roots. The half life is the time for which the effect of a shock to inflation is larger than 0.5. Although easy to interpret this measure has several disadvantages. For example, in case of an oscillating impulse response function this measure might underestimate the inflation persistence and it is difficult to compare series with different forms of impulse response functions.

3.3. Method

As mentioned before, we intend to relate inflation persistence to the degree of central bank transparency by using both the time content of our transparency data as well as the cross-country information. Because it is difficult to determine a different inflation persistence measure for each moment in time, we have included the transparency measure in a direct way in our estimation of the degree of inflation persistence. With equation (8) we test whether and how transparency is related to inflation persistence. The transparency interaction terms grasp the effect of transparency on inflation persistence:

$$\pi_{i,t} = \alpha + Z_{i,t} + \beta_1 \pi_{i,t-1} + \beta_2 T_{i,t} \pi_{i,t-1} + \beta_3 T_{i,t}^2 \pi_{i,t-1} + \sum_{n=1}^{N} \beta_{3+n} Y_{i,t} \pi_{i,t-1} + S_2 + S_3 + S_4 + \varepsilon_{i,t} \tag{8}$$

$$B_{i,t} = \beta_1 + \beta_2 T_{i,t} + \beta_3 T_{i,t}^2 + \sum_{n=1}^{N} \beta_{3+n} Y_{i,t}, \tag{9}$$

with π = inflation (q.o.q. annualized), T = the degree of transparency (which in our sample is between 0 and 13.5), B = the degree of inflation persistence (which varies across countries because of different values for T) and ε = the error term. $i = 1, 2,\ldots, I$ indicates the cross-sectional units and $t = 1, 2,\ldots T$ the periods. An overall constant α is included. Z is a vector of control variables that affect the level of inflation.[7] In addition, we include a vector of control variables that affect the degree of inflation persistence (Y). Last, we control for seasonal patterns in inflation by including three seasonal dummy variables: S_2, S_3 and S_4. The value of these dummy variables is 1 in the quarter which they refer to (respectively the second, third and fourth quarter) and 0 otherwise.

Because the period under consideration is relatively short, we do not explicitly consider breaks in the mean of inflation, only to the extent that they might be captured by time-variation in Z.[8]

Various information criteria can be used to determine the optimal lag length to include in equation (8). For example, Levin et al. (2004) use the Akaike Information Criteria (AIC) to analyze for each country separately the optimal lag size. Because we perform panel data analysis, we instead pick one lag length for the whole sample. Here we present the results of our baseline case with one lag. Our transparency insights are robust to changes in the lag length (see Appendix B.2).

Previous studies have shown that several other factors besides transparency are relevant for inflation persistence too (e.g. Fabiani et al., 2006). By adding control variables to our regressions we correct for this. Detailed information on these control variables is in Appendix A.3. We take into account control factors in two ways. First, some control factors are included as an interaction term with lagged inflation (control variable$^*\pi_{i,t-1}$) because they affect inflation *persistence*. Second, we add control factors that are relevant for the *level* of inflation. The possibility to also include controls for the

[7] Note that not all the control variables that we include are time variant. Therefore they grasp cross-section fixed effects.

[8] Corvoisier and Mojon (2005) show that in most OECD countries three breaks in the mean inflation rate occurred: one to a higher mean (end of the 1960s, beginning 1970s), and two to a lower mean (one in the early to mid 1980s and one in the early 1990s). Ignoring these breaks in inflation results into persistence measures that are too high (see also Gadzinski and Orlandi, 2004).

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

level of inflation is an advantage compared to studies like Dincer and Eichengreen (2009), who use inflation persistence instead of inflation as the dependent variable.

The first control factors that we include in our analysis are for labor. Compared to other costs, labor costs are not easy to adjust. Since labor costs are the lion share of the costs in the services sector, we expect inflation persistence of services to be higher. Previous studies show that inflation persistence differs across sectors. For example, Lünnemann and Mathä (2005) find that aggregate inflation persistence is lower when services are excluded. We correct for the role of labor by including two control variables. The first control variable is an indicator of the labor intensity of the production process (LS) while the second control variable measures the flexibility of wage setting (WF).

Regarding the first control variable, we use "Production process sophistication", which is the survey response to the statement "Production processes use (1 = labor-intensive methods or previous generations of process technology, 7 = the world's best and most efficient process technology)." This so-called soft indicator is taken from the yearly Global Competitiveness Report (GCR) of the World Economic Forum (WEF).

The second control variable we consider is an indicator of the degree of labor market flexibility. By modifying a New Keynesian business cycle model (by including a labor market with matching frictions and rigid wages), Christoffel and Linzert (2005) show that the more rigid wages are the more persistent inflation is. Hoeberichts and Stokman (2010) find that especially in the services sector, wages are relevant for price setting behavior of firms. As an indicator for this degree of flexibility we include "Flexibility of wage determination" (source: GCR, WEF). This series reflects the answers to the survey statement: "Wages in your country are (1 = set by a centralized bargaining process, 7 = up to each individual company)". The higher this variable is, the larger the degree of wage flexibility (WF).

Another factor relevant for price setting behavior is the degree of competition that firms face. When competition is fierce, inflation persistence will be lower because in order to keep market shares, inflation will quickly return to its equilibrium level after a shock dies out. As a control variable we use "Intensity of local competition", which is the outcome of the following survey statement: "Competition in the local market is (1 = limited in most industries and price-cutting is rare, 7 = intense in most industries as market leadership changes over time)" (source: GCR, WEF). What we expect to find is a negative sign on the degree of competition interaction term ($DoC_{i,t}{}^{*}\pi_{i,t-1}$). The higher this indicator of competition is, the lower inflation persistence is. After a shock in an environment of fierce competition firms would be eager to bring inflation quickly back to their equilibrium degree.[9]

The extent of technology usage in a country might also be relevant for inflation persistence. One explanation that Dhyne et al. (2006) give for the lower price stickiness in the United States compared to Europe are the lower costs of price changes resulting from a higher level of technology in the retail sector (e.g. more superstores and e-commerce). If the costs of changing prices are low it will be easier for price setters to bring price changes back to a lower level after a detrimental inflation shock dies out.

Another reason for a link between the degree of technology and inflation persistence is the fact that Internet usage makes it easy to compare prices. In an environment without Internet usage one only needs to compete with firms that are geographically close, whereas Internet usage intensifies the number of competitors. Competition puts downward pressure on inflation persistence: inflation will move quickly back to its equilibrium level after the occurrence of a shock.

As an indicator for the degree of ICT intensity we consider technological readiness (*TR*). This pillar (based on several questions, source: GCR WEF), focuses on the agility with which existing productivity enhancing technologies are adopted.

The last relevant factor for inflation persistence that we control for is customer relations. Customer relations, either implicit or explicit, are an important factor in explaining price stickiness (Fabiani et al., 2006). We expect that when firms put a lot of effort in contracts with customers then current price increases will be in line with previous price increases: inflation is persistent. Instead when not much value is attached to customer relations then inflation will show more variability and less persistence. To

[9] Since it could be that this soft control variable does not measure competition differences between countries that well, we consider another hard control variable: the share of exports to GDP (source: International Financial Statistics, International Monetary Fund). A more open country is likely to face more competition. This would result in lower inflation persistence.

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

correct for the strength of customer relations (*CR*) in a particular country over time we add "Degree of customer orientation" (source: GCR, WEF). This is the outcome in response to the statement "Firms in your country (1 = generally treat their customers badly, 7 = are highly responsive to customers and customer retention)".

As we have mentioned before, we do not only control for factors that affect the level of inflation persistence but we include controls for the level of inflation too. The first factor we control for is the quality of institutions. Good public and private institutions are crucial for the well-functioning of the economy. They might also indicate the quality of one particular institution: the central bank. We expect that the better these institutions are, the lower inflation will be. To correct for the quality of institutions we include the pillar "institutions" from the GCR 2007–2008(WEF). This pillar measures the overall quality of both private and public institutions. Examples of factors that are taken into account are the security of owner rights, corruption and overregulation. Institutions are often regarded as being relevant for economic outcomes.[10]

Secondly, we control for the level of globalization. Nowadays, inflation is low and stable in many countries. One explanation for this artefact is that the world has become more globalized (see e.g. Greenspan, 2005). The increase in global competition puts downward pressure on prices because both companies and employees have lower market power. To correct for the degree of globalization we include the measure of the degree of competition (DoC).[11]

Another often mentioned explanation for low inflation is the conduct of better monetary policy. The focus of monetary policy on price stability has increased; a lot of central banks now act independently from the government and several central banks have become inflation targeters. To prevent that central bank transparency is grasping up an overall better conduct on monetary policy, we correct for the fact that some countries are (or have become) inflation targeters. Note that having an inflation targeting regime entails more than only having a quantified target (IMF, 2005) – which is part of the transparency index - and that also central banks without a formal inflation targeting regime can get the maximum score on political transparency (see Eijffinger and Geraats, 2006). Therefore it is important to control for the presence of an inflation targeting regime.

The last factor we include is the degree of central bank transparency. Central bankers regard transparency as an important tool to build up credibility (Blinder, 2000). Several empirical studies have found that higher degrees of transparency are accompanied with lower levels of inflation (for an overview we refer to van der Cruijsen and Eijffinger, 2010b). To test whether more transparency indeed results in lower levels of inflation (via lower inflation expectations) we have included central bank transparency (*T*) as a control variable.

3.4. Results

The outcomes of our analysis are in Table 2. It turns out to be important to include control variables. They affect the coefficients in front of the transparency interaction terms ($\pi_{t-1}T_t$ and $\pi_{t-1}T_t^2$) and thereby the optimal degree of transparency that is obtained. The results of the estimation of equation (8) including all control variables are in column (5). Transparency matters for inflation persistence: the coefficient on $\pi_{t-1}T_t$ is negative and significant and the coefficient on $\pi_{t-1}T_t^2$ is positive and significant. These results support our hypothesis, that there is an optimal degree of transparency beyond which extra transparency results in more inflation persistence.

For the *level* of inflation several factors are relevant: the quality of institutions, the degree of competition and the period of the year. As expected, better quality of public and private institutions results in a lower degree of inflation. In addition, and in line with previous research, we find that more globalization leads to less inflation.[12] Inflation is relatively high in the first quarter of the year. The existence of an inflation targeting regime and the degree of transparency are irrelevant for the level of inflation.

[10] We tried democracy (Kekic, 2006) as an additional control variable. We find that democracy has no significant effect on the level of inflation and on its persistence. Results are available upon request.

[11] Note that DoC is used as a control for both the level of inflation and inflation persistence.

[12] Alternatively we included exports instead of DoC. This variable is not significant. DoC is probably not only capturing globalization but also other factors that influence the degree of competition.

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

Table 2
Central bank transparency and inflation persistence: panel least squares.

	(1)		(2)		(3)		(4)		(5)		(6)	
	coef.	*p*-value	coef.	*p*-value	coef.	*p*-value	coef.	*p*-value	coef.	*p*-value	coef.	*p*-value
α	4.16***	(0.00)	4.39***	(0.00)	12.55***	(0.00)	4.40***	(0.00)	16.39***	(0.00)	14.47***	(0.00)
$INST_{i,t}$					−0.90***	(0.00)			−1.28***	(0.00)	−1.12***	(0.00)
$DoC_{i,t}$					−0.94**	(0.01)			−1.50***	(0.00)	−1.08***	(0.00)
$IT_{i,t}$					−0.83	(0.16)			0.22	(0.76)		
$T_{i,t}$					0.10	(0.37)			0.13	(0.25)		
$\pi_{i,t-1}$	0.58***	(0.00)	0.76***	(0.00)	0.75***	(0.00)	1.02***	(0.00)	0.51	(0.12)	0.80***	(0.00)
$\pi_{i,t-1}T_{i,t}$			−0.08***	(0.00)	−0.10***	(0.00)	−0.11***	(0.00)	−0.14***	(0.00)	−0.13***	(0.00)
$\pi_{i,t-1}T^2_{i,t}$			0.00***	(0.00)	0.01***	(0.01)	0.01***	(0.01)	0.01***	(0.00)	0.01***	(0.00)
$\pi_{i,t-1}WF_{i,t}$							−0.15***	(0.00)	−0.14***	(0.00)	−0.16***	(0.00)
$\pi_{i,t-1}LS_{i,t}$							−0.02	(0.72)	0.02	(0.56)		
$\pi_{i,t-1}DoC_{i,t}$							−0.01	(0.72)	0.04	(0.23)		
$\pi_{i,t-1}TR_{i,t}$							0.02	(0.78)	0.04	(0.44)		
$\pi_{i,t-1}CR_{i,t}$							0.15***	(0.00)	0.16***	(0.00)	0.19***	(0.00)
$\pi_{i,t-1}IT_{i,t}$							−0.30***	(0.00)	−0.36***	(0.00)	−0.30***	(0.00)
S_2	−2.40***	(0.00)	−2.33***	(0.00)	−2.28***	(0.00)	−2.15***	(0.00)	−2.02***	(0.00)	−2.07***	(0.00)
S_3	−4.03***	(0.00)	−4.02***	(0.00)	−4.04***	(0.00)	−4.00***	(0.00)	−4.04***	(0.00)	−4.03***	(0.00)
S_4	−0.50	(0.33)	−0.64	(0.21)	−0.70	(0.17)	−0.78	(0.12)	−0.85*	(0.09)	−0.85*	(0.09)
R^2	0.36		0.37		0.38		0.39		0.41		0.41	
Sample	1998q1–2005q4		1998q1–2005q4		1998q1–2005q4		1998q1–2005q4		1998q1–2005q4		1998q1–2005q4	
Countries	70		70		70		70		70		70	
Total panel	2188		2188		2188		2188		2188		2188	
S.E. of regr.	8.45		8.41		8.33		8.25		8.13		8.13	
Jarque–Bera	87439	(0.00)	77901	(0.00)	82182	(0.00)	116705	(0.00)	124122	(0.00)	130339	(0.00)
DW	2.00		1.98		1.96		1.96		1.95		1.95	

Note: results of the estimation of equation (8) using q.o.q. inflation rates that are annualized. DoC = degree of competition, INST = quality of public and private institutions, IT = inflation targeting regime, π = inflation, T = transparency index (Dincer and Eichengreen, 2007), WF = wage flexibility, LS = labor share, TR = technological readiness and CR = customer relations, and DW = Durbin–Watson statistic. S_2, S_3 and S_4 are seasonal dummies (1 in the quarter they refer to, otherwise 0). For more information on the variables we refer to Appendix A.

As mentioned before, we have included controls for the degree of inflation *persistence* too. Half of these variables have a significant effect. The negative relationship between wage flexibility and inflation persistence that we predicted, is confirmed. Furthermore, we find that inflation targeting is indeed beneficial, it results in lower inflation persistence.[13] The positive effect of the degree of customer orientation on inflation persistence is also in line with our expectations. However, the labor-intensity of the production process, the degree of competition and technological readiness are not significantly related to inflation persistence.[14]

When we delete the insignificant control variables, the signs and significances of the coefficients remain (see column 6). In Appendix B.1 we compare the outcomes presented in column (6) with those of a regression where we exclude central bank transparency. Transparency is not picking up the effect of any other variable. The size, sign and significance of the control variables does not change much when we exclude transparency in this alternative specification.

Our finding of an optimal intermediate degree of transparency is robust to the use of standard errors that allow for either cross-sectional or period heteroskedasticity.[15] According to the outcomes of the Jarque–Bera test the residuals of our regressions are not normally distributed. However, even with the violation of the normality assumption the least squares estimator is the best linear unbiased estimator given that some other assumptions on the disturbances are not violated (Baltagi, 2008).

Central banks have taken transparency steps for accountability reasons and because these steps might improve economic outcomes. It could be that the latter reason has been especially important for central banks in countries with a poor inflation history. A high degree of inflation persistence might have stimulated transparency steps. Only to some extent we can solve this endogeneity problem by using lags of the transparency index. The outcomes of the regressions using T_{t-1}, T_{t-2}, T_{t-3} or T_{t-4} instead of T_t are in Appendix B.4. Our finding of an optimal intermediate degree of transparency turns out to be robust.[16]

To get more insight into these results, the effect of transparency on the degree of inflation persistence is plotted in Fig. 4. This figure is obtained by calculating the effect of transparency on the persistence coefficient (B) for all theoretically possible values of the central bank transparency index (T): $\beta_2 T + \beta_3 T^2$. In line with our hypothesis we observe a parabola.[17] The finding of an optimal degree of transparency is robust to different lag length specifications (see Appendix B.2).

Note that, as mentioned in Section 3.1, while in theory the observed transparency degree could be 15 in our sample we observe 13.5 at the most. Starting left at the x-axis where the value of the transparency index is 0, moving along the x-axis to the right (where transparency is higher) first results in less inflation persistence. Inflation persistence is minimized at a degree of central bank transparency of 6. Turning to the range where transparency is higher than this optimum, more transparency is accompanied with higher inflation persistence. Central banks would be wise to not become fully transparent. Because most countries have a lower degree of transparency than the optimal degree, they

[13] Our findings are robust to the exclusion of the inflation targeting variable. We still find an optimal intermediate degree of transparency and signs of control variables and their significance do not change much. Therefore serial correlation between inflation targeting and transparency does not seem to be problematic.

[14] The alternative indicator for the degree of competition, the share of exports to GDP was not significant either.

[15] We have performed the regressions of Table 2 with (i) cross-section weights (PCSE) standard errors & covariance (d.f. corrected) to allow for cross-sectional heteroskedasticity, and with (ii) period weights (PCSE) standard errors & covariance (d.f. corrected) to allow for period heteroskedasticity. Results are available upon request.

[16] Alternatively, one could try to work with instruments. Dincer and Eichengreen (2009) are able to confirm our finding of an optimal intermediate degree of transparency only when including transparency directly but not when a fitted value of transparency is taken (based on a regression relating transparency to a constant and Rule of Law). However, note that it is hard to find reliable instruments that strongly relate to central bank transparency (also intuitively) but are exogenous to inflation persistence. As a result, almost all studies on transparency abstain from controlling for endogeneity problems. In addition, even without instruments Dincer and Eichengreen (2009) reject our finding of an optimal intermediate degree of transparency when using inflation persistence instead of inflation as dependent variable. However, they have left their explanatory variables unchanged, including lagged inflation and lagged inflation interacted with transparency and with their controls. However, when inflation persistence instead of inflation is the dependent variable there is no straightforward interpretation of these interaction terms. Furthermore, with inflation persistence as dependent variable it is impossible to include controls for the level of inflation. Not surprisingly, their model performs poorly (R^2 of close to zero). Therefore, and because we include control variables that do relate significantly to both inflation persistence and the level of inflation, we find our model more reliable.

[17] There is no evidence for asymmetry around the optimum. We have tested this by adding the variable $\pi_{t-1}T^3$ to equation (8).

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

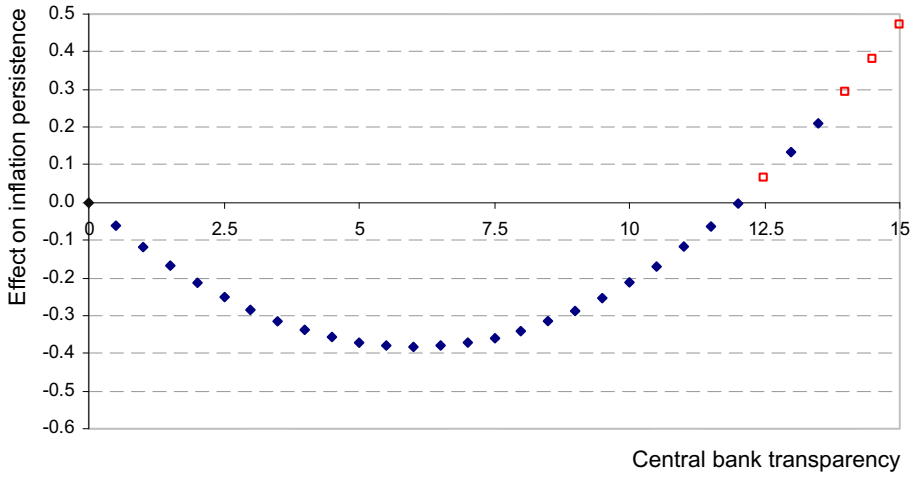

Fig. 4. Effect of central bank transparency on inflation persistence.
Note: this figure plots the effect of central bank transparency (T) on inflation persistence (B): $\beta_2 T + \beta_3 T^2$ using q.o.q. annualized inflation rates. Note that $T > 13.5$ and $T = 12.5$ are not observed in our sample.

might still benefit from further transparency increases. The lower the initial amount of central bank transparency is, the higher the benefit of additional transparency will be.

Our finding of an optimal intermediate degree of transparency of 6 is robust to the use of annual data. Signs of control variables and their significance are robust too, except for the inflation targeting variable which becomes insignificant. We prefer to work with quarterly data, because it is more informative regarding control variables and inflation persistence. Note also that when estimating inflation persistence it is common to work with data at - at least - quarterly frequency.

It is important to note that although our case for the existence of an optimal intermediate degree of transparency is robust to various settings, the exact value of this optimum is not. Our confusion-argument highlights the importance of the capacity of the private sector to absorb information disclosed by the central bank. Because these skills are country-specific, different countries are likely to have different optimal degrees of transparency. In Appendix B.3 we illustrate this by presenting the results of two alternative regressions: one including only non-OECD countries and one with only OECD countries. Based on OECD countries we find an optimum of 7.5 instead of 6. The optimal level of transparency is sensitive to the transparency levels that are observed in practice. Although theoretically transparency ranges between 0 and 15, in practice we do not observe very high levels. In addition, low degrees of transparency are observed much more frequent than high degrees of transparency. For more details on the transparency data we refer to Appendix A.1. We have tested whether our results are driven by a handful of very transparent central banks. In Appendix B.2 (Table B2, column (4)) we show the results of a regression in which we have excluded the central banks with a transparency level of more than 10 in 2005. Still we find support for an optimal intermediate degree of transparency. Although the found optimum is, not surprisingly, a little bit lower (5.5 instead of 6).[18]

4. Conclusion

In this paper we have investigated whether it is desirable for central banks to increase their degree of transparency any further. While previous research analyzed the desirability of particular forms of transparency, we have focused on the optimal *overall* degree of monetary policy transparency. We have argued that some intermediate degree of transparency is desirable. By using two arguments,

[18] Our findings are robust to the exclusion of countries with the lowest degree of democracy, the so-called authoritarian regimes (Kekic, 2006). Results are available upon request.

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

uncertainty and confusion/information overload, we have pointed out that there is likely to be an optimal intermediate degree of central bank transparency at which the quality of inflation forecasts is optimized. Although some degree of transparency might be helpful because it improves the quality of private sector inflation forecasts, a lot of transparency might be detrimental.

First, it could lead to confusion/information overload. As an example consider the Financial Stability Reports published by various central banks. These reports contain a lot of information, which might complicate it for private agents to see the forest for the trees and harms their inflation forecasts. Second, although some information on the conditionality of intended policy and economic outcomes might improve the quality of private sector forecasts, too much information on uncertainty might lower the perceived quality of private sector inflation forecasts. As a consequence inflation will be formed in a relatively backward looking way resulting in high inflation persistence. Then it will be hard for central bankers to perform monetary policy. Steering inflation expectations will not be a very effective strategy. It will take a relatively long time before inflation is in line with the target again.

We have tested whether our case for an optimal intermediate degree of transparency can be confirmed by the data. By linking transparency data from 1998 to 2005 for a large sample of central banks to inflation persistence we find support for our hypothesis. There is an optimal intermediate degree of transparency: neither full secrecy nor complete transparency is optimal. This result is robust to changes in the countries included and the lag specification chosen.

The exact value we observe for the optimum should however be interpreted with care. Our baseline regression, including all countries, results in an optimum of 6. Theoretically, values between 0 and 15 are possible. Note that in practice, however, there is a high incidence of low degrees of central bank transparency whereas very high degrees of transparency (more than 13.5) are not observed at all. The exact value of the optimum we find depends on the countries we include. For example, when we consider only OECD countries the optimum shifts to 7.5. Because the optimal degree of transparency hinges on the capacity of the private sector to process information (our confusion-argument) it makes sense to observe a higher optimal degree of central bank transparency for OECD countries, since their inhabitants are better skilled to process information. In addition, we would like to note that there might be other ways in which transparency influences the economy, not only through affecting the quality of inflation forecasts. The optimal degree of transparency might shift when taking these effects into account.

Most central banks have quite a low degree of transparency (the median degree of transparency in 2005 was 5) and our results suggest that more transparency is likely to be beneficial for these central banks. It could lead to a better quality of the private sector forecasts resulting in lower inflation persistence. However, several central banks (e.g. the Fed and the ECB) already have a high degree of transparency. It is good for these central banks to keep in mind that it is wise to not become completely transparent. A high degree of transparency could result in confusion and too much awareness of the central bank's uncertainty. This might be detrimental for the effectiveness of monetary policy since inflation will be more persistent and therefore more difficult to affect.

A caveat of our research is that central bank transparency is something which is difficult to measure objectively. Perhaps central banks have invented new ways to be transparent, which are not included in the transparency measures currently at hand. Note also that it is complicated to determine the weights that various manners of information disclosure should get. Our analysis suggests that it might be helpful for future research to construct alternative measures of transparency that measure the clarity of information instead of the quantity. In addition, future research might shed more light on the relative importance of the uncertainty channel and the information/overload channel and provide more insight on which specific information to disclose and which specific information to keep secret.

Acknowledgements

We would like to thank Alan Blinder, Francesco Columba, Jakob de Haan, Marcel Fratzscher, Marco Hoeberichts, Joris Knoben, Ad Stokman and seminar participants at DNB, the NAKE Research Day 2008, the Wilfrid Laurier University conference "Central Bank Communication, Decision-making and Governance" organized by Pierre Siklos, and the Columbia University policy debate "Governance, Transparency and Accountability in Financial Institutions and Regulatory Bodies" organized by Joseph Stiglitz for helpful comments and suggestions.

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

Appendices

A. Data

A.1 Central bank transparency

Table A1
Central bank transparency data.

	1998	1999	2000	2001	2002	2003	2004	2005
Minimum	0	0	0	0.5	0.5	0.5	0.5	0.5
	(B)	(B)	(B)	(A&B)	(A&B)	(A)	(A)	(A)
Maximum	11	13	13	13	13.5	13.5	13.5	13.5
	(UK)	(NZ)	(NZ)	(NZ)	(NZ)	(NZ)	(NZ)	(NZ)
Average	3.4	3.6	3.9	4.2	4.7	4.9	5.1	5.2
Stdev	2.4	2.6	2.7	2.8	3.0	3.0	3.0	3.0

Source: Based on the data set from Dincer and Eichengreen (2007), which includes 100 countries.
Note: B = Bangladesh, A = Aruba, NZ = New Zealand, UK = United Kingdom.

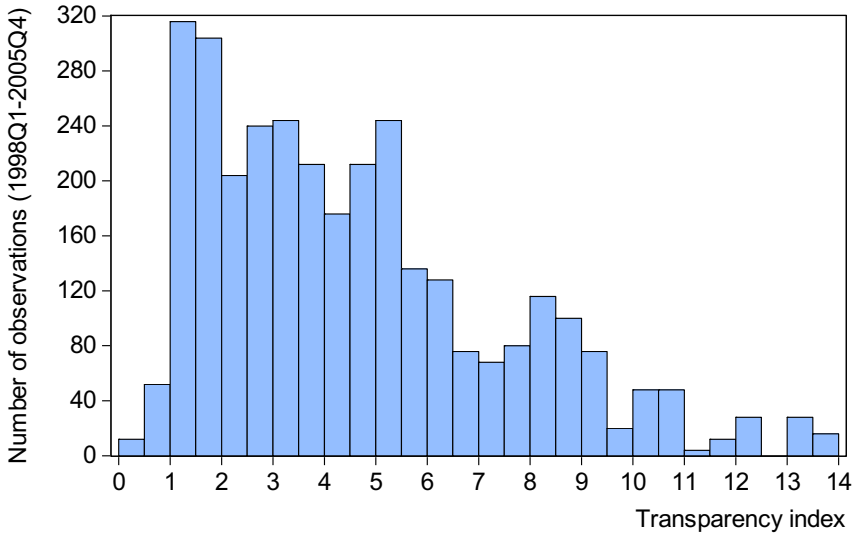

Fig. A1. Central bank transparency data.
Source: This figure is based on the transparency data of Dincer and Eichengreen (2007).

A.2 Inflation

Definition: quarter on quarter annualized inflation rate.
Calculation: $\pi_{i,t} = ((CPI_{i,t} - CPI_{i,t-1})/CPI_{i,t-1})^{*}100^{*}4$ where *CPI* is the Consumer Price Index of country *i* at time *t*.
Source: Quarterly CPI data from the International Monetary Fund, International Financial Statistics.

A.3 Control variables

Labor share (LS)
Indicator: Production process sophistication
Definition: This is the survey response to the statement "Production processes use (1 = labor-intensive methods or previous generations of process technology, 7 = the world's best and most efficient process technology).

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

Source: The Global Competitiveness Report, World Economic Forum. Report 2002–2003 and 2003–2004 (series 10.06), 2004–2005 (series 9.06), 2005–2006 (series 8.05). For 2000, 2001 we take the 2002–2003 value, because of a slightly different definition of the survey question (without labor). For 1998, and 1999 we take this 2002–2003 value too (also because the 1998 and 1999 report are not available in any of the Dutch libraries and on the WEF-site one can only buy reports from 2001 onwards).

Wage flexibility (WF)
Indicator: Flexibility of wage determination
Definition: This is the survey response to the statement: "Wages in your country are (1 = set by a centralized bargaining process, 7 = up to each individual company)".
Source: The Global Competitiveness Report, World Economic Forum. Report 2000 (series 6.11, only slightly different definition. "Wage setting. Wages are determined by each individual company. (1 = strongly disagree; 7 = strongly agree)"), report 2002–2003 (series 10.19), report 2003–2004 (series 10.19), report 2004–2005 (series 9.19), report 2005–2006 (series 8.18). For 1998, 1999 we take the 2000 value since these reports are not available in any of the Dutch libraries and on the WEF-site one can only buy reports from 2001 onwards. This question is not included in the 2001–2002 report, therefore we take the average of the 2000 and 2002–2003 as the 2001 value.

Competition (DoC and Exports)
Indicator 1: Degree of competition (DoC)
Definition: Intensity of local competition is the outcome of the following survey statement: "Competition in the local market is (1 = limited in most industries and price-cutting is rare, 7 = intense in most industries as market leadership changes over time)".
Source: The Global Competitiveness Report, World Economic Forum report 2000 (series 10.01), 2001–2002, 2002–2003 and 2003–2004 (all series 8.01), report 2004–2005 and 2005–2006 (both series 7.01). For 1998, and 1999 we take the 2000 value since these reports are not available in any of the Dutch libraries and on the WEF-site one can only buy reports from 2001 onwards. The definitions in the 2000 and 2001–2002 are slightly different. Definition 2000 report: "Local competition. Competition in local markets is intense and market shares fluctuate constantly. (1 = strongly disagree; 7 = strongly agree)". Definition 2001–2002 report: "In most industries, competition in the local market is (1 = limited and price-cutting is rare, 7 = intense and market leadership changes over time)".
Indicator 2: Exports.
Definition: Exports as a share of GDP.
Source: International Financial Statistics, International Monetary Fund.

Technology (TR)
Indicator: Technological Readiness
Source: The Global Competitiveness Report 2005–2006, World Economic Forum. Note that there is one data point for each country. We assume values to be constant over time. On p. 41 of the report it is explained that technological readiness is the average of series 3.01 (Technological Readiness), 3.02 (Firm-level technology absorption), 3.15 (Laws relating to ICT), 3.04 (FDI and technology transfer), 3.18 (Cellular telephones (hard data)), 3.19 (Internet users (hard data)) and 3.21 (personal computers (hard data)).

Customer relations (CR)
Indicator: Degree of customer orientation
Definition: This is the survey response to the statement "Firms in your country (1 = generally treat their customers badly, 7 = are highly responsive to customers and customer retention)".
Source: The Global Competitiveness Report, World Economic Forum report 2000 (series 11.08), 2001–2002, 2002–2003 and 2003–2004 (all series 10.08), report 2004–2005 (series 9.08) and 2005–2006 (series 8.07). For 1998, and 1999 we take the 2000 value since these reports are not available in any of the Dutch libraries and on the WEF-site one can only buy reports from 2001 onwards. The definitions in the 2000 and 2001–2002 are slightly different. Definition 2000 report: "Firms generally pay close attention to customer satisfaction. (1 = strongly disagree; 7 = strongly agree)". Definition 2001–2002 report: "Firms in your country (1 = generally treat their customers badly, 7 = pay close attention to customer satisfaction)".

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

Institutions (INST)
Indicator: Institutions.
Definition: A pillar based on various series, which measures the quality of public and private institutions (see Global Competitiveness Report, 2007–2008, p. 4).
Source: The Global Competitiveness Report 2007–2008, World Economic Forum.

Inflation targeting (IT)
Definition: This dummy variable is 1 for a particular central bank at a particular moment in time if there is an inflation targeting regime. Otherwise this dummy is 0.
Source: IMF World Economic Outlook 2005: Chapter IV, Does inflation targeting work in emerging markets? Table 4.1, p. 162 (source: National authorities).
IT Countries (adoption date): Israel (1997Q2), Czech Republic (1998Q1), Korea (1998Q2), Poland (1999Q1), Brazil (1999Q2), Chile (1999Q3), Colombia (1999Q3), South Africa (2000Q1), Thailand (2000Q2), Mexico (2001Q1), Hungary (2001Q3), Peru (2002Q1), Philippines (2002Q1), New Zealand (1990Q1), Canada (1991Q1), United Kingdom (1992Q4), Australia (1993Q1), Sweden (1993Q1), Switzerland (2000Q1), Iceland (2001Q1) and Norway (2001Q1).

B. Specification tests

B.1 Regressions with and without transparency

Table B1
Inflation persistence: panel least squares with and without transparency.

	(1)		(2)	
	coef.	*p*-value	coef.	*p*-value
α	14.47***	(0.00)	14.62***	(0.00)
$INST_{i,t}$	−1.12***	(0.00)	−1.06***	(0.00)
$DoC_{i,t}$	−1.08***	(0.00)	−1.20***	(0.00)
$\pi_{i,t-1}$	0.80***	(0.00)	0.00	(0.99)
$\pi_{i,t-1}T_{i,t}$	−0.13***	(0.00)		
$\pi_{i,t-1}T^2_{i,t}$	0.01***	(0.00)		
$\pi_{i,t-1}WF_{i,t}$	−0.16***	(0.00)	−0.09***	(0.00)
$\pi_{i,t-1}CR_{i,t}$	0.19***	(0.00)	0.23***	(0.00)
$\pi_{i,t-1}IT_{i,t}$	−0.30***	(0.00)	−0.31***	(0.00)
S_2	−2.07***	(0.00)	−2.14***	(0.00)
S_3	−4.03***	(0.00)	−3.97***	(0.00)
S_4	−0.85*	(0.09)	−0.65	(0.19)
R^2	0.41		0.40	
Sample	1998q1–2005q4		1998q1–2005q4	
Countries	70		70	
Total panel	2188		2188	
S.E. of regr.	8.13		8.18	
Jarque–Bera	87439	(0.00)	140708	(0.00)
DW	1.95		1.96	

Note: results of the estimation of equation (8) using q.o.q. inflation rates that are annualized. DoC = degree of competition, INST = quality of public and private institutions, IT = inflation targeting regime, π = inflation, T = transparency index (Dincer and Eichengreen, 2007), WF = wage flexibility, CR = customer relations, and DW = Durbin–Watson statistic. S_2, S_3 and S_4 are seasonal dummies (1 in the quarter they refer to, otherwise 0). For more information on the variables we refer to Appendix A.

B.2 Additional autoregressive terms

To get an alternative measure of inflation persistence which is based on more lags (q) we need to include additional autoregressive terms in equation (8). The equation to estimate then becomes as follows:

$$\pi_{i,t} = \alpha + Z_{it} + \sum_{q=1}^{Q} \beta_{1,q}\pi_{i,t-q} + \sum_{q=1}^{Q} \beta_{2,q}T_{i,t}\pi_{i,t-q} + \sum_{q=1}^{Q} \beta_{3,q}T^2_{i,t}\pi_{i,t-q} + \sum_{q=1}^{Q}\sum_{n=1}^{N} \beta_{3+n,q}Y_{i,t}\pi_{i,t-q} + S_2 + S_3 + S_4 + \varepsilon_{i,t}, \quad (10)$$

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

with π = inflation, α = a constant, T = the degree of transparency, and ε = the error term. $i = 1, 2,\ldots, I$ indicates the cross-sectional units and $t = 1, 2,\ldots, T$ the periods. Z is a vector of control variables that affect the level of inflation. In addition we include a set of control variables (Y) that affect the degree of inflation persistence. S_2, S_3 and S_4 are seasonal dummies (1 in the quarter they refer to, otherwise 0). In the baseline analysis (presented in the main text), we have included one lag ($q = 1$). When more than one lag is included, the measure of inflation persistence (B) is:

$$B_{it} = \sum_{q=1}^{Q} \beta_{1,q} + \sum_{q=1}^{Q} \beta_{2,q} T_{i,t} + \sum_{q=1}^{Q} \beta_{3,q} T_{i,t}^2 + \sum_{q=1}^{Q} \sum_{n=1}^{N} \beta_{3+n,q} Y_{i,t}\,. \tag{11}$$

Fig. B1 summarizes the outcomes of up to four lags ($q = 4$). The optimal transparency degree is 6 when $q = 1$, 3 or 4 and 5.5 when $q = 2$.

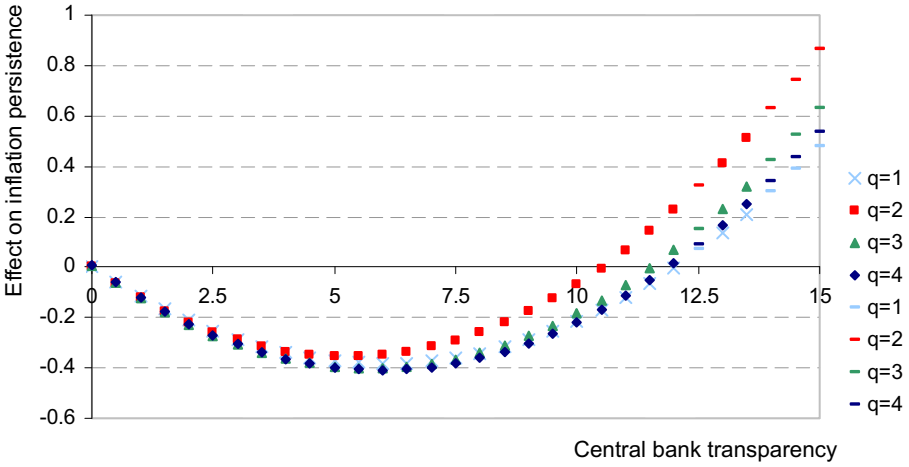

Fig. B1. Effect of central bank transparency on inflation persistence: Various Lag Lengths.
Note: this figure plots the effect of central bank transparency (T) on inflation persistence (B): $\sum_{q=1}^{Q}(\beta_{2,q}T + \beta_{3,q}T^2)$ for various lag lengths ($Q = 1$, $Q = 2$, $Q = 3$ and $Q = 4$). Note that $T > 13.5$ and $T = 12.5$ are not observed in our sample (indicated with -'s in the figure).

B.3 Various samples

Table B2
Central bank transparency and inflation persistence: various samples.

	(1)		(2)		(3)		(4)	
	All countries		OECD		Non-OECD		Excl.T > 10	
	coef.	*p*-value	coef.	*p*-value	coef.	*p*-value	coef.	*p*-value
α	14.47***	(0.00)	7.93***	(0.01)	17.22***	(0.00)	14.81***	(0.00)
$INST_{i,t}$	−1.12***	(0.00)	−1.16***	(0.00)	−1.10***	(0.00)	−1.11***	(0.00)
$DoC_{i,t}$	−1.08***	(0.00)	0.23	(0.67)	−1.63***	(0.00)	−1.15***	(0.00)
$\pi_{i,t-1}$	0.80***	(0.00)	2.41***	(0.00)	0.39	(0.20)	0.83***	(0.00)
$\pi_{i,t-1}T_{i,t}$	−0.13***	(0.00)	−0.10**	(0.02)	−0.15***	(0.00)	−0.14***	(0.00)
$\pi_{i,t-1}T_{i,t}^2$	0.01***	(0.00)	0.01*	(0.06)	0.01**	(0.03)	0.01***	(0.00)
$\pi_{i,t-1}WF_{i,t}$	−0.16***	(0.00)	−0.21***	(0.00)	−0.07**	(0.04)	−0.15***	(0.00)
$\pi_{i,t-1}CR_{i,t}$	0.19***	(0.00)	−0.10	(0.18)	0.18***	(0.00)	0.18***	(0.00)
$\pi_{i,t-1}IT_{i,t}$	−0.30***	(0.00)	−0.41***	(0.00)	−0.06	(0.67)	−0.28***	(0.00)
S_2	−2.07***	(0.00)	−1.21**	(0.05)	−2.33***	(0.00)	−2.32***	(0.00)
S_3	−4.03***	(0.00)	−2.69***	(0.00)	−4.34***	(0.00)	−4.23***	(0.00)
S_4	−0.85*	(0.09)	−0.19	(0.75)	−1.12*	(0.08)	−0.86	(0.11)

(*continued on next page*)

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

Table B2 (*continued*)

	(1)		(2)		(3)		(4)	
	All countries		OECD		Non-OECD		Excl.T > 10	
	coef.	*p*-value	coef.	*p*-value	coef.	*p*-value	coef.	*p*-value
R^2	0.41		0.72		0.33		0.41	
Sample	1998q1–2005q4		1998q1–2005q4		1998q1–2005q4		1998q1–2005q4	
Countries	70		18		52		65	
Total panel	2188		576		1612		2028	
S.E. of regr.	8.13		5.13		8.88		8.4	
Jarque–Bera	87439	(0.00)	18504	(0.00)	74907	(0.00)	106840	(0.00)
DW	1.95		2.38		1.87		1.94	
Optimum	6		7.5		6		5.5	

Note: results of the estimation of equation (8) using various samples. Regression (4) is based on countries with a transparency degree of at most 10 in 2005. DoC = degree of competition, INST = quality of public and private institutions, π = inflation, T = transparency index (Dincer and Eichengreen, 2007), WF = wage flexibility, CR = customer relations, OECD = Organization for Economic Co-operation and Development, and DW = Durbin–Watson statistic. S_2, S_3 and S_4 are seasonal dummies (1 in the quarter they refer to, otherwise 0). For more information on the variables we refer to Appendix A.

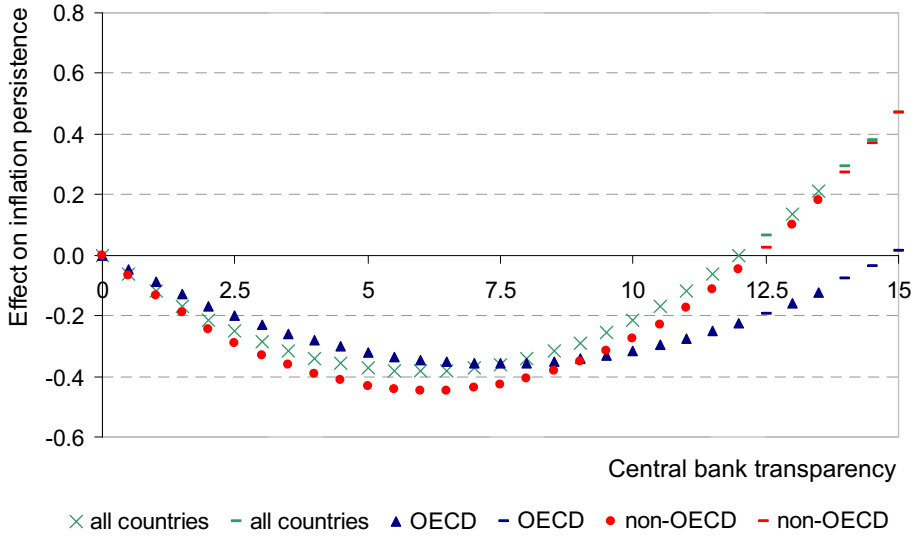

Fig. B2. Effect of central bank transparency on inflation persistence: OECD Versus Non-OECD Countries.
Note: this figure plots the effect of central bank transparency (T) on inflation persistence (B): $\beta_2 T + \beta_3 T^2$ for various samples. Transparency levels that are not observed are indicated with -'s.

B.4 Including lagged values of transparency

Table B3
Central bank transparency and inflation persistence: using lagged values of transparency.

	(1)		(2)		(3)		(4)		(5)	
	coef.	*p*-value	coef.	*p*-value	coef.	*p*-value	coef.	*p*-value	coef.	*p*-value
α	14.47***	(0.00)	13.52***	(0.00)	14.24***	(0.00)	15.27***	(0.00)	14.78***	(0.00)
$INST_{i,t}$	−1.12***	(0.00)	−1.04***	(0.00)	−1.04***	(0.00)	−1.04***	(0.00)	−1.06***	(0.00)
$DoC_{i,t}$	−1.08***	(0.00)	−1.01***	(0.01)	−1.17***	(0.00)	−1.36***	(0.00)	−1.23***	(0.00)
$\pi_{i,t-1}$	0.80***	(0.00)	0.86***	(0.00)	0.67**	(0.01)	0.63**	(0.02)	0.59**	(0.02)
$\pi_{i,t-1}T_{i,t}$	−0.13***	(0.00)								
$\pi_{i,t-1}T^2_{i,t}$	0.01***	(0.00)								
$\pi_{i,t-1}T_{i,t-1}$			−0.13***	(0.00)						

(*continued on next page*)

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

Table B3 (*continued*)

	(1)		(2)		(3)		(4)		(5)	
	coef.	*p*-value	coef.	*p*-value	coef.	*p*-value	coef.	*p*-value	coef.	*p*-value
$\pi_{i,t-1}T^2_{i,t-1}$			0.01***	(0.00)						
$\pi_{i,t-1}T_{i,t-2}$					−0.12***	(0.00)				
$\pi_{i,t-1}T^2_{i,t-2}$					0.01***	(0.00)				
$\pi_{i,t-1}T_{i,t-3}$							−0.13***	(0.00)		
$\pi_{i,t-1}T^2_{i,t-3}$							0.01***	(0.00)		
$\pi_{i,t-1}T_{i,t-4}$									−0.08***	(0.01)
$\pi_{i,t-1}T^2_{i,t-4}$									0.01*	(0.06)
$\pi_{i,t-1}WF_{i,t}$	−0.16***	(0.00)	−0.15***	(0.00)	−0.14***	(0.00)	−0.13***	(0.00)	−0.16***	(0.00)
$\pi_{i,t-1}CR_{i,t}$	0.19***	(0.00)	0.17***	(0.00)	0.20***	(0.00)	0.19***	(0.00)	0.20***	(0.00)
$\pi_{i,t-1}IT_{i,t}$	−0.30***	(0.00)	−0.28***	(0.00)	−0.27***	(0.00)	−0.27***	(0.00)	−0.25***	(0.00)
S_2	−2.07***	(0.00)	−1.73***	(0.00)	−1.64***	(0.00)	−1.62***	(0.00)	−1.61***	(0.00)
S_3	−4.03***	(0.00)	−3.70***	(0.00)	−3.71***	(0.00)	−3.69***	(0.00)	−3.68***	(0.00)
S_4	−0.85*	(0.09)	−0.54	(0.29)	−0.52	(0.30)	−0.55	(0.26)	−0.77	(0.11)
R^2	0.41		0.39		0.38		0.38		0.38	
Sample	1998q1–2005q4		1998q2–2005q4		1998q3–2005q4		1998q4–2005q4		1999q1–2005q4	
Countries	70		70		70		70		70	
Total panel	2188		2120		2052		1984		1916	
S.E. of regr.	8.13		8.03		8.05		7.88		7.32	
Jarque–Bera	87439	(0.00)	137885	(0.00)	137327	(0.00)	156550	(0.00)	31144	(0.00)
DW	1.95		1.97		1.96		1.92		2.00	
Optimum	6		6		6		6		6.5	

Note: results of the estimation of equation (8) using lagged values of the transparency index (T) in (2)–(5). DoC = degree of competition, INST = quality of public and private institutions, π = inflation, T = transparency index (Dincer and Eichengreen, 2007), WF = wage flexibility, CR = customer relations, and DW = Durbin–Watson statistic. S_2, S_3 and S_4 are seasonal dummies (1 in the quarter they refer to, otherwise 0). For more information on the variables we refer to Appendix A.

References

Amato, J.D., Laubach, T., 2003. Rule-of-thumb behavior and monetary policy. European Economic Review 47, 791–831.
Babcock, L., Loewenstein, G., 1997. Explaining bargaining impasse: the role of self-serving biases. The Journal of Economic Perspectives 11 (1), 109–126.
Baltagi, B.H., 2008. Econometrics, fourth ed.. Springer, Berlin-Heidelberg, pp. 95–126 (Chapter 5).
Bernanke, B.S., 2007. Federal Reserve Communications. Speech at the Cato Institute 25th Annual Monetary Conference, Washington D.C., November 14th.
Blinder, A.S., 2000. Central bank credibility: why do we care? How do we build it? American Economic Review 90 (5), 1421–1431.
Carroll, C.D., 2001. The Epidemiology of Macroeconomic Expectations NBER Working Paper No. w8695.
Cestari, V., Del Giovane, P., Rossi-Arnaud, C., 2008. Memory for prices and the euro cash changeover: an analysis for cinema prices in Italy. In: Del Giovane, P., Sabbatini, R. (Eds.), The Euro, Inflation and Consumers' Perceptions, Lessons from Italy. Springer, Berlin–Heidelberg, pp. 125–156.
Christoffel, K., Linzert, T., 2005. The Role of Real Wage Rigidity and Labor Market Frictions for Unemployment and Inflation Dynamics ECB Working Paper No. 556.
Corvoisier, S., Mojon, B., 2005. Breaks in the Mean of Inflation: How They Happen and What to do With Them ECB Working Paper No. 451.
van der Cruijsen, C.A.B., Demertzis, M., 2007. The impact of central bank transparency on inflation expectations. European Journal of Political Economy 23 (1), 51–66.
van der Cruijsen, C.A.B., Eijffinger, S.C.W., 2010a. From actual to perceived transparency: the case of the European Central Bank. Journal of Economic Psychology 31 (3), 388–399.
van der Cruijsen, C.A.B., Eijffinger, S.C.W., 2010b. The Economic Impact of Central Bank Transparency: A survey. In: Siklos, P., Bohl, M., Wohar, M. (Eds.), Challenges in Central Banking: The Current Institutional Environment and Forces Affecting Monetary Policy. Cambridge University Press, New York, pp. 261–319.
Cukierman, A., 2007. The Limits of Transparency CEPR Discussion paper No. 6475.
Dale, S., Orphanides, A., Österholm, P., 2008. Imperfect Central Bank Communication – Information Versus Distraction IMF Working Paper No. 08/06.
Del Giovane, P., Fabiani, S., Sabbatini, R., 2008. What's behind "inflation perceptions"? A survey-based analysis of Italian consumers. In: Del Giovane, P., Sabbatini, R. (Eds.), The Euro, Inflation and Consumers' Perceptions, Lessons from Italy. Springer, Berlin–Heidelberg, pp. 157–198.
Demertzis, M., Hoeberichts, M., 2007. The costs of increasing transparency. Open Economies Review 18 (3), 263–280.
Dhyne, E., Álvarez, L.J., Le Bihan, H., Veronese, G., Dias, D., Hoffmann, J., Jonker, N., Lünnemann, P., Rumler, F., Vilmunen, J., 2006. Price changes in the Euro Area and the United States: some facts from individual consumer price data. Journal of Economic Perspectives 20 (2), 171–192.
Diamond, D.W., Dybvig, P.H., 1983. Bank runs, deposit insurance, and liquidity. Journal of Political Economy 91 (3), 401–419.

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003

Dincer, N.N., Eichengreen, B., 2007. Central Bank Transparency: Why, Where, and with What Effects? NBER Working Paper No. w13003.
Dincer, N.N., Eichengreen, B., 2009. Central Bank Transparency: Causes, Consequences and Updates NBER Working Paper No. w14791.
Ehrmann, M., Fratzscher, M., 2009a. How should central banks communicate? In: Mayes, D., Wood, G. (Eds.), Designing a Central Bank Communication Strategy. Designing Central Banks, Routledge, pp. 170–192.
Ehrmann, M., Fratzscher, M., 2009b. Purdah – on the rationale for central bank silence around policy meetings. Journal of Money, Credit and Banking 41 (2–3), 517–528.
Eijffinger, S.C.W., Geraats, P.M., 2006. How transparent are central banks? European Journal of Political Economy 22 (1), 1–21.
Fabiani, S., Druant, M., Hernando, I., Kwapil, C., Landau, B., Loupias, C., Martins, F., Mathä, T.Y., Sabbatini, R., Stahl, H., Stokman, A.C.J., 2006. What firms' surveys tell about price setting behavior in the euro area. International Journal of Central Banking 2 (3), 3–47.
Gadzinski, G., Orlandi, F., 2004. Inflation Persistence in the European Union, the Euro Area, and the United States ECB Working Paper No. 414.
Gali, J., Gertler, M., López-Salido, J.D., 2001. European inflation dynamics. European Economic Review 45, 1237–1270.
Goodfriend, M., 1986. Secrecy and central banking. Journal of Monetary Economics 17, 63–92.
Gosselin, P., Lotz, A., Wyplosz, C., 2007. Interest Rate Signals and Central Bank Transparency CEPR Discussion Paper No. 6454.
Greenspan, A., November 3, 2005. Testimony Before the Joint Economic Committee.
Haan, J. de, Eijffinger, S.C.W., Waller, S., 2005. The European Central Bank: Credibility, Transparency, and Centralization. CesIfo Book Series. MIT Press, Cambridge (Massachusetts).
Hoeberichts, M.M., Stokman, A.C.J., 2010. Price setting behaviour in the Netherlands: results of a survey. Managerial and Decision Economics 31 (2–3), 135–149.
International Monetary Fund, 2005. Does Inflation Targeting Work In Emerging Markets? In World Economic Outlook (Chapter IV).
Issing, O., 2005. Communication, transparency, accountability: monetary policy in the twenty-first century. Federal Reserve Bank of St. Louis Review 87 (2, Part 1), 65–83.
Jensen, H., 2002. Optimal degrees of transparency in monetary policymaking. Scandinavian Journal of Economics 104 (3), 399–422.
Kekic, L., 2006. The Economist Intelligence Unit's Index of Democracy. The World in 2007. Economist Intelligence Unit.
Levin, A.T., Natalucci, F.M., Piger, J.M., 2004. The macroeconomic effects of inflation targeting. Federal Reserve Bank of St. Louis Review 86 (4), 51–80.
Lünnemann, P., Mathä, T.Y., 2005. Regulated and Services' Prices and Inflation Persistence. ECB Working Paper No. 466.
Mankiw, N.G., Reis, R., 2002. Sticky information versus sticky prices: a proposal to replace the New Keynesian Phillips curve. Quarterly Journal of Economics 117, 1295–1328.
Marques, C.R., 2004. Inflation Persistence: Facts or Artefacts? ECB Working Paper No. 371.
Morris, S., Shin, H.S., 2002. Social value of public information. American Economic Review 92 (5), 1521–1534.
Morris, S., Shin, H.S., 2005. Central bank transparency and the signal value of prices. Brookings Papers on Economic Activity (2), 1–66.
Rabin, M., 1998. Psychology and economics. Journal of Economic Literature 36 (1), 11–46.
Roberts, J.M., 1998. Inflation Expectations and the Transmission of Monetary Policy Federal Reserve Board Finance and Economics Discussion Series Paper No. 98–43.
Sims, C.A., 2003. Implications of rational inattention. Journal of Monetary Economics 50 (3), 665–690.
Stock, J.H., 2001. Comment. In: Bernanke, B.S., Rogoff, K. (Eds.), NBER Macroeconomics Annual 2001.
Svensson, L.E.O., 2006. Social value of public information: comment: Morris and Shin (2002) is actually pro-transparency, not con. American Economic Review 96 (1), 448–452.
Tversky, A., Kahneman, D., 1974. Judgment under uncertainty: heuristics and biases. Science 185 (4157), 1124–1131.
Walsh, C.E., 2007. Optimal economic transparency. International Journal of Central Banking 3 (1), 5–36.
Woodford, M., 2003. Interest and Prices: Foundations of a Theory of Monetary Policy. Princeton University Press, New Jersey/Oxfordshire.
Yellen, J.L., 2007. Implications of Behavioral Economics for Monetary Policy. Speech for the Federal Reserve Bank of Boston Conference: "Implications of Behavioral Economics for Economic Policy", September 28.
Zbaracki, M.J., Ritson, M., Levy, D., Dutta, S., Bergen, M., 2004. Managerial and customer costs of price adjustment: direct evidence from industrial markets. The Review of Economics and Statistics 86 (2), 514–533.

Please cite this article in press as: van der Cruijsen, C.A.B., et al., Optimal central bank transparency, Journal of International Money and Finance (2010), doi:10.1016/j.jimonfin.2010.06.003