

The Effect of Central Bank Transparency on Interest Rate Predictability

Abstract

Central banks' policy rate is a key mechanism for transmitting monetary policy. Through transparency, central banks have the ability to affect market expectations and could potentially improve the effectiveness of their monetary policy by aligning market expectations and policy intentions. This thesis aims to evaluate whether central bank transparency enhances the predictability of interest rates. Using the Eijffinger-Geraats Index, I test the hypothesis that increased central bank transparency leads to a decrease in analysts' 3-month interest rate forecast errors, forecasted three months in advance, during the period 1998-2006 for eight inflation-targeting central banks. Econometric analyses of the central banks individually give mixed results. Five central banks support the hypothesis out of which three are statistically significant. Unobserved factors that have led to a constant decrease in interest rate forecast errors complicate the results for two central banks. One central bank shows evidence against the hypothesis. Generalizing the results, I find support for the hypothesis before controlling for a constant trend in the forecast errors. Therefore, although it appears as if central bank transparency enhances the predictability of interest rates, a firm conclusion cannot be drawn until the cause for this trend in interest rate forecast errors has been established.

Keywords: Central banks; Transparency; Interest rates; Forecast errors

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Contents

Abbreviations	iv
1. Introduction	1
1.1 Aim	2
1.2 Scope	2
1.3 Limitation of scope	3
2. Theory: Introducing Central Banks, Monetary Policy and the Concept of Central Bank Transparency	3
2.1 The role of Central Banks	3
2.2 Types of Monetary Policy Frameworks	4
2.3 The link between Monetary Policy Intentions, Transparency, and Outcomes	4
2.4 Characteristics of Central Bank Transparency	6
2.5 Theory Behind Central Bank Transparency	8
2.6 Summary	14
3. Survey of Transparency Evolution and Consequent Effects	14
3.1 Evidence of Transparency Change	15
3.2 Effects of Transparency	15
4. Methodology	18
4.1 Choice of Method and Main Variables	18
4.2 Control Variables	20
4.3 Sample Selection	22
4.4 Contribution	23
5. Data	23
5.1 Transparency Index	24
5.2 Interest Rate Forecast Errors	24
5.3 Macroeconomic Forecast Errors	25
5.4 Shocks	26
6. Econometric Method	26
6.1 General and Country-Specific Method	26
6.2 Econometric Method for Panel Data Analysis	28
6.3 Time Series Assumptions for OLS Estimates	29
6.4 Panel Data Assumptions for OLS Estimates	30
7. Results and Analysis	31
7.1 Data Analysis	31
7.2 Country-Specific Results and Analysis	33
7.3 Panel Data Results and Analysis	41
7.4 Discussion of Results	42
7.5 Suggestions for Future Research	45
8. Conclusion	46
9. References	47
10. Appendix	51
10.1 Summary Statistics	51
10.2 Economic Shocks	53
10.3 OLS Assumptions	55
10.4 Results	58

Abbreviations

Country	Country code	Central Bank	Central Bank code
Canada	CA	Bank of Canada	BoC
Euro zone	EU	European Central Bank	ECB
Japan	JP	Bank of Japan	BoJ
Norway	NO	Norges Bank	NB
Sweden	SE	Sveriges Riksbank	SRB
Switzerland	CH	Swiss National Bank	SNB
United Kingdom	UK	Bank of England	BoE
United States	US	Federal Reserve	Fed

1. Introduction

Most of us haven't the foggiest notion of what goes on inside the institution that determines how much money will be available to the American economy and what level of interest rates will be charged to make use of that money. (Lehmann-Haupt 1988, p.1)

Lehmann-Haupt's summary of William Greider's book *The Secrets of the Temple* is a good summary of how central banks used to be run. A well-known researcher and former member of the Federal Reserve System's Board of Governors, Professor Frederic Mishkin (2004, p.1), explains what prompted many popular books on this theme to be written:

In the old days, central banks were generally very secretive institutions. Not only did they not clarify what their objectives and strategies were, but they even kept the markets guessing about what the actual settings of policy instruments were. Central banks were perfectly happy to cultivate a mystique as wise but mysterious institutions.

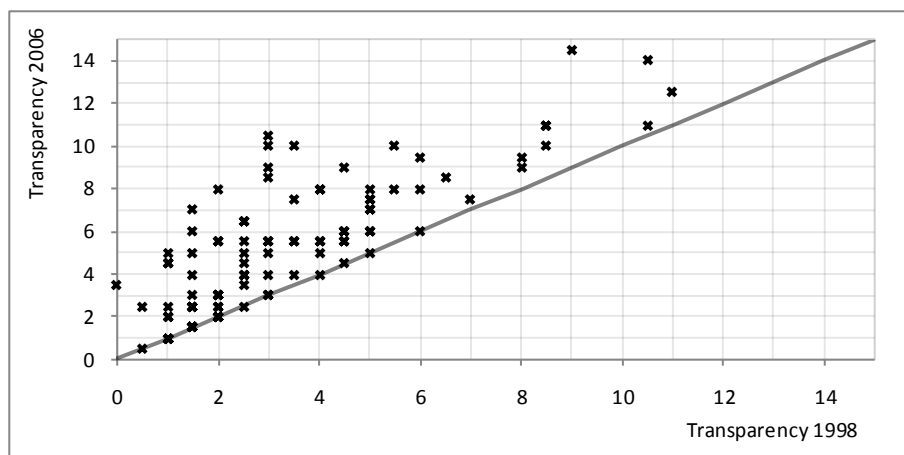
Today, this scenario should appear very remote. In Sweden it is known that the Riksbank's policy is to keep the annual inflation rate at around two per cent by announcing adjustments in its key interest rate, the repo rate. People read the minutes from board meetings and listen to board members make public speeches. They are even presented with the Riksbank's anticipated path for both inflation and the repo rate. However, central banks, including the Riksbank, have not always been as open about their work as they are today. Figure 1 below illustrates the changes made only between 1998-2006. There is a broad consensus that contemporary central banking is different from when William Greider wrote *The Secrets of the Temple*. Dincer and Eichengreen (2006) claim transparency to be the most dramatic difference between modern and historical central banking. As Geraats (2009, p.264) illuminates:

While a few decades ago central banks were often notorious for their secrecy, nowadays they tend to pride themselves on their degree of transparency. In fact, central bank communications have become an important tool for monetary policymaking.

Two key reasons for this change from opacity to transparency can be identified. Firstly, central banks have moved to become independent public institutions from having been directly controlled by governments. To hold independent central banks accountable for their policy decisions, some form of public disclosure of their work needs to be provided. Secondly, monetary policy is about managing expectations of the future because the key decision makers in an economy are forward-looking. Hence, by having a more transparent central bank, monetary policy should become more effective (e.g. Cukierman, 2009; Woodford, 2005).

Figure 1: Transparency levels in 1998 and in 2006

Using the Eijffinger-Geraats Index, out of a sample of 100 central banks it can be shown that 77 per cent of the central banks increased their overall level of transparency between 1998-2006, represented by the plots above the line of unity. No central bank decreased its overall level of transparency.



Data source: Dincer and Eichengreen (2010)

Over the years, a sizable literature has emerged focusing on the theoretical reasons both for and against central bank transparency. Empirical studies have also been made on the effects of transparency with an emphasis on the macroeconomic outcome and its effect on financial markets. Yet, there has always been and there still is a lack of consensus on the best practice and optimal level of transparency for central banks, making it an interesting area for further research (e.g. Blinder, et al., 2008; Carpenter, 2004; Geraats, 2002).

1.1 Aim

While the economic outcome of monetary policymaking is ultimately what a central bank's performance should be judged on, this thesis will take a step back and study the effects of central bank transparency on the interest rate mechanism that transmits monetary policy to the economy. Acknowledging the ability of monetary policy communication to affect market expectations, this thesis aims to evaluate whether increased central bank transparency enhances the predictability of interest rates. By studying central banks both individually and on an aggregate level, I aim to attain both comparable country-specific results as well as a more general result.

1.2 Scope

To begin with, I briefly explain the role of central banks and outline the existing types of monetary policy frameworks in section 2. This should provide a sufficient foundation for understanding central bank transparency's part in policymaking. The linkage between monetary policy intentions, transparency and outcomes is then explained. I then thoroughly explain what central bank transparency refers to, its theoretical motivations from both an accountability and economic perspective as well as what the arguments against transparency are. In section 3, existing literature

on transparency's consequent effects on the economy and financial markets is briefly surveyed. Sections 4, 5, and 6 present the methodology, data and econometric method used for the analysis. Finally, section 7 summarizes and discusses the results followed by a conclusion in section 8.

1.3 Limitation of scope

This thesis will exclusively evaluate the effect of central bank transparency on the accuracy of interest rate forecasts, meaning it will not draw any conclusions related to its effectiveness for monetary policymaking. I restrict the study to a quantitative analysis and will not qualitatively study the underlying process changes that are reflected in the transparency measurements. The analysis is limited to a set of eight inflation-targeting central banks with an independent monetary policy framework during the period 1998-2006 (for an explanation, see section 4.3). Furthermore, the effect is only measured for one interest rate maturity and cannot be generalized for the entire yield curve.

2. Theory: Introducing Central Banks, Monetary Policy and the Concept of Central Bank Transparency

Before analyzing the effect of transparency, it is necessary to thoroughly explain what central bank transparency refers to and what theory says about its advantages and disadvantages. But to start with, a brief explanation of the role central banks play in the economy and the possible monetary policy frameworks it can work under will be presented.

2.1 The role of Central Banks

Although central banks may lack a universal purpose, Conroy and McGuire (2000, p.10) state that, "central banks have a number of objectives, but it is generally considered that their core objectives are monetary policy as well as prudential regulation and supervision of the banking sector". This view is consistent with most literature on the subject. Especially the central banks' objective to manage monetary policy is often taken for granted and it is the area of focus for this thesis.

Building on a similar foundation, Mishkin (2000, p.1) notes that many central banks were globally going through a successful era when they were "keeping inflation low, while their economies experience rapid economic growth". This can generally be interpreted as the end goal of monetary policy. He also summarizes theoretical monetary research and derives the role of a central bank to include price stability maintenance, the adoption of an explicit nominal anchor, and being goal dependent while being instrument independent.

The presented description of central banks should neither be accepted as static nor as the absolute truth. It fits the modern view of independent and transparent central banks, but it may not always be the case. Nevertheless, this description is sufficient for the central banks studied in this analysis.

2.2 Types of Monetary Policy Frameworks

It is important to keep in mind that there are different monetary policy frameworks. A useful way to distinguish between different policy frameworks is to use the IMF's own *de facto* classification of prevailing monetary policy frameworks. The monetary policy framework refers to the nominal anchor adopted, which according to the IMF (2006) could either be:

- (a) an *exchange rate anchor* where the monetary authority buys and sells foreign exchange to maintain the exchange rate at its preannounced level or range as an intermediate target;
- (b) a *monetary aggregate anchor* where the monetary authority uses its instruments to achieve a desired growth of a monetary aggregate (e.g. reserve money, M1 or M2) as an intermediate target;
- (c) an *inflation-targeting framework* where a medium-term numerical inflation target is set with institutional commitment from the monetary authority to achieve this target;

or the country may not have an explicitly stated nominal anchor but instead monitors some combination of these indicators. A last alternative is an IMF-supported or other similar monetary program that places restrictions on monetary and exchange rate policies as well as the reserves of the central bank.

A key determinant for the type of monetary policy regime will be the chosen exchange rate regime. With an independent monetary policy, a country must either sacrifice fixed/pegged exchange rates or free capital movements according to the *impossible trinity hypothesis* developed by the authors of the famous Mundell-Fleming model¹.

Since this thesis aims to investigate central bank transparency's effect on the predictability of interest rates, the analysis will focus on countries with an independent monetary policy where central banks use the policy rate as a main mechanism for monetary policymaking. These countries will naturally tend to have a floating exchange rate and an inflation-targeting central bank.

2.3 The link between Monetary Policy Intentions, Transparency, and Outcomes

One of the key arguments favoring central bank transparency is the consequent increased predictability and hence effectiveness of monetary policy. This section will present and clarify the

¹ For an explanation, see for example Krugman (1999)

technical connection between monetary policy intentions, central banks' policy rates, market expectations, and how transparency contributes to monetary policy effectiveness.

The overriding goal of monetary policy is price stability. Particularly for inflation-targeting central banks, the commonly used instrument to achieve this goal is through a key interest rate, often referred to as the policy rate. An adjustment of the policy rate changes the domestic interest rate level because banks and other financial institutions in the economy will have to follow suit and adjust the money market rates to it. Since the interest rate can be viewed as the cost or rent of money, an increase (decrease) in the interest rate level should reduce (increase) the demand for money in terms of loans and investments while increasing (reducing) savings in the economy, leading to a decline (increase) in economic activity and a lower (higher) rate of inflation.

Technically, the policy rate is a very short-term interest rate and for most central banks it is specifically the overnight interest rate (e.g. Carpenter, 2004; Sibert, 2006). But although this is the monetary policy instrument which is supposed to control price stability, the current interest rate level is of little importance for monetary policy in comparison to longer-term interest rates. Rudebusch, et al. (2006, p.1) eloquently explain why, in a view consistent with that of most other authors (e.g. Amato, et al., 2002; Blinder, 2006; Blinder, et al., 2001; Carpenter, 2004; Lange, et al., 2003):

The current setting of the policy interest rate, which is an overnight or very short-term rate, is on its own of little importance for private agents' decisions about consumption, investment, labor supply, and price setting. Instead, those decisions are more importantly driven by expectations of future short rates, especially as embodied in longer-term interest rates and other assets ... Accordingly, at its core, monetary policy can be considered a process of shaping the entire yield curve of interest rates in order to achieve various macroeconomic objectives.

The yield curve consists of interest rate contracts of different maturities, all quoted at the same point in time. In theory, if the policy rate is the interest rate with the shortest maturity, the longer maturities on the yield curve can be constructed through the geometric mean of expected future short-term interest rates, i.e. policy rates. This is because the expectations theory states that investments in securities of different maturities generate the same expected return (Bernhardsen and Kloster, 2002; Blinder, et al., 2008). For example, the one year interest rate today should be equal to the geometric mean of all overnight rates from today and one year onwards. When setting the one year market interest rate, the current overnight rate will be known as well as all the overnight rates up until the next policy decision. However, the overnight rates from the next policy decision until the maturity date will be unknown and depend on expectations.

This relationship implies that the longer-term interest rates—which really matter for economic activity and the monetary policy goal of price stability—depend almost entirely upon market expectations of future policy rates. As such, it is the market expectations of future policy actions and intentions by central banks that will determine the level of economic activity and inflation (Amato, et al., 2002; Blinder, et al., 2008). Here, it is up to the central banks whether they wish to influence market expectations through their communication by being transparent, or whether they prefer being opaque and have the markets infer their actions based on previous policy actions as the case generally was in the past (Rudebusch, et al., 2006).

2.4 Characteristics of Central Bank Transparency

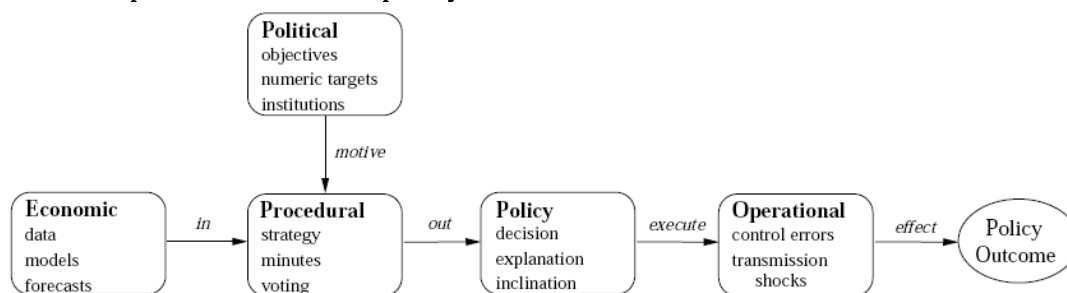
Before analyzing the effect of transparency, it is important to thoroughly explain what central bank transparency is, how and to what extent central banks can be transparent, and why central banks should be transparent.

In its broadest context, central bank transparency refers to the central bank's propensity to disclose information on its monetary policy framework with the public (Ferrero and Secchi, 2007). A leading researcher on the topic, Geraats (2002, p.2), defines transparency in an economic context as “the presence of symmetric information”, consistent with most of the literature. Opacity, on the other hand, refers to asymmetric information which generates uncertainty. That said, transparency should not be interpreted as complete elimination of uncertainty. Geraats (p.2) adds that, “in the case of monetary policy, the central bank and the private sector could both face uncertainty about the structure of the economy; but, as long as both have the same information and are aware of it, transparency prevails”.

There are many areas in which central banks can be transparent. A comprehensive classification of central bank transparency was proposed by Geraats (2001). Several later studies up until today use this classification including those by Eijffinger and Geraats (2006), Ferrero and Secchi (2007), as well as those by Dincer and Eichengreen (2006, 2009) and many other researchers. Its popularity in the literature justifies using it as a foundation for this thesis' analysis and the model is therefore presented below². According to Geraats (2001), it is possible to distinguish five aspects of transparency: political, economic, procedural, policy and operational transparency. For each aspect there are three factors a central bank can be transparent about. Figure 2 illustrates the relationship between the five aspects, followed by an explanation of each aspect cited from Eijffinger and Geraats (2006, pp.2-3):

² A more thorough justification for using Geraats' classification is presented in section 4.1

Figure 2: The five aspects of central bank transparency



Source: Geraats (2002)

Political transparency refers to openness about policy objectives. This comprises a statement of the formal objectives of monetary policy, including an explicit prioritization in case of potentially conflicting goals, and quantitative targets. Political transparency is enhanced by institutional arrangements, like central bank independence, central bank contracts and explicit override mechanisms, because they ensure that there is no undue influence or political pressure to deviate from stated objectives.

Economic transparency focuses on the economic information that is used for monetary policy. This includes the economic data the central bank uses, the policy models it employs to construct economic forecasts or evaluate the impact of its decisions, and the internal forecasts the central bank relies on. The latter are particularly important since monetary policy actions are known to take effect only after substantial lags. So, the central bank's actions are likely to reflect anticipated developments.

Procedural transparency is about the way monetary policy decisions are taken. It involves an explicit monetary policy rule or strategy that describes the monetary policy framework, and an account of the actual policy deliberations and how the policy decision was reached, which is achieved by the release of minutes and voting records.

Policy transparency means a prompt announcement of policy decisions. In addition, it includes an explanation of the decision and a policy inclination or indication of likely future policy actions. The latter is relevant because monetary policy actions are typically made in discrete steps; a central bank may be inclined to change the policy instrument, but decide to wait until further evidence warrants moving a full step.

Operational transparency concerns the implementation of the central bank's policy actions. It involves a discussion of control errors in achieving the operating targets of monetary policy and (unanticipated) macroeconomic disturbances that affect the transmission of monetary policy.

One of the benefits of acknowledging this classification is that Geraats, together with Eijffinger, has constructed an index for central bank transparency that incorporates all the identified elements of central bank transparency above, making it possible to quantify to what extent central banks are

transparent and in what areas. Without an index, Eijffinger and Geraats (2006) claim that transparency would remain a qualitative concept which complicates the debate on transparency. This index has also been updated by Dincer and Eichengreen (2006) at later stages, making it possible to study central banks' recent transparency evolution.

Several other researchers have also attempted to define central bank transparency for the purpose of quantifying it including Fry, Julius, Mahadeva, Roger and Sterne in 2000, Bini-Smaghi and Gros in 2001, Siklos in 2002, and Amtembrink and Waller in 2004 (Dincer and Eichengreen, 2006). Bernanke, Laubach, Mishkin and Posen in 1999 and Blinder, Goodhart, Hildebrand, Lipton and Wyplosz in 2001 also provide insight into the characteristics central bank transparency can take (Eijffinger and Geraats, 2006). Their classifications will not be reviewed here, but they are taken into consideration for the methodology discussed in section 4.1.

2.5 Theory Behind Central Bank Transparency

What motivates central banks to be transparent? The new paradigm with transparent central banks rests of course on some theoretical foundations. The main reasons favoring central bank transparency according to the literature are twofold: Firstly, transparency provides democratic accountability. Secondly, it should make monetary policy more effective by aligning central bank actions and market expectations (e.g. Blinder, 2006; Ferrero and Secchi, 2007). Surveys of central banks confirm these theories as important reasons for transparency. In 1998, Fry, et al. found that 70 out of 94 central banks considered transparency *vital* or *very important* for their monetary policy framework. In 2000, Blinder found that central banks consider transparency important for establishing or maintaining credibility (Geraats, 2009). It is worth noting that the views presented below are mainly based on discussions prior to the financial crisis in 2008—a crisis that had central banks commit to *unconventional* policies³.

Accountability Reasons

Prior to the debate on transparency, one popular central-banking debate focused on the need for central banks to be independent—a debate that Blinder (2006) considers to be *all but over* and one can assume modern central banks to be independent. In a nutshell, a framework with independent central banks was suggested for dealing with the *time inconsistency problem*. The problem refers to a situation when the general public cannot be convinced that the policymaker will commit to its inflation target at all times due to the policymaker's preference for (inflationary) expansive policies in some periods. For example, prior to general elections, the policymaker might want to boost the economy to gain popularity. An *independent* central bank with the objective to maintain price

³ See for example Carvalho, et al. (2011)

stability would, however, not have the incentives to deviate from its target (Apel and Viotti, 1998). A similar situation could arise with non-floating exchange rates, where the policy maker could face political pressure to devalue the currency to boost economic activity (Dincer and Eichengreen, 2006).

One way to control that the central bank does in fact commit to its objective is to hold it accountable for its actions towards its ultimate stakeholders—the general public—as with any other public institution. Naturally, this requires the central bank to be transparent. Simply put, “in exchange for its broad grant of authority, the central bank owes the public transparency and accountability” (Blinder, et al. 2001, p.2). The former chairman of the Federal Reserve, Alan Greenspan (2002, p.6), has also pointed out that, “Openness is an obligation of a central bank in a free and democratic society”.

Dincer and Eichengreen (2009) add that transparency is particularly important in monetary policy regimes that have moved away from fixed and pegged exchange rates—mechanisms that earlier provided some form of accountability. For example, there can be a long lag between inflation-targeting central banks’ policy and its effect on inflation. Hence, publication of two year inflation forecasts provide current information to the public on whether the central bank is taking appropriate steps to control inflation (Mishkin, 2004). Applying Geraats’ classifications of transparency, it can be seen how political transparency is essential for establishing who is responsible for monetary policy decisions. Economic, procedural, and policy transparency provide ex-ante accountability of the motives for policy decisions while operational transparency allows for ex-post accountability of achieving the target based on policy decisions (Geraats, 2002).

It should be noted that transparency does not actually make a central bank accountable, but that it is rather *a means* for evaluating the central bank’s work and holding it accountable. Although the accountability reason for transparency is intuitive and easy to accept, it is not the only reason for transparency. This point is consistently made throughout the literature by for example Geraats (2006). The other reason is its economic effects and this requires more attention.

Economic Reasons

The second reason favoring transparency claims that transparency can improve the effectiveness of monetary policy, which would be beneficial from an economic perspective. This view stretches beyond the idea of a transparent structural framework to also emphasize the value of releasing the central banks’ economic data to the public. In essence, more transparent central banks have the ability to influence the expectations on the market mechanisms that transmit monetary policy, allowing the economy to better and faster reflect the central bank’s desired state. This happens through adjustments of the term structure of interest rates, reactions of stock markets and exchange rates as well as through wage and price settings (Blinder, et al., 2006).

There are both direct and indirect economic effects of transparency. These are sometimes referred to as *ex-post information effects* and *ex-ante incentive effects* respectively, and have been comprehensively studied by Geraats throughout her research.

Information effects particularly refer to the consequent effects of a central bank's information disclosure with the private sector. In this situation, the central bank gives up any information advantage it has over private sector agents, giving them new information to work with and affecting their expectations. A simple example would be a central bank's release of inflation expectations (Geraats, 2006). If it discloses its view to the private sector that inflation is likely to rise to a level above the inflation target over the next twelve months, the information effect is likely to be an adjustment of the private sector's inflation expectations and perhaps even a rise in market interest rates in anticipation of rising policy rates.

The extent to which a central bank's economic forecasts impact private sector forecasts may be disputed. Nevertheless, it is a common argument that central banks devote more resources than any other private sector agent into collecting, processing, analyzing and forecasting economic data. Central banks may therefore have (or at least be believed to have) superior information over the private sector (e.g. Blinder, et al., 2008; Geraats, 2001; Svensson 2006, 2009). Evidence for this has been provided on several occasions. Geraats (2001) points to a study by Romer and Romer in 2006, which shows that the Federal Reserve's inflation forecast has been more accurate than those by commercial forecasters, even at horizons as short as a quarter ahead.

Incentive effects are the indirect structural changes in economic behavior that arise as a consequence of new information structures, as opposed to information effects that arise as a direct result at every instance of information disclosure by central banks. For example, with a new information structure where a central bank becomes more transparent by releasing its inflation forecast, the central bank may be systematically less inclined to pursue an inflationary monetary policy (Geraats, 2006). It would risk losing its credibility otherwise. Meanwhile, private sector inflation expectations could be self-fulfilling and fuel further inflationary pressure. Hence, the central bank has a greater incentive to achieve its target and keep inflation under control. As Geraats together with Faust and Svensson and many other authors argue, "transparency induces the central bank to build and maintain a reputation for low inflation" (Geraats 2006, p.114). Similarly, to withstand private sector scrutiny, the central bank may find greater incentives to generally improve its economic information releases and engage in more fruitful policy meetings with the release of minutes. Although incentive effects may appear similar to the effects of accountability, they remain different because they only operate through effects on private sector expectations (Geraats, 2002).

Altogether, these arguments generate three key economic results according to Geraats (2006, pp.114-115). Firstly, “transparency improves the predictability of monetary policy actions and outcomes”, which includes the setting of the policy instrument and the effects on inflation. Secondly, “transparency tends to induce reputation building as it increases the sensitivity of private sector expectations to unanticipated policy actions and outcomes ... [making] central banks more inclined to pursue low inflation”. Thirdly, “transparency has the potential to enhance credibility and make long-run private sector inflation expectations more stable”.

Arguments for Opacity

Arguments pro transparency do not come without limitations. Perhaps the most infamous dispute was presented by Morris and Shin (2002) in *the American Economic Review* where they warn of *too effective* public signals. They demonstrate how *noise*⁴ in public signals (such as in information disclosures by central banks) may be detrimental to welfare. This applies to cases when individual receiving agents’ private information is precise, yet the agents coordinate their actions in response to a public signal (as with herd behavior of financial markets)⁵, giving the public signal disproportional weight although it may contain a great degree noise. This would magnify any damage caused by the noise making the economy worse off than if the agents had relied on their private information or put less weight on the public signal.

The debate was rebutted by Lars Svensson after more economists started questioning central bank transparency including Jeffrey Amato of the Bank of International Settlements and Tommaso Padoa-Schioppa of the European Central Bank’s executive board through an article in *The Economist* (2004). Based on Morris and Shin’s model, the article titled “It’s not always good to talk” warns of the economic damage central bank transparency can cause, while it encourages the accountability aspects of transparency. Svensson (2006) shows that these warnings in Morris and Shin’s model only apply under very special circumstances and for any *reasonable parameters*⁶, central bank transparency is welfare increasing.

There are also theories dismissing central bank transparency completely, but most of them build on the idea that only surprise market interventions can affect the economy (Carpenter, 2004). Additionally, these theories belong to an older generation of theories. For example, Cukierman and Meltzer (1986) find that there is an optimal level of ambiguity for the policymaker’s preference

⁴ *Noise* can simply be defined as inaccurate information. For more information, see Black (1986).

⁵ The actual model is largely based on Keynes’s beauty contest analogy (Morris and Shin, 2006)

⁶ *Reasonable parameters* is a somewhat mathematically abstract concept, but implies that the model only works if agents either care less about their own fundamental analysis than the extent to which they coordinate themselves with other agents, or that the information provided by the central bank is only 12.5 per cent as accurate as the agent’s (Svensson, 2006).

towards stimulating output or stabilizing inflation. They argue that ambiguity's contribution to asymmetric information is desirable because it enables policymakers to create monetary surprises and surprises are advantageous on average when the objective is to stimulate the economy.

Although this theory seems to contradict theories favoring transparency, they are not mutually exclusive. A transparent central bank that makes forward-looking statements about its actions could still create surprises by taking actions deviating from its prior statements. For example, it could publish inflation expectations and an interest rate path that is higher than what it actually expects as a signal to prompt hikes in market rates without having to actually raise the policy rate. However, this behavior could potentially reduce a transparent central bank's credibility and contradicts the incentive effects presented above.

Furthermore, for a reason similar to the time inconsistency problem and the reasons behind Cukierman and Meltzer's theory, central banks that are committed to both inflation and output gap targeting may find it undesirable to disclose the output gap target. This is because inflation expectations may increase if it is believed the central bank will attempt to stimulate the economy to achieve its output gap target. Consequently, market interest rates may rise, which could reduce economic activity and in turn reduce the output gap further. It would therefore be harder for the central bank to actually reach the output gap target (Geraats, 2009). A central bank that this perhaps applies to, which monitors not only inflation but also the employment level (an element in the output gap), is the Fed for example.

Geraats (2001, p.24) has also provided practical arguments for obfuscation. Firstly, "if a central bank lacks political independence, transparency could make it more prone to political pressures". To prevent uninformed politicians from influencing monetary policy, these central banks may find it more desirable to remain opaque than being transparent. Secondly, "like any bureaucracy, central banks may have an incentive to hide mistakes or embarrassing forecasts".

Is there an Optimal Level of Transparency?

Some concerns have been raised about too much transparency even if the essence of transparency is favorable. For example, beyond a certain level of transparency, more openness could confuse the market especially if members of a monetary policy committee give disperse messages. Some also suggest that both the current economic and institutional environment as well as the past economic track record may be determinants for the optimal level of transparency, making it difficult to say what constitutes a universal optimal communication strategy (Blinder, et al., 2008).

Along the later argument, Posen (2002, p.12) explains the so called *contingent view*, which has its foundations in research by Faust and Svensson as well as Cukierman, that "there is an inverted U-

shaped curve for the amount of desirable transparency with most and least credible central banks disclosing less than central banks of intermediate credibility". The simplest explanation is that central banks will move towards disclosing more information to gain credibility as long as they are not already considered more credible than other central banks of higher degrees of transparency. However, Posen warns against making policy decision based on this view because it lacks empirical evidence and claims there to be stronger evidence favoring more transparency.

Another inverted U-shape theory can be deduced from Mishkin's (2004) paper titled *Can Central Bank Transparency Go Too Far? Too far* refers to an extent of transparency where it no longer serves as a mean to an end. Specifically, transparency should simplify communication with the public and generate support for how central banks conduct monetary policy. At some point, more transparency could complicate the central bank's work and have detrimental effects. For example, Mishkin points out that revealing a conditional future policy rate path could divert attention from current policymaking.

During the debate that arose after the publication of Mishkin's paper, McKibbin (2004) argues that *too far* may still be welfare-enhancing because many central banks have a long way to go before reaching the optimal level of transparency. Even if they increase their transparency beyond the optimal level, the resulting welfare losses will be too small to offset the welfare gains up until the optimal level.

From the information-receiving agents' perspective, transparency could also go too far. van der Cruysen, et al. (2010) show that too much transparency can result in confusion through an information overload, although some intermediate level of transparency is desirable. Using the Eijffinger-Geraats transparency index, they find empirical support for an optimal level of transparency of 7.5 out of 15 for OECD countries in achieving inflation persistence.

In a paper by Cukierman (2009) the limits of transparency are probed in terms of feasibility constraints as well as desirability constraints. Cukierman comes to the balanced conclusion that in some areas of monetary policymaking processes, full transparency is desirable while in other areas, intermediate or minimal transparency is better. Along this nuanced view, perhaps the point made by Carpenter (2004) that, "the degree to which a central bank *is able* to reveal information seems as important as the degree to which *it chooses* to reveal information", is useful to keep in mind before jumping to conclusions.

All in all, Blinder, et al. (2001) claim that the norm favors central bank transparency, which is consistent with most academic literature on the topic. They even write in the *Geneva Report on the*

World Economy (p.2) that, “we believe the arguments for transparency are so strong that the burden of proof should be on those who would withhold information”.

2.6 Summary

In this section it has been established that the main objective of central banks is to achieve low and stable inflation through monetary policymaking. Past theory favored opaque central banks because it was believed that surprise market intervention was most effective for monetary policymaking. When granting central banks with independence, arguments for greater central bank transparency were raised in order to make central banks accountable.

Recent theory also argues that monetary policy can become more effective through increased transparency. This is because the policy instrument—a short term interest rate—is of relatively little importance in comparison to longer-term rates for private agents’ forward-looking economic decisions that ultimately determine the inflation level. Central bank transparency can influence market expectations directly by disclosing valuable economic information and indirectly by giving the central bank an incentive to build reputation as being credible in achieving its policy objective. Eventually, a central bank may be able to align market expectations with its desired policy outcome.

Despite strong theoretical arguments favoring transparency, some concerns have been raised. Some argue that increased transparency can be harmful because too much or too noisy information can confuse the market leading to greater economic volatility. Other theories suggest that transparency could make it more difficult for central banks to achieve their objective if they have both a price stability and output gap objective. Hence, it is not certain whether more central bank transparency is always better than less. Therefore, more empirical research on the effects of transparency is necessary.

3. Survey of Transparency Evolution and Consequent Effects

So far, mainly theories based on stylized models from the past fifteen years have been presented, out of which only some are supported with empirical evidence. A key reason for this absence of evidence is the lack of data or perhaps the challenge of quantifying transparency as suggested by Geraats (2009). In fact, only a handful of research papers have documented the recent evolution of transparency. Yet, to inform of the significant transparency changes that have taken place among central banks and what the observable consequences have been, this section will briefly survey findings from recent research papers.

3.1 Evidence of Transparency Change

In a comprehensive analysis using the Eijffinger-Geraats Index with data collected for the period 1998-2006 by Dincer and Eichengreen, Geraats (2009) finds that there has been a wide increase in central banks' openness in many respects and most notably in the communication of policy decisions (policy transparency) and the macroeconomic analysis (economic transparency) on which those decisions are based.

However, Geraats also finds that there are significant differences across policy frameworks, but that these differences reflect the characteristics of the policy framework. Inflation-targeting central banks have on average exhibited the greatest increase in transparency and particularly in areas of forward-looking nature such as the disclosure of anticipated macroeconomic disturbances. On the other hand, central banks in monetary and exchange rate targeting frameworks have exhibited the lowest level of transparency increase. In support of this discrepancy, Geraats argues that the lack of discretion, particularly for exchange rate targeting regimes, limits the incentive effects of transparency. Central banks without an explicit framework have on average exhibited an intermediate increase in transparency.

A third important conclusion Geraats draws is that there is a significant positive correlation between central bank transparency and GDP per capita, suggesting that central banks in more developed economies have adopted transparency.

Lastly, Geraats finds that there is a significant positive correlation between initial level of inflation and central bank transparency as well as a significant negative correlation between transparency and subsequent inflation levels. This suggests that central banks in economies with high inflation have adopted more transparency to gain credibility and reduce inflation—in line with the theoretical arguments presented in section 2.5.

3.2 Effects of Transparency

There is no doubt that central banks have become more transparent during the last 10-15 years. Theory predominantly predicates the economic benefits of transparency, but what effects of transparency have empirical studies found so far? The ultimate question should be if transparency helps central banks achieve the overriding goal of low and stable inflation. A secondary question is if transparency makes monetary policy more predictable, which is what this thesis will investigate further.

As suggested by Geraats earlier, studies are often complicated by the lack of data on transparency, partly because it is difficult to quantify. According to Dincer and Eichengreen (2006), most studies conducted have been for individual banks, which make the findings difficult to compare between

different central banks making it difficult to generalize the findings. Even in cases where comparative studies have been made, the sample of banks is usually very small or only for a specific point in time. As a result, the findings are not always consistent.

The perhaps most recurring finding with regards to transparency's effect on inflation is that it lowers inflation variability. Some evidence of this was found both by Cecchetti and Krause (2002) using the transparency index by Fry et al. as well as by Demertzis and Hughes Hallett (2007) using the Eijffinger-Geraats Index. In a more recent study, Dincer and Eichengreen (2006, 2009) draw the same conclusion using the Eijffinger-Geraats Index over a longer time period and suggest the reason to be that the public can respond more quickly to policy actions with more transparency, discouraging inflationary policies. They also find that transparency reduces inflation persistency, indicating that transparency does in fact contribute to credibility (albeit this result is statistically less robust).

Regarding the effect of transparency on the inflation level, the results are more mixed. Chortares, et al. (2002) find that an increase in the detail that central banks include in their published forecasts is associated with lower average inflation for a set of 87 countries. However, using the Eijffinger-Geraats Index, Demertzis and Hughes Hallett (2007) find that the average inflation level is not affected by transparency for a sample of nine OECD countries. This somewhat contradicts Geraats' (2009) findings that there is a significant negative correlation between increased transparency and subsequent inflation levels.

If a central bank gains credibility and reputation from being more transparent, its flexibility should also increase according to van der Cruysen, et al. (2006). This in turn reduces the interest rate levels. In their study of eight central banks they find evidence for their hypothesis. The logic behind this relationship is that increased reputation should decrease inflation expectations and thereby long-term interest rates, while increased flexibility should decrease short-term interest rates without increasing longer-term interest rates.

Does monetary policy become more predictable with increased transparency as both theory and intuition would suggest? According to Blinder, et al. (2008) who survey existing literature on the topic, there is evidence that central bank communication has the ability to move financial markets—often even with the effect of aligning expectations with the desired outcome. However, limited research has been conducted about the accuracy of market predictions.

Guthrie and Wright (2000) argue that if market interest rates divert from a central bank's desired levels, a statement by the central bank should be sufficient to restore them. They find empirical evidence for this where tightening announcements by the Reserve Bank of New Zealand leads to

increases in interest rates of all maturities. Similarly, Kohn and Sack (2003) find that statements and policy actions can serve as effective substitutes for one another for the Fed and that they steer market interest rates across the yield curve. They also stress the importance of publishing detailed views on the economic outlook to allow private agents to better anticipate the course of policy. In a study of the ECB, Musard-Gies (2005) also finds that a more hawkish (dovish) statement than the previous is followed by a rise (decline) in both short and long term market interest rates, where the short term rates move more sharply and that the effect peaks at interest rates between 6 or 12 month maturities. This is somewhat different from the conclusion Andersson, et al. (2006) draw in their study of SRB. They find that unexpected speeches particularly affect long term interest rates of 5-year maturities and that the results mainly apply to contractionary speeches.

The ability of central banks to move market interest rates in a desired direction through communication, as shown in the cases above, provides evidence that transparency can align market expectations with desired monetary policy. However, it does not indicate whether policy is predictable, but rather suggests transparency to be an additional instrument for policymaking.

A few studies do find indications of predictability effects. Lange, et al. (2003) finds that the Fed's policy has become increasingly predictable. This is partly due to autoregressive properties, but the authors also conclude that other properties such as transparency could have contributed to the market's ability to predict future federal fund rate movements earlier and more accurately.

By comparing communication strategies instead of transparency, Ehrmann and Fratzscher (2007) find that the ECB and the Fed are equally predictable in their policy decisions where the former uses an individualistic communication strategy and a collegial decision making process while the latter uses collegial communication and decision making. The BoE is less predictable and uses a collegial communication strategy but individualistic decision making process. Rozkrut, et al. (2007) confirms the importance of the communication strategy and committee structure in a study of the Czech Republic, Hungary, and Poland.

In the last three cases, variations of measuring the *surprise component* in short term interest rate movements on the day of policy decision announcements have been used as methods to measure predictability. While this method should give fair indications whether policy decisions are predictable, it does not answer to what extent predictions are accurate, particularly for periods longer than just a few days.

4. Methodology

The remainder of this thesis will analyze whether increased central bank transparency has led to enhanced predictability of interest rates. This section describes the method chosen to test the hypothesis and defines the necessary variables for the analysis.

4.1 Choice of Method and Main Variables

Transparency

Transparency is defined in accordance with Geraats' classification of central bank transparency outlined in section 2.4. Its popularity in recent research makes it a well established definition of transparency and its breadth with five aspects of transparency limits the risk of excluding important transparency factors that may influence forecasts. The construction method used by Eijffinger and Geraats to construct a numerical index also promotes an objective evaluation of transparency as well as comparability between central banks and over time. Recent collection of data by Dincer and Eichengreen for the index enables quantitative studies over a nine year period to be made. The *Eijffinger-Geraats Transparency Index*, *tridx*, will hence be used as the independent variable in this study.

There are alternative measurements of transparency available (see section 2.4), but none of them can be considered as complete as the Eijffinger-Geraats Index. As Eijffinger and Geraats (2004) point out when motivating the index construction, some of the earlier indices lack objectivity in their evaluation method while others may have been detailed accounts of central banks in form of case studies, but not based on a theoretical framework. A further issue is that other measurements lack the time dimension and cannot be used for more comprehensive quantitative studies than pure cross-sectional studies. Perhaps Carpenter's (2004) criticism, that Geraats' classification may be too excessive and that there is substitutability across types of transparency, is valid. On the other hand, it allows us to comprehensively investigate in what respects transparency has changed over time.

In the panel data analysis where there is more data variation to study, I have the ability to break down the overall transparency level and analyze the effects of its five aspects. This makes it possible to analyze whether any particular aspect of transparency affects forecast errors more than others. A quadratic term, $tridx^2$, is also added to analyze whether there are marginal returns to transparency as some theories suggest.

Interest Rate Predictability

The dependent variable in this study measures the predictability of interest rates. Specifically, it will be the *absolute forecast error of interest rates*, $AFE(i3m)$. There is no readily available measurement for $AFE(i3m)$ and it will therefore be constructed from forecasts and actual market interest rates. In

this study, forecasts are defined as analysts' survey responses. Market interest rates will be the matching interest rates to the forecasts. Subtracting the actual market interest rate from the forecasted rate creates a measurement of forecast error. Because focus lies on the size of the forecast error and not the direction, the absolute value of the forecast error will be used.

This analysis focuses on the predictability of market interest rates rather than the actual policy rate because ultimately, it is the market interest rates that matter to economic agents, which in turn affect the price level in the economy. Since the market rates and particularly short-term rates depend on the policy rate as explained in section 2.3, central bank transparency will play an important role for market interest rate forecasts. As shown in Table 5 of the appendix, the short-term market rates correlate almost perfectly with the policy rate.

In particular, the interest rate used in the analysis is the 3-month interest rate—a commonly available interest rate in most countries. It also turns out that the data source used for the forecasts (described later in section 5.2) provides forecasts for 3-month interest rates forecasted three months in advance. Essentially, this implies that analysts have to forecast the interest-rate path over a six-month period. Three months maturity is arguably long enough to have some economic significance⁷, while not being too long of a maturity to be significantly influenced by distant economic events or too many policy-rate changes. Predictability at long horizons would primarily test the incentive effects of transparency—whether the central bank is credible enough to be believed that its short-term policy will not increase inflation and interest rates in the distant future, making the long-term interest rates more predictable. At shorter horizons, both incentive and information effects of transparency can be tested.

An absolute measure of the forecast error, rather than a relative (percentage) error is chosen, because it facilitates the interpretation of the regression results. It works well because the interest rate levels have on average been similar in all countries with the exception of Japan (which has had a zero interest rate policy) and Switzerland where it is somewhat lower (see Table 5 in the appendix). Additionally, during the studied period the central banks have tended to change the interest rate by the same number of percentage points, irrespective of the prevailing interest rate level.

Previous studies have presented other methods to measure interest-rate predictability. While I classify the chosen method as an error-measurement method, a more widely used method could be classified as a surprise-measurement method. Some studies use more complex methods that often rest on stronger assumptions.

⁷ Unfortunately, I have not found any study that investigates what maturity interest rates have the greatest economic impact, including the impact on inflation.

Alternative error-measurement methods would be to use market data instead of survey responses. Forward contracts or calculated implied forward rates for specific future periods can be compared to the period's actual spot rate. For each country, however, both these methods require highly developed financial markets with liquid contracts. In the case of implied forward rates, they also have to be of different maturities. Secondly, calculating the implied forward rate is perhaps best done using the Svensson model (Svensson, 1994), but it requires very complex calculations for each data point. Although market rates should theoretically explain what the future expectations are, there is no guarantee that markets are sufficiently efficient in this aspect. Analysts, however, should be able to provide their best forecast which could even incorporate market-behavioral factors that make rates deviate from their theoretical values.

A surprise-measurement method has commonly been used in varying but similar forms to measure predictability. Bernhardsen and Kloster (2002), Lange, et al. (2003) as well as Ferrero and Secchi (2007) measure the absolute change in market rates between the day of a policy rate announcement and the rate on the day prior to the announcement. The greater the change, the more surprised the market was by the announcement and the less predictable the policy decision was. The limitation of this method is that it only looks at predictability from a very short-term perspective—specifically, if on the day prior to a policy-rate announcement the market trades at the rates it expects after the announcement. Neither does the method actually measure the size of the forecast error.

Another method to measure predictability is also used by Lange, et al. (2003). They measure how early market rates move in the direction of the policy rate change and if these movements are made relatively earlier now than before. Its increased complexity and less intuitive measurement in combination with more extensive calculations and increased need for market data makes it unsuitable for this thesis.

4.2 Control Variables

Many factors will influence analysts' forecasts, the eventual interest rates, and hence the resulting forecast errors. For this study, it would be impossible to control for micro-level factors, but some macro-level controls are available.

Economic Forecast Errors

Central banks have an explicit objective, which according to earlier argumentation is mainly to manage the inflation rate. The complete objective function of central banks is often not known, but it is reasonable to assume that they monitor other macroeconomic factors as well to forecast inflation. If these factors are particularly difficult to forecast for a period, the interest rate is likely to be more difficult to forecast as well. For this reason, the *inflation rate forecast error*, $AFE(CPI)$, will be used as a control variable. The famous Taylor rule can be used as aid in determining other important economic

factors. In addition to deviations in the inflation rate from its target rate, the interest rate should be set according to the size of the output gap which is measured as the difference between actual and potential GDP. There is no official statistic for the output gap, but it can be proxied using the employment level. The Phillips curve illustrates that if an economy reaches full employment, then there will be inflationary pressure. Hence, by controlling for *GDP forecast errors*, $AFE(GDP)$ and *unemployment forecast errors*, $AFE(UE)$, it is possible to use widely available data that influence the inflation rate and is likely to be data considered in monetary policymaking.

Time Trend

Other unobserved factors may gradually affect the predictability of interest rates over time, establishing a trend in the size of the interest rate forecast errors. One can only speculate in all possible explanations for a trend to establish, but the issue of these unobservable factors can be dealt with by controlling for a *time trend*, t , in the regression. The time trend could for example control for the market's potentially increased ability to forecast interest rates because of better analytical skills, or because analysts learn the behavior of central banks as time passes, or that the development and use of IT may gradually have facilitated forecasting. It could also control for the *great moderation*⁸ where a decline in macroeconomic volatility may have increased the predictability of interest rates. Alternatively, the time trend variable might actually control for transparency-related factors that do not show in the transparency index, such as changes in the information quality. The latter would complicate the interpretation of the results, but excluding it increases the risk for biased results.

Economic Shocks

Many unforeseeable events can happen during the three months leading up to the date of the interest rate quote which would be impossible for an analyst to account for in a forecast. These events can severely impact the economy and are referred to as economic shocks. An example would be the 9/11 terrorist attacks on World Trade Center in New York. In response to the attacks, the Fed and other central banks committed to extraordinary measures to avoid a severe drop in aggregate demand which could otherwise trigger a recession. Interest rates forecasted before a shock and then quoted after the shock are likely to be more inaccurate than they would be in absence of the shock. This could lead to biased results and therefore *economic shocks*, *shocks*, will be controlled for in the analysis.

It is specifically the shocks that have caused changes in the policy rate that need to be controlled for. Ideally, these shocks could be controlled for if it was possible to scan through all the minutes from policy meetings. This is far too time consuming nor are the minutes always available for the earlier

⁸ See Bernanke (2004) for a thorough explanation of the *great moderation*.

dates and this is therefore beyond the scope of this paper. Instead, I define shocks as periods when the central bank is *likely* to have reacted to an economic shock based on movements in the policy rate (see section 5.4 for a technical definition). It can either be a positive or negative shock where the policy rate is increased or lowered respectively by more than what can be considered as normal. Looking at the graphs in the appendix (section 10.2), the method chosen seems appropriate as it picks up periods with relatively extreme interest rate movements and with distinctly larger than normal absolute forecast errors.

4.3 Sample Selection

This study will focus on analyzing the effect of central bank transparency on interest rate predictability amongst central banks with an independent monetary policy framework. As explained in section 2.2, the central banks of interest are the ones that use the policy rate as a main instrument for monetary policymaking, which tends to be the inflation-targeting central banks. According to the IMF (2006):

Key features [of an inflation-targeting framework] include increased communication with the public and the markets about the plans and objectives of monetary policymakers and increased accountability of the central bank for attaining its inflation objectives. Monetary policy decisions are guided by the deviation of forecasts of future inflation from the announced target, with the inflation forecast acting (implicitly or explicitly) as the intermediate target of monetary policy.

In other words, transparency is a key feature in inflation-targeting central banks' policymaking, making them particularly interesting to study. Countries with central banks that satisfy the conditions for an independent monetary policy and are inflation-targeting include, according to the IMF: Australia, Brazil, Canada, Chile, Iceland, Israel, Korea, Mexico, New Zealand, Norway, Philippines, Poland, South Africa, Sweden, Turkey, and United Kingdom. By relaxing the condition of inflation as an explicit nominal anchor to allow for monitoring of additional nominal anchors, then Japan, Switzerland, and the United States can be added to the list. Lastly, the countries affiliated with the European Central Bank making up the Euro zone can be considered to belong to this classification as well (ECB, 2000). Of this set of countries, the ones with available data will be used in the analysis.

For the analysis, Consensus Economics' survey set covering the G-7 countries and Western Europe will be used as the source for forecasts. This includes a majority of the inflation-targeting central banks with an independent monetary policy framework and is a mix of the world's perhaps most influential central banks combined with central banks in some smaller economies. The sample studied therefore narrows down to the central banks of: Canada, the Euro zone, Japan, Norway, Sweden, Switzerland, the United Kingdom, and the United States.

The case with the Euro zone requires some adjustments to be made. Since I will be controlling for macroeconomic forecast errors and these are country-specific, one out of three possible economies has to be chosen. I choose to focus on one country to proxy the Euro zone economy, Germany, which is the largest economy in the Euro zone. The other two options would either be to construct a weighted average of the Euro zone countries' macroeconomic forecast errors, or each country of the Euro zone could be used to study the European Central Bank. I rule out these two options because inaccurately chosen weights in the first one would be a source of bias in the analysis. The second option is ruled out because it does not make sense to study the same central bank five times with only the macroeconomic control variables changing. In the panel data analysis, this would also be a source of bias by giving the European Central Bank too much weight. Nevertheless, the interest rate forecast error and central bank transparency remains the same irrespective of what country is chosen and only the macroeconomic control variables vary to some extent between the methods.

In the analysis, I will start by estimating the effect of increased transparency on the predictability of interest rates for each country separately to obtain country-specific results. I will then pool the data for all of the countries in the sample and perform a panel analysis to obtain more general results.

4.4 Contribution

There is a large amount of theoretical literature on the topic of central bank transparency available, but only some have been supported with empirical evidence. One problem is that transparency is a qualitative concept which needs to be quantified for empirical studies. Existing studies are often focused on a limited number of central banks (sometimes only one), or just for a specific point in time. Measurements of transparency may also be subjective and differs between research papers making them difficult to compare and draw general conclusions from.

This thesis contributes to the empirical research by evaluating whether central bank transparency enhances the predictability of interest rates—a specific area of transparency effects where little research has been done so far. The thesis adopts Eijffinger and Geraats' transparency index with Dincer and Eichengreen's data over a longer time period for a number of central banks to obtain comparable results and enable more general conclusions to be drawn.

5. Data

Besides the transparency index, the data used for the analysis can be divided into forecast data and market data. Since the analysis requires some modeling of the raw data, this section will describe each variable's construction in depth.

5.1 Transparency Index

The data used for the Eijffinger-Geraats Index is directly provided by Dincer and Eichengreen⁹ who have occasionally updated the index to account for more years. This dataset from 2009 covers 100 central banks from 1998-2006 on an annual basis, including all of the inflation-targeting ones with and an independent monetary policy framework discussed in section 4.3. For this study, I will use the annual transparency figure for each month during that year—generating 108 observations for each central bank (100 for NB). The index is the sum of its five aspects where each aspect is evaluated based on three criteria (see Figure 2 on page 7), giving it a range from 0-15. In practice, the index actually has a range of 31 values because each of the 15 criteria can take values of 0, 1 or 0.5. No general explanation is given for the difference between a full score of 1 and a partial score of 0.5.

5.2 Interest Rate Forecast Errors

Market Interest Rates

The first component of the forecast error, the market interest rate, is obtained directly from Jonathan H. Wright of Johns Hopkins University. For a study from 2009, Wright collected market rates—dating back long before the transparency index starts—to construct monthly yield curves of zero-coupon nominal government bonds starting at 3-month maturities (see Table 3 in the appendix for original sources). Using this data is convenient because it ensures consistency in the market data over the years and across countries, which is somewhat difficult to obtain for some of the countries. Availability of some financial instruments change over the years and some sources do not report data for the entire time period for example. The market interest rates correlate almost perfectly with the policy rate in each country, implying that market rates move with the policy rate set by the central bank. This can be seen in Table 5 of the appendix.

The interest rates are end-of-month quotes. Since the interest rate on this date might not be fully representative for the interest rate level that month, I will use the average of the interest rate quote both on the last day before the forecasted month and on the last day of the forecasted month.

Interest Rate Forecasts

Interest rate forecast errors are calculated as the absolute difference between the actual market rate and the forecasted value as mentioned in section 4.1.

The second component, the forecast, is collected from analysts and published in Consensus Forecasts on a monthly basis by Consensus Economics. Based on the information provided by Consensus Economics (2011), their surveys stretch back to 1989 in which leading forecasters are asked for

⁹ A detailed overview of the index is provided in Dincer and Eichengreen (2009).

their predictions for over 85 countries. Academic researchers have found that Consensus Forecasts has a better track record than individual forecasters who make up the consensus. Subscribers of the data include investment managers, treasury executives, corporate planners, central bankers and government departments around the world. Using this single source of forecasts ensures consistency in the data collection method. Its wide usage also suggests that it is a generally trusted source for forecast data. For the sample analyzed, there have on average been 19 forecasters for each data point (see Table 4 of the appendix).

Interest rate forecasts used from the surveys are the forecasted 3-month interest rate and the forecasts are made three months in advance. Each forecast error data point therefore matches the transparency index that prevailed at the time when the forecast was made. Table 3 in the appendix lists the specific interest rate forecast surveyed. For all countries, with the exception of Norway, this data is available from many years before and a few years after the availability of the transparency index. In the case of Norway, the forecasts start in June 1998, but the first three are also excluded for measurement-error reasons, generating eight observations fewer than for the rest of the countries.

5.3 Macroeconomic Forecast Errors

Macroeconomic forecast errors are calculated in the same way as the interest rate forecast errors and thus also consist of two components: forecasts and actual economic outcome.

Macroeconomic Data

The data for the actual economic outcome is taken from IMF's World Economic Outlook Database. For each country, it provides annual figures of GDP growth, inflation rate in terms of consumer prices and the unemployment rate. Again, using this single source of data for all countries ensures consistency in calculations over time and across countries.

Macroeconomic Forecasts

The forecasts are taken from Consensus Forecast surveys and are provided by the same forecasters as the ones who provide the interest rate forecasts. A key adjustment that has to be made is modeling the monthly forecasts for the same annual economic figure, so that forecasts closer to the date of the economic figure will not automatically be more accurate than forecasts made earlier. For example, forecasts for the GDP growth in 2003 will most certainly be more accurate in December 2003 than in January 2003. To overcome this problem, I calculate a 12-month moving average of the absolute forecast error each month. Thus in June 2004, forecasts made in July to December 2003 for the GDP growth in 2003 are also considered in addition to the GDP growth forecasts for 2004 made between January and June 2004. Hence, each macroeconomic forecast error can be interpreted as an indicator of how accurate the last 6-month macroeconomic forecasts were on average.

5.4 Shocks

A dummy variable is used to control for economic shocks. Shocks are technically defined as a period when the policy rate changes by more percentage points than it has on average been changed by in the past plus one standard deviation. A second criterion is that the change has to be greater than the average change during the three months preceding the forecast.

The first criterion implies that the threshold for a shock continuously changes with every policy rate change. If markets get used to large movements in the policy rate, it will require even larger changes in the policy rate for it to be considered as a response to a shock and vice versa. The average and standard deviation for each country are calculated as three-years moving averages.

The second criterion allows the policy rate to eventually change by more than its *normal* change after shocks have taken place, once there is an established trend in the rate changes. This is because analysts will adjust to the situation following a shock which includes predicting how severely the economy will be affected and the resulting interest rates. The control variable will not pick up periods when the policy rate is flattening out after steep changes and the policy rate is still allowed to change direction at any time. The three months criterion is chosen to suit the frequency of policy rate decisions; there is likely to have been at least one additional policy decision taken during the three preceding months.

Any period with a shock will affect four forecasts in the dataset: the forecast made the same period since the shock might have happened on a day after the forecast was made, the previous two forecasts for which the shock happens during the *waiting period* before the interest rate is quoted, and the forecast made three months ago which has its interest rate quoted during the month of the shock. On average, 3.8 shocks in each country with 12.8 observations will be controlled for. Japan experienced the most shocks with seven instances and Norway the fewest with nil instances. Table 8 and Figure 21-28 in the appendix summarize the shock periods in detail.

6. Econometric Method

6.1 General and Country-Specific Method

To evaluate whether increased central bank transparency enhances the predictability of interest rates, the hypothesis that increased central bank transparency reduces the absolute forecast error of 3-month interest rates, forecasted three months in advance, is tested. Time series regression will be used for both the country-specific analyses and for the pooled (panel) data analysis of all the countries combined. The choice of specific method for panel data analysis is presented in section 6.2.

The regressions are estimated using Ordinary Least Squares (OLS) under asymptotic properties¹⁰ with the aid of Stata 11 and the methods are based on Dougherty (2007) and Wooldridge (2009).

In order to obtain the Best Linear Unbiased Estimators (BLUE), the necessary assumptions for unbiased and consistent estimators will be tested. In cases where the assumptions do not necessarily hold, corrections are made to make the OLS estimates consistent and unbiased. Hence, valid statistical inferences can be made. An overview of the test results is available in Table 9 in the appendix. The assumptions needed in the analyses of individual countries are first presented below in section 6.3. For the panel data analysis, a few adjustments (presented in section 6.4) have to be made.

The general specification of the model is

$$y_t = \beta_0 + \sum_{h=1}^l \beta_{t-h} Y_{t-h} + \sum_{j=1}^k \beta_j X_{jt} + \mu_t$$

where t is the time period, y is the interest rate forecast error, Y_{t-h} is a set of l number of lagged dependent variables (further discussed in section 6.3), and X_j is a set of k number of explanatory variables including transparency index level, macroeconomic forecast errors, time trend, and shocks. μ_t is the unobserved error term. Four models will be estimated in each case to illustrate the effect of control variables. The most complete model is Model 4 and the simplest is Model 1.

Model 1 estimates the effect of central bank transparency on the interest rate absolute forecast error without controlling for any other factors.

$$AFE(i3M)_t = \beta_0 + \beta_{t-h} AFE(i3M)_{t-h} + \beta_1 tridx_t + u_t$$

Model 2 re-estimates Model 1 by controlling for macroeconomic forecast errors.

$$AFE(i3M)_t = \beta_0 + \beta_{t-h} AFE(i3M)_{t-h} + \beta_1 tridx_t + \beta_2 AFE(CPI)_t + \beta_3 AFE(GDP)_t + \beta_4 AFE(UE)_t + u_t$$

Model 3 and **Model 4** re-estimate Model 1 and Model 2 respectively to also control for time specific effects that can cause a bias in the estimators, namely economic shocks and a constant time trend.

$$AFE(i3M)_t = \beta_0 + \beta_{t-h} AFE(i3M)_{t-h} + \beta_1 tridx_t + \beta_2 t + \beta_3 shock_t + u_t$$

$$AFE(i3M)_t = \beta_0 + \beta_{t-h} AFE(i3M)_{t-h} + \beta_1 tridx_t + \beta_2 AFE(CPI)_t + \beta_3 AFE(GDP)_t + \beta_4 AFE(UE)_t + \beta_5 t + \beta_6 shock_t + u_t$$

¹⁰ Because the sample size is $108 > 30$ for each time series ($100 > 30$ for Norway), large sample properties of OLS are appealed to.

6.2 Econometric Method for Panel Data Analysis

Pooling the data sets for all the countries has the benefit that a more general conclusion can be drawn whether increased transparency leads to enhanced predictability of interest rates. The cross-sectional dimension makes it possible to exploit 856 observations for a large sample study where 14 transparency index levels are used and each has an average of 61.1 observations. By adding the time dimension, the problem of bias caused by unobserved heterogeneity between the countries can also be controlled for.

In this analysis, the unobserved effect, α_i , is eliminated using fixed effects estimates because the observations are not a random sample from a given population, but continuous observations from a specific sample set of countries. A Hausman test (see Table 13 in the appendix) also statistically rejects the key assumptions for using random effects estimates, implying that fixed effects estimates should be used. Specifically, a least squares dummy variable (LSDV) regression model is used with a dummy variable for each country. By dropping the overall intercept, the country-specific unobserved effect becomes the intercept for each country and the fixed effects estimator, the coefficient on the effect of transparency, can be estimated. The regression function now takes the form

$$y_{it} = \sum_{h=1}^l \beta_{t-h} Y_{t-h} + \sum_{j=1}^k \beta_j X_{jit} + \delta t + \sum_{i=1}^n \alpha_i A_i + u_{it}$$

where i is the country of observation, t is the time period, y is the interest rate forecast error, Y_{t-h} is a set of l number of lagged dependent variables (further discussed in section 6.3), and X_j is a set of k number of explanatory variables including transparency index level with its quadratic term and macroeconomic forecast errors. The forecast error for unemployment rate is excluded since some countries lack this data. Furthermore, A_i is a set of n country dummy variables, $\alpha_i A_i$ represents a fixed effect on Y_i for the individual i where α_i is the individual's intercept. δt is the time trend effect for all countries combined and u_{it} is the usual error term, also called the idiosyncratic error in this case.

Performing the panel data analysis also adds more benefits than just generalizing the results. The cross-sectional dimension of the study adds greater variation in the variables and it is therefore possible to include explanatory variables that do not necessarily change for each individual country, but does change across countries. This enables breaking down the transparency index to study the underlying aspects of transparency (Table 7 in the appendix shows this breakdown) as well as adding a quadratic variable of total transparency to see if there are marginal returns to transparency.

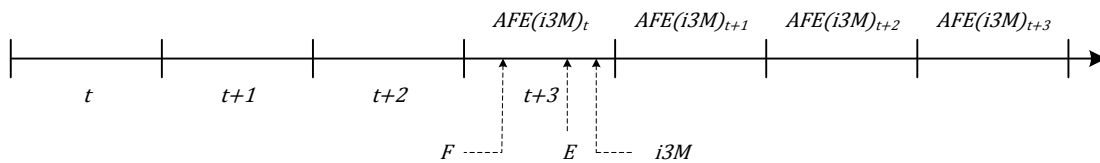
6.3 Time Series Assumptions for OLS Estimates

The first assumption to obtain BLUE estimates is that the time series is linear in parameters and weakly dependent. The linear relationship between the dependent variable and the explanatory variables is investigated using scatter plots shown in Figure 29 in the appendix. Some variables seem to have better explanatory power than others, but since there is no clear non-linear pattern it is reasonable to accept the first part of the assumption.

Weak dependence of a time series is more trivial to show because it lacks a formal definition, but places restrictions on the extent to which related random variables depend on each other over time. However, it can be shown that stable autoregressive processes are weakly dependent—which the time series in this analysis are according to the following explanation. For the forecast errors in this analysis, one can expect that if there is an error $AFE(i3M)_t$ in the interest rate forecast made in period t , the following forecasts made in periods $t + 1$, $t + 2$ and $t + 3$ might also be erroneous by some factor of $AFE(i3M)_t$. This is because the actual interest rate forecasted in period t depends on influential events, E , during the period between the forecast date t and the interest rate quoted at the end of period $t + 3$. These events could happen after any of the following one to three monthly forecasts are made, thus also affecting the forecast errors $AFE(i3M)_{t+1}$, $AFE(i3M)_{t+2}$ and $AFE(i3M)_{t+3}$. Hence, any interest rate forecast error $AFE(i3M)_T$ may depend on its previous values. These values will be controlled for with the benefit of firstly, making the time series an autoregressive processes. Secondly, it controls for forecast errors that have already been accounted for in previous observations and could otherwise lead to biases in the coefficients and thirdly, it removes serial correlation in the error term. The number of lagged values $AFE(i3M)_{T-t}$ is decided when no more serial correlation of the error term remains, summarized in Table 11 in the appendix.

Figure 3: Illustration of autocorrelation cause

An influential event, E , during period $t + 3$ could potentially impact the interest rate quote $i3M$ that period affecting forecast errors from $AFE(i3M)_t$ up to $AFE(i3M)_{t+3}$ when the forecast, F , made in period $t + 3$ precedes the event, E .



With an established autoregressive process, it is still key that the process is stable for it to be weakly dependent. To check this, an augmented Dickey-Fuller test is used to test for unit roots which would indicate that a time series is strongly dependent. The statistical test results (summarized in Table 10 in the appendix) reject the hypothesis of a unit root process for all data sets. Hence, the weak dependence criterion of the first assumption is reasonable to accept.

The second assumption disallows there to be any constant or perfectly collinear independent variables. We know from tables Table 5 and Table 6 in the appendix that there is some variation in all independent variables. To avoid the issue of collinearity, Stata 11 automatically prevents the user from regressing collinear variables and thus it should not be a major concern.

The third assumption of zero conditional mean requires the explanatory variables to be contemporaneously exogenous, meaning that $E(u_t|X_t) = 0$. In other words, the unobserved error cannot be related to the explanatory variables. Unless there are measurement errors, we can assume this assumption to hold for the main set of explanatory variables. However, since the regression follows an autoregressive process, the estimated coefficients might be consistent yet biased if the large sample properties do not hold. Since the sample size is moderately large, it is reasonable to accept this assumption.

Assumption four requires the errors to be contemporaneously homoskedastic. To test this assumption, the Breusch-Pagan/Cook-Weisberg test for heteroskedasticity is performed. It tests the null hypothesis that the error variances are constant versus the alternative that they change as the predicted values of the dependent variable change. Test results are reported in Table 12 in the appendix. In cases where the assumption does not hold, heteroskedastic-robust standard errors are used as a correction.

Finally, assumption five requires the unobserved errors to be serially uncorrelated. From above, it is evident that this assumption does not hold until lags of the dependent variable are included in the regression. Since the order of the autoregressive process is determined when there is no more serial correlation present in the error term (see Table 11 in the appendix), this assumption is corrected for and holds for this analysis.

6.4 Panel Data Assumptions for OLS Estimates

The assumptions for fixed effects estimation are the same as the assumptions in section 6.3, but with a few alternations. In the first assumption, each individual country has to follow a linear regression and be weakly dependent, which has already been confirmed. For the second assumption, the explanatory variables have to change over time for at least some of the countries, which we can see them do even when controlling for specific aspects of transparency (see Table 7). In assumptions three to five, the conditions on the relationships between the idiosyncratic error, u_{it} , and the explanatory variables have the unobserved effect, α_i , added to the explanatory variables. These assumptions hold for the same reasons as before. One modification is made where White's test for homoskedasticity, which is a more general case of the Breusch-Pagan/Cook-Weisberg test, is used instead.

Only one new assumption is necessary and that is the assumption of a random sample from the cross section. Of the 20 countries with central banks that satisfy the conditions for an independent monetary policy and are inflation-targeting, eight are studied in this analysis. Although none of them are specifically chosen, one might question the random selection process when the sample is based on available data. Therefore, the findings of the analysis might be restricted only to the sample set.

7. Results and Analysis

In this section I first analyze the developments in the main variables over the studied time period for all countries. The econometric results obtained are then discussed, starting with country-specific results followed by the panel data results. For the full set of results, see Table 14-16 in the appendix.

7.1 Data Analysis

Transparency Index

After narrowing down the sample size to the sample used for this analysis, I find that all eight central banks have at some point during the period 1998-2006 changed their level of transparency—ending at a higher transparency level in 2006 than they started at in 1998. As can be seen in Table 6 of the appendix, for the sample as a whole there has been some change under each classification of transparency. All central banks made increases to their economic transparency except for the NB which ended on a lower level in 2006 than in 1998 and the Fed which did not make any change.

Only on four occasions was there a decrease in any transparency criterion and only once did it change the overall transparency level. This happened in Japan after the BoJ had increased its economic transparency by 0.5 levels, raising the total from 8 to 8.5 in 2000. It then decreased its operational transparency by 0.5 levels in 2001, giving it a total of 8 again. At another occasion, a 0.5 level drop in the SNB's operational transparency between 1998-99 was compensated for by increases in political and economic transparency. The other two incidents happened when the NB firstly increased its political transparency 1.5 levels and secondly, increased its operational transparency by 0.5 levels by increasing one aspect of it by 1 level and decreasing another by 0.5 levels while thirdly, decreasing its economic transparency by 0.5 levels. This shows that there have only been a very limited number of substitutions between different aspects of transparency. Substitutions could otherwise become a pitfall for the analysis if they are made under a constant total index value in line with Carpenter's criticism (see section 4.1).

Table 1 below outlines the number of months each central bank has exhibited a particular overall level of transparency. On average, each central bank has changed its transparency level 2.5 times and exhibited 3.4 different levels of transparency. The BoC and the Fed have made the fewest changes

with only one change each, while the SNB has made five changes to its transparency. In total, fourteen levels of transparency are covered by the sample. The actual increase in transparency during 1998-2006 was on average 2.3 levels where the average level was 8.5 in 1998 and 10.8 in 2006. The BoC made the smallest overall change in transparency with 0.5 levels while the SRB made the greatest change with 5.5 levels. The highest level of transparency, 14.5, is also found in Sweden while the lowest level of transparency, 6, is found in both Switzerland and Norway.

Table 1: Number of months under a particular transparency index level per country

	Transparency Index Level														Tot obs:
	6	7	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	14.5	
CA									72	36					108
EU					36			12	24	36					108
JP				60	12		36								108
NO	28		36	36											100
SE						12	12				24			60	108
CH	12	12	12	24		12	36								108
UK										12		12	84		108
US					12			96							108
Tot obs:	40	12	48	120	60	24	84	108	96	84	24	12	84	60	856

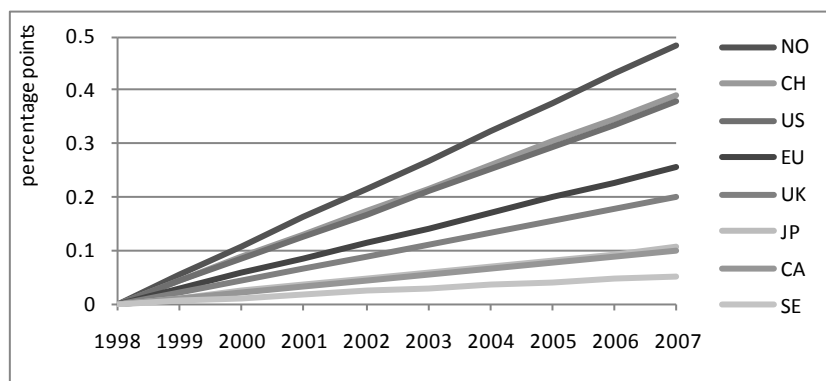
Data source: Dincer and Eichengreen (2010)

Interest Rate Forecast Errors

Looking closer at the interest rate forecast errors, it is evident that the 3-month interest rate has become more predictable in all countries studied. On average (including Japan which has had a zero interest rate policy), forecasts are 0.25 percentage points more accurate by the end of 2006 than in the beginning of 1998. The strongest trend has been in Norway with an improvement of almost 0.5 percentage points, while the weakest development is found in Sweden with only about 0.05 percentage points improved forecast accuracy over the period (see Figure 4 below). Putting this trend into perspective, the forecast error across the sample set and over the entire period has on average been 0.27 percentage points while the interest rate level has on average been 3.08 per cent. Hence, there has been a significant improvement in the predictability of 3-month interest rates. The analyses below will evaluate to what extent this improvement derives from central bank transparency.

Figure 4: Increased predictability of interest rates

The graph shows the linear trend in predictability (inverted slope of absolute forecast errors over time) of the 3-month interest rate during the period 1998-2006 for the eight countries in the sample.



Data source: Consensus Economics (2011); Wright (2011); own calculations

7.2 Country-Specific Results and Analysis

Canada

Figure 5: Forecasted vs. actual interest rate

The graph shows how accurate (full accuracy represented by the line of unity) the forecasts have been under different levels of transparency represented by the differently shaped and colored plots.

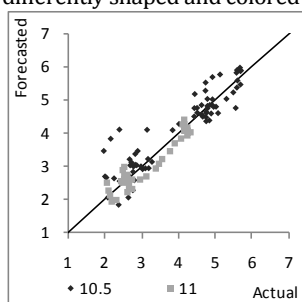
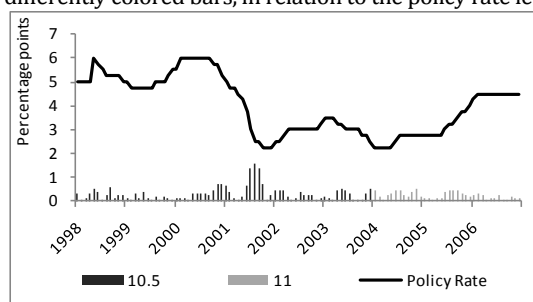


Figure 6: Forecast errors under different transparency levels over time

The graph shows the size of the absolute interest rate forecast errors under different transparency levels represented by the differently colored bars, in relation to the policy rate level.



Data source: Consensus Economics (2011); Dincer and Eichengreen (2010); Thomson Reuters Datastream (2010); Wright (2011); own calculations

The BoC has only experienced a small increase in transparency from 10.5 to 11 when it changed its economic transparency in 2004. Although this change is the smallest in the sample, it started at a much higher level than the average central bank and ended on the average level. Meanwhile, interest rate forecast errors appear to have decreased by roughly 0.1 percentage points over the period and averaged at 0.26 percentage points during the period.

The econometric results indicate that the small increase in transparency has made the 3-month interest rate 0.16 percentage points more predictable. In fact, when adding all the control variables, Model 4 indicates that a 1 level increase in transparency reduces the forecast error by 0.32 percentage points (significant at the 5% level). This effect is also economically significant. Controlling for forecast errors in GDP significantly improves the result. It is somewhat odd that greater forecast

errors in GDP lowers the interest rate forecast error; Greater macroeconomic forecast errors are expected to increase the interest rate forecast error.

Euro zone

Figure 7: Forecasted vs. actual interest rate

The graph shows how accurate (full accuracy represented by the line of unity) the forecasts have been under different levels of transparency represented by the differently shaped and colored plots.

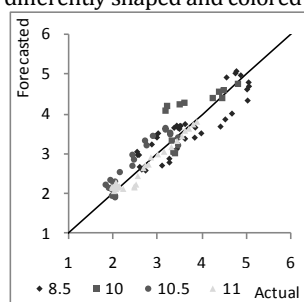
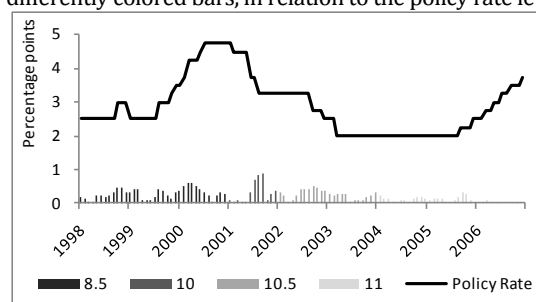


Figure 8: Forecast errors under different transparency levels over time

The graph shows the size of the absolute interest rate forecast errors under different transparency levels represented by the differently colored bars, in relation to the policy rate level.



Data source: Consensus Economics (2011); Dincer and Eichengreen (2010); Thomson Reuters Datastream (2010); Wright (2011); own calculations

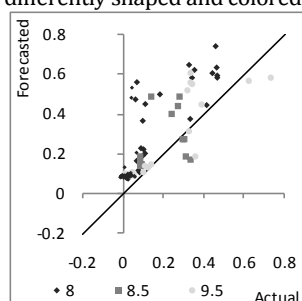
The ECB has gradually increased its transparency in line with the average central bank from 8.5 to 11 in three steps where all the change has been in economic transparency, except for a 0.5 level increase in policy transparency as well. On average, the interest rate forecast error has been 0.22 percentage points, which is the lowest amongst all countries after excluding Japan. At the same time, in comparison to the peers there has been an average improvement in forecast accuracy during the period of roughly 0.25 percentage points.

In Model 1, it appears as if the 3-month interest rate forecast errors have decreased by approximately 0.03 percentage points for each 1 level increase in transparency (significant at the 5% level)—amounting to a total decrease of about 0.07 percentage points during the period. This is somewhat economically significant. However, the time trend variable indicates that there has been a constant trend reducing the forecast error by a total of 0.21 percentage points over the period and transparency would instead have increased the forecast error. With the control variables, the problem that the results lose their economic significance arises and only the time trend variable remains somewhat significant. It is therefore not possible to draw any conclusion from the results. Considering that the ECB is a newly established central bank, it is possible that analysts have gradually become better at understanding the ECB and forecasting related interest rates, irrespective of the ECB's transparency level. On the other hand, aspects of transparency, such as improved quality of information releases, may have helped analysts understand the ECB. This is not necessarily reflected in the transparency index, but could explain the trend variable.

Japan

Figure 9: Forecasted vs. actual interest rate

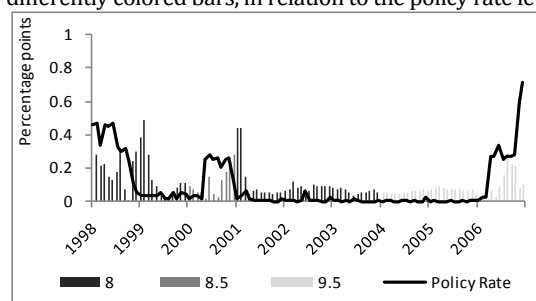
The graph shows how accurate (full accuracy represented by the line of unity) the forecasts have been under different levels of transparency represented by the differently shaped and colored plots.



Data source: Consensus Economics (2011); Dincer and Eichengreen (2010); Thomson Reuters Datastream (2010); Wright (2011); own calculations

Figure 10: Forecast errors under different transparency levels over time

The graph shows the size of the absolute interest rate forecast errors under different transparency levels represented by the differently colored bars, in relation to the policy rate level.



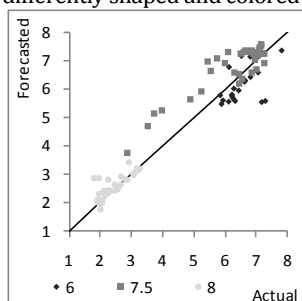
The BoJ has changed its transparency on three occasions, but only experienced an overall increase in transparency from 8 to 9.5, which can be attributed to economic transparency. This is a more restrictive development in transparency than the average central bank in all aspects. Interest rate forecast errors have simultaneously decreased by around 0.1 percentage points. Considering that the average forecast error has been 0.1 percentage points and the average 3-month interest rate level has been 0.13 per cent, this is the most significant improvement in the sample.

Econometric results from Model 4 suggest that every 1 level increase in transparency has decreased the 3-month interest rate forecast error by 0.023 percentage points amounting to a total reduction of 0.035 percentage points for the period (significant at the 5% level). It is fair to say that increases in economic transparency have had some economic significance in Japan. Interestingly, larger overall macroeconomic forecast errors also reduce the interest rate forecast error. Including them actually makes the effect of transparency both statistically and economically more significant. The significant results in Japan could indicate the important role central bank transparency has played under the zero interest rate policy. Both information and incentive effects of transparency might have convinced markets to believe in the BoJ's commitment to the policy, regardless what macroeconomic indicators show, and thereby reduced the forecast errors.

Norway

Figure 11: Forecasted vs. actual interest rate

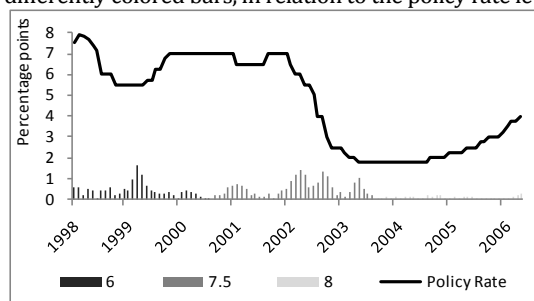
The graph shows how accurate (full accuracy represented by the line of unity) the forecasts have been under different levels of transparency represented by the differently shaped and colored plots.



Data source: Consensus Economics (2011); Dincer and Eichengreen (2010); Thomson Reuters Datastream (2010); Wright (2011); own calculations

Figure 12: Forecast errors under different transparency levels over time

The graph shows the size of the absolute interest rate forecast errors under different transparency levels represented by the differently colored bars, in relation to the policy rate level.



The NB started at the lowest level of transparency in the sample and also ended on a lower level in 2006 than the average central bank started off at in 1998 with a development from 6 to 8. Most of the increase is attributed to political transparency and some to policy and operational transparency. It is the only central bank which has an overall decrease in any aspect of transparency during the period with a decrease of 0.5 levels in economic transparency in 2001. Meanwhile, Norway is the country with the largest average interest rate forecast error of 0.36 percentage points. It is, however, also the country where the forecast errors have decreased the most during the period with a total of approximately 0.5 percentage points.

From the econometric results in Model 4, it seems that each 1 level increase in transparency decreased the 3-month interest rate forecast error by 0.12 percentage points (significant at the 6% level to be precise). Hence, transparency has had an overall effect of reducing the forecast errors by 0.24 percentage points. This result is of strong economic significance. It is important to acknowledge the significance even after controlling for the trend in forecast errors. One could otherwise argue that the increased predictability stems from the fact that Consensus Economics only started to survey analysts on Norway in 1998, much later than the other countries. The analysts may therefore have improved their forecasts gradually, irrespective of NB's transparency level. This could still be true, but it does not explain the entire improvement. Macroeconomic control variables also have a strong effect on the result. While being statistically insignificant individually, they are jointly significant at the 5% level. Since the forecast errors are much lower from 2004, it seems increased policy transparency in 2004 helped the markets understand the central bank's policy intentions better.

Sweden

Figure 13: Forecasted vs. actual interest rate

The graph shows how accurate (full accuracy represented by the line of unity) the forecasts have been under different levels of transparency represented by the differently shaped and colored plots.

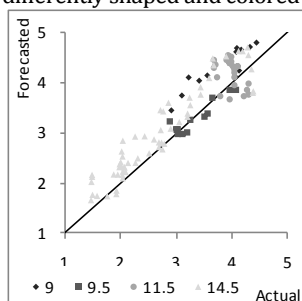
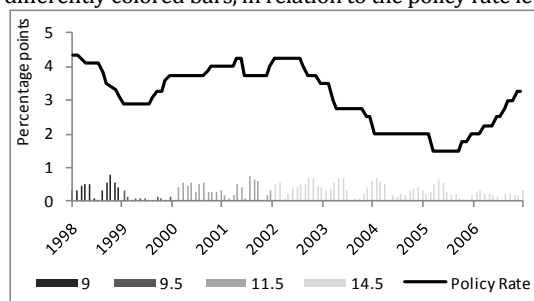


Figure 14: Forecast errors under different transparency levels over time

The graph shows the size of the absolute interest rate forecast errors under different transparency levels represented by the differently colored bars, in relation to the policy rate level.



Data source: Consensus Economics (2011); Dincer and Eichengreen (2010); Thomson Reuters Datastream (2010); Wright (2011); own calculations

The SRB started at a higher level of transparency than the average central bank, exhibited the greatest increase in transparency, and ended on the highest level of all central banks with a development from 9 to 14.5—just 0.5 levels shy of the maximum level possible. The increases in transparency are fairly even spread between all aspects of transparency. Interest rate forecast errors have only decreased marginally, however, by approximately 0.05 percentage points. On average, the forecast errors have been 0.32 percentage points, which is the second highest level in the sample.

There is no indication that the substantial increase in transparency has made the 3-month interest rate more predictable. Econometric results in Model 4 actually suggest that each 1 level increase in transparency increases the forecast error by 0.04 percentage points (significant at the 5% level) totaling at around 0.2 percentage points for the period. There is a significant negative trend in the forecast errors indicating that the forecast errors have decreased by 0.32 percentage points (significant at the 1% level) for the period. Dropping the trend variable gives statistically insignificant results. Overall, it appears as if the increased transparency at already high levels of transparency has actually decreased the predictability of 3-month interest rates in Sweden. The implications of this result will be discussed in more detail in section 7.4 when all results are generalized.

Switzerland

Figure 15: Forecasted vs. actual interest rate

The graph shows how accurate (full accuracy represented by the line of unity) the forecasts have been under different levels of transparency represented by the differently shaped and colored plots.

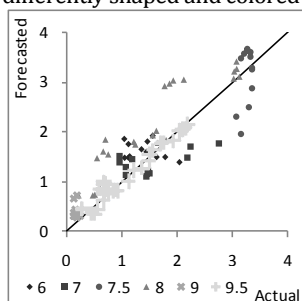
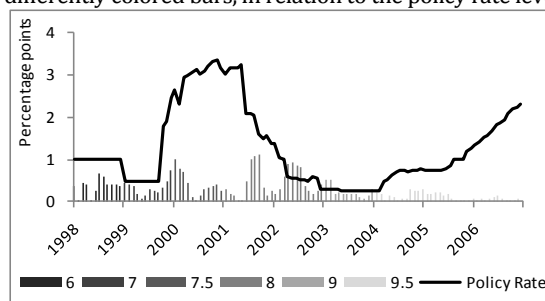


Figure 16: Forecast errors under different transparency levels over time

The graph shows the size of the absolute interest rate forecast errors under different transparency levels represented by the differently colored bars, in relation to the policy rate level.



Data source: Consensus Economics (2011); Dincer and Eichengreen (2010); Thomson Reuters Datastream (2010); Wright (2011); own calculations

The SNB is the other central bank that started out at the lowest level of transparency in the sample with 6 and finished approximately 1 level shy of the average central bank with 9.5. It exhibited the most gradual increase in transparency with five changes and had the second greatest overall increase with most attributed to political transparency followed by economic and operational transparency. Interest rate forecast errors also decreased significantly in Switzerland by almost 0.4 percentage points while averaging at 0.29 percentage points.

Econometric results from Model 1 suggest that each 1 level increase in transparency has reduced the 3-month interest rate forecast errors by around 0.04 percentage points (significant at the 5% level) totaling at 0.15 percentage points for the period. This would be of economic significance. However, the central bank has shocked the market on a few occasions with its interest rate movements—perhaps in response to economic shocks. After controlling for shocks, the results still suggest a 0.03 percentage point decrease in forecast errors per 1 level increase in transparency, but the results lose their statistical significance. Thus, although it appears as if increased transparency has explained some of the enhancement in the predictability of 3-month interest rates in Switzerland, it is not correct to draw this conclusion.

United Kingdom

Figure 17: Forecasted vs. actual interest rate

The graph shows how accurate (full accuracy represented by the line of unity) the forecasts have been under different levels of transparency represented by the differently shaped and colored plots.

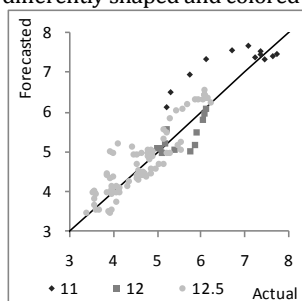
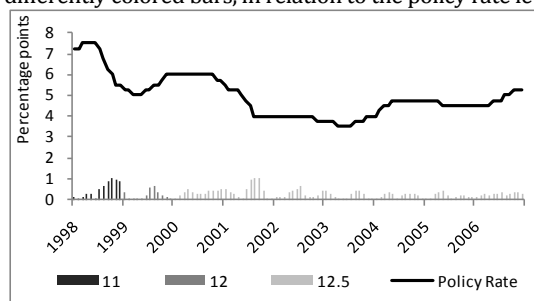


Figure 18: Forecast errors under different transparency levels over time

The graph shows the size of the absolute interest rate forecast errors under different transparency levels represented by the differently colored bars, in relation to the policy rate level.



Data source: Consensus Economics (2011); Dincer and Eichengreen (2010); Thomson Reuters Datastream (2010); Wright (2011); own calculations

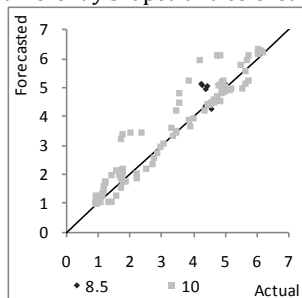
The BoE started at the highest level of transparency in the sample with 11 and ended on the second highest level of transparency with 12.5. The 1.5 level increase is attributed to economic transparency and some operational transparency. Interest rate forecast errors have meanwhile decreased by a moderate, but significant 0.2 percentage points while the average forecast error in United Kingdom has been 0.29 percentage points.

Econometric results suggest that the increase in transparency has had some effect on reducing the 3-month interest rate forecast errors, but all models give statistically insignificant results. The most significant result in Model 1 is significant at the 20% level and suggests that a 1 level increase in transparency decreases the forecast error by around 0.07 percentage points totaling at 0.1 percentage points for the period. This would be of somewhat economic significance. However, the trend variable gives much more significant results. Model 4 suggests that there has been a 0.42 percentage point total decrease in the forecast error over the period due to the trend. This is statistically significant at the 1% level while transparency only accounts for less than a 0.01 decrease in the forecast errors over the period. It can therefore not be concluded that increased transparency in United Kingdom has reduced the 3-month interest rate forecast errors.

United States

Figure 19: Forecasted vs. actual interest rate

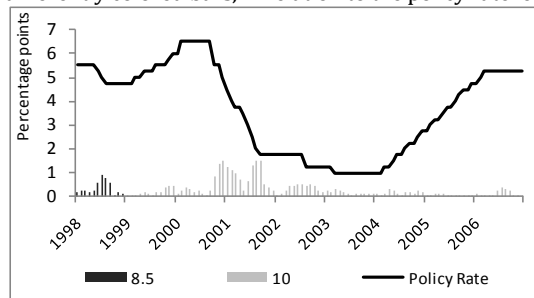
The graph shows how accurate (full accuracy represented by the line of unity) the forecasts have been under different levels of transparency represented by the differently shaped and colored plots.



Data source: Consensus Economics (2011); Dincer and Eichengreen (2010); Thomson Reuters Datastream (2010); Wright (2011); own calculations

Figure 20: Forecast errors under different transparency levels over time

The graph shows the size of the absolute interest rate forecast errors under different transparency levels represented by the differently colored bars, in relation to the policy rate level.



The Fed only made one change to its transparency level by increasing its policy transparency from 1.5 to 3. While it started at the average level of 8.5, its relatively small increase implies that it ended at 10—almost 1 level shy of the average central bank. Interest rate forecast errors have on the other hand decreased by almost 0.4 percentage points. On average, the forecast error has been 0.29 percentage points, in line with the results in many of the other countries.

Econometric results from Model 1 without any control variables indicate that transparency appears to have reduced the 3-month interest rate forecast errors by less than 0.01 percentage points in total. These results are both statistically and economically insignificant, however. Instead, forecast errors of GDP appear to have a much more significant impact on the interest rate forecast errors and when controlling for this, transparency actually appears to have increased the interest rate forecast errors by almost 0.02 percentage points for each 1 level increase in transparency. Once again, this result is insignificant in all ways. Additionally, economic shocks appear to have significantly impacted the forecast errors as well. It can therefore not be concluded what effect the limited increase in transparency has had on the predictability of 3-month interest rates in the United States. The main problem with analyzing the Fed is that the single change came already after one year, leaving little data of lower transparency to study. The results lack statistical significance and are more determined by the control variables used.

A reason why the GDP control variable is particularly significant in the United States might be because the Fed monitors more economic indicators than just inflation (see section 4.3). Specifically, the Fed also has mandate to achieve maximum employment (Fed, 2011), which is achieved by narrowing the output gap. The Fed's political transparency level is the lowest in the sample with only a level of 1—perhaps because it does not reveal what priority it gives to each mandate. This is in line with what most theory argues (see section 2.5), but it could also complicate interest rate forecasting.

Table 2: Summary of country-specific results

	CA	EU	JP	NO	SE	CH	UK	US
Δ Total transparency	0.5	2.5	1.5	2.0	5.5	3.5	1.5	1.5
Mean AFE(i3M)	0.26	0.22	0.10	0.36	0.32	0.29	0.29	0.29
Effect of 1 level transparency increase on AFE(i3M)								
Model 1	-0.110**	-0.027***	-0.006	-0.034	0.004	-0.042***	-0.067*	-0.005
Model 4	-0.319***	0.021	-0.023***	-0.173**	0.037***	-0.033	-0.005	0.016
Total effect of total transparency increase on AFE(i3M)								
Model 1	-0.055**	-0.068***	-0.009	-0.068	0.022	-0.147***	-0.101*	-0.008
Model 4	-0.160***	0.053	-0.035***	-0.346**	0.204***	-0.116	-0.008	0.024

Significance level: **** 1%, *** 5%, ** 10%. * 20%

7.3 Panel Data Results and Analysis

On average, the sample set of central banks increased their overall transparency by 2.3 levels, starting at 8.4 and ended at 10.8. The greatest change was made to economic transparency where the average central bank increased its transparency by almost 1 level.

The results in Model 1 and Model 2 for total transparency suggest that each 1 level increase in overall transparency decreases the 3-month interest forecast error by around 0.85 to 0.09 percentage points, but with a diminishing rate of about 0.003 to 0.004 percentage points for a total effect of approximately -0.082 to -0.086 percentage points (jointly significant at the 1% level). This suggests that a central bank that starts at a transparency index of 6 (minimum in the sample) and increases its transparency to 14.5 (maximum in the sample) could decrease the 3-month interest rate forecast errors by approximately 0.2 percentage points. Beyond a transparency index of 14.2, forecast errors actually start to increase¹¹. The result is economically significant, but so is the actual increase in transparency a central bank would have to commit to. However, as with many of the individual countries, controlling for economic shocks and a constant time trend affects the results.

The results in Model 4 still suggest that each 1 level increase in central bank transparency decreases the 3-month interest rate forecast errors, but by just over 0.04 percentage points and at a diminishing rate of 0.002 percentage points. This is only jointly significant at the 20% level, thus weakening its statistical support. An increase from 6 to 14.5 would in this case only decrease the forecast error by just below 0.01 percentage points. Beyond a transparency index of 10.5, forecast errors actually start to increase. The effect of the constant time trend suggests 3-month interest rates have become approximately 0.1 percentage points more predictable (significant at the 1% level) over the period for other unobserved reasons. It is therefore not possible to draw any firm

¹¹ See Wooldridge (2009) pp. 192-193 for calculation methods

conclusion whether increased overall central bank transparency enhances the predictability of interest rates.

When breaking down the overall level of transparency into its five aspects, results from all models indicate that political and policy transparency decrease the 3-month interest rate forecast errors. Economic transparency indicates the same before controlling for a constant time trend and economic shocks, but not after. The largest economic effect comes from procedural transparency, which actually increases the forecast errors in every model. Few of the individual transparency classifications show individual statistical significance in any of the models, but jointly they are significant at the 20% level, just as they are using the total transparency index.

7.4 Discussion of Results

The results presented indicate that there is mixed evidence for the effect of increased central bank transparency on the predictability of 3-month interest rates. There is stronger evidence in support of the hypothesis, but an unexplained constant negative trend in the forecast errors complicates the results. Therefore, no firm conclusion can be drawn.

The Effect of Transparency

Canada, Japan, and Norway show strong evidence in support of the hypothesis that increased central bank transparency enhances the predictability of interest rates. Switzerland and United Kingdom also indicate a similar effect, but it is not statistically significant. For the Euro zone and to some extent the United States, unobserved factors that have led to a constant decrease in the interest rate forecast errors complicate the results and therefore no conclusion can be drawn. Finally, Sweden is the only country where there is statistical evidence against the hypothesis.

In an attempt to find a more general result, the data is pooled and then unobserved country fixed effects are controlled for. Strong evidence for the hypothesis that increased central bank transparency enhances the predictability of interest rates can be found before controlling for unobserved factors that have lead to a constant decrease in the interest rate forecast errors. Although evidence in favor of the hypothesis still remain after adding this control, the results are only statistically significant at the 20% level.

The results indicate that there are diminishing returns to transparency. An optimal level of transparency exists between 10.5-14.2, depending on the regression model chosen. This might perhaps be explained by the effects of procedural transparency and largely due to the results in Sweden. Sweden is the only country that had an overall increase in procedural transparency. Together with United Kingdom, it is the only country with the maximum level of transparency possible under this classification. They are also the two countries with the highest levels of

transparency. Neither of the two countries generates results in support of the hypothesis. Procedural transparency is achieved by the release of minutes and voting records, which could potentially confuse the market if committee members give disperse messages, as suggested by Blinder, et al. (2008) (see section 2.5).

Based on the discussion in section 2.5 under *Is there an Optimal Level of Transparency*, it is particularly interesting to study the diminishing returns to transparency observed as well as the fact that the most transparent central bank, Sveriges Riksbank, does not contribute to enhanced predictability of interest rates. This could support both Posen's (2002) *contingent view*, Mishkin's (2004) argument that transparency can go *too far*, as well as the findings by van der Cruysen, et al. (2010) that too much transparency can lead to an information overload and confuse the markets. In the first case, the logic would be that the SRB has not been as credible as it wishes, and therefore increased its transparency level. In the second case, increased transparency could have complicated the work of the SRB by for example diverting attention from current policymaking by publishing a conditional forecast of the policy rate path, as the SRB started doing in 2002 (van der Cruysen, et al., 2006). Hypothetically, this could deteriorate credibility giving the central bank more incentives to increase its transparency. One must, however, be careful to draw too strong conclusions about the SRB in this case. As mentioned in section 3.2, Andersson, et al. (2006) found that it is longer interest rates of about 5-year maturities that are affected by the SRB's transparency. It could also be that the SRB has actually become very credible and is thereby able to move the short-term interest rate more than other central banks without affecting inflation expectations—in line with the argumentation by van der Cruysen, et al. (2006). This would make the 3-month interest rate more difficult to predict.

Controlling for Macroeconomic Forecast Errors

It is difficult to draw any conclusion from the impact of controlling for macroeconomic forecast errors. Although all three macroeconomic variables should have considerable influence on the interest rate level in a country, their forecast errors often poorly explain the 3-month interest rate forecast errors. An explanation might be that their forecast horizon is considerably longer than that of interest rate forecasts. Only in Japan, Norway, the United States, and to some extent Canada do the macroeconomic forecast errors significantly impact the results. Less surprising might be that the variables for the Euro zone were the least significant ones—suggesting that it is not enough to study the macroeconomic variables for Germany when forecasting the Euro zone interest rates. From the panel data analysis, forecast errors of the inflation rate generally do increase the 3-month interest rate forecast errors in line with expectations. The effect is minimal, yet statistically significant.

One would generally have expected greater macroeconomic forecast errors to increase the interest rate forecast errors. On several occasions the opposite effect is observed and from the panel data

analysis it appears as if greater forecast errors of GDP decrease forecast errors of the interest rate (but at fairly low significance levels). Observations of this kind can be interpreted as instances when the market has generally been better at forecasting 3-month interest rates than macroeconomic variables. In Japan, for example, it might have been easier to predict the near-zero interest rate than the inflation rate because the central bank is perhaps openly committed to this policy.

Controlling for a Time Trend

By controlling for a constant trend, it can be concluded from the panel data analysis that 3-month interest rate forecast errors have continuously decreased over the period for unobserved reasons. In some countries, this control contributed to more robust results. In other countries it changed the results. When controlling for this trend for the sample set as a whole, results suggest that increased transparency does decrease the 3-month interest rate forecast errors. The problem is that the results lose their statistical significance they had before. A leading explanation for this is that economic transparency seems to decrease the 3-month interest rate forecast errors without the time trend control, but actually increase the forecast errors when adding the control.

As mentioned, it is only possible to speculate what the unobserved effects are. One of the many possible unobserved effects might relate to the means by which IT-development during the period has allowed market agents to exchange information in new ways, making the central bank's economic data less important. If this makes the market a better forecaster than the central bank, economic disclosures by the central bank could create noise in line with the argument by Morris and Shin (see section 2.5). This could perhaps explain the results obtained in economic transparency.

There is also a danger of blindly accepting the effect of this control variable. Since both transparency and the trend variable increase over time, there is a correlation between them. If analysts gradually learn to use the new information provided by central banks when they become more transparent, then the trend actually exists because of transparency.

Aspects of transparency that are not reflected in the transparency index, but that affect forecast errors, could also be important factors reflected in the trend. For example, very little is actually known about the quality of the central banks' information releases. Neither are the communication strategies discussed by Ehrmann and Fratzscher (2007) (see section 3.2) reflected in the transparency index. This has been found to be an important determinant for policy predictability. If any central bank has changed communication strategy during the period, the results could be biased.

Controlling for Economic Shocks

In all countries, economic shocks have contributed to excessive 3-month interest rate forecast errors and on most occasions the results are statistically significant. This is also confirmed by the panel data

analysis. Although the method used to identify shocks might not be conventional, it is coherent and consistent for all countries. Judging from the periods it controls for, observations that otherwise might have been considered to be influential outliers are taken care of. Thus, it reduces the risk of biased coefficients.

Causality

As always in empirical studies, the question of causality is important to address. The question is whether it is central bank transparency that affects interest rate forecasts or if changes in transparency are the results of interest rate forecast errors. Judging from the theoretical literature, central bank transparency has increased partly because of accountability reasons. Consequential changes in transparency will in that case stem from democratic reasons rather than inaccurate forecasts. On the other hand, recent theories promote transparency because it is argued to better align market expectations. In this case, the question is whether changes in transparency are endogenous and reactive to measurements of past forecast errors, or if the changes are exogenous and proactive attempts to affect the market's expectations. Since there is no study to my knowledge that addresses interest rate forecast errors as a reason for increasing transparency, I find the latter more believable; central bank transparency affects forecast errors rather than the reverse.

Limitations

When interpreting the results, it is important to acknowledge the limitations of the study. All observations are made ex-post and one cannot control for what the forecast errors would have been in absence of increased central bank transparency. Some of the central banks, particularly the ones that started on a higher level of transparency in 1998 than the average central bank, might have increased their transparency level prior to the sample period in ways that could have impacted the results significantly if these changes had been taken into consideration. The central banks are not randomly chosen and the general results can therefore at best be applied to the sample set. The method chosen only measures one specific interest rate forecast and does not consider transparency's effect on other interest rates or at different forecast horizons.

7.5 Suggestions for Future Research

The fact that it would be valuable to study a greater sample of central banks over a longer time period is given. It would also be interesting to study each country in greater depth as well as the effect of transparency on other interest rates and using different methods. In regards to the findings above, the perhaps most useful studies to conduct would be to investigate what unobserved factors could have decreased the 3-month interest rate forecast errors over the period and how credible the central banks are—perhaps through the use of proxy variables.

8. Conclusion

The aim of this thesis has been to evaluate whether central bank transparency enhances the predictability of future interest rates. The central bank's policy rate, a key mechanism for transmitting monetary policy, steers market interest rates and ultimately affects the macroeconomic outcome. By being transparent, a central bank has the ability to affect market expectations. A key argument favoring transparency suggests that central bank transparency can enhance the effectiveness of monetary policy by aligning market expectations and policy intentions. Acknowledging this, I test the hypothesis that increased central bank transparency leads to a decrease in interest rate forecast errors. Specifically, the Eijffinger-Geraats Index is used to test its effect on analysts' forecasts for the 3-month interest rate, forecasted three months in advance, for eight inflation-targeting central banks with an independent monetary policy.

It is important to acknowledge that transparency can have other benefits than just making monetary policy more predictable, such as lowering the interest rate level as some studies have found. Neither does this thesis attempt to judge whether more predictable interest rates are actually better for monetary policymaking. In fact, central bank credibility that stems from transparency and makes policy rate setting more flexible without affecting inflation expectations could make interest rates less predictable, but still be more beneficial for monetary policymaking.

Analyses of the countries individually give mixed results. Canada, Japan, and Norway show strong evidence in support of the hypothesis, while the effect in Switzerland and United Kingdom is not statistically significant. In the Euro zone and the United States, unobserved factors that have led to a constant decrease in the interest rate forecast errors complicate the results and therefore no conclusion can be drawn. Finally, Sweden is the only country where there is evidence against the hypothesis. In an attempt to generalize the results for the entire sample I use panel data analysis, where country-specific fixed effects are controlled for. The results support the hypothesis, but are only statistically significant before controlling for a trend in the forecast errors. Particularly the effect of economic transparency changes when controlling for a trend. I also find evidence of diminishing returns to transparency, which would support theories arguing that central bank transparency can contribute to increased noise and confuse the market. This result is, however, also statistically insignificant when controlling for a trend.

Therefore, although it appears as if central bank transparency has enhanced the predictability of interest rates in most countries, a firm conclusion cannot be drawn until it has been determined why there has been a constant trend of decreasing interest rate forecast errors over the period.

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10. Appendix

10.1 Summary Statistics

Table 3: Interest rates forecasted and data sources provided by wright

Country	Forecasted rate	Wright's Market Data Source	Policy Rate
Canada	3 month Treasury Bill Rate	Bank of Canada and BIS database	Bank Rate
Euro zone	3 month Euro Rate	Bundesbank and BIS database	Discount Rate / Short Term Euro Repo Rate
Japan	3 month Yen TIBOR Rate	Datastream and Wright's calculations	Overnight Call Money Rate, Uncollateralized
Norway	3 month Interbank Rate	Norges Bank and BIS database	Sight Deposit Rate
Sweden	3 month Interbank Rate	Riksbank and BIS database	Repo Rate
Switzerland	3 month Euro-Franc Rate	Swiss National Bank and BIS database	3 Month LIBOR Target Rate
UK	3 month Interbank Rate	Anderson and Sleath (1999)	Bank Rate
USA	3 month Treasury Bill Rate	Gürkaynak, Sack and Wright (2007)	Fed Funds Target Rate

Source: Consensus Economics (2011); Thomson Reuters Datastream (2010); Wright (2011)

Table 4: Average number of forecasters for each country in Consensus Forecasts

Country	Average number of forecasters
Canada	15
Euro zone	27
Japan	20
Norway	10
Sweden	13
Switzerland	12
UK	29
USA	26

Source: Ehrmann, et al. (2010)

Table 5: Key variables (excluding transparency)

	CA	EU	JP	NO	SE	CH	UK	US	Avg
No of obs	108	108	108	100	108	108	108	108	107
Start	Apr-98	Apr-98	Apr-98	Dec-98	Apr-98	Apr-98	Apr-98	Apr-98	-
End	Mar-07	Mar-07	Mar-07	Mar-07	Mar-07	Mar-07	Mar-07	Mar-07	-
AFE 3M interest rate									
Mean	0.26	0.22	0.10	0.36	0.32	0.29	0.29	0.29	0.27
StdDev	0.26	0.18	0.09	0.35	0.20	0.26	0.24	0.35	0.24
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	1.56	0.87	0.49	1.65	0.78	1.11	1.02	1.50	1.12
AFE CPI									
Mean	0.91	0.59	0.40	0.75	0.63	0.49	0.92	0.76	0.68
StdDev	0.57	0.24	0.19	0.59	0.35	0.26	0.34	0.29	0.35
Min	0.13	0.11	0.13	0.13	0.08	0.07	0.13	0.16	0.12
Max	2.18	1.15	0.73	2.15	1.74	1.02	1.37	1.41	1.47

AFE GDP

Mean	0.76	0.55	0.92	0.82	0.87	0.74	0.77	0.79	0.78
StdDev	0.61	0.16	0.27	0.41	0.40	0.26	0.59	0.27	0.37
Min	0.06	0.18	0.46	0.20	0.28	0.06	0.20	0.22	0.21
Max	2.40	1.06	1.52	1.63	1.87	1.26	2.42	1.37	1.69

AFE UE

Mean	0.17	1.54	0.14	-	-	-	1.76	0.10	0.74
StdDev	0.04	0.59	0.06	-	-	-	0.28	0.04	0.20
Min	0.09	0.57	0.05	-	-	-	1.23	0.04	0.40
Max	0.29	2.35	0.28	-	-	-	2.39	0.19	1.10

Interest rates

Mean 3M rate	3.71	3.07	0.13	4.79	3.15	1.39	4.98	3.39	3.08
Mean policy rate	3.97	2.89	0.09	4.63	3.10	1.28	4.94	3.64	3.07
Correlation	0.99	0.94	0.99	0.98	0.99	0.96	0.98	0.99	0.98

Source: Consensus Economics (2011); IMF (2011); Thomson Reuters Datastream (2010); Wright (2011); own calculations

Table 6: Transparency changes 1998-2006 by classification and country

	CA	EU	JP	NO	SE	CH	UK	US	Avg
Total									
Min	10.5	8.5	8.0	6.0	9.0	6.0	11.0	8.5	8.4
Max	11.0	11.0	9.5	8.0	14.5	9.5	12.5	10.0	10.8
Δ Total	0.5	2.5	1.5	2.0	5.5	3.5	1.5	1.5	2.3
Political									
Min	3.0	3.0	1.5	1.0	2.0	1.0	3.0	1.0	1.9
Max	3.0	3.0	1.5	2.5	2.5	3.0	3.0	1.0	2.4
Δ Political	0.0	0.0	0.0	1.5	0.5	2.0	0.0	0.0	0.5
Economic									
Min	2.5	1.0	1.0	1.0	1.5	1.0	1.5	2.5	1.5
Max	3.0	3.0	2.5	1.5	3.0	2.0	2.5	2.5	2.5
Δ Economic	0.5	2.0	1.5	-0.5	1.5	1.0	1.0	0.0	0.9
Procedural									
Min	1.0	1.0	2.0	1.0	2.0	1.0	3.0	2.0	1.6
Max	1.0	1.0	2.0	1.0	3.0	1.0	3.0	2.0	1.8
Δ Procedural	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.1
Policy									
Min	2.0	1.5	1.5	1.5	1.5	2.0	1.5	1.5	1.6
Max	2.0	2.0	1.5	2.0	3.0	2.0	1.5	3.0	2.1
Δ Policy	0.0	0.5	0.0	0.5	1.5	0.0	0.0	1.5	0.5
Operational									
Min	2.0	2.0	1.5	1.0	2.0	0.5	2.0	1.5	1.6
Max	2.0	2.0	2.0	1.5	3.0	1.5	2.5	1.5	2.0
Δ Operational	0.0	0.0	0.0	0.5	1.0	0.5	0.5	0.0	0.3

Source: Dincer and Eichengreen (2010); own calculations

Table 7: Number of months under a particular level of transparency by classification and country

	Political					Economic					Procedural			Policy			Operational					
	1	1.5	2	2.5	3	1	1.5	2	2.5	3	1	2	3	1.5	2	3	0.5	1	1.5	2	2.5	3
CA					108				72	36	108				108						108	
EU					108	36			36	36	108			48	60						108	
JP		108				24	48		36			108		108					36	72		
NO	28			72		72	28				100			64	36			28	72			
SE			12	96			24	24		60		48	60	24	24	60				24		84
CH	12		12	48	36	12	48	48			108				108		24	36	48			
UK					108		12		96				108	108						24	84	
US	108								108			108		12		96			108			
Tot	148	108	24	216	360	144	160	72	348	132	424	264	168	364	336	156	24	64	264	336	84	84

Source: Dincer and Eichengreen (2010)

10.2 Economic Shocks

In the graphs below, policy rate movements are shown in shaded grey color in the background and measured on the left axis. The size of the average policy rate change is shown as a dark line across the graph and measured on the right axis. The absolute interest rate forecast errors are represented by the bars on the bottom of the graph, measured on the left axis. The periods of economic shocks that have been controlled for are shaded from top to bottom.

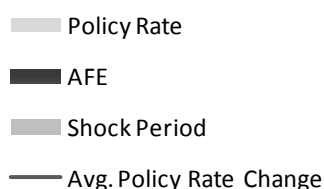


Table 8: Summary of periods with economic shocks controlled for

Country	Shocks	Observations controlled for
CA	2	8
EU	6	21
JP	7	22
NO	0	0
SE	4	16
CH	3	10
UK	4	11
US	3	10
Avg	3.6	12.3

Figure 21: Canada Economic Shocks

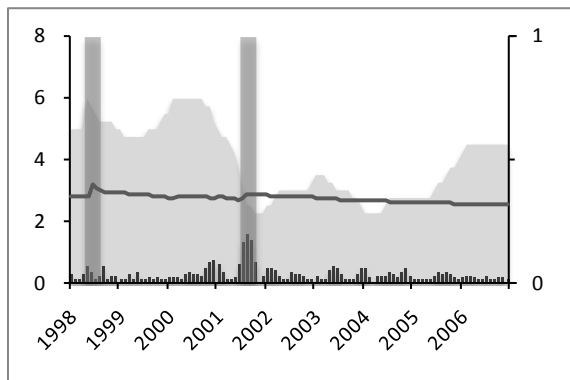


Figure 22: Euro zone Economic Shocks

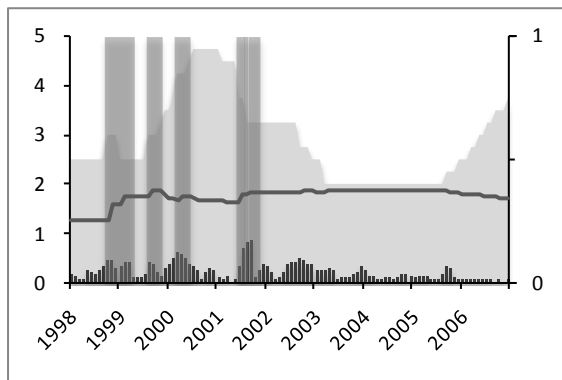


Figure 23: Japan Economic Shocks

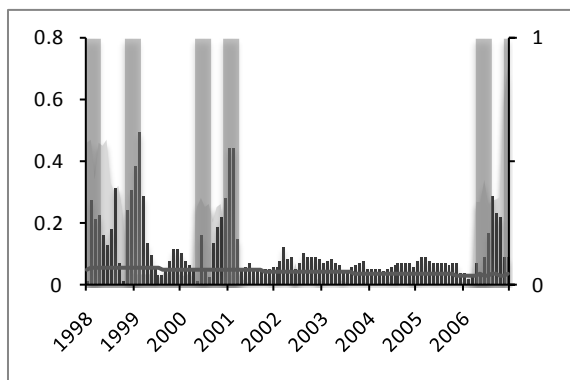


Figure 24: Norway Economic Shocks

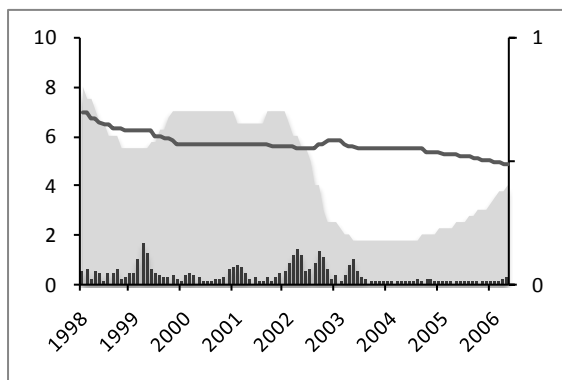


Figure 25: Sweden Economic Shocks

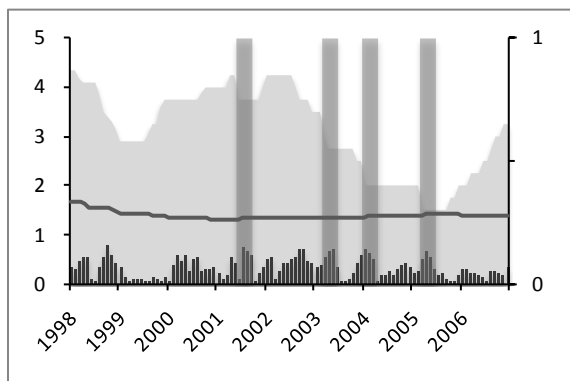


Figure 26: Switzerland Economic Shocks

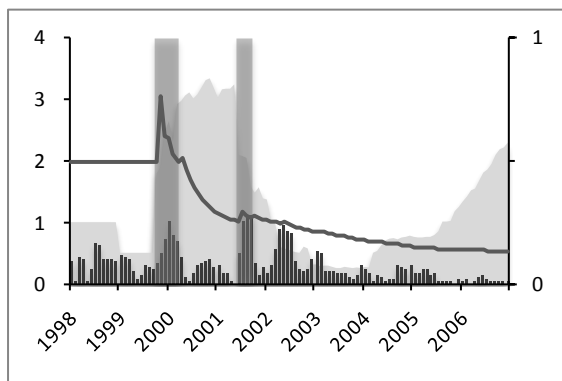


Figure 27: United Kingdom Economic Shocks

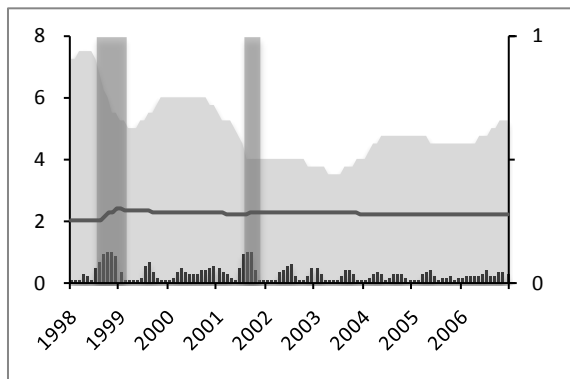
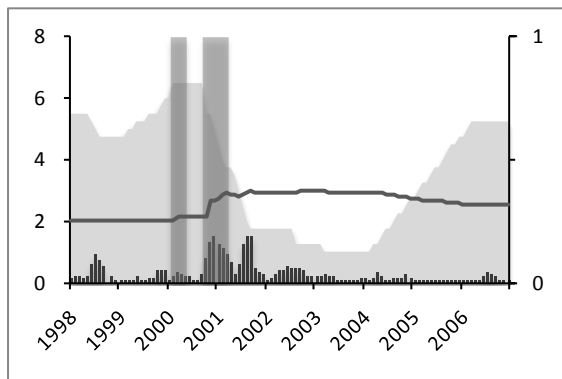


Figure 28: United States Economic Shocks



10.3 OLS Assumptions

Table 9: Summary of test results for OLS assumptions

OLS Assumption	CA	EU	JP	NO	SE	CH	UK	US	Panel
Linearity and Weak Dependence and Some Variation in Explanatory Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No Perfect Collinearity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Zero Conditional Mean	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)
Homoskedasticity	(Yes)	(Yes)	(Yes)	(Yes)	Yes	(Yes)	(Yes)	(Yes)	(Yes)
No Serial Correlation	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)
Cross Section Random Sampling	-	-	-	-	-	-	-	-	No

Note: Yes = assumption satisfied; (Yes) = assumption satisfied after adjustments; No = assumption not satisfied

Table 10: Dickey-Fuller test results for unit roots

	CA	EU	JP	NO	SE	CH	UK	US
AR(1)	-6.24***	-4.80***	-4.87***	-6.72***	-5.72***	-4.89***	-6.86***	-4.30***
AR(1) trend	-6.31***	-5.66***	-5.09***	-6.86***	-5.71***	-6.00***	-7.34***	-4.66***
AR(2)	-4.74***	-4.02***	-3.98***	-6.86***	-5.28***	-4.26***	-5.84***	-3.69***
AR(2) trend	-4.81***	-5.13***	-4.28***	-7.10***	-5.26***	-5.14***	-6.46***	-4.10***
AR(3)	-4.33***	-3.30**	-4.35***	-3.23**	-4.26***	-4.13***	-5.29***	-2.90**
AR(3) trend	-4.39***	-4.49***	-4.65***	-3.60**	-4.24***	-5.37***	-6.00***	-3.34*

Significance level: *** 1%, ** 5%, * 10%

Note: All tests reject the null-hypothesis of a unit root

Table 11: Test results for significance of serially correlated errors

		CA	EU	JP	NO	SE	CH	UK	US	Panel (total)	Panel (by class.)
Model 1	AR(0)	9.71***	10.31***	10.02***	11.91***	7.70***	9.74***	11.22***	15.62***	33.09***	32.93***
	AR(1)	3.23***	2.28**	2.12**	2.18**	2.42**	4.32***	6.85***	4.26***	10.81***	10.81***
	AR(2)	0.40	0.01	0.60	1.12	-0.67	-0.46	-0.37	0.56	1.24	1.22
Model 2	AR(0)	8.87***	9.44***	4.86***	9.26***	7.01***	9.51***	10.69***	5.80***	32.37***	32.15***
	AR(1)	3.20***	2.22**	2.42**	3.50***	2.79***	4.37***	6.86***	5.00***	11.01***	11.02***
	AR(2)	0.05	-0.05	0.31	0.71	-0.79	-0.74	-0.51	-0.04	1.06	1.02
Model 3	AR(0)	7.28***	7.25***	6.81***	11.29***	5.05***	8.93***	8.38***	12.20***	28.3***	28***
	AR(1)	3.66***	2.42**	1.73*	2.90***	3.04***	4.09***	7.25***	4.48***	11.46***	11.43***
	AR(2)	0.79	0.05	0.40	0.87	-0.62	1.55	-1.34	0.70	1.61	1.56
Model 4	AR(0)	7.15***	7.12***	4.57***	9.22***	4.53***	8.76***	7.77***	9.02***	27.61***	26.89***
	AR(1)	3.61***	2.38**	1.92*	2.34**	3.41***	3.97***	7.42***	5.25***	11.71***	11.74***
	AR(2)	0.54	0.04	0.28	0.67	-0.82	1.53	-1.61	-0.12	1.45	1.27

Significance level: *** 1%, ** 5%, * 10%

Note: With two lags of the dependent variable, AR(2), serial correlation in the error term becomes insignificant

Table 12: Test results for homoskedasticity

	CA	EU	JP	NO	SE	CH	UK	US	Panel (total)	Panel (by class.)
Model 1	21.32***	30.15***	82.59***	26.03***	0.10	33.43***	6.54**	35.88***	204.64***	221.00***
Model 2	21.67***	33.16***	115.89***	33.41***	0.25	30.66***	7.61**	29.70***	249.23***	275.85***
Model 3	16.63***	46.90***	109.50***	26.31***	1.58	22.53***	6.14**	30.20***	252.06***	285.50***
Model 4	16.83***	46.90***	121.00***	33.41***	1.15	21.67***	8.21**	24.69***	299.95***	340.59***

Significance level: *** 1%, ** 5%, * 10%

Note: All tests reject the null-hypothesis of homoskedasticity

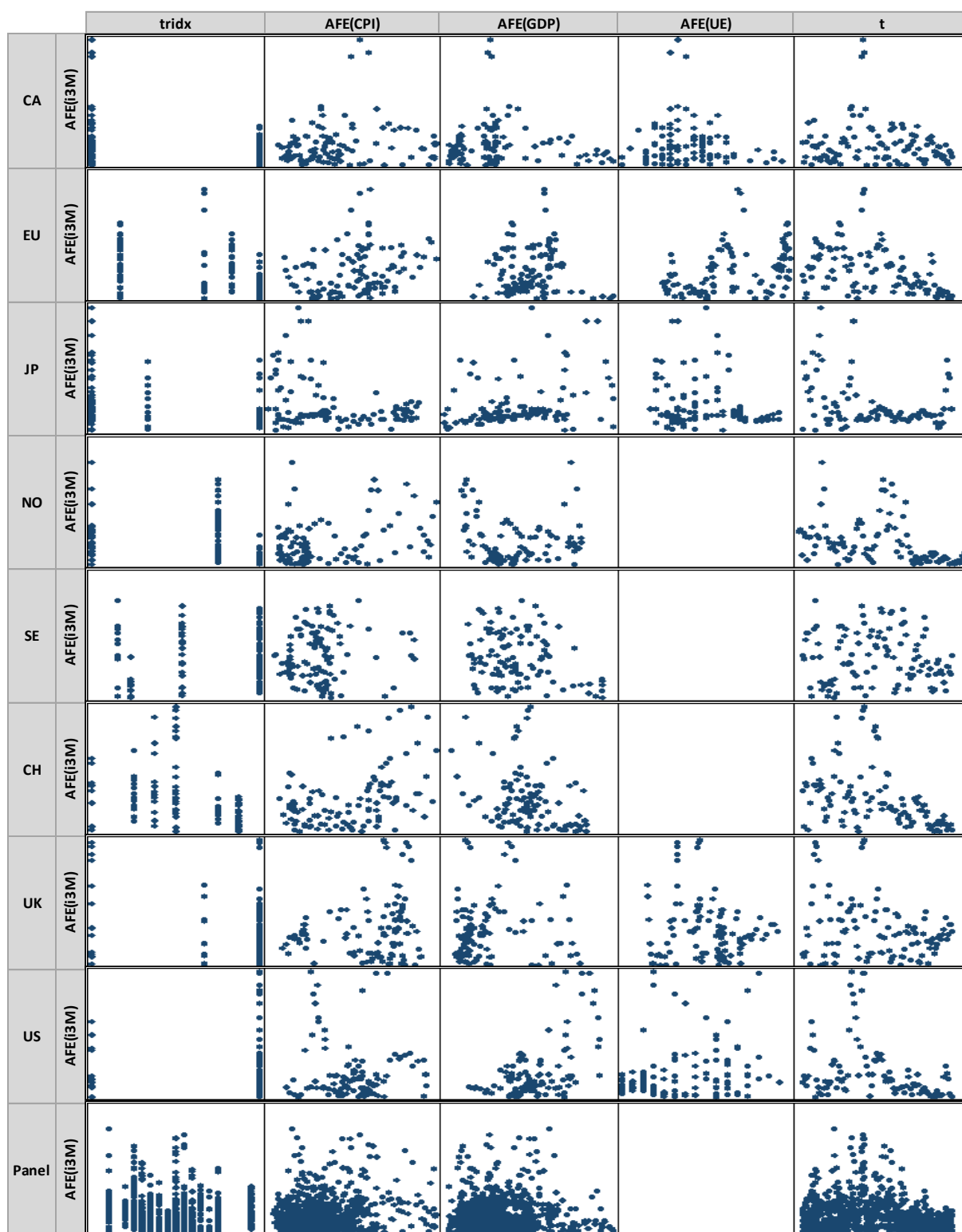
Table 13: Hausman test results for hypothesis of random effects-preferred model

	Panel (total)	Panel (by class.)
Model 1	28.16 ***	7.17
Model 2	22.23 ***	26.64 ***
Model 3	41.79 ***	40.38 ***
Model 4	42.49 ***	37.15 ***

Significance level: *** 1%, ** 5%, * 10%

Note: All tests reject the null-hypothesis of random effects except Model 1 when breaking down the transparency index

Figure 29: Scatter plots of variables for each dataset



10.4 Results

Table 14: Econometric results from country-specific analysis

	Canada				Euro zone			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
AFE(i3M) L1.	0.990**** (0.151)	0.970**** (0.148)	0.856**** (0.126)	0.862**** (0.129)	0.919**** (0.192)	0.908**** (0.191)	0.835**** (0.176)	0.834**** (0.178)
AFE(i3M) L2.	-0.435**** (0.130)	-0.471**** (0.128)	-0.440**** (0.115)	-0.464**** (0.116)	-0.309* (0.207)	-0.316* (0.204)	-0.347*** (0.170)	-0.346*** (0.174)
tridx	-0.110** (0.057)	-0.320**** (0.120)	-0.211** (0.115)	-0.319*** (0.146)	-0.027*** (0.013)	0.001 (0.035)	0.023 (0.028)	0.021 (0.035)
AFE(CPI)	-	-0.009 (0.044)	-	0.001 (0.038)	-	0.051 (0.046)	-	-0.007 (0.050)
AFE(GDP)	-	-0.137*** (0.053)	-	-0.096*** (0.048)	-	0.027 (0.060)	-	0.021 (0.057)
AFE(UE)	-	0.920 (0.717)	-	0.878 (0.706)	-	0.047 (0.057)	-	-0.004 (0.061)
Shock	-	-	0.254*** (0.127)	0.223** (0.135)	-	-	0.087** (0.046)	0.087** (0.047)
t	-	-	0.001 (0.001)	0.001 (0.001)	-	-	-0.002*** (0.001)	-0.002* (0.001)
intercept	1.293*** (0.619)	3.504**** (1.340)	1.731*** (0.802)	2.941*** (1.251)	0.358*** (0.155)	-0.041 (0.440)	0.669**** (0.245)	0.704 (0.631)
R²	0.597	0.620	0.639	0.649	0.610	0.615	0.639	0.639
	Japan				Norway			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
AFE(i3M) L1.	0.888**** (0.144)	0.762**** (0.145)	0.772**** (0.144)	0.715**** (0.143)	0.980**** (0.138)	0.919**** (0.134)	0.974**** (0.138)	0.919**** (0.134)
AFE(i3M) L2.	-0.230**** (0.087)	-0.300**** (0.099)	-0.210*** (0.102)	-0.265*** (0.113)	-0.280*** (0.121)	-0.336**** (0.122)	-0.287*** (0.120)	-0.337**** (0.123)
tridx	-0.006 (0.006)	-0.029**** (0.011)	0.002 (0.009)	-0.023*** (0.012)	-0.040 (0.032)	-0.130** (0.052)	0.002 (0.046)	-0.117** (0.061)
AFE(CPI)	-	-0.136**** (0.047)	-	-0.108*** (0.051)	-	0.047 (0.067)	-	0.047 (0.068)
AFE(GDP)	-	0.053*** (0.026)	-	0.044** (0.026)	-	-0.173* (0.132)	-	-0.168 (0.131)
AFE(UE)	-	-0.154*** (0.065)	-	-0.092 (0.076)	-	-	-	-
Shock	-	-	0.051*** (0.025)	0.036* (0.026)	-	-	-	-
t	-	-	0.000 (0.000)	0.000 (0.000)	-	-	-0.001* (0.001)	-0.000 (0.001)
intercept	0.087* (0.059)	0.332**** (0.119)	0.187* (0.135)	0.293* (0.180)	0.394* (0.252)	1.201** (0.518)	0.813** (0.411)	1.301*** (0.606)
R²	0.582	0.642	0.628	0.659	0.666	0.684	0.658	0.684

Significance level: **** 1%, *** 5%, ** 10%. * 20%

Table 15: Econometric results from country-specific analysis (continued)

	Sweden				Switzerland			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
AFE(i3M) L1.	0.742**** (0.096)	0.709**** (0.097)	0.604**** (0.101)	0.570**** (0.101)	1.005**** (0.122)	0.973**** (0.119)	0.832**** (0.118)	0.831**** (0.119)
AFE(i3M) L2.	-0.234*** (0.097)	-0.263**** (0.097)	-0.283**** (0.093)	-0.313**** (0.093)	-0.389**** (0.114)	-0.395**** (0.112)	-0.309**** (0.088)	-0.305**** (0.090)
tridx	0.004 (0.007)	0.002 (0.010)	0.044**** (0.017)	0.037*** (0.017)	-0.042*** (0.017)	-0.029* (0.018)	-0.032 (0.034)	-0.033 (0.040)
AFE(CPI)	-	0.051 (0.061)	-	0.029 (0.059)	-	0.097* (0.069)	-	-0.024 (0.070)
AFE(GDP)	-	-0.079* (0.048)	-	-0.087** (0.046)	-	-0.068 (0.071)	-	0.007 (0.079)
AFE(UE)	-	-	-	-	-	-	-	-
Shock	-	-	0.119*** (0.048)	0.127**** (0.048)	-	-	0.261**** (0.061)	0.271**** (0.069)
t	-	-	-0.003**** (0.001)	-0.003**** (0.001)	-	-	0.000 (0.001)	0.000 (0.002)
intercept	0.105 (0.096)	0.193 (0.180)	1.354**** (0.439)	1.445**** (0.475)	0.463**** (0.162)	0.368*** (0.186)	0.488* (0.374)	0.538 (0.502)
R²	0.401	0.425	0.466	0.489	0.686	0.698	0.756	0.756
	United Kingdom				United States			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
AFE(i3M) L1.	1.108**** (0.101)	1.103**** (0.102)	1.060**** (0.099)	1.029**** (0.104)	1.166**** (0.155)	1.094**** (0.147)	1.085**** (0.160)	1.016**** (0.148)
AFE(i3M) L2.	-0.544**** (0.081)	-0.550**** (0.082)	-0.597**** (0.095)	-0.610**** (0.099)	-0.390*** (0.162)	-0.449**** (0.160)	-0.388*** (0.158)	-0.454**** (0.153)
tridx	-0.067* (0.048)	-0.062 (0.060)	-0.021 (0.062)	-0.005 (0.062)	-0.005 (0.053)	0.039 (0.056)	0.008 (0.057)	0.016 (0.057)
AFE(CPI)	-	0.035 (0.047)	-	0.017 (0.043)	-	0.012 (0.058)	-	0.065 (0.057)
AFE(GDP)	-	-0.026 (0.039)	-	0.014 (0.040)	-	0.313*** (0.128)	-	0.293*** (0.130)
AFE(UE)	-	-0.027 (0.114)	-	0.348** (0.186)	-	-0.413 (0.540)	-	0.025 (0.424)
Shock	-	-	0.098 (0.084)	0.106 (0.088)	-	-	0.169** (0.091)	0.216**** (0.077)
t	-	-	-0.001* (0.000)	-0.004**** (0.001)	-	-	-0.001** (0.000)	0.000 (0.001)
intercept	0.957* (0.611)	0.932* (0.669)	0.733 (0.686)	1.389* (0.867)	0.117 (0.527)	-0.490 (0.600)	0.435 (0.525)	-0.319 (0.639)
R²	0.696	0.700	0.706	0.717	0.748	0.772	0.773	0.795

Significance level: **** 1%, *** 5%, ** 10%, * 20%

Table 16: Econometric results from panel data analysis

	Panel (total transparency)				Panel (by classification)			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
AFE(i3M) L1.	1.013**** (0.054)	1.009**** (0.054)	0.959**** (0.055)	0.953**** (0.055)	1.010**** (0.055)	1.006**** (0.055)	0.958**** (0.055)	0.949**** (0.055)
AFE(i3M) L2.	-0.349**** (0.051)	-0.356**** (0.051)	-0.357**** (0.050)	-0.365**** (0.050)	-0.349**** (0.051)	-0.356**** (0.051)	-0.357**** (0.050)	-0.367**** (0.050)
tridx	-0.085*** (0.036)	-0.090*** (0.035)	-0.043 (0.037)	-0.042 (0.037)				
tridx²	0.003**** (0.002)	0.004*** (0.002)	0.002* (0.002)	0.002* (0.002)				
political					-0.044* (0.029)	-0.053** (0.028)	-0.025 (0.029)	-0.031 (0.029)
economic					-0.031*** (0.012)	-0.023** (0.012)	0.010 (0.015)	0.026** (0.015)
procedural					0.095* (0.059)	0.095* (0.059)	0.050 (0.059)	0.040 (0.058)
policy					-0.041 (0.037)	-0.045 (0.037)	-0.022 (0.037)	-0.022 (0.036)
operational					0.011 (0.028)	0.019 (0.029)	0.018 (0.027)	0.027 (0.027)
AFE(CPI)		0.033** (0.018)		0.030** (0.017)		0.035*** (0.017)		0.038*** (0.017)
AFE(GDP)		-0.005 (0.013)		-0.024* (0.015)		-0.006 (0.013)		-0.028** (0.015)
Shock			0.094**** (0.025)	0.093**** (0.025)			0.096**** (0.026)	0.098**** (0.026)
t			-0.001**** (0.0)	-0.001**** (0.0)			-0.001**** (0.0)	-0.001**** (0.0)
Country Effect								
CA	0.607**** (0.202)	0.601**** (0.203)	0.718**** (0.202)	0.774**** (0.204)	0.268**** (0.083)	0.243**** (0.088)	0.526**** (0.116)	0.615**** (0.134)
EU	0.579**** (0.198)	0.583**** (0.197)	0.689**** (0.198)	0.752**** (0.198)	0.230**** (0.081)	0.216**** (0.083)	0.497**** (0.115)	0.599**** (0.130)
JP	0.509**** (0.189)	0.522**** (0.188)	0.640**** (0.191)	0.720**** (0.191)	0.004 (0.085)	-0.011 (0.085)	0.365**** (0.136)	0.491**** (0.152)
NO	0.553**** (0.185)	0.556**** (0.185)	0.750**** (0.189)	0.824**** (0.192)	0.204**** (0.071)	0.193**** (0.074)	0.569**** (0.125)	0.693**** (0.146)
SE	0.623**** (0.191)	0.622**** (0.191)	0.708**** (0.189)	0.770**** (0.191)	0.119 (0.113)	0.099 (0.113)	0.450**** (0.146)	0.563**** (0.161)
CH	0.564**** (0.191)	0.574**** (0.189)	0.723**** (0.192)	0.798**** (0.193)	0.235**** (0.078)	0.234**** (0.080)	0.549**** (0.119)	0.674**** (0.135)
UK	0.628**** (0.201)	0.618**** (0.203)	0.715**** (0.199)	0.766**** (0.202)	0.054 (0.155)	0.026 (0.153)	0.421*** (0.186)	0.530**** (0.194)
US	0.604**** (0.199)	0.605**** (0.199)	0.730**** (0.199)	0.794**** (0.20)	0.131** (0.072)	0.103* (0.075)	0.467**** (0.120)	0.567**** (0.141)
R²	0.834	0.835	0.842	0.843	0.835	0.836	0.842	0.844

Significance level: **** 1%, *** 5%, ** 10%. * 20%