Expectations Management of Central Banks

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Diese Dissertation besteht aus drei Arbeitspapieren, von denen zwei in Zusammenarbeit mit jeweils einem Koautor entstanden und in den unten genannten fachrezensierten Zeitschriften publiziert worden sind. Der Eigenanteil an Konzeption, Durchführung und Berichtsabfassung lässt sich folgendermaßen zusammenfassen:

- Detmers, Gunda-Alexandra und Nautz, Dieter (2012):
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Kapitel 1 und 2 entsprechen den in den Fachzeitschriften publizierten Versionen. Die Anhänge in Kapitel 1 und 2 enthalten Abschnitte und zusätzliches Material aus den Versionen der zugehörigen Diskussionspapiere. Außerdem wurde das Literaturverzeichnis aktualisiert, sofern zitierte Artikel zwischenzeitlich veröffentlicht wurden.

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General Introduction and Results

The effectiveness of monetary policy crucially depends on the central bank's ability to manage expectations about the future course of very short-term rates (see Woodford, 2001, 2005). According to the expectations hypothesis of the term structure, these determine the longer-term interest rates that matter for economic decisions and aggregate demand. Specifically, longer-term rates average the current short-term interest rate and the expected future path of short-term rates within a particular maturity. Consequently, managing expectations about interest rates through the issuance of forward guidance steers longer-term rates and thus the state of the economy.

Decades ago, central banks were rather uncommunicative even about their current monetary policy as secrecy was thought to maximize the effectiveness of monetary policy. However, especially since the adoption of inflation targeting as monetary policy framework, central banks have increased their communication with the public and financial markets (see also Mishkin, 2002). This particularly involves clear communication of an explicit objective as well as the bank's intended course of action in order to achieve that goal. The latter implies expectations management in different forms. By now, forward guidance has become an established instrument of monetary policy. Central banks increasingly communicate with the public in order to increase the public's understanding of monetary policy and its ability to anticipate future monetary policy actions (see Rudebusch and Williams, 2008).

Several central banks began issuing forward guidance in a conditional way already before the financial crisis. Yet, expectations management has experienced a quantum leap ever since. Back then, some central banks started to provide forward guidance endowed with a commitment in order to better shape expectations. Campbell et al. (2012) therefore distinguish between two types of forward guidance, namely Delphic and Odyssean forward guidance. Delphic forward guidance is a strategy to announce the central bank's beliefs about the future course of monetary policy conditional on future economic outcomes without a commitment to a particular future path. In contrast, Odyssean forward guidance as issued by several central banks especially since the last financial crisis has a commitment character and, at times when policy rates are restricted by a lower bound, typically involves a promise of prolonged expansionary monetary policy in the future. In practice, this commitment has been linked either to some date in the future or to explicit outcomes in unemployment and inflation. Both of these forward guidance strategies are intended to steer financial markets' expectations about the future course of monetary policy, and the effectiveness of both strategies also depends on the credibility of the corresponding central bank. While central banks should know best about their future actions, market interest rates would only move upon a communication if it is a credible and clear statement that contains some new information to financial market participants (see Filardo and Hofmann, 2014).

The optimal degree of central bank transparency is still under debate, as are the implications of forward guidance for financial market volatility, central bank credibility and social welfare (see e.g. van der Cruijsen et al., 2010; Morris and Shin, 2002; Svensson, 2006). Expectations management is not without risks as public misunderstanding, imprecise or confusing central bank signals or even inconsistent monetary policy could have detrimental effects (see e.g. Issing, 2005). Meanwhile several forms of forward guidance are applied, especially since the financial crisis. In this context, this thesis provides empirical evidence on the effectiveness of central banks' expectations management in three different studies. Thereby it aims at contributing to a deeper understanding of different forward guidance strategies and at monitoring this rather recent trend in monetary policy.

The three papers comprise the analysis of both forward guidance strategies as labelled by Campbell et al. (2012). While chapters 1 and 2 focus on the conditional quantitative forward guidance provided by the Reserve Bank of New Zealand (RBNZ), chapter 3 investigates Odyssean forward guidance as issued by the Federal Reserve System (Fed) in the aftermath of the financial crisis that started in 2007. The RBNZ is known as a pioneer in inflation targeting and as the most transparent central bank (see Dincer and Eichengreen, 2008). It also was the first central bank to publish interest rate projections as a method of forward guidance in 1997. When policy rates approached the zero lower bound in recent years, the Fed, amongst others, introduced a commitment to their forward guidance as a means of unconventional monetary policy. Since then, they have gradually varied the degree of commitment and even disclosed the policymakers' disagreement about the future course of policy rates. These two central banks with a variety of expectations management tools allow research into different aspects that determine the information content of central banks' expectations management.

Chapter 1 investigates the impact of the RBNZ's quarterly interest rate projections on financial markets' expectations. This is done using an event study with days on which the RBNZ publishes the projections over a sample that also covers the period of financial crisis. As forward guidance is intended to reduce uncertainty in financial markets, this paper concentrates on the persistence of market reactions to the surprise component in central bank projections. Chapter 2 focuses on the effect of aging projections on interest rate uncertainty which is proxied by volatility between two publications. In Chapter 3, Odyssean forward guidance and policymakers' disagreement thereon come into focus. The impact of different degrees of commitment on the sensitivity of interest rates to other public information is analyzed and considered in the perspective of policymakers' disagreement.

The present thesis covers these different aspects of central banks' expectations management and is devoted to contributing new evidence to the field of central bank communication and forward guidance as unconventional monetary policy. The main contributions and results of each individual paper can be summarized as follows:

- ***Paper 1***: *The Information Content of Central Bank Interest Rate Projections: Evidence from New Zealand*

  The first paper provides new evidence on the information content of interest rate projections for market expectations about future short-term rates before and during the financial crisis. While the information content of the RBNZ's projections decreases with the forecast horizon in both periods, the impact on market expectations has declined significantly since the outbreak of the crisis. This study reveals that the RBNZ's expectations management only plays a role for short horizons. For longer-term horizons, in contrast, their effect on market expectations is only short-lived and thus volatility-increasing. The release of longer-term projections may therefore even be detrimental since the private sector's ability to assess the quality of that information is limited (see Dale et al., 2011).

- ***Paper 2***: *Stale Forward Guidance*

  The second paper stays with the RBNZ and investigates the time-varying and state-dependent influence of the RBNZ's interest rate projections on market expectations and interest rate uncertainty. Those projections are only updated quarterly and may therefore become stale in between. Confirming the stabilizing effect of fresh central bank announcements, the analysis reveals that interest rate uncertainty rises between two releases of projections. Moreover, rate uncertainty and the importance of macroeconomic news increase if expectations deviate from the rate projected by the central bank. Counterfactual analysis suggests that the efficacy of projections would improve if the central bank updated its projections whenever they become stale.

- ***Paper 3***: *Forward Guidance under Disagreement - Evidence from the Fed's Dot Projections*

  The third paper passes on to the Federal Reserve and focuses on its Odyssean forward guidance issued since the financial crisis. It compares the effectiveness of date- and state-based forward guidance issued since mid-2011 accounting for the influence of disagreement within the Federal Open Market Committee (FOMC). The effectiveness of this policy is investigated through the lens of interest rates' sensitivity to macroeconomic news. The study finds evidence that the Fed's forward guidance reduces sensitivity and hence crowds out other public information. The sensitivity shrinkage is stronger in the case of date-based forward guidance due to its unconditional nature. Yet, high levels of disagreement among monetary policymakers as published through the FOMC's dot projections - which are being used since 2012 - partially restore sensitivity to macroeconomic news. Thus, disagreement appears to reduce the information content of forward guidance and to weaken the Fed's commitment as perceived by financial markets. This paper reaches the conclusion that dot projections as a measure of forward guidance diminished the information content of the Fed's Odyssean forward guidance and therefore reduced its focal point character. Thus, the Fed was able to somewhat attenuate its commitment and restore interest rates' sensitivity to macroeconomic news.

Allgemeine Einführung und Ergebnisse

Die Wirksamkeit von Geldpolitik hängt entscheidend von der Fähigkeit der Zentralbank ab, die Erwartungen über den zukünftigen Verlauf der Kurzfristzinsen zu steuern (siehe Woodford 2001, 2005). Gemäß der Erwartungshypothese der Zinsstruktur bestimmen diese Erwartungen die längerfristigen Zinssätze, welche für wirtschaftliche Entscheidungen und die gesamtwirtschaftliche Nachfrage wesentlich sind. Insbesondere bilden sich Langfristzinsen aus dem Durchschnitt des aktuellen Tageszinssatzes und der erwarteten Entwicklung der Kurzfristzinsen innerhalb einer bestimmten Laufzeit. Die Steuerung von Markterwartungen durch zukunftsgerichtete Hinweise zur Geldpolitik lenkt folglich die längerfristigen Zinsen und beeinflusst damit die Wirtschaftslage.

Vor Jahrzehnten waren Zentralbanken eher unkommunikativ, sogar was die aktuelle Geldpolitik anbelangt; Geheimhaltung galt als förderlich für die Wirksamkeit der Geldpolitik. Jedoch haben Zentralbanken ihre Kommunikation mit der Öffentlichkeit und den Finanzmärkten unterdessen ausgebaut, vor allem seit der Einführung von direkter Inflationssteuerung als geldpolitische Strategie (siehe auch Mishkin 2002). Diese erfordert vor allem eine klare Kommunikation eines expliziten Ziels sowie der beabsichtigten Maßnahmen, um dieses Ziel zu erreichen. Letzteres beinhaltet Erwartungssteuerung in verschiedenen Ausprägungen. Inzwischen sind zukunftsgerichtete Hinweise zur Geldpolitik ein etabliertes Instrument der Geldpolitik. Die Zentralbanken kommunizieren zunehmend mit der Öffentlichkeit, um deren Verständnis von Geldpolitik sowie ihre Fähigkeit zur Antizipation zukünftiger geldpolitischer Entscheidungen zu erhöhen (siehe Rudebusch und Williams 2008).

Einige Zentralbanken begannen bereits vor der Finanzkrise mit bedingten zukunftsgerichteten Hinweisen zur Geldpolitik. Seit der Finanzkrise hat die Erwartungssteuerung durch Zentralbanken jedoch einen Quantensprung erfahren. Einige Zentralbanken begannen ihre zukunftsgerichteten Hinweise mit einer Verbindlichkeit auszustatten, um die Markterwartungen noch besser zu beeinflussen. Campbell et al. (2012) unterscheiden zwischen zwei Arten von zukunftsgerichteten Hinweisen, nämlich Delphischer und Odysseischer Art. Delphische Hinweise zur Geldpolitik sind Zentralbankvorhersagen über voraussichtliche zukünftige Maßnahmen, die durch den momentan prognostizierten Verlauf der Wirtschaft bedingt sind, ohne bindende Festlegung auf einen bestimmten Pfad. Odysseische Zentralbankkommunikation, die vermehrt seit der Finanzkrise und im Kontext eingeschränkter Möglichkeiten konventioneller Geldpolitik aufgrund der Nominalzinsuntergrenze angewandt wird, geht hingegen mit einer Verpflichtung auf gewisse zukünftige geldpolitische Maßnahmen einher. Sie umfasst in der Regel ein Versprechen einer in die Zukunft ausgedehnten expansiven Geldpolitik. In der Praxis wird diese Verpflichtung entweder auf einen gewissen Zeitpunkt in der Zukunft oder explizite zukünftige Entwicklungen z.B der Arbeitslosigkeit und Inflation bezogen. Beide Arten zukunftsgerichteter Hinweise sollen die Finanzmarkterwartungen über den künftigen Kurs der Geldpolitik steuern, und die Wirksamkeit beider Strategien ist unter anderem von der Glaubwürdigkeit der entsprechenden Zentralbank abhängig. Zwar sollten Zentralbanken einen Informationsvorsprung in Bezug auf ihre eigenen zukünftigen Maßnahmen haben, die Zinsen am Finanzmarkt sollten jedoch nur reagieren, wenn die Kommunikation der Zentralbank eine glaubwürdige und klare Aussage darstellt und für Finanzmarktteilnehmer neue Informationen enthält (siehe Filardo und Hofmann, 2014).

Zum optimalen Grad an Transparenz von Zentralbanken bestehen unterschiedliche Auffassungen in der theoretischen und empirischen Literatur, ebenso zu den genauen Auswirkungen zukunftsgerichteter Aussagen auf Finanzmarktvolatilität, Glaubwürdigkeit der Zentralbank und die wirtschaftliche Wohlfahrt (siehe z.B. van der Cruijsen et al. 2010, Morris und Shin 2002, Svensson 2006). Die Erwartungssteuerung ist nicht ohne Risiken, da ein öffentliches Missverständnis, ungenaue oder verwirrende Zentralbanksignale oder gar widersprüchliche Geldpolitik nachteilige Auswirkungen haben könnten (siehe z.B. Issing 2005). Inzwischen und vor allem seit dem Einsetzen der Finanzkrise werden verschiedene Formen zukunftsgerichteter Aussagen verlautbart. In diesem Kontext liefert diese Dissertation empirische Evidenz über die Wirksamkeit von Erwartungssteuerung durch Zentralbanken in drei verschiedenen Studien. Diese Schrift leistet somit einen Beitrag zu einem profunderen Verständnis der verschiedenen Strategien sowie zur Einschätzung dieses relativ neuen geldpolitischen Trends.

Die drei Papiere umfassen die Analyse der verschiedenen Arten von zukunftsgerichteten Hinweisen nach Campbell et al. (2012). Während Kapitel 1 und 2 sich auf die bedingte quantitative Kommunikation durch die Reserve Bank of New Zealand (RBNZ) konzentrieren, untersucht Kapitel 3 die Odysseische Zentralbankkommunikation, wie sie durch das Federal Reserve

System (Fed) in der Zeit nach der Finanzkrise verlautbart worden ist. Die RBNZ ist als Pionierin in der direkten Inflationssteuerung sowie als transparenteste Zentralbank (siehe Dincer und Eichengreen 2007) bekannt. Die RBNZ war auch die erste Zentralbank, die im Jahr 1997 quantitative Zinsprojektionen als eine Methode der zukunftsgerichteten Kommunikation einführte. Als sich die Leitzinsen in den USA der Nominalzinsuntergrenze näherten, begann die Fed ihre zukunftsgerichtete Kommunikation mit einem Versprechen als Form von unkonventioneller Geldpolitik auszustatten. Seitdem hat die Fed den Grad der Verpflichtung allmählich variiert und offenbart seit 2012 auch die unterschiedlichen Einzelmeinungen der Entscheidungsträger über den weiteren Verlauf der Leitzinsen in Form von Punktprojektionen. Diese beiden Zentralbanken mit einer Vielzahl von Erwartungssteuerungsinstrumenten ermöglichen die Erforschung verschiedener Aspekte, die den Informationsgehalt zukunftsgerichteter Zentralbankkommunikation bestimmen.

Kapitel 1 untersucht die Auswirkungen der vierteljährlich veröffentlichten Zinsprognosen der RBNZ auf Finanzmarkterwartungen. Dies geschieht mit Hilfe einer Ereignisstudie an Tagen, an denen die RBNZ ihre Zinsprojektionen veröffentlicht; die Stichprobe deckt auch den Zeitraum der Finanzkrise ab. Da zukunftsgerichtete Hinweise zur Geldpolitik die Unsicherheit und damit die Volatilität an Finanzmärkten verringern sollen, konzentriert sich dieses Papier auf die Persistenz von Marktreaktionen auf die Überraschungskomponente in den Zentralbankprojektionen. Kapitel 2 konzentriert sich auf die Auswirkungen alternder Projektionen auf die Zinsunsicherheit, die durch Volatilität zwischen zwei Publikationen approximiert wird. In Kapitel 3 rücken die Odysseische Zentralbankkommunikation der Fed und die Uneinigkeit der geldpolitischen Entscheidungsträger in den Fokus. Die Auswirkungen unterschiedlicher Abstufungen der Verbindlichkeit von Zentralbankversprechen auf die Reaktivität der Zinssätze in Bezug auf andere öffentliche Informationen werden unter Berücksichtigung der Uneinigkeit im geldpolitischen Komitee analysiert.

Die vorliegende Arbeit behandelt diese verschiedenen Aspekte der Erwartungssteuerung von Zentralbanken und liefert neue Ergebnisse auf dem Gebiet der Zentralbankkommunikation und unkonventioneller Geldpolitik. Die wichtigsten Beiträge und Ergebnisse der einzelnen Papiere lassen sich wie folgt zusammenfassen:

- ***Papier 1***: *The Information Content of Central Bank Interest Rate Projections: Evidence from New Zealand*

  Das erste Papier legt neue Erkenntnisse über den Informationsgehalt von Zinsprognosen für die Markterwartungen über zukünftige Kurzfristzinsen vor und während der Finanzkrise dar. Während sich der Informationsgehalt der Projektionen der RBNZ in beiden Perioden mit dem Prognosehorizont verringert, sind die Auswirkungen auf die Erwartungen seit dem Ausbruch der Krise deutlich zurückgegangen. Diese Studie zeigt, dass die Erwartungssteuerung der RBNZ nur für kurzfristige Zeithorizonte eine Rolle spielt. Für längerfristige Horizonte hingegen ist ihre Wirkung nur von kurzer Dauer und wirkt damit volatilitätssteigernd. Die Veröffentlichung von längerfristigen Prognosen kann daher sogar schädlich sein, denn die Fähigkeit des privaten Sektors, die Qualität dieser Informationen zu beurteilen, ist begrenzt (siehe Dale et al. 2011).

- ***Papier 2***: *Stale Forward Guidance*

  Das zweite Papier ist ebenfalls der RBNZ gewidmet und untersucht den über die Zeit variierenden und zustandsabhängigen Einfluss von Zinsprojektionen auf die Finanzmarkterwartungen und die Zinsunsicherheit. Die Projektionen werden nur vierteljährlich durch die Zentralbank aktualisiert und können somit in der Zwischenzeit veralten. Die Analyse bestätigt die stabilisierende Wirkung von hochaktuellen Zentralbankankündigungen und zeigt, dass die Zinsunsicherheit am Markt zwischen zwei Projektionsveröffentlichungen ansteigt. Des Weiteren steigen die Kursunsicherheit sowie die Bedeutung makroökonomischer Nachrichten an, wenn die Erwartungen am Markt von denen der Zentralbank abweichen. Eine kontrafaktische Analyse deutet darauf hin, dass die Wirksamkeit von Projektionen verbessert werden könnte, indem die Zentralbank ihre Projektionen aktualisiert, wann immer sie veralten.

- ***Papier 3***: *Forward Guidance under Disagreement - Evidence from the Fed's Dot Projections*

  Das dritte Papier geht über zur U.S. Federal Reserve und konzentriert sich auf die seit der Finanzkrise verlautbarte Odysseische Zentralbankkommunikation. Es vergleicht die Wirksamkeit von datums- und zustandsbezogenen Zentralbankversprechen, die seit Mitte 2011 verkündet werden, und geht dabei insbesondere auf den Einfluss von Meinungsverschiedenheiten innerhalb des Federal Open Market Committee (FOMC) ein. Die Wirksamkeit dieser Politik wird mit Blick auf die Reaktivität von Zinssätzen auf makroökonomische Nachrichten untersucht. Die Studie stellt fest, dass die Odysseische Zentralbankkommunikation der Fed die Reaktivität der Zinsen reduziert und damit andere öffentliche Informationen verdrängt. Die Reduzierung der Reaktivität ist stärker im Falle der datumsbezogenen Versprechen aufgrund ihrer sehr bedingungslosen Natur. Ein hohes Maß an Uneinigkeit unter den geldpolitischen Entscheidungsträgern – gemessen an den seit 2012 veröffentlichten Punktprojektionen des FOMC – stellt die Reaktivität von Zinsen auf makroökonomische Nachrichten wieder her. Somit scheint Uneinigkeit der Entscheidungsträger den Informationsgehalt zukunftsgerichteter Aussagen zu reduzieren und das Versprechen der Zentralbank in der

Wahrnehmung der Finanzmärkte abzuschwächen. Das Papier kommt zu dem Schluss, dass die Punktprojektionen als ein Instrument von zukunftsgerichteter Kommunikation den Informationsgehalt der Odysseischen Kommunikation verringern und damit ihren Fokuspunktcharakter reduzieren. Dadurch war die Fed in der Lage, ihr zuvor verlautbartes bedingungsloses Versprechen abzumildern und die Reaktivität der Zinssätze auf makroökonomische Nachrichten wiederherzustellen.

Chapter 1

The Information Content of Central Bank Interest Rate Projections: Evidence from New Zealand

Gunda-Alexandra Detmers and Dieter Nautz

Abstract

The Reserve Bank of New Zealand was the first central bank to publish interest rate projections as a tool for forward guidance of monetary policy. This chapter provides new evidence on the information content of interest rate projections for market expectations about future short-term rates before and during the financial crisis. While the information content of interest rate projections decreases with the forecast horizon in both periods, we find that their impact on market expectations has declined significantly since the outbreak of the crisis.

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1.1 Introduction

Central banks take different views on how to manage expectations about future monetary policy. In particular, it is not clear to what extent central banks should reveal information about the policy-intended future interest rate path. In June 1997, the Reserve Bank of New Zealand (RBNZ) was the first central bank to publish interest rate projections within their quarterly Monetary Policy Statements (MPSs). Each MPS is a comprehensive analysis of the state of the economy and contains projections for several key economic time series. Yet for the RBNZ's management of expectations about future monetary policy decisions, the publication of the future interest rate track for the 90-day interest rate is of particular importance. This chapter provides new evidence on the information content of the RBNZ's interest rate projections for market expectations about future short-term rates before and during the financial crisis.

There is a lively debate on the pros and cons of providing explicit projections of future policy rates. Many central banks remain sceptical against the announcement of an interest rate projection because the public might not appreciate its uncertainty and conditionality, see Archer (2005). Morris and Shin (2002) argue that there is a risk that markets may focus too intently on the public projections and pay too little attention to other private sources of information. As a result, incorrect public forecasts would generate a joint error that will distort the assessment of market participants. Svensson (2006) showed that the public signal must be extremely inaccurate in order to decrease welfare. In the same vein, Rudebusch and Williams (2008) find that providing interest rate projections helps shaping market expectations if the public's understanding of monetary policy implementation is imperfect.

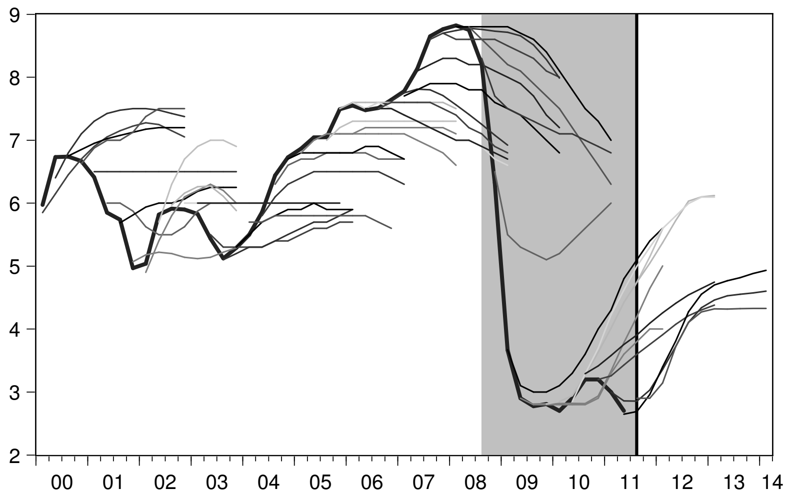
The evidence on the empirical performance of central bank interest rate projections is mixed. Winkelmann (2016) finds that the announcement of the Norges Bank key rate projections has significantly reduced market participants' revisions of the expected future policy path. In contrast, Andersson and Hofmann (2010) show that the publication of interest rate projections is not an important issue for central banks with already a high degree of transparency. For those central banks, announcing the forward interest rate tracks may neither improve the predictability of monetary policy nor the anchoring of long-term inflation expectations. Goodhart and Lim (2011) find that the RBNZ's interest rate projections are even inefficient and useless for horizons of more than two quarters. The current chapter builds on Moessner and Nelson (2008) and Ferrero and Secchi (2009) who investigate the impact of the RBNZ's interest rate projections on market's expectations derived from futures rates for the pre-crisis period. Moessner and Nelson (2008) estimate a statistically significant impact of projections on futures rates at their announcement day. The response of futures rates can only be seen as an indication of an efficient expectations management of the central bank if it is not reversed over the following days. In this case, the effect of newly announced interest rate projections on market expectations would have been only elusive and volatility-increasing. Ferrero and Secchi (2009) show that the impact of the projections is in fact persistent but they only consider forecast horizons up to four quarters ahead. Advancing on Ferrero and Secchi (2009), we investigate the market response to the RBNZ's longer-term interest rate projections up to six quarters ahead. The focus of our chapter is, however, on whether the information content of interest rate projections has changed during the recent crisis. Our results indicate that the impact of projections on market expectations has significantly decreased since the outbreak of the crisis.

The remainder of the chapter is structured as follows. Chapter 1.2 describes the interest rate projections of the RBNZ, while Chapter 1.3 derives their unanticipated and anticipated components using futures rates. Chapter 1.4 analyzes the response of futures rates to a newly announced interest rate projection. Chapter 1.5 provides some concluding remarks.

1.2 The Interest Rate Projections of the RBNZ

At the RBNZ, the quarterly MPSs are the most important tool for communicating both, current and future monetary policy decisions. Each MPS contains projections for several key economic time series. While the public gives considerable attention to the RBNZ's projections for inflation, the exchange rate and output growth, the RBNZ's publication of the future interest rate track for the 90-day interest rate should be crucial for the management of expectations about future interest rate decisions.[1]

Figure 1.1: Interest Rate Projections and the 90-Day Interest Rate



Notes: Quarterly projections for the 90-day bank bill rate around its actual monthly level (continuous bold line). The light shaded area refers to the period as of September 2008. The vertical line represents the end of the sample. Data are taken from the Monetary Policy Statements of the RBNZ from March 2000 through September 2011.

We collected the interest rate projections published in the 47 MPSs from

[1] Following e.g. Karagedikli and Siklos (2008), speeches and press releases became less important over the recent years. Guender and Rimer (2008) discuss the monetary policy implementation in New Zealand and analyze the effects of the RBNZ's liquidity management on the 90-day bank bill rate.

March 15, 2000 until September 15, 2011.[2] Our sample therefore allows to investigate whether the impact of the RBNZ's interest rate projections on market expectations has changed during the crisis. The information about the projected future interest rate path of the 90-day bank bill rate is taken as published in the MPS at 9:00 am on a publication day. In general, the quarterly projections refer to horizons of eight to twelve quarters.[3] Due to the availability of futures data, the empirical analysis shall focus on the impact of interest rate projections up to an horizon of six quarters ahead.

Figure 1.1 shows the interest rate projections made by the RBNZ for the entire sample period and gives a first impression on its relationship to the actual development of the 90-day interest rate. Apparently, projecting the future interest rate track is not an easy task, particularly during the financial crisis. As a consequence, the projections substantially change from one MPS publication to the next. According to the RBNZ, a significant portion of these changes is associated with changes in its view of the current situation of the economy. In particular, the projections depend on the RBNZ's inflation target and the forecasts of inflation. Note that the shape of most projection paths suggests a mean-reverting behavior of the interest rate in the sense that future interest rates are projected to decrease eventually in times of expected interest rate increases and *vice versa*. This might reflect the central bank's desire to move back to a neutral stance.

[2] Although the RBNZ already started publishing forward interest rate tracks in 1997, the early years up to the introduction of the official cash rate in March 1999 are characterized by the RBNZ's 'open mouth operations', see Guthrie and Wright (2000). Due to the availability of some control variables the estimation period starts in 2000.

[3] In the period from March 2000 until August 2001, projections were only made for the first and second semesters over the projection horizon. A linear interpolation has been applied in order to get data that corresponds to the quarters. In 2002, the projections were only made up to an horizon of five to eight quarters ahead.

1.3 The Impact of Interest Rate Projections on Market Expectations: The Empirical Setup

1.3.1 Market Expectations about Future 90-Day Interest Rates

Following e.g. Hamilton (2009), the effect of a newly announced interest rate projection on market expectations should be reflected in the response of the corresponding futures rates. In particular, we consider the futures rate for the 90-day bank bill rate as a market-based proxy for prevailing market expectations about future 90-day interest rates.[4] Specifically, let $f^j(t)$ be the futures rate at the end of day t corresponding to the contract which expires j quarters ahead. The immediate impact of interest rate projections on the expected 90-day rate j quarters ahead should be reflected in $\Delta f^j(t) = f^j(t) - f^j(t-1)$, i.e. the daily change of futures rates observed at the announcement day.

The release of projections can only be viewed as stabilizing if their impact on market expectations persists over time. In contrast, if the response of futures rates is reversed over the following days, then the effect of the monetary policy announcement is only short-lived and volatility increasing. In order to analyze the persistence of the projections' effect on market expectations, we also consider their impact on the futures rates up to n business days ahead, i.e. $f^j(t+n) - f^j(t-1)$.

[4] 90 Day Bank Bill Futures are traded at the Sydney Futures Exchange since December 1986. Futures rates are calculated by 100 minus the contract price as given by Bloomberg L.P. These typically contain potentially time-varying risk premia and thus may not perfectly reflect the expected future 90-day interest rate, compare Ferrero and Secchi (2009).

1.3.2 Expected and Unexpected Changes of Interest Rate Projections

Market expectations about future interest rates should mainly react to the unanticipated part of a monetary policy announcement. For evaluating the response of market interest rates, it is therefore crucial to identify the anticipated and unanticipated parts of a newly released interest rate projection. To that aim, let $p^j(t) - p^{j+1}(t-1)$ denote the actual change in the interest rate projection for the 90-day interest rate j quarters ahead observed at an announcement day. Note that the projection available at $t-1$ has already been released one quarter before. Therefore, the relevant projection in $t-1$ refers to $j+1$ quarters ahead. In line with the literature, we assume that the expected value $E_{t-1}p^j(t)$ of the upcoming projection is reflected in the corresponding futures rates. Note that the futures contracts expire not exactly at the end of a quarter but about two weeks before, i.e. on the first Wednesday after the 9th day of the months March, June, September, and December. As a result, $E_{t-1}p^j(t)$ may depend on both, the futures rates expiring in j and $j-1$ quarters ahead. In the following, we account for the (bi-weekly) overlap of futures contracts and the quarterly (i.e. 12-weekly) projections by defining $E_{t-1}p^j(t) = \frac{10}{12} \cdot f^{j-1}(t-1) + \frac{2}{12} \cdot f^j(t-1)$, but our main results are not affected by this particular weighting scheme. After these preliminaries, the actual change in the interest rate projection can be decomposed as

$$p^j(t) - p^{j+1}(t-1) = \left[p^j(t) - E_{t-1}p^j(t)\right] + \left[E_{t-1}p^j(t) - p^{j+1}(t-1)\right] \quad (1.1)$$

$$= \Delta p^{j,unexp}(t) + \Delta p^{j,exp}(t) \quad (1.2)$$

where $\Delta p^{j,unexp}(t)$ and $\Delta p^{j,exp}(t)$ denote the unexpected and expected part of the change of the interest rate projection, respectively.

The empirical analysis on the impact of interest rate projections on market expectations about the future course of the 90-day interest rate is based on the following regressions:

$$
\begin{aligned}
f^j(t+n) - f^j(t-1) &= \alpha^j + \beta^{j,exp} \cdot \Delta p^{j,exp}(t) + \beta^{j,unexp} \cdot \Delta p^{j,unexp}(t) \\
&\quad + \gamma^j \cdot X(t+n) + \varepsilon^j(t+n) \qquad (1.3)
\end{aligned}
$$

where n denotes the number of business days after the publication of an interest rate projection and $j = 1, \ldots 6$ is the horizon of the futures rate in quarters. $f^j(t-1)$ and $f^j(t+n)$ indicate the futures rates before and n days after the announced projection. Following Karagedikli and Siklos (2008), the equations are augmented by a vector of control variables $X(t+n)$, including the change of the effective exchange rate, government bond yields for Australia and the US as well as the Citigroup Economic Surprise Index for New Zealand as provided by Bloomberg L.P.[5]

1.4 The Response of Futures Rates to Interest Rate Projections: Empirical Results

Let us now investigate how the RBNZ's interest rate projections for the 90-day interest rate have affected the corresponding futures rates during the crisis period. For all forecast horizons ($j = 1, \ldots, 6$), Table 1 shows the estimates for the immediate effect ($n = 0$) and the long-run effects of projections which are exemplarily presented for $n = 20$.

The results clearly indicate that the impact of interest rate projections for market expectations has strongly decreased since the outbreak of the crisis. Compared with earlier results obtained by Moessner and Nelson (2008) and Ferrero and Secchi (2009), virtually all coefficients related to interest rate pro-

[5] For more detailed information about the control variables, see Table 2.E in the Appendix.

Table 1.1: The Response of Futures Rates to Interest Rate Projections

$$f^j(t+n) - f^j(t-1) = \alpha^j + \beta^{j,exp} \cdot \Delta p^{j,exp}(t) + \beta^{j,unexp} \cdot \Delta p^{j,unexp}(t) + \gamma^j \cdot X(t+n) + \varepsilon^j(t+n)$$

		1 quarter ahead	2 quarters ahead	3 quarters ahead	4 quarters ahead	5 quarters ahead	6 quarters ahead
$n=0$	β^{exp}	0.08**	0.07**	0.05*	0.04**	0.03	0.03
immediate effect		(0.04)	(0.03)	(0.03)	(0.02)	(0.02)	(0.03)
	β^{unexp}	0.23**	0.14*	0.07	0.04	0.02	0.02
		(0.11)	(0.07)	(0.05)	(0.03)	(0.03)	(0.04)
	R^2	0.42	0.37	0.36	0.38	0.41	0.39
	Quandt-Andrews	**04.12.2008**	**04.12.2008**	04.12.2008	04.12.2008	08.03.2007	08.03.2007
		(27.35)***	(13.62)**	(8.77)	(6.97)	(6.45)	(6.50)
$n=20$	β^{exp}	0.11*	0.09*	0.08	0.05	−0.03	−0.07
long-run effect		(0.06)	(0.05)	(0.06)	(0.07)	(0.08)	(0.11)
	β^{unexp}	0.17	0.08	0.06	0.01	−0.05	−0.10
		(0.16)	(0.12)	(0.10)	(0.08)	(0.08)	(0.10)
	R^2	0.52	0.61	0.61	0.58	0.56	0.54

Notes: The sample covers MPS publication days from March 15, 2000 until September 15, 2011. White standard errors in parentheses; *** (**) [*] denotes significance at the 1 % (5 %) [10 %] level. Quandt-Andrews indicates the policy day with the most likely breakpoint location together with the Max Wald F-statistic. A standard trimming value of 15 % allowed us to compare breakpoints between March 20, 2002 and December 10, 2009. $X(t+n)$ denotes a vector of control variables (effective exchange rate, foreign long-term yields, economic surprise variable).

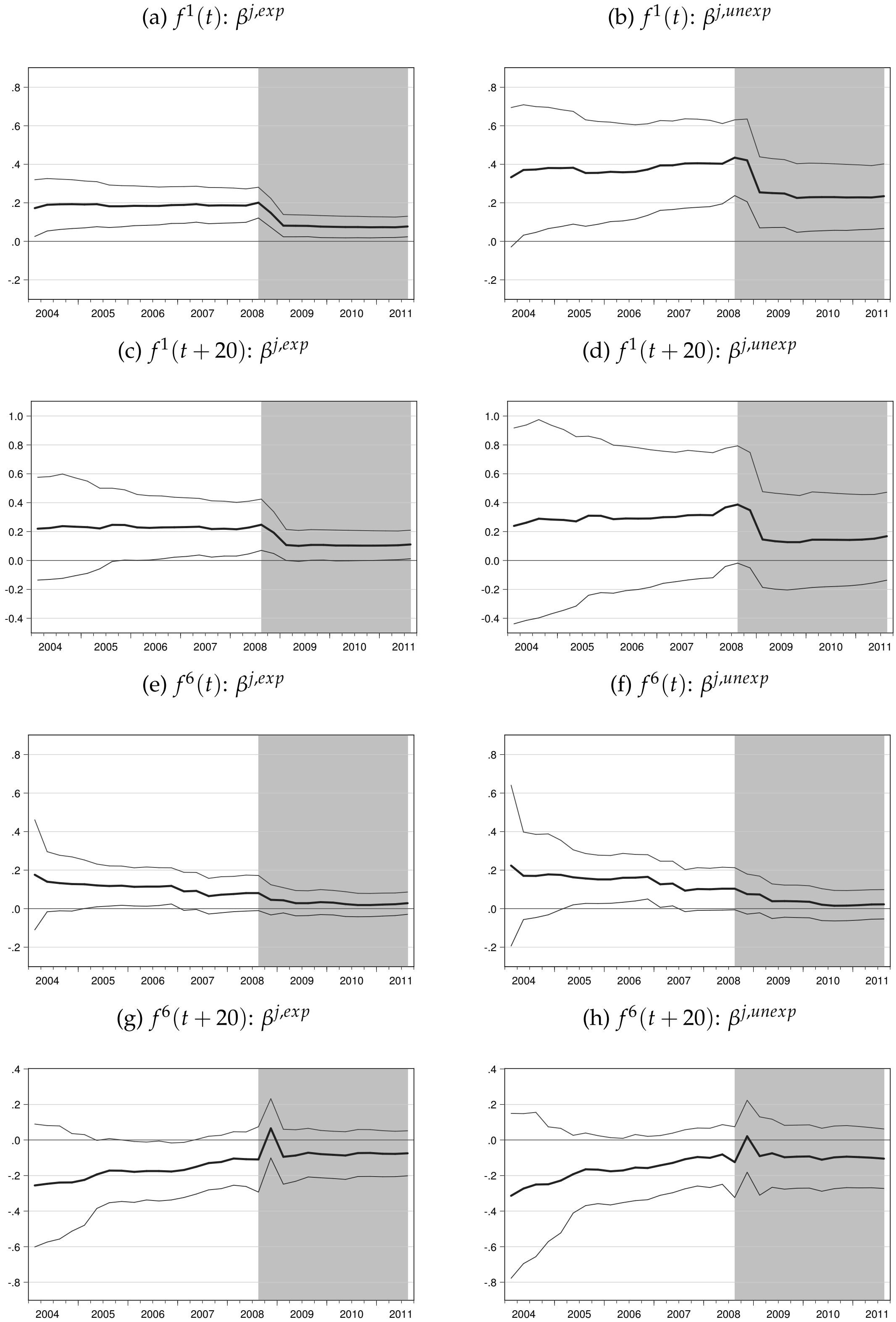
jections are smaller and less significant than their counterparts of the pre-crisis period. This suggests that the empirical relationship between interest rate projections and futures rates has changed over time. In order to investigate the timing and the significance of a structural break, we performed Quandt-Andrews endogenous breakpoint tests for $n = 0$, see Andrews (1993). Table 1 shows that the corresponding maximum F-statistics typically indicate a break in the coefficients of interest rate projections at the first MPS publication during the post-Lehman era, i.e. December 4, 2008.

In order to shed more light on the role of the financial crisis for the significance of interest rate projections, we performed recursive estimations of Equation 1.3. Figure 2 depicts recursive estimates of the coefficients of expected and unexpected changes in projections, i.e. $\beta^{j,exp}$ and $\beta^{j,unexp}$. We present the results for futures rates with one and six quarter horizons. Apparently, the relationship between interest rate projections and market expectations has been rather stable before September 2008. In accordance with Moessner and Nelson (2008) and Goodhart and Lim (2011), both components of the interest rate projection have a significant and plausibly signed immediate effect ($n = 0$) on market expectations particularly for short forecasting horizons, see upper panel of Figure 2. In contrast, the weak long-run effects ($n = 20$) of longer-term projections on the corresponding futures rates suggest that market participants perceived the RBNZ's longer-term interest rate projections as less reliable even before the outbreak of the crisis.[6]

The coefficients remain stable during the financial crisis. This applies for all forecast horizons and for both, short- and long-run effects of interest rate projections. In most cases, however, they are very close to zero and rarely

[6] The significant influence of expected changes in the central bank's projection might indicate that the 90-day Bank Bill Future is only an imperfect proxy for market expectations about changes in the RBNZ's projections. Moessner and Nelson (2008) also find that expected changes of projections have a significant impact on the change of futures rates. Ferrero and Secchi (2009) use a proxy for the unexpected change in the interest rate projections that as well contains its expected component.

Figure 1.2: The Changing Information Content of Interest Rate Projections



Notes: Recursive estimates and ± 2 standard error bands for $\beta^{j,exp}$ and $\beta^{j,unexp}$ from $f^j(t+n) - f^j(t-1) = \alpha^j + \beta^{j,exp} \cdot \Delta p^{j,exp}(t) + \beta^{j,unexp} \cdot \Delta p^{j,unexp}(t) + \gamma^j X(t+n) + \varepsilon^j(t+n)$ at the one and six quarter horizon. The light shaded area refers to the period as of September 2008.

significant. One interpretation of this decline in significance would be that interest rate projections failed to gauge market expectations when the economic outlook is extremely uncertain. In this situation, the information content of longer-term interest rate projections is not clear and market participants may thus ignore central bank projections to a large degree. However, futures-based proxies for market's expectations of the RBNZ projections become less reliable in times of financial turbulence when risk premia are high and unstable. Therefore, in particular during the crisis, the behavior of futures rates might be only loosely connected to the credibility of the RBNZ's interest rate projections.

1.5 Concluding Remarks

For monetary policy to be effective, it is crucial to shape the market expectations about the future path of short-term rates. To that aim, the Reserve Bank of New Zealand has adopted a quantitative forward guidance strategy including long-term interest rate projections. This chapter explores the information content of the RBNZ's interest rate projections for market expectations during the financial crisis.

The current study showed that the information content of interest rate projections depends on the forecast horizon and on the degree of uncertainty about the economic outlook. For the pre-crisis period, our results confirm that the RBNZ's interest rate projections were an efficient tool for guiding market expectations - at least for short-term horizons. For longer-term horizons, however, their effect on market expectations is only short-lived and thus, volatility increasing. According to Dale et al. (2011), this may suggest that the release of longer-term projections may even be detrimental because of the private sector's limited ability to assess the quality of that information. Since the outbreak of the financial crisis, the role of interest rate projections for futures rates has decreased significantly. Recursive estimations reveal that there is a sharp decline in the size and significance of all coefficients related to interest rate projections. This result may be partly explained by unstable risk premia that impede the appropriateness of futures rates as proxy measures for market expectations in times of turbulence. Yet an element of risk remains that markets tend to ignore central bank projections that are perceived as less reliable. Following Moessner and Nelson (2008), in this situation the release of interest rate projections may even damage the central bank's credibility.

Appendices

Table 1.A summarizes the main results of the regressions for the pre-crisis period for $j = 1, \cdots, 6$. In addition to the estimates for the immediate effect ($n = 0$), long-run effects of projections are exemplarily presented for $n = 20$, but the main findings do not depend on this choice. The complete set of results of Table 1.A in terms of the control variables is provided in Tables 1.B and 1.C.[7] The upper panel shows the immediate effect ($n = 0$) of the interest rate projections on market expectations. In line with Kuttner (2001), the coefficients of the unexpected change, β^{unexp}, tend to be larger than the coefficient of the expected change, β^{exp}.

An important insight from Table 1.A is that the long-run impact ($n = 20$) of interest rate projections depends on the forecasting horizon. In contrast to Ferrero and Secchi (2009), we only find a persistent and thus, expectations-stabilizing impact of projections on futures rates up to two quarters ahead. For futures contracts maturing more than two quarters ahead, the significant response estimated at the announcement day is reversed only a few days later. Therefore, there is no persistent impact of longer-term interest rate projections on the corresponding futures rates. In contrast to Ferrero and Secchi (2009), this result suggests that market participants perceive the RBNZ's longer-term interest rate projections as less reliable.

[7]While the influence of exchange rates, i.e. the trade-weighted index, is particularly striking for the immediate change of futures rates, the long-run response is also driven by foreign exchange rates.

Table 1.A: The Response of Futures Rates to Interest Rate Projections in the Pre-Crisis Period

$$f^j(t+n) - f^j(t-1) = \alpha^j + \beta^{j,exp} \cdot \Delta p^{j,exp}(t) + \beta^{j,unexp} \cdot \Delta p^{j,unexp}(t) + \gamma^j X(t+n) + \varepsilon^j(t+n)$$

		1 quarter ahead	2 quarters ahead	3 quarters ahead	4 quarters ahead	5 quarters ahead	6 quarters ahead
$n = 0$ immediate effect	β^{exp}	0.20***	0.16***	0.12***	0.08***	0.08***	0.08**
		(0.04)	(0.04)	(0.03)	(0.02)	(0.03)	(0.04)
	β^{unexp}	0.43***	0.28***	0.16**	0.11**	0.09**	0.10*
		(0.10)	(0.10)	(0.07)	(0.05)	(0.04)	(0.05)
	R^2	0.63	0.60	0.50	0.49	0.45	0.42
$n = 20$ long-run effect	β^{exp}	0.25**	0.18**	0.10	0.08	−0.07	−0.11
		(0.09)	(0.09)	(0.07)	(0.07)	(0.07)	(0.09)
	β^{unexp}	0.39*	0.23	0.14	0.06	−0.05	−0.12
		(0.19)	(0.17)	(0.14)	(0.10)	(0.08)	(0.10)
	R^2	0.62	0.69	0.69	0.68	0.72	0.71

Notes: The sample covers MPS publication days from March 15, 2000 until September 11, 2008. For the long-run effect, the MPS from June 5, 2008 is the last observation in the pre-crisis period. White standard errors in parentheses; *** (**) [*] denotes significance at the 1 % (5 %) [10 %] level. $X(t+n)$ denotes a vector of control variables (effective exchange rate, foreign long-term yields) as described in the text. The full table of results is provided in Tables 1.B and 1.C.

Table 1.B: The Immediate Response of Futures Rates to Interest Rate Projections in the Pre-Crisis Period ($n = 0$)

$$f^j(t+n) - f^j(t-1) = \alpha^j + \beta^{j,exp} \cdot \Delta p^{j,exp}(t) + \beta^{j,unexp} \cdot \Delta p^{j,unexp}(t) + \gamma^j X(t+n) + \varepsilon^j(t+n)$$

	1 quarter ahead	2 quarters ahead	3 quarters ahead	4 quarters ahead	5 quarters ahead	6 quarters ahead
α	-0.03	-0.01	0.00	-0.01	-0.01	-0.01
	(0.02)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)
β^{exp}	0.20***	0.16***	0.12***	0.08***	0.08***	0.08**
	(0.04)	(0.04)	(0.03)	(0.02)	(0.03)	(0.04)
β^{unexp}	0.43***	0.28***	0.16**	0.11**	0.09**	0.10*
	(0.10)	(0.10)	(0.07)	(0.05)	(0.04)	(0.05)
γ^{twi}	5.21*	7.67***	8.02***	8.27***	7.72***	8.29***
	(2.56)	(2.64)	(2.73)	(2.60)	(2.57)	(2.97)
γ^{AUS}	0.11	0.05	-0.02	0.12	0.09	0.19
	(0.22)	(0.28)	(0.30)	(0.31)	(0.31)	(0.32)
γ^{US}	-0.23	-0.05	0.18	0.25	0.33	0.49
	(0.23)	(0.24)	(0.25)	(0.26)	(0.30)	(0.37)
γ^{ecosur}	0.00	0.00	0.001*	0.001**	0.001**	0.002***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.001)
R^2	0.63	0.60	0.50	0.49	0.45	0.42

Notes: The sample covers MPS publication days from March 15, 2000 until September 11, 2008. For the long-run effect, the MPS from June 5, 2008 is the last observation in the pre-crisis period. White standard errors in parentheses; *** (**) [*] denotes significance at the 1 % (5 %) [10 %] level. $X(t+n)$ denotes a vector of control variables (effective exchange rate, foreign long-term yields) as described in the text.

Table 1.C: The Long-Run Response of Futures Rates to Interest Rate Projections in the Pre-Crisis Period ($n = 20$)

$$f^j(t+n) - f^j(t-1) = \alpha^j + \beta^{j,exp} \cdot \Delta p^{j,exp}(t) + \beta^{j,unexp} \cdot \Delta p^{j,unexp}(t) + \gamma^j X(t+n) + \varepsilon^j(t+n)$$

	1 quarter ahead	2 quarters ahead	3 quarters ahead	4 quarters ahead	5 quarters ahead	6 quarters ahead
α	-0.05^{*}	-0.02	0.00	0.04	0.03	0.04
	(0.03)	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)
β^{exp}	0.25^{**}	0.18^{**}	0.10	0.08	-0.07	-0.11
	(0.09)	(0.09)	(0.07)	(0.07)	(0.07)	(0.09)
β^{unexp}	0.39^{*}	0.23	0.14	0.06	-0.05	-0.12
	(0.19)	(0.17)	(0.14)	(0.10)	(0.08)	(0.10)
γ^{twi}	0.39	0.52	1.08	1.12	2.17^{*}	2.46^{*}
	(1.01)	(1.01)	(1.13)	(1.28)	(1.18)	(1.25)
γ^{AUS}	0.32^{**}	0.42^{***}	0.43^{***}	0.35^{**}	0.30^{*}	0.17
	(0.13)	(0.11)	(0.11)	(0.13)	(0.16)	(0.19)
γ^{US}	0.11	0.23	0.30^{*}	0.39^{**}	0.41^{**}	0.51^{**}
	(0.14)	(0.15)	(0.16)	(0.17)	(0.17)	(0.19)
γ^{ecosur}	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
R^2	0.62	0.69	0.69	0.68	0.72	0.71

Notes: The sample covers MPS publication days from March 15, 2000 until September 11, 2008. For the long-run effect, the MPS from June 5, 2008 is the last observation in the pre-crisis period. White standard errors in parentheses; *** (**) [*] denotes significance at the 1 % (5 %) [10 %] level. $X(t+n)$ denotes a vector of control variables (effective exchange rate, foreign long-term yields) as described in the text.

Chapter 2

Stale Forward Guidance

Gunda-Alexandra Detmers and Dieter Nautz

Abstract

Quarterly central bank projections regarding future interest rate decisions may become stale when new information enters the market. Using data from New Zealand, we find the predicted time-varying and state-dependent effects of interest rate projections on market expectations and uncertainty.

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2.1 Introduction

Since the outbreak of the financial crisis, many central banks have adopted forward guidance, defined as statements about the likely path of the future policy rate, in order to anchor rate expectations more firmly and to curb the volatility of interest rates. However, forward guidance is also useful in less turbulent times. In particular, the publication of interest rate projections is a powerful tool for both explaining monetary policy and guiding market expectations, see Rudebusch and Williams (2008). Yet, only few central banks used forward guidance before the crisis. In 1997, the Reserve Bank of New Zealand (RBNZ) was the first central bank to publish projections of the future 90-day rate in order to guide interest rate expectations up to three years in the future. The RBNZ publishes projections only once a quarter and a similar timing has been adopted by several other central banks, see Andersson and Hofmann (2010). Consequently, quarterly projections may become stale when new information enters the market. Since the remaining information content of a current projection is not always obvious, stale projections may even undermine the expectations management of the central bank. This chapter explores the time-varying and state-dependent effects of the RBNZ's projections on interest rate expectations and uncertainty in order to assess the empirical consequences of stale forward guidance.[1]

The usefulness of regularly announced interest rate projections for central bank communication is still under debate. The information content of interest rate projections is typically investigated in event studies that focus on the projections' impact on market rates at or close to the announcement day, see Moessner and Nelson (2008), Detmers and Nautz (2012), Moessner (2013) and

[1] Recently, the ECB and the FED used forward guidance to *assure* that policy rates will be low for an extended period of time, see European Central Bank (2014). Forward guidance as provided by the RBNZ's regular interest rate projections, however, is not to be misinterpreted as a commitment to the projected interest rate path.

Winkelmann (2016). Goodhart and Lim (2011) conclude from a forecast analysis that the RBNZ's interest rate projections are useless for a horizon of more than two quarters ahead. According to Neuenkirch (2012), projections contribute to a high transparency index of the RBNZ which reduces the bias and variation of rate expectations. However, none of these contributions considers the time-varying information content of interest rate projections.

This chapter builds on Ehrmann and Sondermann (2012) who investigate the time-varying effect of the quarterly Bank of England Inflation Report on various market interest rates. They find that central bank communication becomes stale because interest rate uncertainty and the relative importance of macroeconomic news rise between two releases of inflation reports. They cannot, however, investigate state-dependent effects because the staleness of an Inflation Report cannot be measured directly. In contrast, the staleness of an interest rate projection is reflected in the futures rate whose maturity exactly matches the rate projected by the central bank. In particular, large deviations of market expectations from the projected rate indicate that the projection has become stale.

We propose two hypotheses on the time- and state-dependent effects of interest rate projections. Hypothesis 1 emphasizes the varying importance of macroeconomic news for rate expectations. Following Ehrmann and Sondermann (2012), macroeconomic news become relatively more important as the information content of an ageing interest rate projection decreases. Moreover, the relative influence of macroeconomic news on rate expectations should also increase if markets perceive the current projection to be stale, i.e. if the spread between the futures and the projected rate increases. Finally, this state-dependent effect of projections should also be time-dependent. In particular, a stale projection may not be a big issue for market expectations if it is already seen as outdated. Hypothesis 2 focuses on the effects of projections on interest rate uncertainty. Interest rate uncertainty should increase between two releases of central bank projections and if markets perceive the interest rate projection to be stale. This uncertainty-increasing effect of stale projections is the stronger, the longer markets have to wait for an updated projection. We test these predictions within an EGARCH model for daily changes in futures rates of various maturities.

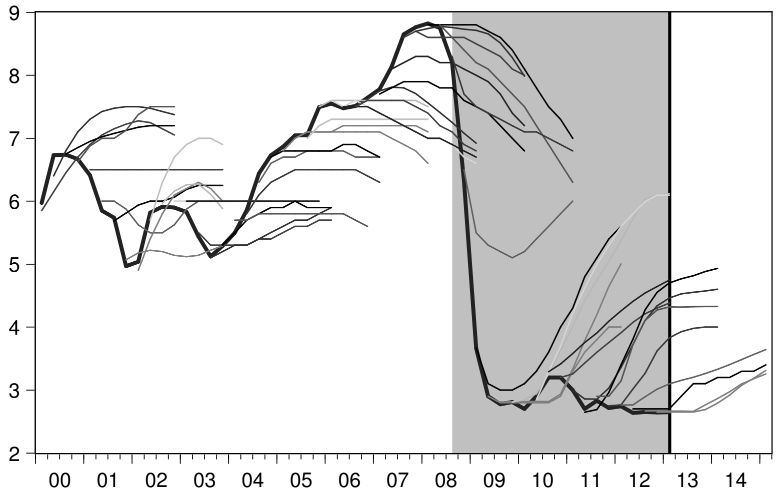
Next, we discuss the effects of projections on market expectations, interest rate volatility, and the relative importance of macroeconomic news. Chapter 2.3 introduces the econometric model and presents the estimation results. Chapter 2.4 concludes.

2.2 The RBNZ's Interest Rate Projections

Since 1997, the RBNZ has been projecting the 90-day bank bill rate for the following 8 to 12 quarters within its quarterly Monetary Policy Statement (MPS). Between two MPS releases, projections are never updated. Figure 2.1 shows that interest rate projections change substantially from one release to the next. Apparently, projections often lose much of their relevance over the course of a quarter.

We use futures rates on the 90-day bank bill rate j quarters ahead as a proxy for prevailing market expectations about future interest rates. Following Detmers and Nautz (2012), futures rates f_t^j and projections p_t^j are adjusted in order to obtain data with constant maturity j. If f_t^j is close to p_t^j, market expectations are in line with the central bank projection suggesting that the perceived information content of the current projection is still high. Yet, new information might lead markets to expect the future interest rate to differ from the current central bank projection. In this case, f_t^j deviates from p_t^j. In the following, the spread $|f^j - p^j|_{t-1}$ measures the staleness of the projection p_t^j.

Figure 2.1: Interest Rate Projections and the 90-Day Interest Rate



Notes: Quarterly projections for the 90-day bank bill rate around its actual monthly level (bold line). The shaded area indicates the financial crisis. The vertical line represents the end of the sample. Data are taken from the Monetary Policy Statements of the RBNZ from March 2000 through February 2013.

Typically, market expectations are in line with the central bank interest rate projection, at least shortly after the release of a new interest rate path. However, as time goes by and new information arrives, market expectations may start to deviate from the central bank projection and the spread $|f^j - p^j|$ widens accordingly. As a consequence, the remaining information content of the current interest rate projection becomes dubious. The resulting signal-extraction problem may imply (a) time-varying, (b) state-dependent, and (c) a combination of time- and state-dependent effects of projections on both, market expectations about future interest rates as well as interest rate uncertainty.

Hypothesis 1: The relative importance of macroeconomic news for rate expectations

a) rises between two releases of interest rate projections,

b) is the larger, the wider the spread $|f^j - p^j|$.

c) The effect claimed in b) is the larger, the longer markets have to wait for an updated projection.

The intuition behind Hypothesis 1 is as follows: As time between two releases elapses, interest rate projections age and their significance declines. This implies that macroeconomic news become relatively more important for the formation of rate expectations which explains part a). Similarly, the relative influence of macroeconomic news on rate expectations increases if $|f^j - p^j|$ is large and markets perceive the recent projection to be stale, compare part b). According to part c), this state-dependent effect should also be time-dependent. In particular, a stale projection should not distort market expectations significantly when the new projection is about to be published.

Hypothesis 2: Interest rate uncertainty

a) rises between two releases of interest rate projections,

b) is the larger, the wider the spread $|f^j - p^j|$.

c) The effect claimed in b) is the smaller, the longer markets have to wait for an updated projection.

Hypothesis 2a considers the purely time-varying effect of projections on interest rate uncertainty. When the current projection ages, markets cannot be sure of its continuing relevance. Therefore, the information content of a projection declines over time implying increasing interest rate uncertainty until the new projection is published. Beyond this pure time-effect, 2b states that uncertainty also rises if the rate expected by the market increasingly deviates from the rate projected by the central bank. Finally, 2c takes into account that effects of stale projections are also time-dependent because markets distinguish between a deviation of futures rates from the central bank projection observed at the beginning and the end of a quarter.

2.3 The Impact of Stale Projections on Interest Rate Expectations and Uncertainty

2.3.1 The Econometric Model

Market expectations about the future 90-day bank bill rate j quarters ahead are reflected in the corresponding futures rate f_t^j. We model the daily change in expectations as follows:

$$\begin{aligned} \Delta f_t &= \alpha + \delta \Delta f_{t-1} + \sum_k \gamma^k x_t^k + \sum_k \gamma^{k,\tau} x_t^k \cdot \tau_t + \sum_k \gamma^{k,s} x_t^k |f-p|_{t-1} \\ &\quad + \sum_k \gamma^{k,s,\tau} x_t^k |f-p|_{t-1} \tau_t + \eta Z_t + \varepsilon_t, \end{aligned} \quad (2.1)$$

where we suppressed the maturity-index j for the sake of readability and Z_t controls for monetary policy days. Market expectations depend on various macroeconomic news variables (x^k), interest rate projections ($|f-p|$), and the age of the current projection (τ_t). We calculate $0 \leq \tau_t \leq 1$ as the number of days since the last release divided by the length of the quarter. Thus, τ_t equals 0 at the announcement day and 1 the day before the subsequent announcement. Note that the impact of macroeconomic news variables on rate expectations is not necessarily constant over time (γ^k), but could be time-varying ($\gamma^{k,\tau}$) or state-dependent ($\gamma^{k,s}$). Finally, we allow for a combined effect which is captured by the coefficient ($\gamma^{k,s,\tau}$) of the interaction variable $x_t^k |f-p|_{t-1}\tau_t$.

According to Hypothesis 1, the relative importance of macroeconomic news on rate expectations should increase both a) over time between two releases ($\gamma^{k,\tau} > 0$) and b) in the spread $|f-p|$ ($\gamma^{k,s} > 0$). Following part c) of Hypothesis 1, the latter state-dependent effect of macroeconomic news should be the stronger, the longer markets have to wait for an updated projection ($\gamma^{k,s,\tau} < 0$). The set of macroeconomic news variables incorporates surprises resulting from quarterly announcements of GDP (x^{GDP}) and inflation (x^{CPI}) as well as the daily changes of U.S. bond yields with two year maturity (Δr^{US}) and of New Zealand's effective exchange rate (Δe). This set of macroeconomic variables should capture the main determinants of the RBNZ's interest rate policy.

Interest rate uncertainty is not constant over time. Following Ehrmann and Sondermann (2012), the conditional variance of futures rates is assumed to follow an augmented EGARCH(1,1) model. For each maturity $j = 1, \ldots, 5$, we consider the following variance equation:

$$\begin{aligned} log(\sigma_t^2) &= \omega_o + \omega_1 \left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right| + \omega_2 \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \omega_3 log(\sigma_{t-1}^2) + \psi D_t \\ &\quad + \rho^{\tau} \tau_t + \rho^s |f-p|_{t-1} + \rho^{s,\tau} |f-p|_{t-1} \tau_t, \end{aligned} \tag{2.2}$$

where D_t controls for monetary policy days as well as announcement days of GDP and inflation data. According to Hypothesis 2a, uncertainty should rise over time until the next projection is published. In the variance equation above, this implies $\rho^{\tau} > 0$. Correspondingly, ρ^s measures the state-dependent effect of a projection on interest rate uncertainty. Following Hypothesis 2b, interest rate uncertainty increases the more interest rate expectations deviate from the central bank projection which implies that $\rho^s > 0$. However, we also expect this effect to decrease between two projection releases implying $\rho^{s,\tau} < 0$, compare Hypothesis 2c.

2.3.2 Empirical Results

We estimate the empirical model for the pre-crisis and the crisis period separately.[2] In this chapter, we focus on the results obtained for U.S. interest rates,

[2] In our empirical analysis, the sample period runs from March 1, 2000 until February 28, 2013. It does not start in 1997 because of data unavailability for some control variables. This

Table 2.1: The Response of Rate Expectations in New Zealand to U.S. Interest Rates

	j=1	j=2	j=3	j=4	j=5
pre-crisis: March 1, 2000 - Sep 12, 2008					
Δr_t^{US}	0.09***	0.21***	0.29***	0.33***	0.39***
	(0.02)	(0.03)	(0.03)	(0.03)	(0.04)
$\Delta r_t^{US} \cdot \tau_t$	0.03	-0.05	-0.06	-0.05	-0.09
	(0.04)	(0.05)	(0.05)	(0.06)	(0.07)
$\Delta r_t^{US} \cdot \|f-p\|_{t-1}$	0.51***	0.26***	0.11	0.03	-0.06
	(0.09)	(0.09)	(0.07)	(0.06)	(0.06)
$\Delta r_t^{US} \cdot \|f-p\|_{t-1} \cdot \tau_t$	-0.31**	-0.06	-0.04	-0.01	0.08
	(0.13)	(0.12)	(0.10)	(0.10)	(0.09)
crisis: Sep 15, 2008 - Feb 28, 2013					
Δr_t^{US}	0.10**	0.35***	0.30**	0.33***	0.16
	(0.05)	(0.09)	(0.12)	(0.12)	(0.11)
$\Delta r_t^{US} \cdot \tau_t$	0.04	-0.18	-0.10	-0.10	0.35*
	(0.08)	(0.16)	(0.18)	(0.19)	(0.18)
$\Delta r_t^{US} \cdot \|f-p\|_{t-1}$	-0.25**	-0.43***	-0.12	-0.09	0.15
	(0.10)	(0.13)	(0.16)	(0.16)	(0.16)
$\Delta r_t^{US} \cdot \|f-p\|_{t-1} \cdot \tau_t$	0.39***	0.62***	0.32	0.25	-0.17
	(0.14)	(0.20)	(0.21)	(0.22)	(0.22)

Notes: The table shows the time-varying and state-dependent effects of U.S. bond yields on futures rates of maturity j, see Equation (2.1). *** (**) [*] denotes significance at the 1 % (5 %) [10 %] level; standard errors in parentheses. The complete set of results is provided in the appendix of this chapter.

because these are the most important exogenous drivers for changes in New Zealand's interest rate expectations. Before the crisis, the results obtained for shorter maturities ($j = 1, 2$) provide strong evidence in favor of Hypotheses 1b and 1c, see the first panel of Table 2.1. While the impact of U.S. rates increases when the current projection becomes stale, i.e. if the spread $|f - p|$ widens, this effect vanishes when the projection ages. A significant (yet, wrongly signed) state-dependent effect of U.S. rates can also be found for the crisis period.

sample period avoids a structural break due to changes in the RBNZ's monetary policy framework in 1999, see Guender and Rimer (2008). The empirical analysis is restricted to $j = 1, \ldots, 5$ since data for longer-term futures rates are available only from 2007 onward. For detailed information about the data, see the appendix of this chapter.

Again, in line with Hypothesis 1c, this state-dependent effect of stale projections shrinks with the age of a projection.

Table 2.2: Interest Rate Projections and Interest Rate Uncertainty in New Zealand

	j=1	j=2	j=3	j=4	j=5
pre-crisis: March 1, 2000 - Sep 12, 2008					
$\widehat{\rho}^{\tau}$	0.15**	-0.04	-0.07	-0.16	-0.17
	(0.07)	(0.09)	(0.12)	(0.11)	(0.11)
$\widehat{\rho}^{s}$	1.22***	0.99***	0.99***	0.50***	0.31***
	(0.16)	(0.14)	(0.16)	(0.11)	(0.10)
$\widehat{\rho}^{s,\tau}$	-0.98***	-0.62***	-0.64***	-0.28***	-0.16
	(0.21)	(0.21)	(0.22)	(0.16)	(0.15)
crisis: Sep 15, 2008 - Feb 28, 2013					
$\widehat{\rho}^{\tau}$	0.27***	0.61***	0.48***	0.17***	0.10**
	(0.05)	(0.13)	(0.12)	(0.07)	(0.05)
$\widehat{\rho}^{s}$	0.34***	0.81***	0.41***	0.11*	0.03
	(0.09)	(0.13)	(0.11)	(0.06)	(0.05)
$\widehat{\rho}^{s,\tau}$	-0.38***	-0.80***	-0.44***	-0.10	-0.02
	(0.12)	(0.18)	(0.15)	(0.09)	(0.07)

Notes: The table shows the estimates from the conditional variance equation of futures rates with maturities of *j* quarters, compare Equation (2.2). *** (**) [*] denotes significance at the 1 % (5 %) [10 %] level, standard errors in parentheses. The complete set of results is provided in the appendix of this chapter.

Table 2.2 summarizes the estimation results on the time-varying and state-dependent effects of probably stale interest rate projections on interest rate uncertainty based on variance equation 2.2. According to Hypothesis 2a, interest rate uncertainty should increase between two releases of projections implying $\rho^{\tau} > 0$. Table 2.2 shows that this purely-time dependent effect is particularly important in the crisis period. In this period, an ageing projection contributes significantly to higher market uncertainty. It is worth emphasizing that this effect confirms the usefulness of projections in the crisis, since uncertainty drops in response to a fresh projection. We also find strong empirical support for a state-dependent effect of interest rate projections on uncertainty. Confirming Hypothesis 2b, we estimate that interest rate uncertainty increases significantly ($\rho^s > 0$) when interest rate expectations deviate from the corresponding interest rate projection. This result holds for the pre-crisis as well as the crisis period and irrespective of the projection horizon. The uncertainty-increasing effects of stale projections are also found to be time dependent. Particularly for shorter horizons ($j < 5$), the distorting impact of a stale projection shrinks when the projection becomes older. Put differently, in line with Hypothesis 2c the distorting effects of stale projections are the more severe, the longer markets have to wait for an updated projection.

2.4 Conclusions

This chapter shows that interest rate projections are a helpful tool for central bank expectations management but they could probably be used more efficiently. In particular, the central bank could update its projections whenever new information cast doubt on the validity of the current projection. Once market expectations and central bank projections diverge too far, the central bank could adjust its projection (if market expectations correctly anticipated future changes of projections) or reestablish the validity of the current projection (if market expectations were incorrect). In any case, interest rate uncertainty declines and thus, central bank communication improves if forward guidance is prevented from becoming stale.

Appendices

Table 2.A provides information about the staleness of interest rate projections for different maturities. As expected, the average staleness of projections rises with increasing maturity and is higher during the financial crisis. Time-series plots of futures and projected rates are shown in Figure 2.A.

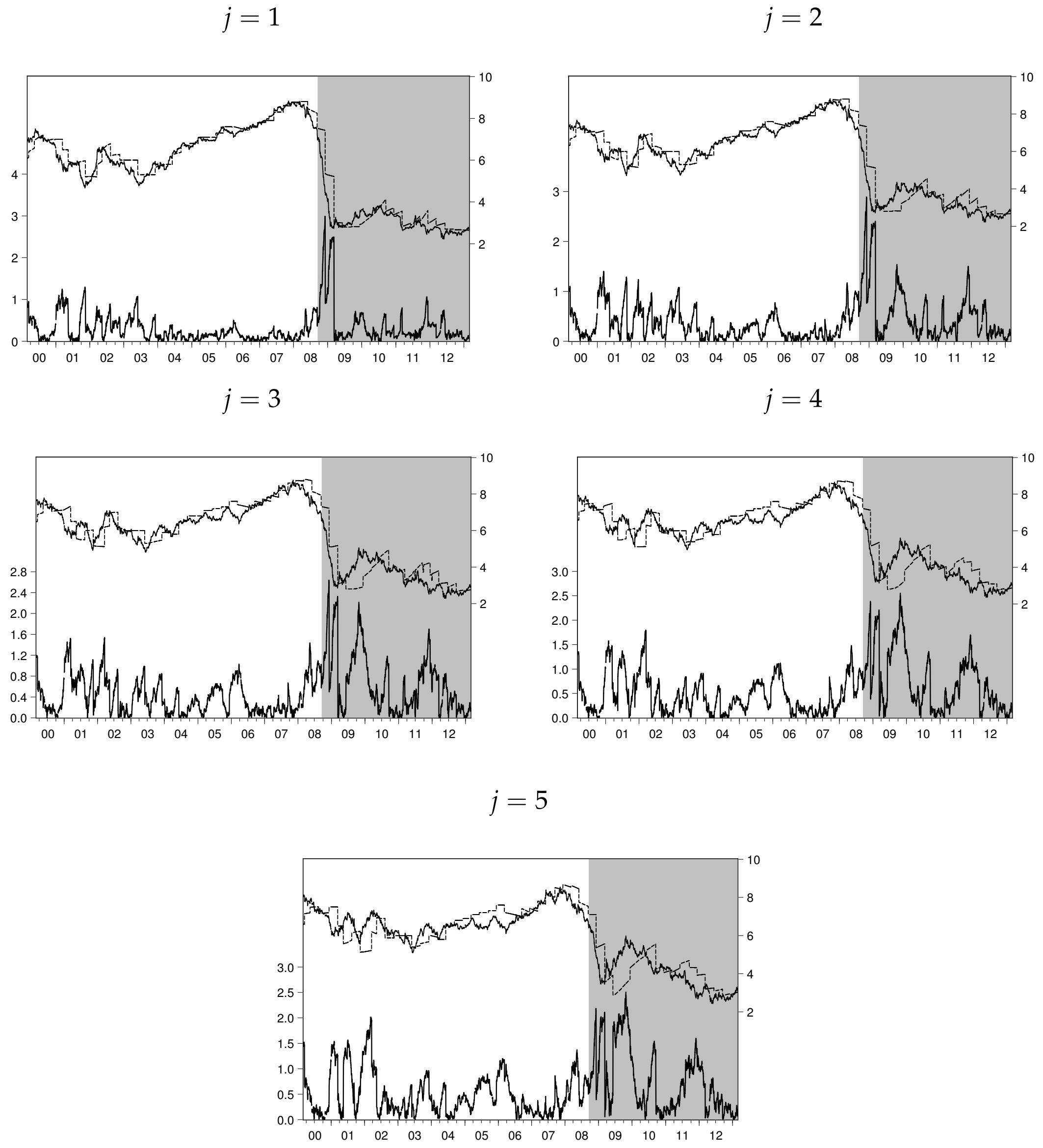
Table 2.A: The Average Staleness of Interest Rate Projections

maturity in quarters	j=1	j=2	j=3	j=4	j=5
pre-crisis: March 1, 2000 - Sep 12, 2008					
median($\|f^j - p^j\|$)	16.74	24.39	31.26	36.61	37.39
crisis: Sep 15, 2008 - Feb 28, 2013					
median($\|f^j - p^j\|$)	19.38	31.90	48.94	55.48	55.52

Notes: We use the spread between the futures rate and the corresponding projection, $|f^j - p^j|_{t-1}$, as a proxy-variable for the degree of staleness of an interest rate projection. Median is denoted in basis points. We assume that the crisis period started with the Lehman failure on September 15, 2008.

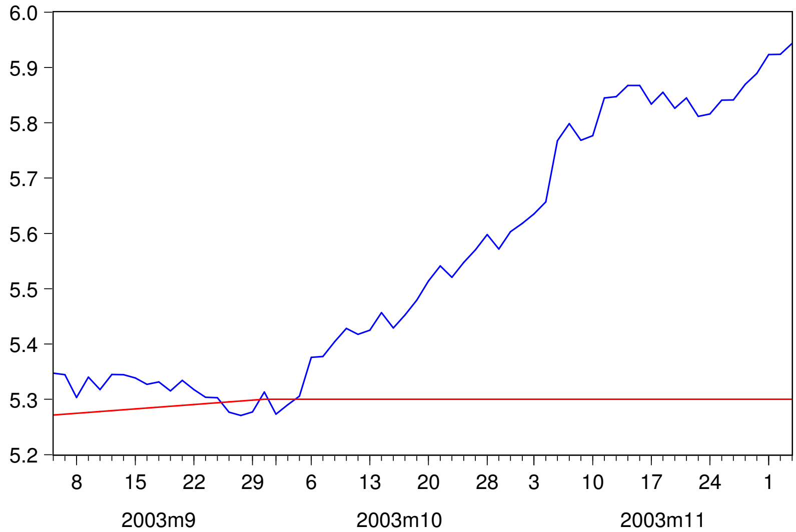
Figure 2.B shows the development of market expectations following the projection's release on September 4, 2003. While interest rate expectations are initially in line with the central bank interest rate projection, expectations begin to diverge after about 20 business days. Apparently, with new information entering the market, the remaining information content of the current interest rate projection becomes dubious.

Figure 2.A: Interest Rate Projections and Futures Rates in New Zealand



Notes: Futures rates f_t and central bank interest rate projections p_t (dashed line) in percentage points at horizons $j = 1, \ldots, 5$ as well as the absolute deviation $|f_t - p_t|$ (at the bottom, left scale) from March 2000 until February 2013. The shaded area refers to the period as of September 2008.

Figure 2.B: An Interest Rate Projection that Becomes Stale



Notes: The Figure shows the RBNZ's interest rate projection of for $j = 1$ (red line) and the corresponding futures rate between two interest rate projections in 2003. The increased spread indicates that markets eventually perceive the central bank projection to be stale.

Table 2.B: The EGARCH Model for Futures Rates: Complete Results for the Pre-Crisis Sample

$j=1$	Δf_t	α	β^{MPS}	β^{OCR}	δ	γ^{CPI}	$\gamma^{CPI,s}$	γ^{GDP}	$\gamma^{GDP,s}$	γ^{US}	$\gamma^{US,\tau}$	$\gamma^{US,s}$	$\gamma^{US,s,\tau}$	γ^{EFF}	$\gamma^{EFF,\tau}$	$\gamma^{EFF,s}$	$\gamma^{EFF,\tau,s}$
		0.001	0.20***	0.11***	0.08***	0.03***	-0.01	-0.003	0.03	0.09***	0.03	0.51***	-0.31**	0.002	-0.01	-0.02	0.03
		(0.001)	(0.08)	(0.04)	(0.02)	(0.01)	(0.03)	(0.01)	(0.05)	(0.02)	(0.04)	(0.09)	(0.13)	(0.004)	(0.01)	(0.02)	(0.03)
	$log(\sigma_t^2)$	ω_o	ω_1	ω_2	ω_3	η^{OCR}	η^{MPS}	ρ_τ	ρ_s	$\rho_{s,\tau}$	η^{CPI}	$\eta^{CPI,s}$	η^{GDP}	$\eta^{GDP,s}$			
		-4.02***	0.38***	-0.04**	0.52***	1.94***	0.29	0.15**	1.22***	-0.98***	0.12	1.04	0.36	0.25			
		(0.23)	(0.04)	(0.02)	(0.03)	(0.14)	(0.27)	(0.07)	(0.16)	(0.21)	(0.41)	(1.38)	(0.44)	(1.36)			
$j=2$	Δf_t	α	β^{MPS}	β^{OCR}	δ	γ^{CPI}	$\gamma^{CPI,s}$	γ^{GDP}	$\gamma^{GDP,s}$	γ^{US}	$\gamma^{US,\tau}$	$\gamma^{US,s}$	$\gamma^{US,s,\tau}$	γ^{EFF}	$\gamma^{EFF,\tau}$	$\gamma^{EFF,s}$	$\gamma^{EFF,\tau,s}$
		0.001	0.16**	0.12***	0.11***	0.04***	-0.03	-0.01	0.04	0.21***	-0.05	0.26***	-0.06	0.01	-0.01	-0.04*	0.04
		(0.001)	(0.06)	(0.04)	(0.02)	(0.01)	(0.02)	(0.01)	(0.04)	(0.03)	(0.05)	(0.09)	(0.12)	(0.01)	(0.01)	(0.02)	(0.03)
	$log(\sigma_t^2)$	ω_o	ω_1	ω_2	ω_3	η^{OCR}	η^{MPS}	ρ_τ	ρ_s	$\rho_{s,\tau}$	η^{CPI}	$\eta^{CPI,s}$	η^{GDP}	$\eta^{GDP,s}$			
		-4.43***	0.36***	0.001	0.43***	1.67***	0.42	-0.04	0.995***	-0.62***	0.22	0.63	-0.08	2.08**			
		(0.35)	(0.04)	(0.02)	(0.05)	(0.22)	(0.35)	(0.09)	(0.14)	(0.21)	(0.43)	(1.26)	(0.43)	(1.02)			
$j=3$	Δf_t	α	β^{MPS}	β^{OCR}	δ	γ^{CPI}	$\gamma^{CPI,s}$	γ^{GDP}	$\gamma^{GDP,s}$	γ^{US}	$\gamma^{US,\tau}$	$\gamma^{US,s}$	$\gamma^{US,s,\tau}$	γ^{EFF}	$\gamma^{EFF,\tau}$	$\gamma^{EFF,s}$	$\gamma^{EFF,\tau,s}$
		0.001	0.11*	0.11***	0.10***	0.04***	-0.05	0.004	-0.01	0.29***	-0.06	0.11	-0.04	-0.0001	-0.001	-0.01	0.01
		(0.001)	(0.06)	(0.04)	(0.02)	(0.01)	(0.03)	(0.01)	(0.03)	(0.03)	(0.05)	(0.07)	(0.10)	(0.01)	(0.01)	(0.02)	(0.02)
	$log(\sigma_t^2)$	ω_o	ω_1	ω_2	ω_3	η^{OCR}	η^{MPS}	ρ_τ	ρ_s	$\rho_{s,\tau}$	η^{CPI}	$\eta^{CPI,s}$	η^{GDP}	$\eta^{GDP,s}$			
		-5.20***	0.36***	0.05**	0.31***	1.57***	0.51	-0.07	0.99***	-0.64***	0.50	0.17	-0.66	3.03***			
		(0.35)	(0.04)	(0.03)	(0.05)	(0.26)	(0.40)	(0.12)	(0.16)	(0.22)	(0.59)	(1.36)	(0.55)	(1.13)			
$j=4$	Δf_t	α	β^{MPS}	β^{OCR}	δ	γ^{CPI}	$\gamma^{CPI,s}$	γ^{GDP}	$\gamma^{GDP,s}$	γ^{US}	$\gamma^{US,\tau}$	$\gamma^{US,s}$	$\gamma^{US,s,\tau}$	γ^{EFF}	$\gamma^{EFF,\tau}$	$\gamma^{EFF,s}$	$\gamma^{EFF,\tau,s}$
		0.001	0.08*	0.13***	0.10***	0.03***	-0.05	0.01	-0.01	0.33***	-0.05	0.03	-0.01	-0.004	0.004	0.005	-0.01
		(0.001)	(0.04)	(0.04)	(0.02)	(0.01)	(0.04)	(0.01)	(0.02)	(0.03)	(0.06)	(0.06)	(0.10)	(0.01)	(0.01)	(0.01)	(0.02)
	$log(\sigma_t^2)$	ω_o	ω_1	ω_2	ω_3	η^{OCR}	η^{MPS}	ρ_τ	ρ_s	$\rho_{s,\tau}$	η^{CPI}	$\eta^{CPI,s}$	η^{GDP}	$\eta^{GDP,s}$			
		-4.12***	0.41***	0.06**	0.44***	1.25***	0.67*	-0.16	0.50***	-0.28*	0.32	0.68	-1.06**	3.09***			
		(0.32)	(0.04)	(0.02)	(0.05)	(0.23)	(0.35)	(0.11)	(0.11)	(0.16)	(0.38)	(0.72)	(0.48)	(0.88)			
$j=5$	Δf_t	α	β^{MPS}	β^{OCR}	δ	γ^{CPI}	$\gamma^{CPI,s}$	γ^{GDP}	$\gamma^{GDP,s}$	γ^{US}	$\gamma^{US,\tau}$	$\gamma^{US,s}$	$\gamma^{US,s,\tau}$	γ^{EFF}	$\gamma^{EFF,\tau}$	$\gamma^{EFF,s}$	$\gamma^{EFF,\tau,s}$
		0.001	0.07**	0.12***	0.08***	0.03**	-0.04	0.01	-0.02	0.39***	-0.09	-0.06	0.08	-0.005	0.004	0.01	-0.02
		(0.001)	(0.03)	(0.03)	(0.02)	(0.01)	(0.04)	(0.02)	(0.03)	(0.04)	(0.07)	(0.06)	(0.09)	(0.01)	(0.01)	(0.01)	(0.02)
	$log(\sigma_t^2)$	ω_o	ω_1	ω_2	ω_3	η^{OCR}	η^{MPS}	ρ_τ	ρ_s	$\rho_{s,\tau}$	η^{CPI}	$\eta^{CPI,s}$	η^{GDP}	$\eta^{GDP,s}$			
		-3.80***	0.46***	0.06**	0.48***	1.05***	0.81**	-0.17	0.31***	-0.16	0.38	0.61	-0.89*	2.48***			
		(0.30)	(0.04)	(0.02)	(0.04)	(0.22)	(0.33)	(0.11)	(0.10)	(0.15)	(0.30)	(0.53)	(0.49)	(0.73)			

Notes: The table shows the empirical results from equations (2.1) and (2.2):

$$\Delta f_t^j = \alpha^j + \delta^j \Delta f_{t-1}^j + \beta^{MPS,j} D_t^{MPS}(p_t^j - f_{t-1}^j) + \beta^{OCR,j} D_t^{OCR}(r_t^{OCR} - r_{t-1}^{30}) + \sum_k \gamma^{k,j} s_t^k + \sum_k \gamma^{k,\tau,j} s_t^k \tau_t + \sum_k \gamma^{k,s,j} s_t^k \cdot |f^j - p^j|_{t-1} + \sum_k \gamma^{k,s,\tau,j} s_t^k \cdot |f^j - p^j|_{t-1} \tau + \varepsilon_t^j$$

$$log(\sigma_t^{2,j}) = \omega_o^j + \omega_1^j \cdot \left| \frac{\varepsilon_{t-1}^j}{\sigma_{t-1}^j} \right| + \omega_2^j \cdot \frac{\varepsilon_{t-1}^j}{\sigma_{t-1}^j} + \omega_3^j \cdot log(\sigma_{t-1}^{2,j}) + \eta^{OCR,j} D_t^{OCR} + \eta^{MPS,j} D_t^{MPS} + \eta^{CPI,j} D_t^{CPI} + \eta^{CPI,s,j} D_t^{CPI} |f^j - p^j|_{t-1} + \eta^{GDP,j} D_t^{GDP} +$$
$$\eta^{GDP,s,j} D_t^{GDP} |f^j - p^j|_{t-1} + \sum_k \lambda^{k,j} D_t^k + \sum_k \lambda^{k,s,j} D_t^k |f^j - p^j|_{t-1} + \rho_\tau^j \tau_t + \rho_s^j |f^j - p^j|_{t-1} + \rho_{s,\tau}^j |f^j - p^j|_{t-1} \tau_t$$

For an explanation of the variables refer to Table 2.E. The sample covers business days from February 24, 2000 until September 12, 2008. *** (**) [*] denotes significance at the 1 % (5 %) [10 %] level; standard errors in parentheses.

Table 2.C: The EGARCH Model for Futures Rates: Complete Results for the Crisis Sample

$j=1$	Δf_t	α	β^{MPS}	β^{OCR}	δ	γ^{CPI}	$\gamma^{CPI,s}$	γ^{GDP}	$\gamma^{GDP,s}$	γ^{US}	$\gamma^{US,\tau}$	$\gamma^{US,s}$	$\gamma^{US,s,\tau}$	γ^{EFF}	$\gamma^{EFF,\tau}$	$\gamma^{EFF,s}$	$\gamma^{EFF,\tau,s}$
		0.002*	-0.05	0.08***	0.08**	-0.00	0.07***	0.01	0.13*	0.10**	0.04	-0.25**	0.39***	0.001	0.001	0.01	-0.01
		(0.001)	(0.04)	(0.03)	(0.04)	(0.01)	(0.02)	(0.01)	(0.08)	(0.05)	(0.08)	(0.10)	(0.14)	(0.01)	(0.01)	(0.02)	(0.03)
	$log(\sigma_t^2)$	ω_o	ω_1	ω_2	ω_3	η^{OCR}	η^{MPS}	ρ_τ	ρ_s	$\rho_{s,\tau}$	η^{CPI}	$\eta^{CPI,s}$	η^{GDP}	$\eta^{GDP,s}$			
		-1.02***	0.31***	-0.02	0.92***	1.45***	-0.59**	0.27***	0.34***	-0.38***	1.22***	-0.82	0.09	0.65			
		(0.11)	(0.03)	(0.02)	(0.01)	(0.21)	(0.27)	(0.05)	(0.09)	(0.12)	(0.25)	(0.67)	(0.32)	(0.97)			
$j=2$	Δf_t	α	β^{MPS}	β^{OCR}	δ	γ^{CPI}	$\gamma^{CPI,s}$	γ^{GDP}	$\gamma^{GDP,s}$	γ^{US}	$\gamma^{US,\tau}$	$\gamma^{US,s}$	$\gamma^{US,s,\tau}$	γ^{EFF}	$\gamma^{EFF,\tau}$	$\gamma^{EFF,s}$	$\gamma^{EFF,\tau,s}$
		0.003*	-0.05*	0.05	0.08**	-0.01	0.09***	0.04	0.10	0.35***	-0.18	-0.43***	0.62***	0.01	-0.004	-0.002	0.02
		(0.002)	(0.02)	(0.03)	(0.03)	(0.01)	(0.02)	(0.02)	(0.07)	(0.09)	(0.16)	(0.13)	(0.20)	(0.01)	(0.02)	(0.02)	(0.03)
	$log(\sigma_t^2)$	ω_o	ω_1	ω_2	ω_3	η^{OCR}	η^{MPS}	ρ_τ	ρ_s	$\rho_{s,\tau}$	η^{CPI}	$\eta^{CPI,s}$	η^{GDP}	$\eta^{GDP,s}$			
		-0.59***	0.17***	-0.02	0.95***	1.29***	-0.76***	0.10***	0.07	-0.05	0.57**	-0.02	0.08	1.17			
		(0.10)	(0.02)	(0.02)	(0.01)	(0.18)	(0.23)	(0.04)	(0.05)	(0.07)	(0.29)	(0.45)	(0.32)	(0.83)			
$j=3$	Δf_t	α	β^{MPS}	β^{OCR}	δ	γ^{CPI}	$\gamma^{CPI,s}$	γ^{GDP}	$\gamma^{GDP,s}$	γ^{US}	$\gamma^{US,\tau}$	$\gamma^{US,s}$	$\gamma^{US,s,\tau}$	γ^{EFF}	$\gamma^{EFF,\tau}$	$\gamma^{EFF,s}$	$\gamma^{EFF,\tau,s}$
		0.002	-0.04	0.09	0.09**	-0.004	0.07***	0.06***	0.07	0.30**	-0.10	-0.12	0.32	0.01	-0.003	-0.004	0.01
		(0.002)	(0.04)	(0.07)	(0.04)	(0.02)	(0.02)	(0.02)	(0.04)	(0.12)	(0.18)	(0.16)	(0.21)	(0.01)	(0.02)	(0.01)	(0.02)
	$log(\sigma_t^2)$	ω_o	ω_1	ω_2	ω_3	η^{OCR}	η^{MPS}	ρ_τ	ρ_s	$\rho_{s,\tau}$	η^{CPI}	$\eta^{CPI,s}$	η^{GDP}	$\eta^{GDP,s}$			
		-2.50***	0.30***	0.04	0.69***	1.32***	-0.37	0.48***	0.41***	-0.44***	-0.03	0.35	0.38	-0.25			
		(0.41)	(0.05)	(0.03)	(0.05)	(0.34)	(0.55)	(0.12)	(0.11)	(0.15)	(0.53)	(0.76)	(0.63)	(1.21)			
$j=4$	Δf_t	α	β^{MPS}	β^{OCR}	δ	γ^{CPI}	$\gamma^{CPI,s}$	γ^{GDP}	$\gamma^{GDP,s}$	γ^{US}	$\gamma^{US,\tau}$	$\gamma^{US,s}$	$\gamma^{US,s,\tau}$	γ^{EFF}	$\gamma^{EFF,\tau}$	$\gamma^{EFF,s}$	$\gamma^{EFF,\tau,s}$
		0.002	-0.06***	0.11**	0.09**	-0.01	0.07***	0.08***	0.03	0.33***	-0.10	-0.09	0.25	0.01	0.004	-0.003	0.01
		(0.002)	(0.02)	(0.05)	(0.04)	(0.02)	(0.02)	(0.03)	(0.04)	(0.12)	(0.19)	(0.16)	(0.22)	(0.01)	(0.02)	(0.01)	(0.02)
	$log(\sigma_t^2)$	ω_o	ω_1	ω_2	ω_3	η^{OCR}	η^{MPS}	ρ_τ	ρ_s	$\rho_{s,\tau}$	η^{CPI}	$\eta^{CPI,s}$	η^{GDP}	$\eta^{GDP,s}$			
		-1.35***	0.29***	0.01	0.84***	1.18***	-0.38	0.17**	0.11*	-0.10	-0.04	0.26	0.13	0.23			
		(0.23)	(0.04)	(0.02)	(0.03)	(0.25)	(0.36)	(0.07)	(0.06)	(0.09)	(0.51)	(0.63)	(0.64)	(0.97)			
$j=5$	Δf_t	α	β^{MPS}	β^{OCR}	δ	γ^{CPI}	$\gamma^{CPI,s}$	γ^{GDP}	$\gamma^{GDP,s}$	γ^{US}	$\gamma^{US,\tau}$	$\gamma^{US,s}$	$\gamma^{US,s,\tau}$	γ^{EFF}	$\gamma^{EFF,\tau}$	$\gamma^{EFF,s}$	$\gamma^{EFF,\tau,s}$
		0.003	-0.06***	0.09**	0.06*	-0.01	0.06***	0.08***	0.03	0.16	0.35*	0.15	-0.17	0.01	0.01	-0.003	0.01
		(0.002)	(0.01)	(0.04)	(0.03)	(0.02)	(0.02)	(0.03)	(0.05)	(0.11)	(0.18)	(0.16)	(0.22)	(0.01)	(0.02)	(0.01)	(0.02)
	$log(\sigma_t^2)$	ω_o	ω_1	ω_2	ω_3	η^{OCR}	η^{MPS}	ρ_τ	ρ_s	$\rho_{s,\tau}$	η^{CPI}	$\eta^{CPI,s}$	η^{GDP}	$\eta^{GDP,s}$			
		-0.88***	0.23***	0.03*	0.89***	1.04***	-0.47	0.10*	0.02	-0.01	-0.16	0.41	-0.07	0.68			
		(0.19)	(0.04)	(0.02)	(0.03)	(0.20)	(0.28)	(0.05)	(0.05)	(0.07)	(0.36)	(0.45)	(0.58)	(0.80)			

Notes: The table shows the empirical results from equations (2.1) and (2.2):

$$\Delta f_t^j = \alpha^j + \delta^j \Delta f_{t-1}^j + \beta^{MPS,j} D_t^{MPS}(p_t^j - f_{t-1}^j) + \beta^{OCR,j} D_t^{OCR}(r_t^{OCR} - r_{t-1}^{30}) + \sum_k \gamma^{k,j} s_t^k + \sum_k \gamma^{k,\tau,j} s_t^k \tau_t + \sum_k \gamma^{k,s,j} s_t^k \cdot |f^j - p^j|_{t-1} + \sum_k \gamma^{k,s,\tau,j} s_t^k \cdot |f^j - p^j|_{t-1} \tau + \varepsilon_t^j$$

$$log(\sigma_t^{2,j}) = \omega_o^j + \omega_1^j \cdot \left| \frac{\varepsilon_{t-1}^j}{\sigma_{t-1}^j} \right| + \omega_2^j \cdot \frac{\varepsilon_{t-1}^j}{\sigma_{t-1}^j} + \omega_3^j \cdot log(\sigma_{t-1}^{2,j}) + \eta^{OCR,j} D_t^{OCR} + \eta^{MPS,j} D_t^{MPS} + \eta^{CPI,j} D_t^{CPI} + \eta^{CPI,s,j} D_t^{CPI} |f^j - p^j|_{t-1} + \eta^{GDP,j} D_t^{GDP} +$$
$$\eta^{GDP,s,j} D_t^{GDP} |f^j - p^j|_{t-1} + \sum_k \lambda^{k,j} D_t^k + \sum_k \lambda^{k,s,j} D_t^k |f^j - p^j|_{t-1} + \rho_\tau^j \tau_t + \rho_s^j |f^j - p^j|_{t-1} + \rho_{s,\tau}^j |f^j - p^j|_{t-1} \tau_t$$

For an explanation of the variables refer to Table 2.E. The sample covers business days from September 15, 2008 until February 28, 2013. *** (**) [*] denotes significance at the 1 % (5 %) [10 %] level; standard errors in parentheses.

Counterfactual Analysis

The results presented in Chapter 2.3 suggest that the central bank could lower interest rate uncertainty by maintaining the freshness of projections. In this appendix, we propose a counterfactual analysis in order to evaluate the volatility effects of alternative implementation schemes for central bank projections. To that end, we consider the following schemes:

(1) **Projections with daily update:** The central bank announces its interest rate projections on a daily basis. Accordingly, staleness of projections is not an issue and market expectations should be in line with projections. In the counterfactual analysis, this scenario implies that $\widetilde{|f-p|} \equiv 0$ and $\widetilde{\tau}_t \equiv 0$.

(2) **Projections with state-dependent update:** The central bank announces a new projection (or reinforces the current one) whenever $|f-p|$ rises above a certain threshold of S basis points. In this scenario, market expectations are constrained by a band of 2 S basis points around the projection. In the counterfactual analysis, this implementation scheme implies that $\widetilde{|f-p|} \leq S$. Since the central bank is paying constant attention to the information content of the current projection, time-varying effects on interest rate uncertainty should be negligible, i.e. $\widetilde{\tau}_t \equiv 0$.

The counterfactual volatilities for the alternative schemes are derived from the EGARCH models estimated for each maturity and sample period. The counterfactual conditional volatility $\widetilde{\sigma}_t^2$ is obtained via a dynamic simulation of the estimated variance equation:

$$
\begin{aligned}
log(\widetilde{\sigma}_t^2) &= \hat{\omega}_o + \hat{\omega}_1 \left| \frac{\hat{\varepsilon}_{t-1}}{\hat{\sigma}_{t-1}} \right| + \hat{\omega}_2 \frac{\hat{\varepsilon}_{t-1}}{\hat{\sigma}_{t-1}} + \hat{\omega}_3 log(\widetilde{\sigma}_{t-1}^2) + \hat{\psi} D_t \\
&\quad + \hat{\rho}^{\tau} \widetilde{\tau}_t + \hat{\rho}^{s} \widetilde{|f-p|}_{t-1} + \hat{\rho}^{s,\tau} \widetilde{|f-p|}_{t-1} \widetilde{\tau}_t \qquad (2.3)
\end{aligned}
$$

The counterfactual values of $|f-p|$ are defined as $\widetilde{|f-p|} \equiv min\{|f-p|, S\}$, where S defines the threshold value that triggers an update of the projection. For the scenario of daily updated projections, the threshold S equals 0. Typically, central banks change interest rates in steps of 25 or 50 basis points. Therefore, we use thresholds of 12.5 and 25 basis points for the state-dependent projection updates. Note that the size of the threshold can be interpreted as the degree of the central bank's aversion against stale projections. Finally, since the implementation schemes under consideration rule out pure time effects of projections, the original $\tau_t \in [0,1]$ is replaced by $\widetilde{\tau}_t \equiv 0$.

Table 2.D summarizes the results from the counterfactual analysis. The first row shows for each horizon the median of the conditional standard deviation of futures rates *estimated* for the current practice of quarterly projections. As expected, interest rate uncertainty increases with the projection horizon j and is larger during the financial crisis period. All remaining rows show counterfactual standard deviations resulting from the hypothetical alternative implementation schemes introduced above.

Row 2 of Table 2.D presents the counterfactual interest rate volatility for the limiting case of daily projection updates. Since daily projections imply $\widetilde{|f-p|}_{t-1} \equiv 0$ and $\widetilde{\tau}_t \equiv 0$, the resulting counterfactual volatility is by construction always lower than the estimated volatility implied by quarterly projections. Therefore, the counterfactual standard deviations obtained for daily projections define a lower bound for interest rate volatility. They give a benchmark for the potential improvement that can be obtained by modifying the implementation scheme of projections. The second row implies that this gain – reflected in the difference between average volatilities obtained for projections with quarterly and daily updates – has remarkably increased both in absolute and relative terms since the outbreak of the crisis. The reductions in average standard deviations range from 0.17 to 0.58 basis points before and from 1.65

Table 2.D: Counterfactual Analysis of Alternative Projection Implementation Schemes

	pre-crisis period					crisis period				
Implementation scheme \ maturity	j=1	j=2	j=3	j=4	j=5	j=1	j=2	j=3	j=4	j=5
Projections with quarterly update $\hat{\sigma}(\lvert f^j - p^j \rvert)$	2.66	3.10	3.32	3.51	3.71	2.98	4.11	4.82	5.12	5.43
(1) **Projections with daily update** $\widetilde{\sigma}(\lvert \widetilde{f^j - p^j} \rvert \equiv 0, \widetilde{\tau}_t \equiv 0)$	2.08	2.62	2.79	3.20	3.54	0.99	2.16	2.70	3.30	3.78
(2a) **Projections with state-dependent update** $\widetilde{\sigma}(min\{\lvert f^j - p^j \rvert, 12.5\}, \widetilde{\tau}_t \equiv 0)$	2.35	2.90	3.05	3.41	3.72	1.40	2.44	2.88	3.41	3.83
(2b) **Projections with state-dependent update** $\widetilde{\sigma}(min\{\lvert f^j - p^j \rvert, 25\}, \widetilde{\tau}_t \equiv 0)$	2.57	3.11	3.25	3.57	3.84	1.60	2.70	3.07	3.54	3.90

Notes: The table shows the medians of the estimated standard deviations of futures rates in basis points in the first row. The corresponding counterfactual standard deviations based on Equation (2.3) are presented in the subjacent rows. In both subperiods, the starting date of the counterfactual analysis is the first monetary policy day with a published projection, i.e. March 15, 2000 and December 4, 2008.

to 2.12 basis points during the crisis period. These are improvements of 5-22 % and 30-67 % respectively.

Rows 3 and 4 of Table 2.D show the average counterfactual standard deviations of the state-dependent implementation schemes for central bank interest rate projections. In these scenarios, the central bank updates its projection whenever the market perceives the current projection as being too stale, i.e. whenever $|f - p|$ exceeds the threshold S. In practice, this can be accomplished by adjusting the projection to market expectations or by confirming the current projection. Since the deviations of futures rates from the corresponding projections are significantly larger, the volatility dampening effects of thresholds can be expected to be more pronounced in the crisis period.

The counterfactual analysis confirms that interest rate volatility would have been significantly lower if state-dependent projections had been used during the crisis period. Even for a large threshold ($S = 25$), interest rate volatility decreases remarkably implying volatility gains close to the first best scenario of daily projections. By contrast, in the pre-crisis period, significant volatility-decreasing effects require the introduction of a small threshold of 12.5 basis points, while the volatility-reducing gains of a large threshold remain negligible.

For both periods, the counterfactual exercise suggests that the efficacy of the RBNZ's interest rate projections could have been improved by a state-dependent implementation scheme that ensures a certain degree of freshness of projections. In practice, this more flexible way to implement interest rate projections can be accomplished by adjusting the projection to market expectations (if market expectations correctly anticipated the future change of projections) or by confirming the current projection (if market expectations were incorrect).

Table 2.E: List of Variables

f_t^j	futures rate for the 90-day rate j quarters ahead, maturity-adjusted [Source: Bloomberg L.P. / Code: ZBj Comdty]
	[*Futures rates are calculated by 100 minus the contract price from 90-day Bank Bill Futures traded at the Sydney Futures Exchange.*]
p_t^j	central bank interest rate projection of the 90-day rate j quarters ahead, maturity-adjusted [Source: RBNZ]
τ_t	time measure for the age of the current interest rate projection
	[$0 \leq \tau_t \leq 1$ *is the number of days since the last release divided by the total number of days between the preceding and the subsequent release of RBNZ's interest rate projections:* $\tau_t = 0$ *on the announcement day;* $\tau_t = 1$ *on the day before the subsequent announcement*]
Δr_t^{US}	change in the U.S. two-year government bond yield [Bloomberg L.P. / USGG2YR Index]
Δe_t	change in the New Zealand effective exchange rate [Bloomberg L.P. / NZTW Index]
x_t^{CPI}	CPI surprises for New Zealand [RBNZ, Statistics NZ]
x_t^{GDP}	GDP surprises for New Zealand [RBNZ, Statistics NZ]
	[*CPI and GDP surprises are calculated as the difference between the expectation [RBNZ Survey of Expectations] and the actual value on the announcement days (once a quarter).*]
D_t^{CPI}	impulse dummy that equals one on CPI announcement days
D_t^{GDP}	impulse dummy that equals one on GDP announcement days
D_t^{MPS}	impulse dummy that equals one on projection publication days
D_t^{OCR}	impulse dummy that equals one on OCR announcement days
r_t^{OCR}	Official Cash Rate [RBNZ]
r_t^{30}	New Zealand 30-day bank bill yields [RBNZ]
$D_t^{MPS}(p_t^j - f_{t-1}^j)$	monetary policy surprise in current projection
$D_t^{OCR}(r_t^{OCR} - r_{t-1}^{30})$	monetary policy surprise in OCR rate

Chapter 3

Forward Guidance under Disagreement - Evidence from the Fed's Dot Projections

Gunda-Alexandra Detmers

Abstract

This paper compares the effectiveness of date- and state-based forward guidance issued by the Federal Reserve since mid-2011 accounting for the influence of disagreement within the FOMC. Effectiveness is investigated through the lens of interest rates' sensitivity to macroeconomic news and I find that the Fed's forward guidance reduces the sensitivity and therefore crowds out other public information. The sensitivity shrinkage is stronger in the case of date-based forward guidance due to its unconditional nature. Yet, high levels of disagreement among monetary policy makers as published through the FOMC's dot projections since 2012 partially restore sensitivity to macroeconomic news. Thus, disagreement appears to lower the information content of forward guidance and to weaken the Fed's commitment as perceived by financial markets. The dot projections are therefore able to reduce the focal point character of forward guidance.

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3.1 Introduction

Forward guidance has become a key instrument in central banking over the past years as the need to manage expectations about the future path of monetary policy has increased. According to e.g. Blinder et al. (2008), forward guidance is essential for an effective monetary policy when policy rates are very low and uncertainty is high. Since the Federal Reserve (Fed) and other central banks (as e.g. the European Central Bank and the Bank of Canada) adopted this measure as a consequence of the financial crisis, the term *forward guidance* has come to be interpreted as a promise to keep interest rates low for an extended or explicit period of time or until a certain condition is met.[1] Yet, forward guidance had already been used before the crisis in conjunction with other macroeconomic projections as a measure of expectations management and central bank transparency.

The Fed's forward guidance has experienced different designs, especially since the eruption of the financial crisis.[2] In December 2008, the Fed started off with a qualitative open-ended forward guidance which was then extended to include explicit time and state dimensions. Specifically, from August 2011, the Fed provided unconditional forward guidance in the form of a date-based commitment to keep interest rates low for an explicit period of time. This horizon was adjusted in subsequent monetary policy meetings. In December 2012, the Fed then adopted state-based forward guidance by linking a future rise in the federal funds rate to certain outcomes in unemployment and inflation.[3] This step conditioned forward guidance on macroeconomic developments and thus made it less rigid. In January 2012, the participants of the Federal Open

[1]For a review of forward guidance strategies at the zero lower bound by the Fed, the Bank of England, the ECB and the Bank of Japan, see Filardo and Hofmann (2014), Contessi and Li (2013a) and Contessi and Li (2013b). For research on the effects on expectations by committing to a future policy path in the context of low interest rates, see e.g. Eggertsson and Woodford (2003).

[2]This paper concentrates on the Fed's forward guidance issued since 2008. For literature on the Fed's communication and forward guidance beforehand - including the period between 2003-2005, see e.g. Woodford (2005) and Meade et al. (2015).

[3]Date- and state-based forward guidance are sometimes also referred to as calendar- and threshold-based forward guidance, compare Femia et al. (2013).

Market Committee (FOMC)[4] began to provide their individual assessments of the appropriate future policy rate path in order to enhance the public's understanding of monetary policy decisions that depend on the Committee's assessment of macroeconomic conditions, see Federal Reserve System (2011). Before, the FOMC had already published a tendency of macroeconomic projections based on individuals' assessments of the appropriate future policy rate. Yet, a clear communication of the latter with all individual projections conveying the Committee's disagreement is expected to influence market expectations about future monetary policy. However, it is still unclear how and to what extent markets react to this kind of forward interest rate publications.

This paper is the first to comprehensively compare the effectiveness of date- and state-based forward guidance and to consider the impact of disagreement within the FOMC thereon. Specifically, this paper builds on Swanson and Williams (2014) and Raskin (2013) and investigates effectiveness through the lens of interest rates' sensitivity to macroeconomic news. Macroeconomic models suggest that macroeconomic news do not persistently impact short-term interest rates. Therefore long-term rates that represent the expected future path of short rates should not be affected. However, Gürkaynak et al. (2005) find that interest rates along the term-structure move upon a macroeconomic surprise. This reaction pattern can be used in order to analyze the effect of central banks' expectations management on the yield curve. For conditional and unbinding forward guidance, one would wish sensitivity to either stay constant or even rise (compare Moessner and Nelson, 2008) as the central bank projection just increases the information set of market participants and should not crowd out other signals. Market participants would thus understand the conditional nature of forward guidance. By contrast, forward guidance that conveys sort of a commitment would result in a lower responsiveness of interest rates of respective maturities if the promise is perceived as credible. This

[4]In fact, not only the members of the FOMC but also the non-voting Reserve Bank presidents provide their assessments within the Summary of Economic Projections. Hereinafter, if not explicitly stated, the term "participants" comprises all those who participate in the assessment that is published by the FOMC. For further details, see Chapter 3.3 and Appendix A.

rather unconditional forward guidance would constitute a focal point in the financial market such that interest rates would be less affected by macroeconomic news. Forward guidance thus crowds out other information that market participants would typically use to form expectations. While date-based forward guidance can be considered as being purely unconditional, state-based forward guidance is conditional and still contains some commitment character. Therefore, one would expect the sensitivity of interest rates to macroeconomic news to be higher than in the unconditional case.

The sample of this paper covers a base period from December 2008 until August 2011 and I allow for an altered sensitivity change due to date- and state-based forward guidance respectively thereafter. I find that both date- and state-based forward guidance are effective in lowering the sensitivity of Treasury yields to macroeconomic news. Yet, the impact of date-based forward guidance is stronger. This is due to its unconditional character which induces market participants to be less attentive to other macroeconomic developments. As credibility is crucial for the effectiveness of forward guidance, this implies that financial market participants believe in the promise by the central bank to keep interest rates low, despite a potential time-inconsistency problem. By contrast, under state-based forward guidance, the sensitivity shrinkage is less pronounced as market expectations are steered to account for macroeconomic developments.

A key contribution of this paper is to let these effects differ with the level of disagreement on the future policy path that is provided in the quarterly dot projections of the FOMC. These projections reveal that policy makers do not entirely agree on future monetary policy. Thus, if the central bank provides information on disagreement, this could be detrimental to the impact of forward guidance. In line with this intuition, I find that high levels of disagreement among policy makers result in a higher sensitivity of interest rates to macroeconomic news especially during the date-based forward guidance period for the medium- to longer-run. Thus, the publication of dot projections as a measure to heighten transparency is able to reduce the focal point character of forward guidance and somehow responds to the criticism of Morris and Shin (2002).

This analysis arrives at the result that financial market participants attached credence to the Fed's forward guidance since the financial crisis erupted in 2008. The findings further support that conditioning forward guidance and publishing dot projections conveying the disagreement among monetary policy makers helps to consolidate financial market participants' attentiveness to information.

This paper contributes to a strand of literature that examines the effectiveness of forward guidance by means of sensitivity analysis and is therefore closely related to e.g. Swanson and Williams (2014), Raskin (2013) as well as Moessner and Nelson (2008). It further contributes to the literature on decision making of monetary policy committees and the communication of those decisions. While some literature is in favor of communicating only the consensus view of committee members Ehrmann and Fratzscher (2013), Riboni and Ruge-Murcia (2014) argue that dissenting votes help to better anticipate future monetary policy decisions.

The rest of the paper is organized as follows. In the next chapter, I summarize the evolution of the Fed's forward guidance since 2008 and link it to the literature. In Chapter 3.2.3 the empirical model is introduced and the empirical results on date- and state-based forward guidance are presented. Chapter 3.3 discusses the FOMC's dot projections as well as several measures of disagreement. In Chapter 3.4, the empirical model is augmented by measures of disagreement. It will further present some robustness checks where I control for policy uncertainty and then allow for asymmetric effects due to interest rates' proximity to the zero lower bound. Finally, Chapter 3.5 concludes.

3.2 The FOMC's Forward Guidance since 2008

The Federal Open Market Committee (FOMC) is responsible for the conduct of monetary policy at the U.S. Federal Reserve (Fed). The FOMC meets regularly eight times a year to review the current target level for the federal funds rate and to steer market expectations about its future level, for instance through issuing economic projections.

While monetary policy decisions at the Fed were not announced at all before 1994 (see Nautz and Schmidt, 2009), policy makers have moved to making concrete statements and now even provide forward guidance in their monetary policy statements (see Wynne, 2013).[5] The FOMC already issued forward guidance from 2003 to 2005 when the federal funds rate was at 1%, affirming that "policy accommodation can be maintained for a considerable period" (Federal Reserve System, 2003). As the policy rate approached the zero lower bound in December 2008, the Fed again started projecting future levels of the federal funds rate. Traditional monetary policy was bounded and forward guidance therefore became an essential tool (see Blinder et al., 2008).

Forward guidance was adopted by several other central banks already before the financial crisis in order to manage financial markets' expectations and to make the public learn about the central bank's reaction function.[6] This expectations management was further intended to lower interest rate uncertainty and thus financial market volatility, and represented a significant increase in central bank transparency. However, monetary policy makers always tried to emphasize the conditional character of these future paths. The influence of these projections on long-term interest rates was therefore rather limited (compare Detmers and Nautz, 2012). By contrast, unconditional projections about the future policy path may serve as a commitment device to steer longer-term rates, especially when policy rates are already very low.[7] Campbell et al. (2012) define this assurance to stick to accommodative monetary policy as "Odyssean forward guidance". In contrast, the projection of a presumable path conditional on the future economy represents a nonbinding forward guidance that

[5]For a historical review of the Fed's forward guidance, see also Contessi and Li (2013a).

[6]The Reserve Bank of New Zealand was the first central bank to publish quantitative interest rate projections in 1997 (see Detmers and Nautz, 2012). Other central banks followed in providing forward guidance, as for example the Bank of Norway in 2005 and Sveriges Riksbank in 2007.

[7]The Bank of Japan introduced this kind of forward guidance already in 1999, when the policy rate was 0.15% (see Contessi and Li, 2013b).

the authors refer to as "Delphic forward guidance". All the different designs of forward guidance implemented by the Fed since 2008 can be classified as Odyssean forward guidance. In the following, the terms *conditional* and *unconditional* will therefore signify the different degrees of the Fed's Odyssean forward guidance.

3.2.1 Date- and State-based Forward Guidance

In December 2008, together with the most recent rate cut, the FOMC initially committed itself to a low future level of the federal funds rate in a verbal statement. At that time, expected inflation was too low to be consistent with the Fed's mandate and standard monetary policy tools had lost their effectiveness. The FOMC stated that "weak economic conditions are likely to warrant exceptionally low levels of the federal funds rate for some time" (see Federal Reserve System, 2008).[8] This warranty got strengthened in the March 2009 statement by spanning "an extended period of time".

In August 2011, the FOMC surprisingly[9] introduced an explicit horizon which was renewed and prolonged in the January and September 2012 statements (see Table 3.1). The horizon always covered the next 2 to 3 years over which the FOMC expected to not increase the target for the federal funds rate. This *date-based forward guidance* comes close to an unconditional commitment to keep the policy rate at the current level and is thus the most binding forward guidance ever issued. However, FOMC participants expressed their concern that the press misinterpreted the date as a full commitment (see Federal Reserve System, 2012).

There are advantages and disadvantages to the concept of committing to low policy rates. On the one hand, such commitment might serve as an extensive economic stimulus, especially if the commitment period is longer than

[8] In line with e.g. Femia et al. (2013), exceptionally low levels are construed as the current level or range respectively of the target federal funds rate.

[9] See Raskin (2013) and Femia et al. (2013).

Table 3.1: Forward Guidance at the Federal Reserve since December 2008

Dec 16, 2008	The Fed **starts to provide forward guidance** and projects low levels of the federal funds rate "for some time".
March 18, 2009	The Fed **prolongs the horizon** to "an extended period of time".
Aug 9, 2011	**Date-based** forward guidance (= unconditional forward guidance)
	Aug 9, 11: "at least through mid-2013" Jan 25, 12: "at least through late-2014" Sep 13, 12: "at least through mid-2015"
Jan 25, 2012	Publication of **dot projections** revealing disagreement among FOMC participants
Sep 13, 2012	Committee expects that a highly accommodative stance of monetary policy will remain appropriate for a **considerable time after** the economic recovery strengthens.
Dec 12, 2012	**State-based** forward guidance (= conditional forward guidance linked to actual unemployment rate and inflation projections)
March 19, 2014	Extension of time horizon of forward guidance; low interest rate levels **even after** employment and inflation are near mandate-consistent levels.

Notes: This table summarizes the most important changes in forward guidance at the U.S. Federal Reserve through FOMC Statements between December 2008 and March 2015. This paper focuses on the shaded entries. Source: Federal Reserve System.

expected by market participants (compare Woodford, 2012).[10] On the other hand, by committing to low future policy rates, the central bank loses flexibility and might run into a time-inconsistency problem (see also Woodford, 2012): At the time when improved economic conditions would allow a rise in the policy rate despite a still valid promise of low levels, the central bank either risks to lose credibility by deviating from its promise or an overshooting in inflation and output above the levels consistent with the bank's target. Nakata (2014) shows that despite this overshooting the decline in output and inflation is less extreme during crisis periods due to a re-anchoring of inflation expectations. Furthermore, an overshooting is relatively easy to cope with as conventional monetary policy is effective again. Yet, knowing about the time-

[10]While the Fed's policy could be viewed as an extended commitment following Woodford (2012), Contessi and Li (2013a) suggest that date-based forward guidance may have also signaled either a weaker economic outlook or a change in the policy rule of the Federal Reserve.

inconsistency, the public might not believe in the central bank's commitment in the first place, lowering the stimulating effect of forward guidance on the economy. Thus, effective forward guidance is mostly a matter of central bank credibility and public understanding (see Filardo and Hofmann, 2014).[11]

Soon, FOMC statements additionally became more explicit about the economic conditions warranting low future rates (see for instance the FOMC's statement on September 13, 2012). As a consequence of such a policy, the public may learn about the central bank's reaction function, helping policy makers to regain flexibility.

In December 2012, the date-based forward guidance was then succeeded by a *state-based forward guidance* that had already been discussed in January 2012 (see Federal Reserve System (2012), page 14). Instead of being explicit about the horizon, the FOMC started to link a future rise in the federal funds rate to numerical economic conditions, i.e. thresholds in unemployment and projected inflation.[12] In the same statement, the FOMC emphasized that these thresholds are consistent with the date-based forward guidance issued before. Yet, no statement has since specified or prolonged an explicit horizon. The unconditional and therefore inflexible date-based forward guidance was thus somehow replaced by a rather conditional state-based forward guidance .[13]

In order to provide further economic stimulus, the FOMC started in September 2012 to repeatedly affirm that the federal funds rate target would stay low "for a considerable time after the economic recovery strengthens". Since March 2014, this statement has become more explicit as the FOMC now anticipates low policy rates even after unemployment and inflation have reached levels consistent with the Fed's mandate (see Woodford, 2012).

[11]Filardo and Hofmann (2014) further suggest that forward guidance is potentially useful if there is a commitment that is clearly communicated and interpreted in the intended way.

[12]Specifically, unemployment should decline to 6.5 %, inflation projections at the one and two year horizon should be between 2 - 2.5% and longer-run inflation expectations should be well-anchored before a rise in policy rates would be appropriate.

[13]For comparison, the European Central Bank (2014) distinguishes four categories of forward guidance, namely pure qualitative forward guidance, qualitative forward guidance conditional on narrative, calendar-based and outcome-based forward guidance.

3.2.2 Literature on the Effects of Forward Guidance

According to theory, central bank disclosures about future monetary policy might become a focal point and crowd out private information, see Morris and Shin (2002). This might be detrimental to social welfare, especially when the public signal is wrong. However, Svensson (2006) shows that if public and private signals are of the same precision, welfare is higher with a central bank providing information about its projected future policy. This strand of the literature focuses on conditional forward guidance applied before the financial crisis. For binding forward guidance, however, economic stimulus triggered by the central bank can only be achieved when forward guidance translates into financial markets' expectations as forward guidance partially replaces standard monetary policy tools. The public forward guidance signal is therefore *intended* to reduce the relevance of other macroeconomic information.

The empirical analysis of forward guidance typically concentrates on its level and volatility effects on interest rate expectations, as well as on its impact on the sensitivity of interest rates to other news. There is evidence that central bank interest rate projections conditional on the economic outlook influence market expectations and interest rates, at least for short to medium horizons (see e.g. Moessner and Nelson, 2008). Yet, the effect diminished after the outbreak of the financial crisis in 2008 (Detmers and Nautz, 2012). Filardo and Hofmann (2014) show that the level effect of the Fed's commitment to low future policy rates on interest rates and expectations up to an horizon of 10 years was highest for the qualitative open-ended forward guidance issued in December 2008 ("for some time") and March 2009 ("extended period of time"). However, these statements coincided with a the most recent rate cut and the announcement of asset purchases. The response of interest rates to the introduction of date-based forward guidance in August 2011 was quite large, especially for the two year horizon. On the day state-based forward guidance was first issued, the effect was quite small or even positive. Yet, the authors ascribe effectiveness to state-based forward guidance as there were also announcements on the reduction of asset purchases. Futhermore, Wu and

Xia (2016) find that extending the expected period of exceptionally low policy rates by one year has a macroeconomic effect comparable to a rate cut by 15 basis points. This suggests that forward guidance can substitute conventional monetary policy at the zero lower bound at least to some extent.

Interest rate projections should persistently affect market expectations and lower financial market volatility. An immediate effect on the policy day with a retraction in the following days is viewed as volatility-increasing and contradicts the spirit of central bank transparency (see Ferrero and Secchi, 2009; Detmers and Nautz, 2012). Fresh central bank announcements on the projected future path potentially lower interest rate uncertainty. Stale projections, by contrast, may lead to increased volatility (see e.g. Detmers and Nautz, 2014). Furthermore, in the case of the Fed's binding forward guidance, Filardo and Hofmann (2014) show that volatility of rate expectations was lower during date- and state-based forward guidance periods than in the period with only qualitative forward guidance, especially for horizons up to two years. In particular, date-based forward guidance results in lower volatility for the medium-term while volatility at the shorter horizon is even lower in the state-based forward guidance period.

The Sensitivity of Interest Rates to Macroeconomic News as a Measure of Monetary Policy Effectiveness

Gürkaynak et al. (2005) show that the reaction of longer-term rates to macroeconomic shocks is at odds with macroeconomic models. These predict that short-term rates would move upon a macroeconomic surprise but rapidly return to their steady state values afterwards. Therefore, macroeconomic surprises should not affect long-term rates at all as long as expectations are well anchored. In contrast to theory, the authors find evidence that macroeconomic news also impact long-term interest rates and argue that surprises must have led to an adjustment of the expected steady state level of inflation. The empirical literature builds on this reaction pattern to identify the effectiveness of forward guidance. In particular, if forward guidance reduces the sensitivity to macroeconomic news, this suggests that market participants perceive forward guidance as unconditional and are less attentive to other developments.

Moessner and Nelson (2008) find no evidence that forward guidance lowers the market's reaction to other news. In particular, they detect increased responsiveness of futures rates to macroeconomic surprises in the period from August 2003 until December 2005, when it was announced that policy accommodation potentially would be maintained for a considerable period. The authors welcome this result as it shows that market participants are not inattentive to developments outside the Fed.[14][15] In this period, although the federal funds rate was quite low at 1%, it was still above the zero lower bound. Forward guidance in this period was substantially weaker and more of an open-ended design as there was still room for standard monetary policy instruments. This is different for the forward guidance issued after reaching the zero lower bound in December 2008 when the central bank mostly relied on forward guidance as its monetary policy tool.

Swanson and Williams (2014) show that interest rates along the yield curve should be less sensitive to macroeconomic news at the zero lower bound. This especially applies for short-term interest rates that are insensitive to both positive and negative shocks, as long as the zero lower bound is strongly binding with a negative shadow rate.[16] The authors argue that only large positive shocks would be able to generate a rise in the short-term rate. Thus, when the central bank publicly commits to keep policy rates at the zero lower bound for a certain period, expected short-term rates within this horizon should not move upon a shock. As longer-term rates average the actual short-term rate and the expected future path of short-term rates, this effect should spread along the yield curve. Swanson and Williams (2014) find decreased responsiveness of Treasury yields to macroeconomic surprises at the short end of the

[14]By contrast, Swanson and Williams (2014) show that sensitivity of Treasury yields of three and six months significantly shrinks during the same period.

[15]In the same vein, Moessner et al. (2015) find that the forward guidance of the Sveriges Riksbank did not significantly impact the sensitivity of interest rates as market participants understood its conditionality.

[16]Moessner et al. (2015) support this finding for Sweden.

yield curve during the zero lower bound period. While sensitivity to macro news is highest in the beginning of 2008, it significantly declines for 3- and 6-month horizons around March 2009, when the wording “extended period of time” expanded the horizon of presumably low interest rates and therefore strengthened forward guidance.

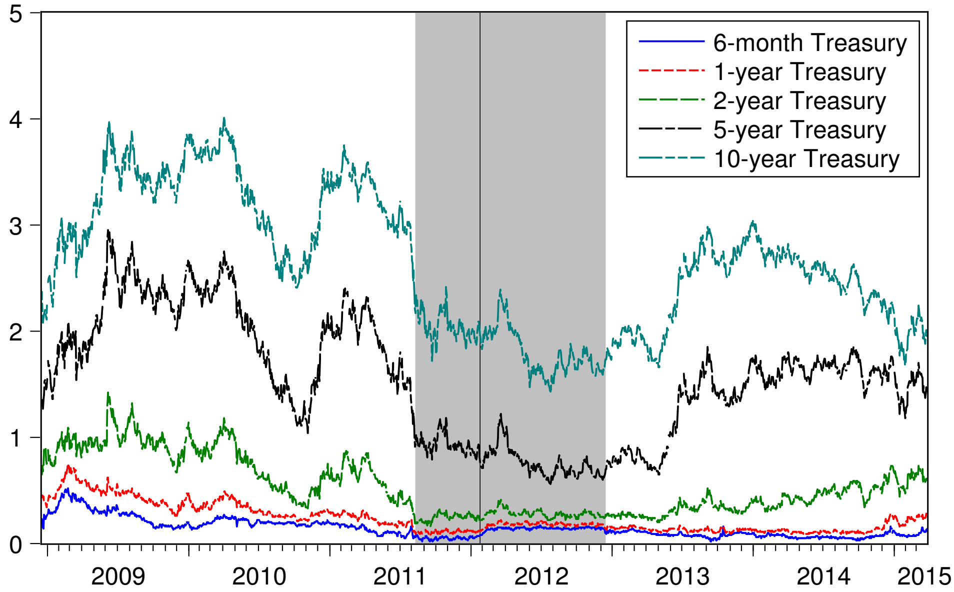
3.2.3 The Relevance of Forward Guidance for the Sensitivity of Treasury Yields

According to both theoretical and empirical literature, macroeconomic surprises should lead to at least a short-lasting move in short-term interest rates. By contrast, long-term interest rates should not move significantly upon macroeconomic news if expectations are well anchored. Yet, at the zero lower bound, the reaction of short-term rates should be reduced or not happen at all, see Swanson and Williams (2014).

In the empirical analysis, I use U.S. government Treasury yields available at the Federal Reserve Board at multiple horizons from 6 months to 20 years. Figure 3.1 depicts the evolution of a set of Treasury yields over the sample period from December 2008 until March 2015. The dark shaded area represents the date-based forward guidance period, while the state-based period begins thereafter. Short-term interest rates are rather low and close to the zero lower bound that prevails throughout the whole sample. During the date-based forward guidance period, interest rates of medium- to long-run maturities were lower than before. Committing to low interest rates for an explicit horizon therefore seems to be an effective forward guidance strategy to steer longer-term interest rates. Yet, Figure 3.1 does not allow inferences about the impact of introducing state-based forward guidance. However, longer-term rates rise in mid-2013, suggesting that economic data indicated an upcoming lift-off. In fact, the Fed at that time announced to reduce its asset purchase programs which led to the “2013-taper tantrum”.

For analyzing the sensitivity of Treasury yields to macroeconomic news,

Figure 3.1: Treasury Yields



Notes: Treasury yields at maturities 6m, 1y, 2y, 5y, 10y. Dark shaded area represents the time period of date-based forward guidance from August 9, 2011 onwards. State-based forward guidance started in the period thereafter, i.e. on December 12, 2012. Vertical line represents the introduction of dot projections on January 25, 2012.

I use actual releases together with the median forecast of the RTR poll from Datastream. I compute surprises as the difference between forecast and actual releases and normalize them by their historical standard deviations. Following the literature (e.g. Gürkaynak et al., 2005; Swanson and Williams, 2014; Raskin, 2013), the regressions include economic surprises on output, prices and labor specifically capacity utilization, consumer confidence, core CPI, GDP (advance), ISM manufacturing index, leading indicators, new home sales, non-farm payrolls, core PPI, retail sales ex. autos and the unemployment rate. Panel A in Table 3.A in the Appendix summarizes some statistics on the set of macroeconomic surprises. While there are only 25 observations for the quarterly release of the GDP (advance), there are 72 to 76 observations of all other macroeconomic variables due to a monthly release schedule. As some releases are communicated at the same day, there are 603 announcement days in the sample.

Binding forward guidance, whether conditional or unconditional, should result in financial market participants becoming less attentive to macroeconomic news. If forward guidance does not reduce sensitivity to macroeconomic news at all, this could have three reasons. First, the central bank or the issued forward guidance may not be credible from market participants' point of view. Second, this could imply a bad transparency scheme of the central bank. Markets then would be unable to correctly process the provided information (see e.g. Filardo and Hofmann, 2014). Third, markets might have already priced in the prolonged period of low interest rates. Yet, this would involve no reason for the Fed to insist on forward guidance as intensively as done in this period since binding forward guidance is costly due to a loss in flexibility. In order to analyze the effectiveness of the different strategies, I will consider the following hypotheses in the empirical model. The first hypothesis to be tested in the model therefore reads:

Hypothesis 1: *Credible binding central bank forward guidance should lead to a decreased sensitivity of Treasury yields to macroeconomic surprises.*

The sample period allows to investigate whether a potential sensitivity decreasing effect differs between date- and state-based forward guidance. Date-based forward guidance as pursued by the Fed is an unconditional commitment such that Treasury yields should not be affected by any surprising macroeconomic developments if the guidance is credible, compare Swanson and Williams (2014) and Raskin (2013). Specifically, if the central bank commits itself to keep interest rates at the actual level for an explicit horizon, interest rates that match this maturity should not significantly move upon a macroeconomic surprise. By contrast, state-based forward guidance is a conditional commitment and linked to unemployment and inflation projections. If a commitment is conditional on macroeconomic developments, market participants should be attentive to macroeconomic surprises for the formation of expectations. Consequently, the sensitivity shrinkage should be higher under date-based than under state-based forward guidance due to a different level of conditionality. This is a refined approach which translates into the second hypothesis:

Hypothesis 2: *Due to its unconditionality, the sensitivity-lowering effect of date-based forward guidance should be more pronounced than in the state-based forward guidance regime when markets are more attentive to macroeconomic developments.*

Empirical Model and Results

Advancing on Swanson and Williams (2014) and Raskin (2013), I analyze the sensitivity of Treasury yields to macroeconomic news by letting the sensitivity depend on the prevailing forward guidance design. For Treasury yields of maturities $j = 6$ months, $1, 2, 3, 5, 10, 20$ years, I estimate the empirical model on all macroeconomic release dates t from December 16, 2008 until March 30, 2015:[17]

$$\Delta r_t^j = \alpha^j + \sum_k \beta^{k,j} s_t^k (1 + \gamma^{d,j} D_t^{date} + \gamma^{s,j} D_t^{state}) + \varepsilon_t^j \tag{3.1}$$

where s^k are the macroeconomic surprises introduced above. D_t^{date} and D_t^{state} represent step dummies that equal 1 in the respective time periods, see Table 3.1 and Figure 3.1. The γ's then determine the overall change in the yield's sensitivity to macroeconomic news during the date-based and state-based forward guidance period respectively.

I expect sensitivity of Treasury yields to macroeconomic news to shrink when binding forward guidance is issued, especially for the short- to medium-run. In line with Hypothesis 1, this implies that the coefficients of date- and state-based forward guidance dummies should be negative, i.e. $\gamma < 0$. Yet, as short-term rates are bounded, one could also expect this sensitivity shrinkage to be absent in the very short-run. Since there should be a higher importance of macroeconomic news in times of state-based forward guidance following Hypothesis 2, the effects of the two concepts of forward guidance are allowed to differ. Specifically I expect $|\widehat{\gamma}^{d,j}| > |\widehat{\gamma}^{s,j}|$ and a significant estimate of $\gamma^{d,j}$ for longer maturities j than of $\gamma^{s,j}$.

[17] The estimation results are robust to whether only announcement days or all business days are covered in the sample.

Table 3.2: The Sensitivity-Lowering Effect of Date- and State-based Forward Guidance on Treasury Yields to Macroeconomic News

	6months	1year	2years	3years	5years	10years	20years
Capacity utilization	0.17	-0.20	0.33	0.43	0.02	-0.53	-0.63
	(0.20)	(0.20)	(0.39)	(0.43)	(0.53)	(0.49)	(0.45)
Consumer confidence	0.01	-0.04	0.38	0.54	0.72	0.85	1.12**
	(0.14)	(0.33)	(0.59)	(0.56)	(0.65)	(0.54)	(0.57)
Core CPI	-0.29	-0.19	-0.70	-0.71	-0.89	-0.96	-0.86
	(0.28)	(0.40)	(0.78)	(0.78)	(0.90)	(0.83)	(0.67)
GDP advance	0.38**	0.09	1.13*	1.73*	2.16*	2.42**	2.43**
	(0.18)	(0.15)	(0.66)	(1.03)	(1.12)	(1.19)	(1.14)
ISM index	0.36*	0.00	0.28	0.69	1.25*	1.57*	1.57**
	(0.18)	(0.24)	(0.65)	(0.61)	(0.73)	(0.81)	(0.74)
Leading indicators	-0.11	0.01	0.50	0.59	0.40	0.21	-0.21
	(0.22)	(0.15)	(0.48)	(0.69)	(1.00)	(1.09)	(0.95)
New homes	0.19	-0.02	0.02	-0.05	-0.15	-0.15	-0.09
	(0.22)	(0.21)	(0.41)	(0.48)	(0.52)	(0.40)	(0.38)
Nonfarm payrolls	0.83*	2.57***	6.03***	5.64***	5.76***	3.63***	3.10***
	(0.45)	(0.86)	(2.02)	(1.92)	(1.69)	(1.13)	(0.98)
Core PPI	0.18	0.48	1.70**	2.17**	2.25**	1.31	1.39
	(0.15)	(0.40)	(0.71)	(0.86)	(0.98)	(1.00)	(1.08)
Retail sales ex. autos	0.21	0.36*	0.54	1.25**	1.88**	2.13***	2.15***
	(0.14)	(0.20)	(0.43)	(0.57)	(0.84)	(0.79)	(0.80)
Unemployment	0.19	0.16	0.31	0.61	0.79	0.77	0.77
	(0.24)	(0.47)	(1.03)	(0.95)	(1.02)	(0.79)	(0.72)
Date-based FG: γ^d	-0.75***	-0.86***	-0.94***	-0.83***	-0.67***	-0.17	-0.05
	(0.14)	(0.05)	(0.03)	(0.07)	(0.14)	(0.38)	(0.46)
State-based FG: γ^s	-1.26***	-0.65***	-0.33	0.08	0.32	0.55	0.55
	(0.22)	(0.19)	(0.28)	(0.4)	(0.42)	(0.49)	(0.46)
$H_0 : \beta = 0$ p-value	0.11	0.13	0.02	0.04	0.05	0.13	0.09
R^2	0.05	0.14	0.16	0.13	0.11	0.08	0.08

Notes: Estimations for Equation 3.1 for all announcement days between December 16, 2008 and March 30, 2015. i.e. 603 observations for each horizon. $\Delta r_t^j = \alpha^j + \sum_k \beta^{k,j} s_t^k (1 + \gamma^{d,j} D_t^{date} + \gamma^{s,j} D_t^{state}) + \varepsilon_t^j$; Newey-West standard errors in parentheses; *** (**) [*] denotes significance at the 1% (5%) [10%] level. $H_0 : \beta = 0$ tests for all βs being jointly zero and states the respective p-value.

Table 3.2 summarizes the results from estimating Equation 3.1. All significant responses are plausibly signed. In line with Raskin (2013), surprises in nonfarm payrolls and retail sales excluding autos significantly affect interest rates along the yield curve. Note that the base period from December 2008 until August 2011 is already a period in which short-term interest rates are no longer sensitive to the whole set of macroeconomic news (compare Swanson and Williams, 2014). Here, for instance, nonfarm payrolls significantly affect Treasury yields except for the very short-run. Yet, there are significant effects of the ISM manufacturing index and the advance release of GDP along the yield curve as well as of core PPI for medium-term rates. Yet, as the period from December 2008 onwards is a period with rather low sensitivity to macroeconomic news, some results have to be interpreted with caution. Specifically, the test on joint significance of all βs cannot be rejected for horizons of 6 months, 1 and 10 years; still, the R^2 is just as high as in comparable studies.

The shaded area in Table 3.2 shows the main coefficients of interest, namely the effect of forward guidance on the sensitivity of Treasury yields. With $\gamma^d < 0$ for all horizons, there is a sensitivity-lowering effect of date-based forward guidance throughout the yield curve. The reaction of Treasury yields to macroeconomic surprises is thus lower under date-based forward guidance. This effect is statistically significant for horizons up to 5 years. Thus date-based forward guidance has a rather expansive influence as the announced horizons only covered the next 2 or 3 years. Reasons for this could be further announcements that low interest rates would prevail even after the economic recovery has strengthened (Woodford, 2012) or a strong correlation between Treasury yields of different maturities. The Fed's forward guidance thus seems to be rather credible as the public does not expect the Fed to deviate from its promise despite a time-inconsistency problem.

State-based forward guidance only results in a sensitivity shrinkage at the short end of the yield curve. Market participants seem to consider low policy rates as guaranteed for the very short-run but are attentive to macroeconomic developments for the formation of medium- to longer-run expectations. The discrepancy in the strength of reactions to date- and state-based forward guidance confirms their different conditionality. In fact, Berriel et al. (2015) find evidence that the degree of commitment decreases in December 2012. Financial market participants observe this decline in commitment and become more attentive to macroeconomic news. The results affirm the hypotheses proposed above and show that different forward guidance strategies represent some scope for effective expectations management even at the zero lower bound.

3.3 The FOMC's Dot Projections and Disagreement

In January 2012, the FOMC started to disclose participants' individual assessments of the appropriate future policy rate. These publications aim to enhance the transparency of the Federal Reserve System and potentially increase the public's understanding of monetary policy (see Federal Reserve System, 2011). Yet, FOMC participants might disagree in their view of the appropriate future path. Through the regularly published dot projections, this disagreement becomes public information and might affect financial markets' perception of the Fed's forward guidance and impair its effectiveness. Specifically, the reaction of interest rates to macroeconomic surprises may become stronger in the presence of disagreement.

After a short review of literature on disagreement within monetary policy committees, this chapter presents and discusses the FOMC's dot projections. I further measure the enclosed disagreement that will (in Chapter 3.4) augment the empirical model of Chapter 3.2 in order to investigate the disagreement's effect on interest rates' sensitivity and on the effectiveness of other forward guidance.

3.3.1 Disagreement within Monetary Policy Committees: Literature and Background

Monetary policy committees primarily decide on the current policy rate. Yet, they might disagree on the appropriate monetary policy. Disagreement is treated differently depending on whether decisions are taken on a majority or consensus approval. In the first case, as for the FOMC, dissenting committee members do not prevent decision making. Dissenting votes might even help to predict future policy decisions (see Gerlach-Kristen (2004) for the Bank of England and Riboni and Ruge-Murcia (2014) for the Sveriges Riksbank and the Federal Reserve).[18] In contrast to Riboni and Ruge-Murcia (2014), Ehrmann and Fratzscher (2013) find that central bank communication enhances the predictability of monetary policy decisions and lowers market uncertainty if the consensus or majority view is communicated rather than the individualistic views of committee members. In line with this finding, there is little information about disagreement among monetary policy makers although central banks have tended to increase their transparency in recent decades.[19]

It seems obvious that committee members disagree not only on current monetary policy but also on its appropriate future path. This is particularly observable in the case of the FOMC already before the crisis. Blinder (2004) classifies the FOMC's structure as collegial; however, its communication tends to be individualistic with differing views across members (see Blinder et al., 2008). While the collegial character is apparent in the actual monetary policy decision, the individualistic communication essentially matters for expectations management through speeches and is especially reflected in the individual assessments. The FOMC already published projections for GDP, CPI and unemployment before 2012, though in a restricted way with only range and

[18] In a committee with consensus-rule, in contrast, the role of dissenting votes differs as it involves more discussion, an intense debate about the different opinions and efforts of persuasion.

[19] This particularly applies to disagreement about appropriate future monetary policy. Furthermore, there are central banks, as for instance the RBNZ, that only have one governor and therefore full agreement by definition.

central tendency[20] rather than individual forecasts. These projections were conditioned on each member's assessment of the monetary policy path, but the FOMC did not incorporate these in the Summary of Economic Projections until January 2012. An underlying reason is that the public might misinterpret these publications as specific intended policy paths. This concern was also voiced in the discussions surrounding the introduction of dot projections when some members suggested to refrain from this kind of projections at this time or to rather decide on a common interest rate path (see Federal Reserve System, 2011). Yet, to date, other central banks as e.g. the Bank of Canada do not disclose their members' views about the future path at all and are therefore insufficiently transparent according to Neuenkirch and Siklos (2014).

Reasons for Disagreement

There may be different reasons for FOMC participants to disagree on the appropriate future interest rate path. First, participants may have a different outlook on the economy as suggested by their economic projections. Regional Reserve Bank presidents may especially be biased in decision-making towards the economic situation in their own region. Second, the participants' individual future interest rate paths might depend on their voting status. As Banternghansa and McCracken (2009) outline, participants' assessments may differ depending on their voting status. If Reserve Bank presidents are voting members, they might change their assessment of appropriate monetary policy with a bias towards the situation in the region of the respective Reserve Bank. Third, their individual policy reaction functions may differ. In this context, Dovern (2015) examines a set of projected variables of each participant in the Survey of Professional Forecasters in order to investigate whether forecasters disagree on the model or on the particular scenario that will materialize. There might be further characteristics that influence participants' view on the appropriate current and future monetary policy. Smales and Apergis (2016) show

[20]Central tendency is a trimmed range excluding the extreme values, i.e.the three highest and lowest projections respectively.

that e.g. the FOMC member's time spent at the Federal Reserve System is an important factor in the committee's decision making process.

In the present study, however, these aspects cannot be covered due to the anonymity of dot projections.[21] It is not possible to link rate projections to participants' economic outlook or their voting status. Similarly, projections neither reveal the individual projected paths nor their adjustments from one publication to the next. One might be concerned that the data are noisy due to participating non-voting Reserve Bank presidents that cannot be distinguished from decision-making members. However, within the horizon of projections, all members (or at least their representatives or successors) will eventually enter the decision-making circle of the FOMC.[22]

Neuenkirch and Siklos (2014) state different risks for monetary policy decision making by committees that might partially apply to the assessments. They list a free rider problem and information cascades as a variant where committee members ignore independent signals and simply agree with other members for convenience. Furthermore, polarized committee members might tend to extreme assessments that are either extremely cautious or risk-taking. Therefore, actual disagreement might differ from the published dot projections. However, it is the communicated and perceived disagreement that should matter for the effectiveness of the Fed's forward guidance.

Different aspects of the Fed's dot projections have been analyzed and used in only some studies as of yet. Svensson (2015) compared the median policy rate path to market expectations. Berriel et al. (2015) use the FOMC's dot projections to extract the degree of commitment. In particular, they find a decrease in commitment after December 2012 when state-based forward guidance was issued. Morris (2015) determines which monetary policy rule can explain FOMC's rate projections best. Yet, this paper is the first to consider the impact of FOMC's disagreement about the future policy path on the effectiveness of forward guidance and therefore closes an important gap.

[21]There is a publication lag of several years for the detailed projection information.

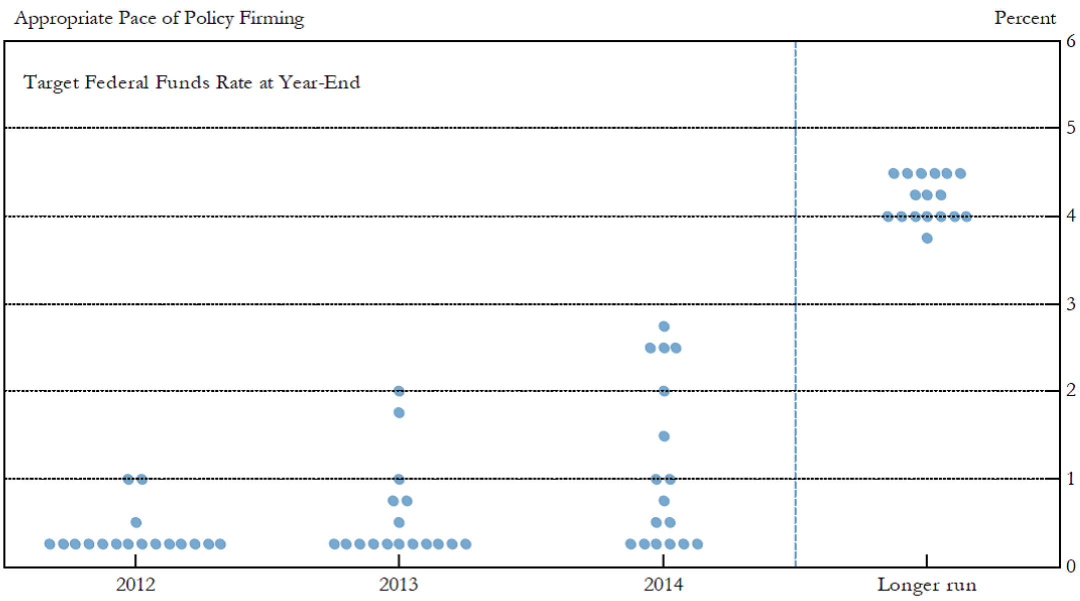
[22]For some background information on the composition of participants in the quarterly projections, refer to Appendix A.

3.3.2 The Dot Projections

At the end of 2011, the FOMC decided to incorporate individual members' projections of appropriate monetary policy into its Summary of Economic Projections from 2012.[23] Projections would be published after every second monetary policy meeting, i.e. in general four times a year.[24]

There are generally 17 participants in the regular assessment of the economy and policy options. This number is subject to changes in the Board of Governors, see Appendix A that offers some institutional background of the composition of FOMC participants. In the assessments covered by this paper's sample, there are 16 to 19 participants in each assessment.

Figure 3.2: FOMC Participants' Assessments of Appropriate Monetary Policy Issued on January 25, 2012



Notes: Each dot indicates an FOMC participant's assessment of the appropriate federal funds rate target level or midpoint of target range at the end of the specified calendar year and for the longer-run. Data is rounded to the nearest 0.25%. Source: Federal Reserve System - FOMC Summary of Economic Projections.

Figure 3.2 depicts the first publication of individual assessments issued in

[23] See Federal Reserve System (2011).

[24] In general, assessments are provided after monetary policy meetings in March, June, September and December; except for 2012 when there were five publications in January, April, June, September and December.

January 2012. In every assessment, participants are asked about the appropriate pace of policy firming. Dots indicate the appropriate target level or midpoint of the target range for the federal funds rate at the end of the respective year and for the longer-run according to the assessment of every individual participant. The longer-run projections assume that the federal funds rate will converge to this rate under appropriate monetary policy and that no further shocks hit the economy. They can thus be interpreted as the interest rate that is believed to prevail in the steady state.

While all participants viewed a future rise in the policy rate as appropriate (see longer-run), 6 out of 17 participants preferred to not increase the federal funds rate target until at least late 2014. 11 participants regarded low levels of 1% and below as adequate to the projected economic situation within this horizon. This is somehow in line with the date-based forward guidance issued on the same day which projects exceptionally low interest rates through late 2014. None of the FOMC participants expected a return to normal conditions in the very near future. Especially in due consideration of gradualism in the adjustment of interest rates, Figure 3.2 suggests that steady state conditions will not be achieved before 2016 in the opinion of participants.

Disagreement

While dots are quite dense for the shortest horizon, they spread out over time. Reasons for rather little disagreement about the appropriate level at the end of the current year may include gradualism and in particular the commitment to a low federal funds rate that was supported by nearly all decision-making members at this meeting.[25] While the bulk of dots is located between 0.25% and 1% for the next three years, some participants expected that a substantial rise in future interest rates is already reasonable within this horizon. Specifically, 6 participants seem to not agree on the date-based forward guidance. If this promise means to stay at the current policy rate level, only 6 will fully

[25] In fact, Jeffrey M. Lacker voted against the FOMC monetary policy action on January 25, 2012 as he did not agree with providing the explicit time period ("through late 2014") of an exceptionally low federal funds rate, see Federal Reserve System (2012).

agree with the issued date-based forward guidance.

In contrast, disagreement on the longer-run path of interest rates seems to be less pronounced. Thus, participants have rather similar views on the steady state level of the policy rate. Yet, there is still some disagreement on how to achieve policy goals in the longer-run. Their individual policy reaction functions may differ and there is also some disagreement among FOMC participants on the optimal longer-run values of output and unemployment (see FOMC Summary of Projections).

Development of projections over time

In the period between January 25, 2012 and March 30, 2015, there were 14 assessments, 6 of which (September and December projections) include a prolonged horizon of up to 4 years (see Figure 3.A in Appendix). The (dis)agreement pattern observed in Figure 3.2 is in general consistent with subsequent dot projection publications; i.e. there is lower disagreement in the short-term (end of current year) as well as in the longer-run while disagreement is larger at intermediate horizons. This partly contrasts with private sector forecasters that also rather agree on the policy rate in the near term, while there is high disagreement about average short-term rates at long horizons for 6 to 11 years, see Andrade et al. (2014). Yet, their understanding of those long-run expectations may rather differ from the longer-run or steady state level that policy makers are asked to assess in their projections.

In the respective *December projections* (Panels d, h, l in Figure 3.A), there is no disagreement on the rate at the end of the current year indicating that there is no other review of the federal funds rate target scheduled for the rest of the year. The end-of-this-year target is therefore seen as guaranteed, aside from unscheduled decisions that could be taken. Yet, participants could still see a higher interest rate as appropriate implying that they disagree with the decision on the current policy rate.[26] Another striking feature of Figure 3.A

[26] One could attempt to draw conclusions from the voting and the minutes. For instance, in the September 2012 projection, 18 of the 19 participants agree on an end-of-2012 target rate of 25 basis points while one person views an end-of-year rate of 50 basis points as appropriate.

is that in 2013 there is no disagreement about the respective end-of-year rate already in the September projection. FOMC participants potentially felt committed to the unconditional forward guidance that had been issued or foresaw the targeted variables as far from mandate-consistent levels and thus somehow already agreed on the next monetary policy step.

The *longer run projections* refer to normal economic conditions and thus to the steady state that FOMC participants have in mind. In the first half of 2012, the longer-run seems to correspond to an uncertain point in time (or at least far ahead) for all participants. However, already from September 2012 on, there is an overlap of projected rates for the end of 2015 and for the longer-run. Thus, some participants viewed late-2015 as constituting a return to longer-run conditions.[27] Thenceforward, there is in general an overlap of dots at explicit and longer-run horizons implying that the steady state is expected to be achieved within that explicit time frame.

I now examine the *evolution of the median projected path over time*.[28] In the following, eoy_0 refers to the current projection for end of this year, eoy_1 for the end of next year and eoy_2 as well as eoy_3 for the end of subsequent years, respectively. lr represents the longer-run or steady state projection. Panel (a) in Figure 3.3 displays the evolution of median projections at the different horizons. There are four continuous lines for the horizons eoy_0, eoy_1, eoy_2 and lr. FOMC participants' assessments appear to be consistent over time. The projection for the end of the current year eoy_0 continuously lies at 25 basis points until September 2014, when the median FOMC participant projects the federal funds rate to even decline to 12.5 basis points.[29] Yet, in March 2015, the me-

In the December 2012 decision on the target rate, one person voted against the Fed action to leave the target rate unchanged. However, a direct conclusion cannot be drawn, since participants might change their mind and the participant that disagreed in September might have been a non-voting participant. At least, the composition of participants did not change in the meantime.

[27] In the projection issued in June 2012, one end-of-2014 projection coincides with a longer-run projection. However, these dots could refer to different participants.

[28] As the decision-making process in the committee is rather collegial (see Blinder, 2004) and due to typical interest rate cuts and rises by multiple of 25 basis points, votes for the current policy rate target would always end up in a choice for the median rather than the mean.

[29] An important reason for this downward move is that the FOMC rounds projections to the nearest 0.125% instead of 0.25% starting with the September 2014 meeting, see Figure 3.A.

dian short-term projection increases to 62.5 basis points. This is in line with the eoy_1 projections that has been issued earlier: the median of eoy_1 already increases in March 2014. Similarly, the median of the eoy_2 projection starts to increase already in March 2013. The eoy_2 projection is further characterized by some seasonality with projected rates declining in the assessments at the end of the year. The median participant seems to revise his projection downwards, possibly because the current economic outlook has worsened.

Figure 3.3: Statistical Properties of Dot Projections

Notes: (a) Median, (b) standard deviation, (c) range and (d) interquartile range for dot projections at horizons eoy_0, eoy_1, eoy_2 as well as for the longer-run, lr for the sample period from January 25, 2012 until March 18, 2015. Vertical lines represent the last projection in each calender year. Source: Federal Reserve System - FOMC Summary of Economic Projections and author's calculations.

Subsidiary observations about the longer-run

Both Figure 3.A in the Appendix as well as Panel (a) in Figure 3.3 indicate that the perceived appropriate longer-run or steady state level of the target federal funds rate changes over time. Between mid-2012 and mid-2014, the median for lr declines from 4.25% to 3.75%. This could be due to participants modifying their policy reaction function or adjusting their long-term goals for output and unemployment. As longer-run projections for inflation remained at 2%, this implies a decline in the equilibrium real rate that is in line with other official forecasts, compare Hamilton et al. (2015).

As projections ask for the appropriate path of monetary policy rates, one would expect that future rates gradually adjust until the steady state level is reached. Yet, in the September 2014 projection, it is certain that one participant's assessment of the appropriate policy rate was higher for 2017 than for the longer-run.[30] This participant seems to favor the policy suggested by Woodford (2012). This policy implies keeping interest rates at low levels for horizons longer than necessary, while accepting an overshooting in inflation and output that has to be corrected for by a policy rate target above the steady state rate.

Interestingly, there is at least some overlap of longer-run interest rates projections and the longest definite projection horizon from September 2012 on, signaling an improvement of economic conditions. Yet, it is astonishing that there is a single exception for the June 2013 projection as the Fed signaled greater optimism in its statement of the respective meeting (see Federal Reserve System, 2013) and a possible tapering of quantitative easing. Yet, it was emphasized that the "highly accommodative stance of monetary policy will remain appropriate for a considerable time after the asset purchase program ends"[31].

[30]This could have been the case as well between September 2012 and June 2016 (except for the June 2013 projection), but one cannot infer this from the dots.

[31]See Federal Reserve System (2013).

3.3.3 Measuring Disagreement

The heterogeneity in dot projections can be interpreted as the aggregate disagreement among FOMC participants and can be measured in different ways. Due to the anonymity of dots, disagreement is measured within each cross-section at each point in time.[32] This gives one value of disagreement for each horizon after every second meeting. Although some FOMC participants might reveal changes in opinion through speeches in the meantime, one can hardly infer a change in the overall disagreement from them. Thus, I assume disagreement to be constant between two disclosures of projections and financial markets to perceive this current level of disagreement to be still valid.

The *range* provides a plain measure of disagreement. However, it gives a disproportionate role to outliers while there is no information about the disagreement among the remaining members. Dissenting votes in current monetary policy decisions are quite usual (see Riboni and Ruge-Murcia, 2014), yet they do not prevent decisions from being taken if adopted by majority approval as in the case of the FOMC. Second moments such as the cross-sectional *standard deviation* are a comprehensive measure of all votes and assign the same weight to all dots. Yet, the standard deviation describes the distribution of votes around the mean while monetary policy makers would rather base their decision on the median. Therefore, quantile-based measures such as the *interquartile range* as for instance used in Mankiw et al. (2004) and Andrade et al. (2015) seem to be more adequate. The interquartile range is defined as the difference between the 75^{th} and the 25^{th} percentiles of a distribution, $Q_{0.75}$ and $Q_{0.25}$, thus $IQR = Q_{0.75} - Q_{0.25}$. This measure is centered around the median and trims extreme votes that are likely to dissent in upcoming policy decisions.

Table 3.3 shows some summary statistics about the dot projections for the different horizons. Aside from eoy_3, all horizons are disclosed in the 14 regular projections that were issued over the sample period. The shortest projected

[32] By contrast, Banternghansa and McCracken (2009) use the degree of disagreement by individual members instead of the aggregate disagreement as the full data set for FOMC projections on GDP, CPI and unemployment for the period between 1992 and 1998 got disclosed with a lag of ten years.

Table 3.3: Disagreement Pattern along the Horizon

	eoy_0	eoy_1	eoy_2	eoy_3	*longer run*
Obs.	14	14	14	6	14
Horizon in months *(min - max)*	0.5 - 11	12.5 - 23	24.5 - 35	36.5 - 39.5	-
avg. std. dev.	0.14	0.53	0.92	0.98	0.30
avg. range	0.52	1.87	3.04	3.44	1.09
avg. IQR	0.02	0.40	1.03	1.13	0.30

Notes: This table summarizes the average evolution of participants' assessments along the horizon for the period between January 25, 2012 until March 18, 2015 covering 14 disclosures of dot projections.

horizon is half a month (mid-December projection for the end of the year, eoy_0); the longest projection horizon is almost 40 months and is covered in every September issue, when the horizon of dot projections is extended by another calendar year. Since FOMC participants project the target rate for the end of the following calendar years, the horizon of projections is not constant and depends on the date of each monetary policy meeting within a year. Thus, for instance horizon eoy_0 varies from half a month to 11 months.

Disagreement increases along horizons

Table 3.3 further lists the average disagreement based on the three measures along the horizons for the publications between January 2012 and March 2015. Confirming the observations of Figure 3.A, disagreement is small in the short-run (eoy_0)[33] and increases with the horizon for all three measures. Yet, for the longer-run assessment, disagreement is again lower. The increase of disagreement along the horizon is also revealed in panels (b) to (d) of Figure 3.3 that depict the evolution over time of the three disagreement measures for horizons eoy_0, eoy_1 and eoy_2. Measures seem to be characterized by some seasonality with disagreement decreasing towards the end of the year. This is particularly

[33]This is in line with Banternghansa and McCracken (2009) who investigate FOMC projections on GDP, CPI and unemployment for the period from 1992 until 1998.

apparent for range and standard deviation of projections over short horizons. The most likely reason for this is that the actual horizon of projections varies over the year, see Table 3.3. In general, the disagreement pattern of range and standard deviation looks quite similar while the evolution of IQR over time differs. This is also supported by the respective correlations between disagreement measures at different horizons (see Table 3.4).

Table 3.4: Correlation of Disagreement Measures

	eoy_0			eoy_1			eoy_2		
	sd	*range*	*iqr*	*sd*	*range*	*iqr*	*sd*	*range*	*iqr*
std. dev.	1.00			1.00			1.00		
range	0.99	1.00		0.96	1.00		0.80	1.00	
IQR	0.62	0.62	1.00	0.79	0.68	1.00	0.38	-0.09	1.00

Notes: Correlation between different disagreement measures (standard deviation *sd*, range and interquartile range *iqr*) at the three horizons, eoy_0, eoy_1 and eoy_2.

There is no disagreement on the policy rate for the end of the current year in each December policy meeting for all measures. The interquartile range for that horizon (eoy_0) is actually continuously equal to zero until 2014. This illustrates that at least half of the policy makers agree on the future policy path in the short-run while standard deviation and range reveal the presence of some outliers. Those participants favor an increase in the target federal funds rate within the current year. Furthermore, the interquartile range for eoy_1 is rather low during the 2013 policy meetings while it is substantially higher in the meetings at the beginning of 2012 and since 2014. Therefore, assuming that participants' policy reaction functions did not change substantially within that period and were fairly similar across participants, this implies rather close economic outlooks of participants from September 2012 until December 2013.

A vast difference in measures becomes apparent in March 2013. While the range of the projected federal funds rate target almost 3 years (eoy_2) ahead is 4.25, the interquartile range is only 0.75. In fact, most of the participants agreed on a projected target between 0.5% and 1.25% while some participants viewed an increase of the target to up to 4.5% as appropriate (see also Figure 3.A Panel

(e) in the Appendix).

Choice of horizons studied

Due to the absence of disagreement for eoy_0 in the December and some September projections as well as the infrequent publication of eoy_3 horizons, the analysis in Chapter 3.4 will provide the results for horizons eoy_1 and eoy_2. This is also in line with the time dimensions of forward guidance issued within the FOMC Statement, as eoy_1 and eoy_2 mostly cover the date-based forward guidance horizon of 2 - 3 years.[34] As demonstrated in Chapter 3.2, date-based forward guidance foresaw low interest rates through late 2014, when dot projections were first provided in January 2012. This horizon was prolonged to mid-2015 in the statement of September 2012. When state-based forward guidance came into effect in December 2012, the FOMC emphasized that this was in line with the mid-2015 horizon. Indeed, with date-based forward guidance succeeded by state-based forward guidance, the FOMC never redeemed this explicit horizon. As eoy_2 is only covered by the date-based horizon for the data until 2013, it seems best to measure disagreement based on participants' projections for the end of next year, eoy_1.

The next chapter augments the empirical model of Chapter 3.2 by the interquartile range for eoy_1 in order to investigate the impact of disagreement on the effectiveness of forward guidance. The analysis thus examines the impact of disagreement on the policy rate target at the end of next year on the information content and credibility of forward guidance. Results for horizon eoy_2 as well as for range and standard deviation are provided in the appendix and will serve as robustness checks.

[34] In September and December 2012, the date-based horizon is also covered by eoy_3. Furthermore, in March 2015, the mid-2015 horizon is only covered by eoy_0.

3.4 Forward Guidance under Disagreement

Finally, I augment the empirical model from Chapter 3.2 with a measure of disagreement and analyze the consequences of disagreement for the Fed's forward guidance. Specifically, this chapter investigates the influence of disagreement among FOMC participants on the sensitivity of Treasury yields to macroeconomic news and allows this effect to be different for date- and state-based forward guidance.

3.4.1 Empirical Model and Results

Filardo and Hofmann (2014) point out that monetary policy committees such as the FOMC might impair the effectiveness of forward guidance as compromises on a future interest rate track might weaken the credibility and clarity of the central bank's commitment. However, if the public explicitly gets to know about the FOMC's actual disagreement on the future policy path, the information content of binding forward guidance should decline likewise. As observed in Figure 3.2, on the day when date-based forward guidance in the FOMC's statement was extended to late-2014, only 6 participants agreed on the current level of the target federal funds rate to be appropriate within that horizon. This could impair the strength and effectiveness of forward guidance. Market participants might perceive the commitment character of central bank's projections as less credible and therefore use other information to form expectations. For the period since January 2012, when the Federal Reserve started to publish the dot projections, forward guidance should therefore be investigated in connection with this disagreement information.[35]

If disagreement impairs the effectiveness of forward guidance, market participants should again be more attentive to other information such as macroeconomic news. While this paper found a sensitivity shrinkage during the forward guidance periods, the sensitivity should rise again when policy

[35] The Fed only started disclosing dot projections within the period of date-based forward guidance, such that part of this period (August 2011 - January 2012) goes without information on disagreement.

makers do not agree on that specific forward guidance. Therefore, I propose the third hypothesis:

Hypothesis 3: *The sensitivity of Treasury yields to macroeconomic news should depend on the level of disagreement and increase with higher levels thereof.*

As shown in Chapter 3.2, the two forward guidance strategies of different strengths have different effects on the sensitivity of Treasury yields. Similarly to the rationale behind Hypothesis 2, one expects this effect to differ with the commitment character of forward guidance. Disagreement should especially impair the effectiveness of unconditional forward guidance, i.e. heighten sensitivity in times of date-based forward guidance. The fourth hypothesis thus reads:

Hypothesis 4: *The sensitivity shrinkage of Treasury yields to macroeconomic news should be less pronounced the higher the disagreement among policy makers. Due to different effectiveness of forward guidance strategies, sensitivity should particularly be restored during the date-based forward guidance period.*

In order to account for the impact of disagreement, I allow the sensitivity of Treasury yields to further depend on a disagreement measure introduced above. Specifically, I use the interquartile range from FOMC dot projections at the end of next year, eoy_1. Due to the quarterly publication scheme of projections, this horizon varies from 12 to 23 months and is covered by date-based forward guidance at least until the end of 2014 (compare Table 3.1). I augment the empirical model from Chapter 3.2.3 by this disagreement measure and continue to allow for different effects for date- and state-based forward guidance:[36]

[36] Including the non-interacted variables following Ozer-Balli and Sørensen (2012) does not alter the main results of this analysis.

$$\Delta r_t^j = \alpha^j + \sum_k \beta^{k,j} s_t^k (1 + \gamma^{d,j} D_t^{date} + \gamma^{s,j} D_t^{state} + \delta^{d,j} DA_t \cdot D_t^{date} + \delta^{s,j} DA_t \cdot D_t^{state}) + \varepsilon_t^j \tag{3.2}$$

where DA_t is the disagreement measure of dot projections published at every second monetary policy meeting. DA_t equals zero before the introduction of dot projections and is assumed to be constant until the next publication. Hypothesis 3 implies that the respective coefficients should be positive ($\delta > 0$) as a high level of disagreement should lower the impact of forward guidance. In other words, the sensitivity of Treasury yields to macroeconomic news should be higher under disagreement on the appropriate future path than in the case of forward guidance under full agreement. Yet, Hypothesis 4 suggests that the effect of disagreement is different under the two forward guidance schemes. Specifically, disagreement should be more detrimental when date-based forward guidance is issued, i.e. $|\delta^{d,j}| > |\delta^{s,j}|$.

Accounting for disagreement in Equation 3.2 hardly alters the β coefficients for the sensitivity to macroeconomic news in a significant way, see Table 3.B in the Appendix.[37] Table 3.5 shows the estimation results for the forward guidance and disagreement parameters of Equation 3.2. In the case of no disagreement the impact of forward guidance is fully captured by the γ-coefficients in the upper panel of the table.[38] If there is disagreement, the effect of forward guidance on the sensitivity of interest rates is composed of γ plus δ multiplied by the actual level of disagreement, DA_t.

In the short- to medium-run, results for the γ-coefficients do not qualitatively change compared to Table 3.2. For the longer-run, however, date-based forward guidance still has a significant effect that does not even decline with maturity. Thus, if there is no disagreement on the appropriate future policy

[37] Merely news in core producer prices do now significantly impact Treasury yields of also longer horizons.

[38] As there were no dot projections before January 2012, DA_t is assumed to be zero. Measuring DA_t by the interquartile range, there is full agreement during 2012 Q4 and 2013 Q3, Q4.

Table 3.5: The Sensitivity Shrinkage Effect of Forward Guidance under Disagreement

	6months	1year	2years	3years	5years	10years	20years
Date-based FG: γ^d	-0.82***	-0.86***	-0.97***	-0.89***	-0.82***	-0.72***	-0.76***
	(0.13)	(0.05)	(0.02)	(0.04)	(0.08)	(0.18)	(0.16)
State-based FG: γ^s	-1.63***	-0.79***	-0.64***	-0.24	0.19	0.53	0.56
	(0.37)	(0.12)	(0.21)	(0.34)	(0.43)	(0.47)	(0.44)
Date-FG*DA: δ^d	1.21	0.06	0.40**	0.92**	2.14***	4.12***	4.61***
	(0.83)	(0.20)	(0.18)	(0.42)	(0.80)	(1.33)	(1.38)
State-FG*DA: δ^s	0.99	0.51	1.02**	1.21*	0.64	0.17	-0.07
	(0.60)	(0.49)	(0.48)	(0.63)	(0.56)	(0.56)	(0.56)
$H_0 : \beta = 0$ p-value	0.14	0.18	0.03	0.06	0.05	0.04	0.02
R^2	0.06	0.14	0.17	0.14	0.11	0.10	0.10

Notes: Estimations for Equation 3.2 for all announcement days between December 16, 2008 and March 30, 2015. i.e. 603 observations for each horizon. $\Delta r_t^j = \alpha^j + \sum_k \beta^{k,j} s_t^k (1 + \gamma^{d,j} D_t^{date} + \gamma^{s,j} D_t^{state} + \delta^{d,j} DA_t \cdot D_t^{date} + \delta^{s,j} DA_t \cdot D_t^{state}) + \varepsilon_t^j$; Newey-West standard errors in parentheses; *** (**) [*] denotes significance at the 1% (5%) [10%] level. $H_0 : \beta = 0$ tests for all βs being jointly zero and states the respective p-value. The whole set of results is reported in Table 3.B in the Appendix.

within the FOMC, date-based forward guidance is highly credible and affects the whole yield curve.[39] The fact that coefficients do not decline for longer-term maturities also points to a rather high correlation in longer-term rates. For the same period, if disagreement is high, the sensitivity shrinkage is less pronounced than in the case of no disagreement. For the short-run (up to one year maturity), however, disagreement about the appropriate rate at end of next year does not impair the credibility of the short-run commitment to low interest rates. Markets seem to take the actual low policy rate as guaranteed for up to one year and are hardly attentive to macroeconomic news. Disagreement in case of the date-based forward guidance especially matters for the medium- to long-run. If FOMC members disagree about the future appropriate path (IQR between 0 and 0.75), this may lead market participants to be even more attentive to news compared to the base period (see longer-term horizons from 5 years on).

In the case of state-based communication, forward guidance under full agreement especially matters for horizons up to 2 years. Yet, disagreement increases the sensitivity of Treasury yields for the medium-run (2 and 3 year maturity). For the 3 year maturity, this means that disagreement also leads to increased sensitivity, as becomes clear from the lack of a significant effect of state-based forward guidance, $\gamma s, 3y$. The results are in line with Hypothesis 3, especially for the date-based forward guidance period, and therefore in turn confirm Hypothesis 4.

My results are robust to the choice of the disagreement measure (see Chapter 3.3.3) as well as of the horizon (eoy_1 and eoy_2). For comparison, the whole set of results for range, standard deviation and the different horizons is reported in Tables 3.B to 3.G in the Appendix. In line with my main findings, disagreement affects interest rates of medium to longer maturities in the date-based forward guidance period. In the state-based forward guidance period, by contrast, the impact of disagreement only applies for a horizon of 6 months

[39]This result also applies for the period between August 2011 and January 2012, when dot projections were not provided.

or none when using alternative measures of disagreement.

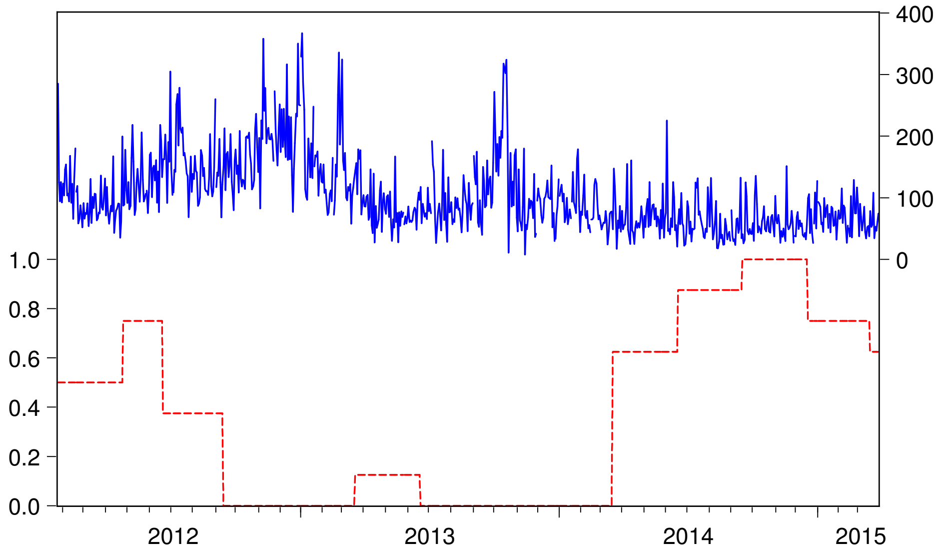
The analysis above shows that including disagreement is important for considering the credibility of forward guidance and the corresponding effect on the sensitivity of Treasury yields to macroeconomic news. While the β coefficients throughout the yield curve and the γs at least for the short-run are robust to the inclusion of disagreement, it can have detrimental effects for medium- to longer-term rates. Furthermore, disagreement in times of binding forward guidance might impede forward guidance at horizons above one year. Although disclosing dot projections may help the public understand the FOMC's reaction function, this measure of forward guidance is costly for other types of issued forward guidance and their credibility.

Increased transparency in form of the dot projections reduces the information content of forward guidance if policy makers disagree. Yet, the interpretation of this result is twofold. On the one hand, disagreement weakens the credibility and strength of forward guidance and therefore might harm this policy measure that the Fed relies on in times of exceptionally low policy rates. On the other hand, market participants learn about the central bank's policy reaction function and rationally form interest rate expectations by considering available information on macroeconomic developments. Furthermore, the Fed was able to attenuate its strong commitment by the issuance of dot projections and the disagreement therein. This will be crucial if the economic situation leads the Fed to deviate from its promise and the public demands accountability.

3.4.2 The Role of Policy Uncertainty

As argued by Swanson and Williams (2014) and Raskin (2013), monetary policy uncertainty may affect the sensitivity of interest rates to macroeconomic news. One could raise concern that disagreement within the FOMC merely reflects general monetary policy uncertainty or in a broader sense economic policy uncertainty. Therefore, I check the robustness of the above results to including a news-based index of economic policy uncertainty for the U.S. This index follows the methodology developed by Baker et al. (2016) and quantifies the number of newspaper articles on a given day that contain specific terms as for instance *economy*, *uncertainty* or *federal reserve*.[40]

Figure 3.4: Policy Uncertainty and Disagreement



Notes: Policy uncertainty index and disagreement measured by the interquartile range of dot projections for the end of next year (dashed line), eoy_1, for the sample period from January 25, 2012 until March 30, 2015. Source: `http://www.policyuncertainty.com/us_daily.html` and own calculations from Chapter 3.3.3.

Figure 3.4 depicts the evolution of the index together with disagreement as measured by the interquartile range of dot projections at the end of next year, eoy_1. The uncertainty index reveals higher values between spring 2012 and spring 2013 and is generally lower in the period thereafter. Specifically, policy uncertainty is highest around the introduction of state-based forward guidance in December 2012. By contrast, disagreement about the future monetary policy was zero at that time. Thus, policy makers seem to agree more on keeping interest rates low when economic uncertainty is high, especially in these times of exceptionally low policy rates. While policy uncertainty decreases over the whole sample, disagreement is highest in the last year of the dataset. Actually, policy uncertainty is negatively correlated with all disagree-

[40]The index is taken from `http://www.policyuncertainty.com/us_daily.html`.

ment measures. Disagreement should therefore not result from policy uncertainty according to this index.

In order to check the robustness of the results in Chapter 3.4.1 to the inclusion of policy uncertainty, I now augment the model in Equation 3.2 by the above index for the dot projections period and let the sensitivity of interest rates jointly depend on this index p_t that was standardized beforehand.

$$\Delta r_t^j = \alpha^j + \sum_k \beta^{k,j} s_t^k (1 + \gamma^{d,j} D_t^{date} + \gamma^{s,j} D_t^{state} + \delta^{d,j} DA_t \cdot D_t^{date} + \delta^{s,j} DA_t \cdot D_t^{state} + \eta^j p_t \cdot D_t^{dots}) + \varepsilon_t^j \quad (3.3)$$

where $D^{dots} = 1$ in the sample period starting on January 25, 2012 and zero in the previous period.

Table 3.6 shows the estimation results for the main coefficients of interest in Equation 3.3.[41] For all horizons but 6 months, η is statistically insignificant and explanatory power remains rather constant. Consequently, there are only slight numerical changes in the estimated coefficients which do not harm the main results from the previous subsection. The estimates for both the effects of forward guidance (γ) and disagreement (δ) are in line with the previous findings for all maturities.

Yet, policy uncertainty influences the sensitivity of treasury yields in the short-run. Although one would expect higher uncertainty to lead to increased sensitivity, η features a negative sign. Thus, market participants seem to believe in guaranteed low interest rates even more strongly in times of high economic uncertainty, at least for the very short-run. As forward guidance and dot projections are in fact meant to influence the medium- to long-run expectations, this particular result is of rather little importance to this analysis.

Overall, the core findings about the impact of disagreement on the effec-

[41] β coefficients are virtually the same for all maturities and can be reviewed in Table 3.H in the Appendix.

Table 3.6: The Role of Policy Uncertainty

	6months	1year	2years	3years	5years	10years	20years
Date-based FG: γ^d	-0.74***	-0.86***	-0.96***	-0.88***	-0.82***	-0.71***	-0.75***
	(0.16)	(0.05)	(0.02)	(0.04)	(0.08)	(0.17)	(0.16)
State-based FG: γ^s	-2.03***	-0.72***	-0.69***	-0.34	0.19	0.72	0.78
	(0.49)	(0.17)	(0.25)	(0.37)	(0.51)	(0.58)	(0.54)
Date-FG*DA: δ^d	1.32	0.04	0.41**	0.95**	2.14***	3.91***	4.39***
	(1.18)	(0.19)	(0.18)	(0.40)	(0.81)	(1.26)	(1.30)
State-FG*DA: δ^s	0.28	0.54	0.98**	1.11*	0.63	0.24	0.02
	(0.52)	(0.48)	(0.45)	(0.58)	(0.52)	(0.52)	(0.52)
policy uncertainty: η	-1.01*	0.11	-0.09	-0.19	-0.01	0.39	0.46
	(0.59)	(0.14)	(0.16)	(0.25)	(0.33)	(0.40)	(0.39)
$H_0 : \beta = 0$ p-value	0.20	0.17	0.03	0.06	0.06	0.04	0.02
R^2	0.07	0.14	0.17	0.14	0.11	0.10	0.10

Notes: Estimations for Equation 3.3 for all announcement days between December 16, 2008 and March 30, 2015. i.e. 603 observations for each horizon. Disagreement is measured by the interquartile range of dot projections for the end of next year, eoy_1. $\Delta r_t^j = \alpha^j + \sum_k \beta^{k,j} s_t^k (1 + \gamma^{d,j} D_t^{date} + \gamma^{s,j} D_t^{state} + \delta^{d,j} DA_t \cdot D_t^{date} + \delta^{s,j} DA_t \cdot D_t^{state} + \eta^j p_t \cdot D_t^{dots}) + \varepsilon_t^j$; Newey-West standard errors in parentheses; *** (**) [*] denotes significance at the 1% (5%) [10%] level. $H_0 : \beta = 0$ tests for all βs being jointly zero and states the respective p-value. Refer to Table 3.H in the Appendix for the whole set of results.

tiveness of forward guidance are robust to the inclusion of economic policy uncertainty. Thus, disagreement about the future course of monetary policy should not be mistaken for policy uncertainty. Disagreement among policy makers in contrast is an important factor when investigating the information content of forward guidance.

3.4.3 Asymmetric Sensitivity at the Zero Lower Bound

With interest rates close to the zero lower bound, the sensitivity may differ with the sign and size of macroeconomic surprises. Specifically, surprises that are expected to decrease interest rates might result in rather weak reactions, or none at all, when interest rates are already close to zero and a lower bound is a binding constraint. Rate-increasing macroeconomic surprises, by contrast, would still lead to an increase in interest rates. Forward guidance - as issued by the FOMC since the crisis - is intended to keep interest rates low along the yield curve and is thus particularly oriented towards reducing the sensitivity to rate-increasing surprises. Consequently, the effects of forward guidance and disagreement among policy makers on the sensitivity of interest rates to news could be different. This asymmetry may thus impact the results in Chapter 3.4.1.[42] While forward guidance in general shrank and policy makers' disagreement restored sensitivity, I expect forward guidance and disagreement to be especially influential in case of rate-increasing surprises.

I therefore distinguish between surprises that are expected to lead to either a rate increase or a decrease, i.e. s^{k+} and s^{k-}, and allow for different influences of forward guidance (γ^{+} and γ^{-}) and disagreement (δ^{+} and δ^{-}) on the sensitivity of interest rates.[43] The effect of forward guidance and disagreement on the sensitivity of interest rates should differ with the sign of surprises due to

[42] As Swanson and Williams (2014) emphasize, the sensitivity of short-term interest rates to macroeconomic news can still be symmetric if the shadow rate is negative (compare Wu and Xia, 2016) in presence of a strongly binding zero lower bound. Only large rate-increasing surprises would then result in a response of interest rates.

[43] Essentially, in this dataset, all positive macroeconomic surprises short of unemployment are expected to involve a rate increase. There are 275 announcement days with only surprises that would imply a rate increase and 244 days with rate-decreasing surprises; the remaining 84 represent days with both rate-increasing and -decreasing surprises.

rates' proximity to the zero lower bound.

Table 3.7 shows the results for the differentiated γ- and δ-coefficients based on Equation 3.2. As noted above, the base-period until mid-2011 is already a period with low sensitivity to macroeconomic news. This is essentially true for the rate-decreasing surprises, as can be seen in the test result on joint significance of those surprises while the rate-increasing surprises are jointly significant throughout the yield curve. Differentiating between rate-increasing and -decreasing surprises also results in higher explanatory power for all horizons.

In line with intuition, the main results of this paper (see 3.4.1) are especially valid for the rate-increasing surprises (see upper panel of Table 3.7). Date-based forward guidance significantly reduces sensitivity of interest rates across all maturities, while the more conditional state-based forward guidance only matters for horizons up to the medium-term. Disagreement is mainly important for the medium- to longer-term rates for the sample under date-based forward guidance.

As expected, the results for the rate-decreasing surprises contrast with the results of Chapter 3.4.1 (see lower panel of Table 3.7). Results for the short- to medium-run became generally less significant. The slightly significant effects of date-based forward guidance, γ^{d-}, and disagreement during that period, δ^{d-}, in the longer-run estimations reveal wrong signs; yet, as the β^{-}s are only slightly significant, one should not draw conclusions from this.

This chapter therefore concludes that forward guidance and thus also policy makers' disagreement thereon essentially matter for rate-increasing surprises.

3.5 Conclusion

Forward guidance is an essential tool for the effectiveness of monetary policy. Especially since the crisis, the importance of managing financial market expectations has increased due to the presence of the zero lower bound. Yet, for forward guidance to be effective, a central bank's credibility is crucial, espe-

Table 3.7: Asymmetric Sensitivity Changes

		6months	1year	2years	3years	5years	10years	20years
		for rate-increasing surprises s^{k+}						
Date-based FG:	γ^{d+}	-0.90***	-0.89***	-0.97***	-0.93***	-0.93***	-0.94***	-0.96***
		(0.05)	(0.03)	(0.01)	(0.02)	(0.05)	(0.06)	(0.03)
State-based FG:	γ^{s+}	-1.10***	-0.89***	-0.61***	-0.47**	-0.07	0.08	-0.04
		(0.17)	(0.11)	(0.14)	(0.18)	(0.29)	(0.33)	(0.33)
Date-FG*DA:	δ^{d+}	-0.06	-0.21	0.10	0.68**	1.64***	2.85***	3.21***
		(0.17)	(0.23)	(0.10)	(0.35)	(0.41)	(0.60)	(0.70)
State-FG*DA:	δ^{s+}	0.58*	0.55*	0.46**	0.36	-0.11	-0.67	-0.68
		(0.33)	(0.32)	(0.23)	(0.27)	(0.36)	(0.45)	(0.49)
		for rate-decreasing surprises s^{k-}						
Date-based FG:	γ^{d-}	-1.00	-0.74***	-0.34	-1.11**	0.87	2.72*	3.39**
		(0.83)	(0.21)	(0.92)	(0.55)	(1.06)	(1.53)	(1.57)
State-based FG:	γ^{s-}	-2.47***	-0.93***	-0.38	-0.10	0.05	0.33	0.47
		(0.91)	(0.17)	(-0.69)	(0.60)	(0.57)	(0.60)	(0.57)
Date-FG*DA:	δ^{d-}	5.35**	0.53	0.77	1.78	-0.54	-2.77	-3.77*
		(2.66)	(0.53)	(1.57)	(1.30)	(1.36)	(1.76)	(2.06)
State-FG*DA:	δ^{s-}	-1.67	0.13	3.50	2.51*	1.19	-0.07	-0.65
		(1.59)	(0.39)	(2.14)	(1.50)	(1.04)	(0.89)	(0.85)
$H_0 : \beta^+ = 0$	p-value	0.01	0.04	0.00	0.00	0.00	0.00	0.00
$H_0 : \beta^- = 0$	p-value	0.51	0.04	0.25	0.03	0.02	0.12	0.07
R^2		0.12	0.21	0.24	0.20	0.15	0.14	0.15

Notes: Estimations for all announcement days between December 16, 2008 and March 30, 2015. i.e. 603 observations for each horizon. $\Delta r_t^j = \alpha^j + \sum_k \beta^{k+,j} s_t^{k+}(1 + \gamma^{d+,j} D_t^{date} + \gamma^{s+,j} D_t^{state} + \delta^{d+,j} DA_t \cdot D_t^{date} + \delta^{s+,j} DA_t \cdot D_t^{state}) + \sum_k \beta^{k-,j} s_t^{k-}(1 + \gamma^{d-,j} D_t^{date} + \gamma^{s-,j} D_t^{state} + \delta^{d-,j} DA_t \cdot D_t^{date} + \delta^{s-,j} DA_t \cdot D_t^{state}) + \varepsilon_t^j$; Newey-West standard errors in parentheses; *** (**) [*] denotes significance at the 1% (5%) [10%] level. $H_0 : \beta = 0$ tests for βs being jointly zero and states the respective p-value.

cially if the guidance conveys a commitment. If a central bank's forward guidance does not affect financial markets' expectations, this could either mean that markets already expect what the central bank projects[44], that markets do not believe in those projections or that the guidance lacks clarity.

This paper shows that forward guidance as issued by the Federal Reserve since 2011 was an effective tool to influence interest rates. Financial markets believed in the central bank's promise to keep interest rates at low levels and were therefore less attentive to other macroeconomic news. However, the decrease in sensitivity of interest rates to macroeconomic news was less pronounced when guidance was linked to explicit conditions.

In 2012 when FOMC participants started to disclose dot projections, financial markets learned about the disagreement among policy makers on the future path of interest rates. The publication of a disagreement signal can have detrimental effects on how forward guidance is perceived by markets. In line with this intuition, I find that the effectiveness of forward guidance was lowered by disagreement implying that market participants were again more attentive to macroeconomic news. Yet, this can be interpreted in two ways. On the one hand, forward guidance is less effective as financial markets do not see the low rate as guaranteed. On the other hand, before introducing dot projections, the FOMC was concerned that markets interpret forward guidance as a full commitment. Therefore, by the publication of disagreement, the FOMC managed to weaken any such interpretation. While the Fed was able to reduce interest rates also at the longer end of the yield curve by providing an unconditional policy rate path through date-based forward guidance, it regained flexibility by implementing other forward guidance measures such as state-based forward guidance and dot projections.

[44] See also the "follow the markets" principle discussed in Blinder (2004).

Appendices

Appendix A: The Participants in the Individual Assessments

The FOMC consists of the Board of Governors (5 members in general), the president of the Federal Reserve Bank of New York as well as four Reserve Bank Presidents on a rotating basis with one-year terms. Nonvoting presidents participate in the meeting, but they are not allowed to vote on actual policy decisions, although they can influence the decision-making process. Yet, individual assessments about the appropriate future policy rate are given by the members of the FOMC as well as by alternate members and attendant non-voting regional Reserve Bank presidents. Overall, there are generally 17 participants in the regular assessment of the economy and policy options. This number is subject to changes in the Board of Governors. In the assessments covered by this paper's sample, there are 16 to 19 participants in each assessment. Specifically, the Board of Governors consisted of 7 members instead of 5 between May 2012 and June 2013. Furthermore, after Janet L. Yellen took office as Chair of the Board of Governors in February 2014, there were only four members in the BoG.

While there is at least an annual change in the composition of the FOMC due to the rotating voting status of regional Reserve Bank presidents, there is more continuity in the composition of the participants in the economic projections.There are three members that did not even change their function throughout the whole sample, two of which have voting status. FOMC Vice Chair William C. Dudley (President of New York Fed) and the respective alternate member Catherine M. Cumming (1st Vice President of New York Fed) as well as Daniel K. Tarullo, member of the Board of Governors. Janet L. Yellen was a member of the FOMC throughout the sample although her status changed from regular Board member to the Chair position in February 2014 when she succeeded Ben Bernanke. While there were some changes in the composition of the Board of Governors, there was only one change in the group of regional Reserve Bank presidents. President Sandra Pianalto of the Federal Reserve of Cleveland was succeeded by Loretta J. Mester in May 2014. Furthermore, three regional Reserve Bank Presidents designated the respective vice presidents as their representatives, yet, only when they held non-voting status. All other presidents of the regional Reserve Banks held their position as president throughout the sample, but changed their status within the FOMC meeting (voting, alternate, non-voting). Yet, also a non-voting member can try to steer the decision-making process of the FOMC and relate his or her own assessment to the region's requirements.

Table 3.A: Summary Statistics of U.S. Macroeconomic Surprises

Panel A

	base period (Dec 16, 2008 - Aug 8, 2011)					**date-based** (Aug 9, 2011 - Dec 11, 2012)					**state-based** (Dec 12, 2012 - Mar 30, 2015)				
	Mean	Std. dev.	Min	Max	Obs	Mean	Std. dev.	Min	Max	Obs	Mean	Std. dev.	Min	Max	Obs
Capacity utilization	-0.02	0.35	-1.00	0.80	31	-0.10	0.34	-1.00	0.60	16	-0.03	0.41	-0.80	0.80	28
Consumer confidence	-0.05	5.44	-10.50	12.80	31	0.27	5.86	-7.50	12.00	16	0.66	4.91	-8.30	8.60	27
Core CPI	0.01	0.10	-0.20	0.20	31	-0.01	0.09	-0.10	0.20	16	-0.02	0.09	-0.20	0.10	28
GDP advance	-0.25	1.29	-3.40	1.60	11	-0.08	0.16	-0.30	0.10	5	-0.02	0.82	-1.20	1.00	9
ISM index	0.67	2.13	-4.20	3.50	32	0.01	1.36	-2.30	2.10	16	0.30	1.85	-4.70	3.40	27
Leading indicators	0.08	0.38	-1.30	1.00	32	0.09	0.20	-0.30	0.40	16	0.05	0.18	-0.30	0.40	28
New homes	-0.01	0.04	-0.11	0.08	32	-0.00	0.01	-0.02	0.02	16	0.00	0.04	-0.10	0.08	28
Nonfarm payrolls	-10.38	74.15	-109.00	175.00	32	26.69	127.40	-83.00	459.00	16	4.63	55.81	-122.00	91.00	27
Core PPI	0.00	0.23	-0.70	0.40	31	0.19	0.69	-0.30	2.70	16	0.00	0.11	-0.20	0.40	25
Retail sales ex. auto.	-0.21	1.05	-4.80	1.40	31	0.05	0.33	-0.50	0.50	16	-0.10	0.34	-1.00	0.50	28
Unemployment	-0.02	0.20	-0.50	0.30	32	-0.11	0.15	-0.40	0.10	16	-0.06	0.13	-0.30	0.10	27

Panel B

	before dots (Dec 16, 2008 - Jan 24, 2012)					**since dots** (Jan 25, 2012 - Mar 30, 2015)				
	Mean	Std. dev.	Min	Max	Obs	Mean	Std. dev.	Min	Max	Obs
Capacity utilization	-0.01	0.34	-1.00	0.80	37	-0.08	0.40	-1.00	0.80	38
Consumer confidence	0.07	5.77	-10.50	12.80	36	0.48	4.85	-8.30	8.60	38
Core CPI	0.01	0.10	-0.20	0.20	37	-0.02	0.09	-0.20	0.10	38
GDP advance	-0.23	1.23	-3.40	1.60	12	-0.05	0.68	-1.20	1.00	13
ISM index	0.68	2.01	-4.20	3.50	37	0.12	1.73	-4.70	3.40	38
Leading indicators	0.09	0.36	-1.30	1.00	37	0.05	0.19	-0.30	0.40	39
New homes	-0.01	0.04	-0.11	0.08	7	0.00	0.04	-0.10	0.08	39
Nonfarm payrolls	2.30	104.45	-109.00	459.00	37	3.55	56.21	-122.00	93.00	38
Core PPI	0.08	0.49	-0.70	2.70	37	0.00	0.12	-0.30	0.40	35
Retail sales ex. auto.	-0.17	0.97	-4.80	1.40	37	-0.06	0.34	-1.00	0.50	38
Unemployment	-0.04	0.20	-0.50	0.30	37	-0.07	0.13	-0.40	0.10	38

Notes: Macroeconomic surprises are computed as actual release minus the median forecast of the RTR poll from Datastream. Panel A separates the sample in the base period and the two different forward guidance periods. Panel B shows surprises for the period before and since the publication of dot projections.

Figure 3.A: Dot Projections

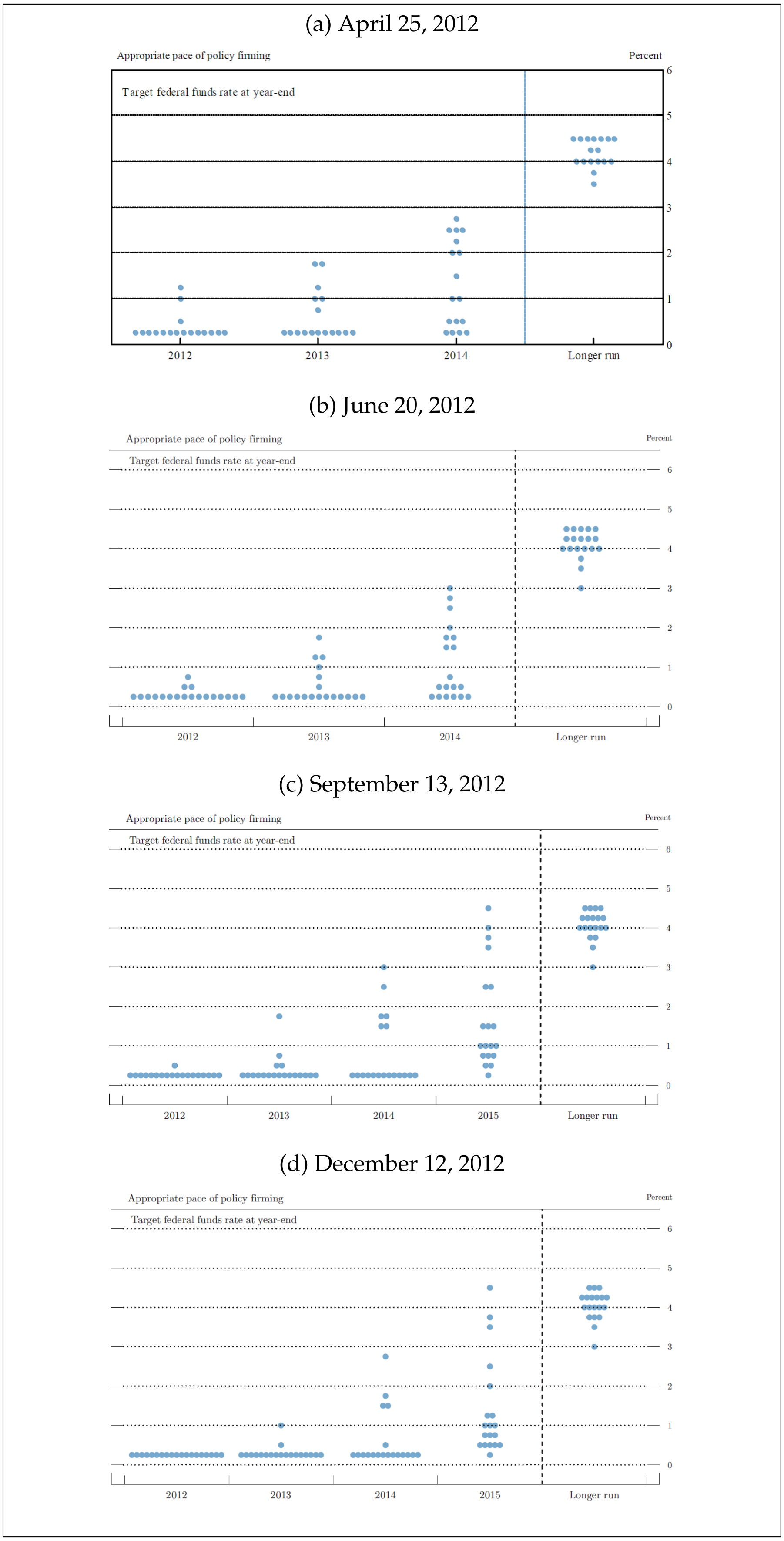
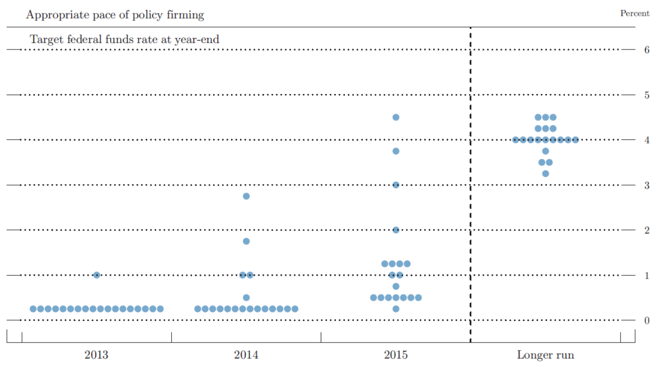
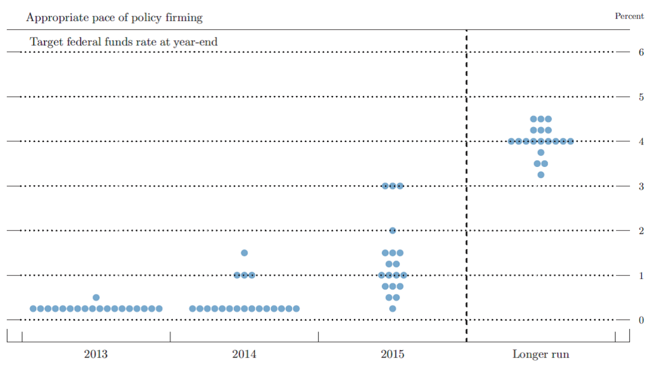


Figure 3.A: **Dot Projections** continued

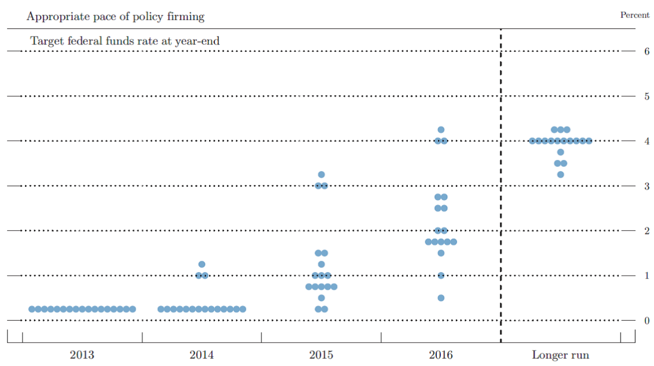
(e) March 20, 2013



(f) June 19, 2013



(g) September 18, 2013



(h) December 18, 2013

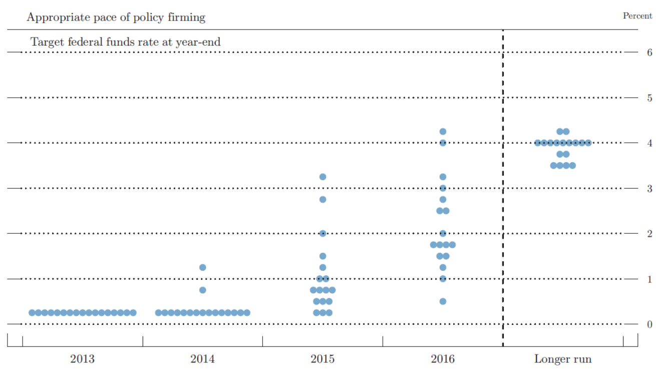
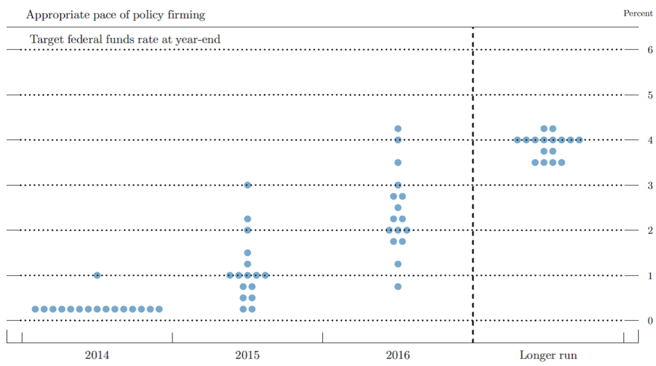
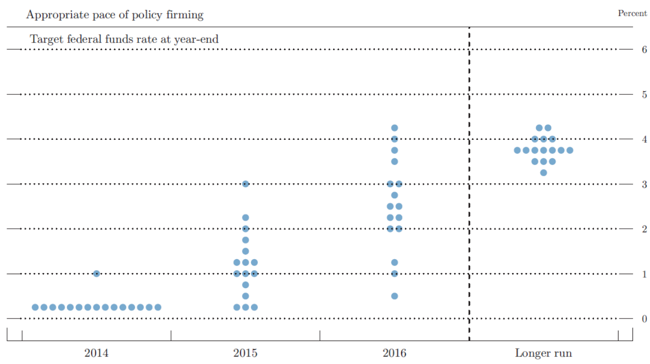


Figure 3.A: **Dot Projections** continued

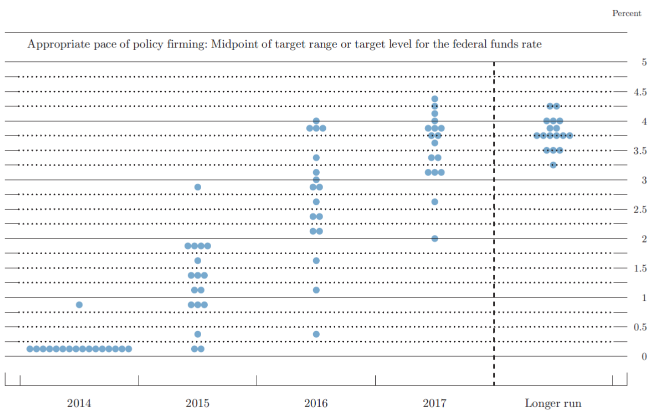
(i) March 19, 2014



(j) June 18, 2014



(k) September 17, 2014



(l) December 17, 2014

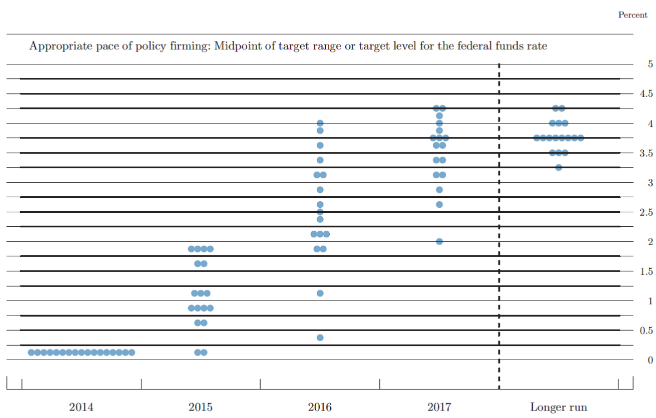
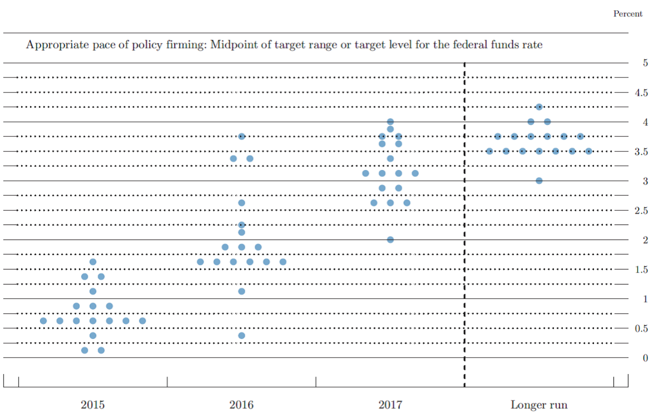


Figure 3.A: **Dot Projections** continued

(m) March 18, 2015



Notes: Dot projections from the Summaries of Projections in (a)-(d) 2012, (e)-(h) 2013, (i)-(l) 2014 as well as of (m) March 2015. Each dot indicates the appropriate level in the view of an individual participant at the end of the specified calendar year or for the longer-run respectively. Data is rounded to the nearest 0.25% or 0.125% since September 2014 respectively. Source: Federal Reserve System - FOMC Summary of Economic Projections.

Table 3.B: The Effect of Forward Guidance under Disagreement (*iqr* for eoy_1) on Treasury Yields

	6months	1year	2years	3years	5years	10years	20years
Capacity utilization	0.21	-0.09	0.51	0.58	0.22	-0.30	-0.42
	(0.18)	(0.23)	(0.36)	(0.37)	(0.47)	(0.42)	(0.35)
Consumer confidence	0.01	-0.08	0.38	0.40	0.57	0.65	0.84*
	(0.12)	(0.32)	(0.50)	(0.45)	(0.52)	(0.41)	(0.43)
core CPI	-0.36	-0.19	-0.72	-0.61	-0.78	-0.78	-0.61
	(0.27)	(0.37)	(0.63)	(0.60)	(0.76)	(0.75)	(0.62)
GDP advance	0.32*	0.10	1.10*	1.69*	2.16**	2.47**	2.46**
	(0.17)	(0.15)	(0.61)	(0.94)	(1.06)	(1.14)	(1.13)
ISM index	0.39**	0.06	0.29	0.67	1.13*	1.3*	1.28*
	(0.17)	(0.25)	(0.63)	(0.58)	(0.67)	(0.70)	(0.67)
Leading indicators	-0.13	0.00	0.37	0.50	0.40	0.42	0.18
	(0.20)	(0.15)	(0.44)	(0.61)	(0.87)	(0.91)	(0.85)
New homes	0.21	0.01	0.05	-0.05	-0.18	-0.21	-0.16
	(0.19)	(0.20)	(0.36)	(0.41)	(0.47)	(0.39)	(0.38)
Nonfarm payrolls	0.77*	2.53***	5.89***	5.36***	5.47***	3.77***	3.47***
	(0.43)	(0.86)	(2.02)	(1.91)	(1.67)	(1.07)	(0.92)
Core PPI	0.16	0.49	1.78**	2.48**	3.02**	3.35***	4.04***
	(0.16)	(0.41)	(0.79)	(1.03)	(1.18)	(1.13)	(1.31)
Retail sales ex. autos	0.19	0.36*	0.63	1.33**	1.89**	2.05***	2.04***
	(0.13)	(0.20)	(0.46)	(0.57)	(0.80)	(0.73)	(0.73)
Unemployment	0.16	0.24	0.54	0.89	1.02	0.80	0.73
	(0.22)	(0.48)	(1.05)	(0.96)	(0.99)	(0.70)	(0.62)
γ^d: Date	-0.82***	-0.86***	-0.97***	-0.89***	-0.82***	-0.72***	-0.76***
	(0.13)	(0.05)	(0.02)	(0.04)	(0.08)	(0.18)	(0.16)
γ^s: State	-1.63***	-0.79***	-0.64***	-0.24	0.19	0.53	0.56
	(0.37)	(0.12)	(0.21)	(0.34)	(0.43)	(0.47)	(0.44)
δ^d: DA (Date)	1.21	0.06	0.40**	0.92**	2.14***	4.12***	4.61***
	(0.83)	(0.20)	(0.18)	(0.42)	(0.80)	(1.33)	(1.38)
δ^s: DA (State)	0.99	0.51	1.02**	1.21*	0.64	0.17	-0.07
	(0.60)	(0.49)	(0.48)	(0.63)	(0.56)	(0.56)	(0.56)
$H_0 : \beta = 0$	0.14	0.18	0.03	0.06	0.05	0.04	0.02
R^2	0.06	0.14	0.17	0.14	0.11	0.10	0.10

Notes: Estimations for Equation 3.2 for all announcement days between December 16, 2008 and March 30, 2015. i.e. 603 observations for each horizon. $\Delta r_t^j = \alpha^j + \sum_k \beta^{k,j} s_t^k (1 + \gamma^{d,j} D_t^{date} + \gamma^{s,j} D_t^{state} + \delta^{d,j} DA_t \cdot D_t^{date} + \delta^{s,j} DA_t \cdot D_t^{state}) + \varepsilon_t^j$; Newey-West standard errors in parentheses; *** (**) [*] denotes significance at the 1% (5%) [10%] level. $H_0 : \beta = 0$ tests for all βs being jointly zero and states the respective p-value.

Table 3.C: The Effect of Forward Guidance under Disagreement (*iqr* for eoy_2) on Treasury Yields

	6months	1year	2years	3years	5years	10years	20years
Capacity utilization	0.24	-0.08	0.52	0.56	0.09	-0.54	-0.74*
	(0.17)	(0.23)	(0.36)	(0.39)	(0.49)	(0.46)	(0.44)
Consumer confidence	0.02	-0.12	0.41	0.40	0.57	0.60	0.74*
	(0.11)	(0.32)	(0.52)	(0.48)	(0.56)	(0.44)	(0.45)
Core CPI	-0.33	-0.19	-0.80	-0.72	-0.95	-1.00	-0.86
	(0.24)	(0.37)	(0.68)	(0.66)	(0.83)	(0.78)	(0.63)
GDP advance	0.30*	0.10	0.99	1.68*	2.17*	2.54**	2.48**
	(0.16)	(0.15)	(0.66)	(1.00)	(1.13)	(1.19)	(1.16)
ISM index	0.39**	0.06	0.35	0.76	1.17*	1.29*	1.24*
	(0.17)	(0.25)	(0.63)	(0.58)	(0.67)	(0.7)	(0.67)
Leading indicators	-0.11	0.00	0.44	0.54	0.42	0.40	0.13
	(0.21)	(0.15)	(0.45)	(0.63)	(0.90)	(0.95)	(0.86)
New homes	0.20	0.01	0.02	-0.02	-0.14	-0.18	-0.11
	(0.19)	(0.21)	(0.39)	(0.44)	(0.51)	(0.42)	(0.40)
Nonfarm payrolls	0.78*	2.54***	5.93***	5.45***	5.69***	4.07***	3.76***
	(0.43)	(0.86)	(2.01)	(1.91)	(1.67)	(1.11)	(0.96)
Core PPI	0.19	0.49	1.83**	2.43**	2.89***	2.94***	3.36***
	(0.16)	(0.40)	(0.78)	(0.97)	(1.09)	(1.02)	(1.18)
Retail sales ex. autos	0.18	0.36*	0.61	1.31**	1.90**	2.08***	2.07***
	(0.13)	(0.20)	(0.46)	(0.58)	(0.82)	(0.74)	(0.74)
Unemployment	0.20	0.21	0.42	0.75	0.76	0.46	0.31
	(0.22)	(0.48)	(1.04)	(0.95)	(0.94)	(0.67)	(0.62)
γ^d: Date	-0.80***	-0.86***	-0.96***	-0.89***	-0.84***	-0.71***	-0.73***
	(0.12)	(0.05)	(0.02)	(0.04)	(0.08)	(0.16)	(0.16)
γ^s: State	-2.68***	-1.37***	-1.51***	-1.31***	-0.45	0.13	0.47
	(0.74)	(0.44)	(0.51)	(0.48)	(0.50)	(0.57)	(0.66)
δ^d: DA (Date)	0.18	0.01	0.11*	0.28**	0.65***	1.16***	1.31***
	(0.22)	(0.07)	(0.06)	(0.11)	(0.21)	(0.36)	(0.38)
δ^s: DA (State)	1.71**	0.88	1.43**	1.71**	0.93	0.40	-0.07
	(0.81)	(0.67)	(0.69)	(0.76)	(0.58)	(0.61)	(0.67)
$H_0 : \beta = 0$	0.14	0.17	0.03	0.05	0.04	0.03	0.02
R^2	0.06	0.14	0.17	0.14	0.12	0.10	0.10

Notes: Estimations for Equation 3.2 for all announcement days between December 16, 2008 and March 30, 2015. i.e. 603 observations for each horizon. $\Delta r_t^j = \alpha^j + \sum_k \beta^{k,j} s_t^k (1 + \gamma^{d,j} D_t^{date} + \gamma^{s,j} D_t^{state} + \delta^{d,j} DA_t \cdot D_t^{date} + \delta^{s,j} DA_t \cdot D_t^{state}) + \varepsilon_t^j$; Newey-West standard errors in parentheses; *** (**) [*] denotes significance at the 1% (5%) [10%] level. $H_0 : \beta = 0$ tests for all βs being jointly zero and states the respective p-value.

Table 3.D: The Effect of Forward Guidance under Disagreement (*range* for eoy_1) on Treasury Yields

	6months	1year	2years	3years	5years	10years	20years
Capacity utilization	0.26	-0.22	0.33	0.44	-0.13	-0.67	-0.76*
	(0.18)	(0.19)	(0.38)	(0.42)	(0.5)	(0.45)	(0.42)
Consumer confidence	0.06	-0.04	0.39	0.51	0.59	0.60	0.74
	(0.12)	(0.33)	(0.58)	(0.53)	(0.59)	(0.46)	(0.47)
Core CPI	-0.38	-0.19	-0.71	-0.71	-1.05	-1.09	-0.90
	(0.26)	(0.41)	(0.76)	(0.74)	(0.92)	(0.83)	(0.64)
GDP advance	0.28*	0.09	1.13*	1.74*	2.12*	2.41*	2.44**
	(0.17)	(0.15)	(0.66)	(1.02)	(1.15)	(1.24)	(1.18)
ISM index	0.36**	-0.01	0.29	0.68	1.14*	1.28*	1.24*
	(0.16)	(0.24)	(0.65)	(0.60)	(0.68)	(0.71)	(0.66)
Leading indicators	-0.12	0.01	0.48	0.58	0.45	0.38	0.08
	(0.21)	(0.15)	(0.47)	(0.67)	(0.95)	(0.99)	(0.86)
New homes	0.23	-0.02	0.02	-0.05	-0.14	-0.16	-0.09
	(0.18)	(0.21)	(0.41)	(0.47)	(0.54)	(0.44)	(0.41)
Nonfarm payrolls	0.75*	2.57***	6.03***	5.57***	5.91***	4.25***	3.85***
	(0.43)	(0.86)	(2.02)	(1.92)	(1.68)	(1.13)	(0.98)
Core PPI	0.13	0.48	1.74**	2.33**	2.64***	2.61***	3.04***
	(0.15)	(0.40)	(0.73)	(0.93)	(0.99)	(0.96)	(1.14)
Retail sales ex. autos	0.20	0.36*	0.55	1.29**	1.87**	2.06***	2.06***
	(0.13)	(0.20)	(0.44)	(0.58)	(0.82)	(0.74)	(0.73)
Unemployment	0.14	0.16	0.31	0.63	0.61	0.34	0.22
	(0.21)	(0.47)	(1.05)	(0.95)	(0.93)	(0.66)	(0.62)
γ^d: Date	-0.77***	-0.86***	-0.96***	-0.89***	-0.83***	-0.68***	-0.69***
	(0.14)	(0.05)	(0.02)	(0.04)	(0.07)	(0.15)	(0.16)
γ^s: State	-2.35***	-0.57*	-0.45	-0.12	0.53	0.73	0.62
	(0.73)	(0.31)	(0.33)	(0.47)	(0.58)	(0.60)	(0.57)
δ^d: DA (Date)	0.18	0.00	0.10	0.28**	0.63***	1.10***	1.24***
	(0.22)	(0.07)	(0.07)	(0.11)	(0.2)	(0.34)	(0.38)
δ^s: DA (State)	0.58*	-0.05	0.07	0.11	-0.15	-0.19	-0.12
	(0.31)	(0.19)	(0.20)	(0.25)	(0.23)	(0.23)	(0.25)
$H_0 : \beta = 0$	0.15	0.12	0.02	0.04	0.03	0.04	0.03
R^2	0.06	0.14	0.17	0.13	0.11	0.10	0.10

Notes: Estimations for Equation 3.2 for all announcement days between December 16, 2008 and March 30, 2015. i.e. 603 observations for each horizon. $\Delta r_t^j = \alpha^j + \sum_k \beta^{k,j} s_t^k (1 + \gamma^{d,j} D_t^{date} + \gamma^{s,j} D_t^{state} + \delta^{d,j} DA_t \cdot D_t^{date} + \delta^{s,j} DA_t \cdot D_t^{state}) + \varepsilon_t^j$; Newey-West standard errors in parentheses; *** (**) [*] denotes significance at the 1% (5%) [10%] level. $H_0 : \beta = 0$ tests for all βs being jointly zero and states the respective p-value.

Table 3.E: The Effect of Forward Guidance under Disagreement (*range* for eoy_2) on Treasury Yields

	6months	1year	2years	3years	5years	10years	20years
Capacity utilization	0.20	-0.21	0.24	0.37	-0.21	-0.67	-0.73*
	(0.18)	(0.19)	(0.38)	(0.41)	(0.47)	(0.43)	(0.40)
Consumer confidence	0.05	-0.03	0.36	0.52	0.53	0.55	0.72
	(0.13)	(0.33)	(0.59)	(0.54)	(0.58)	(0.46)	(0.48)
Core CPI	-0.31	-0.19	-0.72	-0.77	-1.13	-1.13	-0.91
	(0.27)	(0.40)	(0.77)	(0.77)	(0.88)	(0.8)	(0.61)
GDP advance	0.33*	0.09	1.12*	1.70*	1.99*	2.32*	2.46**
	(0.17)	(0.15)	(0.66)	(1.03)	(1.13)	(1.24)	(1.17)
ISM index	0.36**	0.00	0.31	0.68	1.17*	1.33*	1.28*
	(0.18)	(0.24)	(0.64)	(0.60)	(0.68)	(0.71)	(0.65)
Leading indicators	-0.11	0.01	0.48	0.59	0.39	0.33	0.08
	(0.21)	(0.15)	(0.47)	(0.68)	(0.94)	(0.98)	(0.86)
New homes	0.22	-0.02	0.01	-0.06	-0.09	-0.13	-0.10
	(0.20)	(0.21)	(0.39)	(0.47)	(0.47)	(0.41)	(0.40)
Nonfarm payrolls	0.82*	2.57***	6.06***	5.64***	6.01***	4.28***	3.84***
	(0.45)	(0.86)	(2.02)	(1.92)	(1.69)	(1.14)	(0.98)
Core PPI	0.16	0.48	1.68**	2.24**	2.45***	2.47***	2.91**
	(0.15)	(0.40)	(0.70)	(0.88)	(0.92)	(0.94)	(1.14)
Retail sales ex. autos	0.21	0.36*	0.54	1.27**	1.87**	2.06***	2.06***
	(0.14)	(0.20)	(0.43)	(0.57)	(0.82)	(0.74)	(0.73)
Unemployment	0.16	0.16	0.27	0.58	0.56	0.32	0.19
	(0.22)	(0.47)	(1.02)	(0.92)	(0.88)	(0.64)	(0.61)
γ^d: Date	-0.79***	-0.86***	-0.96***	-0.89***	-0.82***	-0.66***	-0.68***
	(0.12)	(0.05)	(0.02)	(0.04)	(0.06)	(0.15)	(0.17)
γ^s: State	-2.72**	-0.31	0.28	0.39	2.01	1.59	0.59
	(1.31)	(0.72)	(1.31)	(1.60)	(1.55)	(1.45)	(1.47)
δ^d: DA (Date)	0.10	0.00	0.06	0.16**	0.37***	0.65***	0.75***
	(0.13)	(0.04)	(0.04)	(0.07)	(0.12)	(0.20)	(0.23)
δ^s: DA (State)	0.43	-0.10	-0.18	-0.09	-0.52	-0.36	-0.06
	(0.36)	(0.22)	(0.4)	(0.49)	(0.42)	(0.39)	(0.43)
$H_0 : \beta = 0$	0.13	0.13	0.02	0.04	0.04	0.04	0.03
R^2	0.05	0.14	0.17	0.13	0.11	0.10	0.10

Notes: Estimations for Equation 3.2 for all announcement days between December 16, 2008 and March 30, 2015. i.e. 603 observations for each horizon. $\Delta r_t^j = \alpha^j + \sum_k \beta^{k,j} s_t^k (1 + \gamma^{d,j} D_t^{date} + \gamma^{s,j} D_t^{state} + \delta^{d,j} DA_t \cdot D_t^{date} + \delta^{s,j} DA_t \cdot D_t^{state}) + \varepsilon_t^j$; Newey-West standard errors in parentheses; *** (**) [*] denotes significance at the 1% (5%) [10%] level. $H_0 : \beta = 0$ tests for all βs being jointly zero and states the respective p-value.

Table 3.F: The Effect of Forward Guidance under Disagreement (sd for eoy_1) on Treasury Yields

	6months	1year	2years	3years	5years	10years	20years
Capacity utilization	0.22	-0.20	0.36	0.47	-0.07	-0.63	-0.74*
	(0.17)	(0.20)	(0.39)	(0.42)	(0.50)	(0.47)	(0.44)
Consumer confidence	0.04	-0.04	0.39	0.50	0.59	0.60	0.75*
	(0.12)	(0.33)	(0.58)	(0.53)	(0.58)	(0.44)	(0.45)
Core CPI	-0.36	-0.19	-0.71	-0.68	-1.00	-1.04	-0.86
	(0.27)	(0.4)	(0.75)	(0.73)	(0.90)	(0.82)	(0.64)
GDP advance	0.31*	0.09	1.13*	1.75*	2.15*	2.46**	2.49**
	(0.17)	(0.15)	(0.66)	(1.01)	(1.13)	(1.21)	(1.16)
ISM index	0.37**	-0.00	0.29	0.68	1.14*	1.28*	1.24*
	(0.17)	(0.25)	(0.65)	(0.60)	(0.68)	(0.71)	(0.67)
Leading indicators	-0.12	0.01	0.47	0.57	0.45	0.40	0.13
	(0.21)	(0.15)	(0.47)	(0.66)	(0.93)	(0.97)	(0.85)
New homes	0.23	-0.02	0.02	-0.05	-0.15	-0.17	-0.11
	(0.19)	(0.21)	(0.41)	(0.46)	(0.53)	(0.43)	(0.40)
Nonfarm payrolls	0.77*	2.57***	6.02***	5.54***	5.82***	4.14***	3.75***
	(0.43)	(0.86)	(2.02)	(1.92)	(1.68)	(1.11)	(0.96)
Core PPI	0.15	0.48	1.74**	2.36**	2.76***	2.88***	3.39***
	(0.16)	(0.40)	(0.74)	(0.95)	(1.04)	(1.00)	(1.19)
Retail sales ex. autos	0.20	0.36*	0.56	1.29**	1.89**	2.07***	2.07***
	(0.13)	(0.20)	(0.44)	(0.58)	(0.83)	(0.75)	(0.74)
Unemployment	0.14	0.16	0.34	0.67	0.68	0.42	0.31
	(0.22)	(0.48)	(1.05)	(0.96)	(0.95)	(0.67)	(0.62)
γ^d: Date	-0.79***	-0.86***	-0.96***	-0.89***	-0.84***	-0.71***	-0.73***
	(0.13)	(0.05)	(0.02)	(0.04)	(0.07)	(0.16)	(0.16)
γ^s: State	-2.26***	-0.65**	-0.53*	-0.23	0.40	0.57	0.45
	(0.68)	(0.27)	(0.29)	(0.43)	(0.54)	(0.57)	(0.55)
δ^d: DA (Date)	0.71	0.03	0.35*	0.90**	2.08***	3.73***	4.24***
	(0.75)	(0.21)	(0.2)	(0.36)	(0.66)	(1.13)	(1.24)
δ^s: DA (State)	1.93*	-0.01	0.42	0.67	-0.22	-0.30	-0.06
	(1.06)	(0.64)	(0.70)	(0.93)	(0.86)	(0.87)	(0.94)
$H_0 : \beta = 0$	0.14	0.13	0.02	0.04	0.04	0.03	0.02
R^2	0.06	0.14	0.17	0.13	0.11	0.10	0.10

Notes: Estimations for Equation 3.2 for all announcement days between December 16, 2008 and March 30, 2015. i.e. 603 observations for each horizon. $\Delta r_t^j = \alpha^j + \sum_k \beta^{k,j} s_t^k (1 + \gamma^{d,j} D_t^{date} + \gamma^{s,j} D_t^{state} + \delta^{d,j} DA_t \cdot D_t^{date} + \delta^{s,j} DA_t \cdot D_t^{state}) + \varepsilon_t^j$; Newey-West standard errors in parentheses; *** (**) [*] denotes significance at the 1% (5%) [10%] level. $H_0 : \beta = 0$ tests for all βs being jointly zero and states the respective p-value.

Table 3.G: The Effect of Forward Guidance under Disagreement (sd for eoy_2) on Treasury Yields

	6months	1year	2years	3years	5years	10years	20years
Capacity utilization	0.20	-0.21	0.23	0.34	-0.18	-0.64	-0.73*
	(0.19)	(0.19)	(0.38)	(0.4)	(0.47)	(0.44)	(0.42)
Consumer confidence	0.04	-0.02	0.34	0.51	0.52	0.57	0.73
	(0.13)	(0.33)	(0.58)	(0.54)	(0.57)	(0.45)	(0.47)
Core CPI	-0.29	-0.18	-0.71	-0.77	-1.09	-1.09	-0.87
	(0.26)	(0.40)	(0.76)	(0.76)	(0.86)	(0.79)	(0.62)
GDP advance	0.35**	0.08	1.13*	1.66	2.00*	2.38*	2.51**
	(0.17)	(0.15)	(0.65)	(1.02)	(1.12)	(1.23)	(1.16)
ISM index	0.35**	-0.01	0.31	0.67	1.14*	1.30*	1.25*
	(0.18)	(0.24)	(0.64)	(0.59)	(0.67)	(0.71)	(0.65)
Leading indicators	-0.12	0.00	0.46	0.57	0.38	0.36	0.12
	(0.21)	(0.15)	(0.47)	(0.68)	(0.93)	(0.98)	(0.86)
New homes	0.21	-0.02	0.01	-0.06	-0.10	-0.15	-0.11
	(0.20)	(0.20)	(0.38)	(0.44)	(0.46)	(0.41)	(0.41)
Nonfarm payrolls	0.83*	2.57***	6.06***	5.67***	5.98***	4.23***	3.80***
	(0.45)	(0.86)	(2.02)	(1.92)	(1.69)	(1.14)	(0.97)
Core PPI	0.17	0.47	1.66**	2.19**	2.50***	2.64***	3.12***
	(0.16)	(0.39)	(0.69)	(0.85)	(0.94)	(0.97)	(1.17)
Retail sales ex. autos	0.22	0.36*	0.55	1.27**	1.87**	2.07***	2.07***
	(0.14)	(0.20)	(0.43)	(0.57)	(0.81)	(0.74)	(0.73)
Unemployment	0.16	0.16	0.30	0.59	0.62	0.37	0.24
	(0.23)	(0.47)	(1.00)	(0.90)	(0.88)	(0.65)	(0.61)
γ^d: Date	-0.8***	-0.86***	-0.96***	-0.89***	-0.83***	-0.68***	-0.71***
	(0.12)	(0.05)	(0.02)	(0.04)	(0.06)	(0.15)	(0.16)
γ^s: State	-2.64**	0.12	0.81	1.18	2.48	1.38	0.20
	(1.29)	(0.81)	(1.44)	(1.70)	(1.67)	(1.50)	(1.56)
δ^d: DA (Date)	0.32	0.01	0.18	0.46**	1.05***	1.86***	2.13***
	(0.37)	(0.12)	(0.11)	(0.18)	(0.34)	(0.58)	(0.64)
δ^s: DA (State)	1.43	-0.79	-1.17	-1.15	-2.30	-1.02	0.22
	(1.26)	(0.8)	(1.47)	(1.72)	(1.57)	(1.44)	(1.62)
$H_0 : \beta = 0$	0.12	0.13	0.02	0.04	0.04	0.04	0.02
R^2	0.05	0.14	0.17	0.13	0.12	0.10	0.10

Notes: Estimations for Equation 3.2 for all announcement days between December 16, 2008 and March 30, 2015. i.e. 603 observations for each horizon. $\Delta r_t^j = \alpha^j + \sum_k \beta^{k,j} s_t^k (1 + \gamma^{d,j} D_t^{date} + \gamma^{s,j} D_t^{state} + \delta^{d,j} DA_t \cdot D_t^{date} + \delta^{s,j} DA_t \cdot D_t^{state}) + \varepsilon_t^j$; Newey-West standard errors in parentheses; *** (**) [*] denotes significance at the 1% (5%) [10%] level. $H_0 : \beta = 0$ tests for all βs being jointly zero and states the respective p-value.

Table 3.H: The Role of Policy Uncertainty

	6months	1year	2years	3years	5years	10years	20years
Capacity utilization	0.28**	-0.14	0.55	0.65*	0.23	-0.54	-0.68
	(0.13)	(0.22)	(0.36)	(0.39)	(0.47)	(0.46)	(0.42)
Consumer confidence	-0.03	-0.05	0.38	0.39	0.57	0.59	0.73*
	(0.05)	(0.31)	(0.50)	(0.47)	(0.53)	(0.38)	(0.39)
Core CPI	-0.47**	-0.17	-0.74	-0.63	-0.78	-0.78	-0.60
	(0.24)	(0.37)	(0.63)	(0.60)	(0.76)	(0.77)	(0.64)
GDP advance	0.20	0.11	1.09*	1.75*	2.16**	2.31**	2.24**
	(0.18)	(0.15)	(0.62)	(0.97)	(1.08)	(1.14)	(1.12)
ISM index	0.32**	0.06	0.28	0.67	1.14*	1.28*	1.26*
	(0.14)	(0.25)	(0.63)	(0.59)	(0.67)	(0.69)	(0.65)
Leading indicators	-0.14	0.00	0.38	0.51	0.40	0.41	0.15
	(0.19)	(0.15)	(0.44)	(0.61)	(0.87)	(0.94)	(0.87)
New homes	0.20	0.01	0.04	-0.04	-0.18	-0.17	-0.11
	(0.15)	(0.20)	(0.37)	(0.41)	(0.47)	(0.39)	(0.37)
Nonfarm payrolls	0.65	2.54***	5.88***	5.35***	5.47***	3.91***	3.61***
	(0.41)	(0.86)	(2.02)	(1.91)	(1.67)	(1.10)	(0.94)
Core PPI	0.22	0.49	1.78**	2.47**	3.02**	3.23***	3.89***
	(0.14)	(0.40)	(0.79)	(1.02)	(1.18)	(1.09)	(1.26)
Retail sales ex. Autos	0.19	0.36*	0.63	1.32**	1.89**	2.10**	2.10***
	(0.13)	(0.20)	(0.46)	(0.57)	(0.80)	(0.75)	(0.75)
Unemployment	0.19	0.23	0.55	0.89	1.02	0.74	0.62
	(0.18)	(0.47)	(1.05)	(0.97)	(0.99)	(0.68)	(0.60)
γ^d: Date	-0.74***	-0.86***	-0.96***	-0.88***	-0.82***	-0.71***	-0.75***
	(0.16)	(0.05)	(0.02)	(0.04)	(0.08)	(0.17)	(0.16)
γ^s: State	-2.03***	-0.72***	-0.69***	-0.34	0.19	0.72	0.78
	(0.49)	(0.17)	(0.25)	(0.37)	(0.51)	(0.58)	(0.54)
δ^d: DA (Date)	1.32	0.04	0.41**	0.95**	2.14***	3.91***	4.39***
	(1.18)	(0.19)	(0.18)	(0.40)	(0.81)	(1.26)	(1.30)
δ^s: DA (State)	0.28	0.54	0.98**	1.11*	0.63	0.24	0.02
	(0.52)	(0.48)	(0.45)	(0.58)	(0.52)	(0.52)	(0.52)
η policy uncertainty	-1.01*	0.11	-0.09	-0.19	-0.01	0.39	0.46
	(0.59)	(0.14)	(0.16)	(0.25)	(0.33)	(0.40)	(0.39)
$H_0 : \beta = 0$	0.20	0.17	0.03	0.06	0.06	0.04	0.02
R^2	0.07	0.14	0.17	0.14	0.11	0.10	0.10

Notes: Estimations for Equation 3.3 for all announcement days between December 16, 2008 and March 30, 2015. i.e. 603 observations for each horizon. Disagreement is measured by the interquartile range of dot projections iqr for the end of next year eoy_1. $\Delta r_t^j = \alpha^j + \sum_k \beta^{k,j} s_t^k (1 + \gamma^{d,j} D_t^{date} + \gamma^{s,j} D_t^{state} + \delta^{d,j} DA_t \cdot D_t^{date} + \delta^{s,j} DA_t \cdot D_t^{state} + \eta^j p_t \cdot D_t^{dots}) + \varepsilon_t^j$; Newey-West standard errors in parentheses; *** (**) [*] denotes significance at the 1% (5%) [10%] level. $H_0 : \beta = 0$ tests for all βs being jointly zero and states the respective p-value.

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Ehrenwörtliche Erklärung

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