THE INTERACTION BETWEEN FINANCIAL MARKETS AND MONETARY POLICY

by

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Declaration

I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

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To my loving father,

my inspiration and guidance.

Abstract

This thesis deals with the interaction between financial markets and monetary policy from three different perspectives. First, I study the perspective of equity investors and their reaction to the Federal Open Market Committee (FOMC) announcements, when they disagree on Nominal Interest Rate level decisions. My evidence shows that investor expectations formulated prior to FOMC announcements have a significant impact on equity prices, particularly when these expectations are not aligned with the FOMC committee decisions. My results reconcile past findings on the monetary policy surprise literature and more recent empirical findings on the effect of FOMC announcements on equity markets. Moreover, as I find no effect on equity returns when the FOMC committee decision is anticipated by the market, a practical implication of my study is that monetary policy authorities should take into account market expectations when formulating disclosure policy in order to improve alignment with financial market expectations and smooth out their economic consequences.

Second, I provide evidence of the effects of the European Central Bank (ECB) monetary policy shocks on the real economy, specifically on industrial production and inflation. This analysis investigates how the ECB monetary policy shocks impact industrial production (output) and inflation (prices) following the established narrative methodology of Romer & Romer (2004). Past standard statistical approaches have yielded very limited results in terms of magnitude. The narrative methodology, conversely, has yielded significant effects of monetary shocks on prices and output. Most of these studies analysed the effect of monetary policy in the United States and only a recent portion of the literature has extended

the analysis to other countries (United Kingdom and Canada). This chapter contributes to the extant literature in extending the narrative methodology to the Eurozone and adapting it to include the unconventional monetary policies put in place by the Governing Council of the ECB in the past decade. To do so, I gather a novel dataset of macroeconomic forecasts and construct a new measure of monetary policy shocks. Industrial production responds to unpredictable monetary policy shocks with a decline of over 0.5%. On the contrary, inflation responds weakly to monetary shocks, with a very modest and unstable decrease of 0.05%. Furthermore, I provide empirical evidence of the heterogeneous responses of inflation and output among Eurozone countries. These last results are particularly relevant to policy makers of the ECB Governing Council, given that their policy decisions should have a homogenous effect on the Eurozone economy.

Third, I investigate whether financial market stability is a concern for monetary policy makers in the case of the European Central Bank (ECB) and Bank of England (BOE). Whether financial market stability should be a concern of monetary policy makers is an unresolved and long debated question, which has resurfaced after the 2008 financial crisis. In this chapter, I propose a forward-looking Augmented Taylor (1993) Rule to investigate the conduct of monetary policy and apply this idea to the 2003–2018 time period for both the ECB and the BOE. I show that a forward-looking Augmented Taylor Rule explains the deviation of observed rates consistent with its implied rates. By including a measure of Financial Market Stability Slack, I also show that the evolving preferences of monetary policy makers have taken into account the financial markets turmoil, particularly in the aftermath of the 2008 financial crisis.

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The Interaction between Financial Markets and Monetary Policy

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Abbreviations

AVG	………………………………….	Average
BOE	………………………………….	Bank of England
BOC	………………………………….	Bank of Canada
CA	………………………………….	Canada
CAPM	………………………………….	Capital Asset Pricing Model
CRSP	………………………………….	The Centre for Research in Security Prices
ECB	………………………………….	European Central Bank
EMH	………………………………….	Efficient Market Hypothesis
EST	………………………………….	Estimate
EU	………………………………….	Eurozone
FED	………………………………….	Federal Reserve
FMSS	………………………………….	Financial Market Stability Slack
FOMC	………………………………….	Federal Open Market Committee
GDP	………………………………….	Gross Domestic Product
GMM	………………………………….	Generalized Method of Moments
IT	………………………………….	Inflation Targeting
MAX	………………………………….	Maximum
MED	………………………………….	Median

MIN	…………………………………	Minimum
NLS	…………………………………	Non-Linear Square
NMP	…………………………………	Neutral Monetary Policy
OLS	…………………………………	Ordinary Least Squares
SE	…………………………………	Standard Error
SPF	…………………………………	Survey of Professional Forecasters
STDEV	…………………………………	Standard Deviation
UK	…………………………………	United Kingdom
US	…………………………………	United States
VAR	…………………………………	Vector Autoregressive
VFTSE	…………………………………	FTSE 100 Volatility Index
VIX	…………………………………	S&P 500 Volatility Index
VSTOXX	…………………………………	EURO STOXX 50 Volatility Index

The actions taken by central banks and other authorities to stabilize a panic
in the short run can work against stability in the long run,
if investors and firms infer from those actions that they will never bear the
full consequences of excessive risk-taking.

B. Bernanke

Chapter 1

Introduction

This thesis aims to explore the interaction between central bank monetary policy and the financial market, as two distinct although coexisting and influential entities. The developments in monetary policy institutions' communication and operating paths have highlighted the delicate balance between these two entities. The maintenance of this balance is vital to preserve the stability of financial markets and to enhance the effectiveness of monetary policy. The interaction between these two entities manifests itself in the monetary policy transmission mechanism. The financial market is an essential component of this mechanism, and therefore unavoidably influenced by it. The aftermath of the 2008 financial crisis has also highlighted the influence that the financial market and its precarious stability might have on the decision making process of policy makers.

Monetary policy is a powerful tool that might have unexpected or unwanted consequences, which make the understanding of its transmission mechanisms essential in order to successfully conduct it. Mishkin (1995) in his "Symposium on the Monetary Transmission Mechanism" explores the main types of monetary transmission mechanisms found in the early literature, two of which are directly connected to equity prices.

First, he defines the "Asset Price Effects" channel, by invoking the Tobin's q theory of investments (Tobin, 1969) that provides a mechanism by means of which monetary policy can affect the economy through its effects on the valuation of equities. The mechanism is provided by the link between the Tobin's *q* and investment spending: lower equity prices will lead to a lower *q* and ultimately a lower investment spending.

Second, he discusses the credit channel, also discussed by Bernanke & Gertler (1995), that emphasized how asymmetric information and costly enforcement of contracts creates agency problems in financial markets. Two channels of monetary transmission arise as a result of agency issues in credit markets: the bank lending channel and the balance-sheet channel. The balance-sheet channel is directly connected to the purpose of this thesis, as ultimately affects businesses' equity valuations.[1] The balance-sheet channel arises from the effects that monetary policy (expansionary or contractionary) has on the net worth of business firms, the influence on their cash flow and ultimately on equity valuations. The common denominator between the asset price effects and the balance-sheet channel is the lowering of the firms' net worth and the resulting in a lower investment spending and conclusively in a lower aggregate demand.

As described above the balance-sheet channel and Tobin's *q* are offering an analogous explanation to the monetary policy effects on equity prices. The balance-sheet channel regards firms as borrowers, considering that reducing the net worth of firms will, not only

[1] The bank lending channel is by no means less important, although less correlated to the purpose of this thesis

lead to a lower investment spending, but also to a weaker financial position that will affect their external finance premiums and the overall terms of credit that they face.

Mishkin (1995) also shows that an extreme form of the credit channel could lead to monetary policy effects on the economy via a financial crisis (Mishkin, 1995). Mishkin (1996) defines a financial crisis as a disruptive event that sharply increases the asymmetric information problems so that financial markets are no longer able to efficiently channel funds to the most productive investment opportunities. Mishkin (1996) outlines five factors that can potentially promote a financial crisis: (a) an increase in interest rates, (b) a decline in stock markets, (c) an unanticipated decline in the price level, (d) an increase in the uncertainty level and (e) bank panic.

These mechanisms and the financial literature in general, agree on the fact that a contractionary monetary policy, will lead to a decrease in equity prices. This fact is known to academics as much as to financial market practitioners, who in recent years have allocated a substantial amount of time and resources in forecasting, analysing and hedging the decision of monetary policy makers around the world. However, as monetary policy institutions progressed in their communication policies, we can observe that financial market actors have been adjusting their aptitude and approach in interpreting the signals of central banks.

The Federal Reserve (FED), through its Federal Open Market Committee (FOMC), before 1994 did not schedule the monetary policy meetings, leaving financial market actors to "discover" the changes in the Federal Funds Rate. Only after 1994 did, the FED begin to pre-schedule FOMC meetings, and give appropriate notice of them, when the announcement included a change in the interest rate level. Several other improvements were also made in communication policy. In 2000, the FOMC started to give appropriate notice of the announcement, not only when an interest rate change was voted but also when the level of the interest rate remained constant. The majority of FOMC announcements are pre-scheduled, specifically 8 announcements per year, although on rarer occasions the FOMC has given information on the state of monetary policy during unscheduled meetings, normally held in the form of conference calls.

The first chapter of this thesis analyses the expectations of financial market participants formulated prior to the FOMC announcements, and how these expectations affect equity returns. My research extends Kuttner's (2001) pioneer methodology to investigate whether the expectations of investors and the possible disagreement with the FOMC announcements are a possible explanation for the observed equity excess returns at the FOMC announcement day. To analyse these expectations, I compute the daily probabilities assigned by the market to an interest rate change across the whole trading week before the meeting. I depart from Kuttner's (2001) original approach that focuses only on the day before the announcements and instead consider the whole trading week before the announcement day. Different from earlier studies, I propose a new approach to classify the FOMC announcements based on the expectations of investors regarding the outcome of the meetings. My empirical analysis takes then a standard event-study approach, while controlling directly for information that jointly affects monetary policy and equity prices. Further, I investigate whether the reaction is in line with asset pricing theory (e.g. the Capital Asset Pricing Model, CAPM) so that predictions are related to the systematic risk exposure of stock portfolios.

Two different strands of the literature attribute different explanations to the equity excess returns associated with macroeconomic and monetary policy announcements. Monetary economists attribute this excess return on the surprise component of interest rate changes (Cochrane & Piazzesi, 2002; Ehrmann & Fratzscher, 2004; Rigobon & Sack, 2004; Bernanke & Kuttner, 2005; Kontonikas, MacDonald & Saggu, 2013; Gertler & Karadi, 2015; Fausch & Sigonius, 2018), whereas the more recent literature on the "announcement effect" attributes the excess return to the substantial risk compensation on equity markets during short announcement windows (Savor & Wilson, 2013; Lucca & Moench, 2015; Ai & Bansal, 2018; Wachter & Zhu, 2018).

My study suggests an alternative explanation, which could help to reconcile the results of the two strands of the literature by acknowledging both the relevance of the announcement effect and the interest rate surprise and by adding one factor: the expectations of investors regarding the content of the announcement. My results provide novel empirical evidence that the FOMC announcements, where market actors disagree with the committee decisions, are followed by an average equity impact of 40 basis points (bps), depending on the content of the announcement. Additionally, when investigating the hypothesis on stock portfolios sorted with respect to their market beta exposures, the impact on the equity ranges from 110 bps for high-beta stock portfolios to 30 bps for a low-beta portfolios. This last result is in line with past findings from Savor & Wilson (2013, 2014) and Wachter & Zhu (2018) who find that, despite its poor performance in explaining the cross-section of equity returns, the CAPM is overall a good fit to explain equity returns at the time of macroeconomic announcements.

My research also provides fresh evidence on a specific case of monetary policy announcements, which is generally included but often overlooked in the literature. This specific case is when the level of the Federal Fund Target rate is left unchanged by the FOMC. The Neutral Monetary Policy (NMP) analysis includes all these FOMC announcements and the reasons to analyse it separately rely on the potential additional uncertainty that these announcements carry. Bernanke & Kuttner (2005) explored the hypothesis that the market reacted to the actions or inactions of the FOMC[2] and found that the "direction" of the movement (interest rate hike or cut) is not an important determinant of the market reaction, whereas a "no change", combined with an interest rate surprise, is associated with a positive and statistically significant reaction.

In my analysis, I report that disagreement is associated with a slightly higher (about 50 bps) equity premium around NMP FOMC announcements. This result can be ascribed to two possible explanations. First, confirming an additional layer of uncertainty surrounding these announcements and, second, the "timing" around these announcements made in my sample period. The additional layer of uncertainty can arise from two sources. First, the NMP FOMC announcements leave investors with the open question on when a central bank will take action on the interest rates, and, second, if investors disagree with neutrality, it doesn't provide a clear message on the state of the economy.

The "timing" of the NMP FOMC announcements is related to the fact that these announcements were mostly made during post-crisis and bear market conditions, where

[2] See (Bernanke & Kuttner, 2005, section E, p. 1233).

stocks are known to react more strongly to monetary policy statements and surprises (Barsistha & Kurov, 2008; Kurov, 2010; 2012; Kontonikas, MacDonald, & Saggu, 2013). The main contribution of my first chapter is to provide new empirical evidence that the additional equity return associated with FOMC announcements is, in fact, driven by the expectations of investors, which I identified prior to the FOMC announcement and realised on the announcement day. In particular, when these expectations diverge from the FOMC decision, and disagreement is observed between investors and monetary policy makers, I find a strong reaction on the equity market. My contribution to the literature follows three different paths. Investors formulate expectations on monetary policy innovation relatively in advance of the scheduled FOMC meeting date, my research highlights this point and provides empirical evidence of investors expectations the 5 trading days window before the FOMC announcement. Second, the NMP analysis corroborates my first hypothesis and documents an additional layer of uncertainty that reaches the financial markets when no change in the current monetary policy occurs. Last, I show that equity returns respond rationally when financial markets disagree with central bank monetary policy, as CAPM theory would predict.

The seminal work of Kuttner (2001) and then Bernanke & Kuttner (2005) has initiated a strand of the literature which identifies unpredictable monetary policy changes with financial market-based measures. A different body of the literature has focused on identifying unpredictable monetary shocks, by analysing the information set of monetary policy makers, and further assessing their impact on macroeconomic variables. The causality patterns between monetary policy and macroeconomic variables make researchers work "*econometrically challenging*" for two main reasons: endogenous movements and anticipatory effects. Past studies have used different vector autoregressive (VAR) approaches to overcome the endogeneity issue of monetary policy and macroeconomic variables (Christiano, Eichenbaum & Evans, 1996; 1999; Uhlig, 2005). These studies find very little effect of monetary policy on macroeconomic variables. Conversely, Romer & Romer (2004) present evidence of significant effects of monetary policy shocks on macroeconomic variables in the United States (US). Their approach, different from past studies, estimates that monetary shocks are orthogonal, with respect to the information set available to policy makers at the decision time, and so they are able to solve the issues of both endogeneity and anticipatory movements.

To estimate orthogonal monetary policy shocks, Romer & Romer (2004) implement an identification strategy first proposed by Christiano, Eichenbaum & Evans (1999) and define the intended changes in interest rate as "the sum" of a systematic and an unpredictable component. The systematic component is redefined by Romer & Romer (2004) as the information set available to policy makers at the meeting date. The information set of policy makers is composed by a set of forecasted and ex-post macroeconomic variables, which are available to policy makers at the meeting date. In particular the forecasted variables are inflation and GDP and the ex-post variables, included to control for the current state of the economy, are the unemployment rate and the interest rate level. The later studies of Cloyne & Hürtgen (2016) and Champagne & Sekkel (2018) found similar evidence in the United Kingdom (UK) and Canada (CA).

My second chapter takes stock of that literature and develops a monetary policy shocks series for the European Central Bank (ECB) and investigates its effects on Eurozone inflation and industrial production. To develop the monetary policy shocks series, I follow closely the methodology of Romer & Romer (2004) and the identification strategy first proposed by Christiano, Eichenbaum & Evans (1996). I partially depart from Romer & Romer (2004) and I add an additional control variable to take into account the unconventional monetary policy measures put in place by the ECB.

In addition, I estimate the impulse responses of inflation and industrial production by following two different methodologies: a classical baseline VAR approach, to make my results as comparable as possible with empirical studies on other countries, and linear projections *á la* Jordà (2005). Consistent with the existing literature, I find that output is more responsive to monetary policy shocks, having a decline of over -0.5% and starting its downward path 10 months after the shocks. Conversely, the response of inflation to monetary policy shocks is very weak and unstable. My results on output are in line with past findings that used data of central banks in the UK, US and CA. Moreover, similar to past studies, I document a rise in prices and output, often define in the literature as "the price puzzle" (Sims, 1992), when estimating the impact of contractionary shocks with the official interest rates as a measure of shocks instead of my measure of monetary policy shocks.

I also investigate the response of inflation and industrial production of single Eurozone countries. Unlike earlier studies in the UK and CA, the ECB monetary shocks affect, in fact, a number of deeply diverse countries. The inflation headline observed by the ECB Governing Council, the Harmonised Index of Consumer Prices (HICP), is a cross-country weighted average of the HICP indexes across the monetary union, and therefore representative of the countries included in it. However, the 2011 sovereign debt crisis highlighted significant differences among the Eurozone countries, which have profound effects on their economic performances. My research has gathered data for Germany, France, Spain, Italy, Portugal and Greece to analyse individual country responses of inflation and output.

The response of industrial production is quite homogenous, following the negative trend observed for the Eurozone as whole. In particular, the negative trend of output starts within 10 months and peaks after 24, with the peaks ranging from -0.50% to -1%. What is noticeably different among the countries is in the initial path of output. The response of inflation is weaker compared to the response of industrial production, in line with past results, although diverse among the included countries. A constant declining path is observed only in the case of Germany and France, whereas other countries display a rather volatile path, with the isolated case of Greece that shows inflation rising after the shock.

My second chapter thus contributes to the literature in four different ways. First, I provide a new series of monetary shocks for the ECB computed following Romer & Romer (2004) and by gathering a new dataset of forecasts for the ECB. Second, I provide empirical evidence of the effects of monetary shocks on output and prices on the Eurozone.

Third, earlier results (Romer & Romer, 2004; Cloyne & Hürtgen, 2016; Champagne & Sekkel, 2018) found that the narrative methodology resolves the issue of the "price puzzle". My analysis provides evidence that this result holds also in the case of the Eurozone and that the narrative methodology, compared to a traditional recursive VAR with the change in the nominal interest rate as a measure of shock, resolves the price puzzle issue. Last, but not least, and unlike previous studies on the ECB, I provide evidence of the heterogeneous responses of output and prices among the Eurozone countries.

In the two first chapters of this thesis, I have primarily focused on the *unintended* effects of monetary policy on financial markets and the real economy. Conversely, the *intended* effects or goals of monetary policy are stated clearly in the mandates of central banks. In fulfilling their mandates, monetary policy makers have a large amount of information to process and to analyse. Friedman & Kuttner (2010) rightly note that most of the literature has debated how central banks *should* optimally set interest rates, while much less attention has been directed to the more important question on how they actually *do* set them. The second question remains therefore open, although, in the past two decades, most of the world central banks have committed to the inflation targeting (IT) framework. My third chapter aims to tackle this question and investigate the determinants of interest rates setting within the well-known Taylor (1993) Rule framework. The chapter presents fresh evidence that an *Augmented* Taylor (1993) Rule, which includes measures of financial markets' stability, better explains the conduct of monetary policy for the ECB and Bank of England (BOE), across the 2003–2018 sample period. It is worth pointing out that similar studies have been carried out in the context of the FED (Oet & Lyytinen, 2017) and the ECB (Gorter, Jacobs, & De Haan, 2008), although not in the context of the BOE and not making a direct comparison between these two influential institutions (the ECB and BOE).

I also differentiate between a "simple-feedback" and a "forward-looking" monetary policy rule. Following the theoretical critique of Svensson (2003, 2010, 2019), I provide empirical evidence that a forward-looking monetary policy rule is more suited to set interest rates, given the fact that monetary policy affects the economy with a lag.

The Taylor (1993) Rule has been unofficially used by many institutions around the world. Moreover, its formula links directly the level of inflation and output growth to the optimal level of the official interest rates. The Taylor (1993) Rule has been therefore particularly relevant in discussions around the IT framework. Including some of its alternative versions, the Taylor (1993) Rule has been quite successful in explaining the monetary policy conduct of the Eurozone. Clarida, Gali & Gertler (1998) interpret the short-term interest rate dynamics in two groups of countries, G3 (Germany, Japan, US) and E3 (UK, France, Italy), by including a "smoothing factor" in the formula. Gerlach & Schnabel (2000) provide empirical evidence that the short-term interest rate of the Eurozone in the 1990s can be well explained by a Taylor (1993) Rule with a coefficient of 0.5 on the output gap and 1.5 on inflation. Following Svensson's (2003) critique, Gorter, Jacobs & De Haan (2008) estimated a forward-looking Taylor Rule for the ECB, providing empirical evidence that for the pre-crisis period 1997–2006 a forward-looking Taylor Rule better explains the monetary policy conduct of the ECB.

Oet & Lyytinen (2017) show that a Tri-Mandate Taylor-type Rule better explains the conduct of monetary policy in the US. More specifically, they include financial stability in the form of a "financial stability slack" variable to investigate whether financial stability has entered the discussions of the FOMC committee. The dispute on whether financial stability should be included in the mandate of central banks started with the discussion of Bernanke & Gertler (1999), who asserted that financial stability shouldn't enter the discussion of central bankers. Kuttner (2011) revised this prescription and pointed out that financial market stability should be pursued in order to support price stability. Bernanke (2011) further revised the doctrine and practice of central banks in light of the 2008 financial crisis experience. He pointed out the level of consensus on monetary policy and on the IT framework that central banks had reached in the two decades prior to the 2008 financial crisis. Bernanke recognised that, although the framework had helped in producing a long period of macroeconomic stability, it ultimately was not by itself enough to ensure financial stability.

I also investigate additional factors that are worth exploring to understand in more detail the dynamics of financial market stability. In particular, I include in my study an "international financial market stability" variable, which is a measure of financial market stability slack for the US analogous to Taylor (1999b). A novel result that emerges from this analysis is the joint importance of both the domestic and international financial market stability in affecting monetary policy makers' decisions.

In the case of the ECB, in fact, the US financial market stability is definitely a concern for policy makers. This result can be interpreted as the joint effort of monetary policy makers in re-establishing trust among investors and towards institutions in the aftermath of the financial crisis. On the contrary, in the case of the BOE, the variable related to US financial market stability never enters with a statistically significant estimate.

The first contribution of this chapter is to provide empirical evidence that financial markets are a concern for policy makers, particularly during economic downturns. This study doesn't aim to assess whether financial stability *should* be included in the mandate of central banks, but whether it has been already included as a consequence of the financial crisis events. Similar to the findings of Oet & Lyytinen (2017) in the case of the FED, I find that financial market stability is definitely already a source of concern for the ECB and BOE policy makers. The second contribution of this chapter is to support empirically the criticisms raised by Svensson (2003, 2010, 2019) and find evidence that a forward-looking monetary policy is better, given that monetary policy affects the economy with a lag. Last, I provide a comparison of the conduct of the monetary policy of two influential institutions: although there is significant evidence on the FED and on the ECB, much less has been said about the BOE's monetary policy.

Chapter 2

What Happens When Equity Investors Disagree with the FOMC?

2.1 Introduction

> …. The effect of monetary policy on the economy today depends not only, or even primarily, on the FOMC's current target for the federal funds rate or the quantity of assets on its balance sheet, but rather on how the public expects the Federal Reserve to set the paths of these variables in the future.

(Remarks by Janet Yellen, Vice-Chair of Board of Governors of the Federal Reserve System, November 13, 2012)

As stated by Janet Yellen, the level of alignment of market expectations regarding future monetary policy decisions with the actual FOMC decisions reflects the effectiveness of monetary policy practices. As financial markets are a fundamental part of the monetary policy channel, they are inevitably influenced by it. This chapter addresses the following question: does disagreement of investors towards monetary policy announcements affect the dynamics of equity markets? To investigate this question, I develop a simple framework to analyse the expectations of investors in regard to upcoming FOMC announcements and how these expectations are reflected in equity returns.

The methodology employed is inspired by the pioneer research of Kuttner (2001) and Kuttner & Bernanke (2005). Kuttner (2001) analysed the interest rate changes deliberated by the FOMC to disentangle an expected from an unexpected component using the Federal Funds Futures and the Effective Federal Funds Rate.[3] Owens & Webb (2001) employ the assumptions of Kuttner (2001) to reconstruct the expected interest rate *after* the FOMC announcement,[4] which in simple words is the sum of the current level of the Federal Funds Target rate and the change (or no change) expected by investors. They further propose a method to covert the changes expected by investors into probabilities.

Combining these two approaches, I compute the probabilities assigned by investors to interest rate changes. These probabilities are singularly computed each day, for the whole week before the FOMC announcements. This time period, the week before, is also defined as the "blackout period", during which policy makers are forbidden from disclosing official information on the upcoming FOMC announcement. Investors should be therefore developing their expectations free from the influence of other monetary policy updates from institutional sources. This method, partially departs from Kuttner (2001) and Bernanke & Kuttner (2005), who consider the unexpected component of an interest rate change only the day before the FOMC announcement.

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[3] Kuttner (2001) proposed two ways to disentangle the expected from the unexpected component of interest rate changes. A first methodology proposed the difference between the Federal Funds Futures and the average of the Effective Federal Funds rate throughout the month (see equation (5) in Kuttner, 2001). A second formula, also employed by Bernanke & Kuttner (2005), computes the change in the Federal Funds Futures around the FOMC announcement date.

[4] By "expected interest rate *after* the FOMC announcement" I intend the Federal Fund Target rate level that investors expect to be declared by the FOMC and that will be therefore the new (regardless whether it remains unchanged) reference level of the Federal Fund Target rate.

I define the "disagreement" of market actors towards the FOMC announcement when their expectations (in form of probabilities) deviate from the FOMC decisions. Specifically, I postulate, that for each FOMC announcement, investors expect a change in the Federal Fund Target rate when the probability of an interest rate change is higher than 50% on the majority of days. Finally, "disagreement" is identified by combining the probabilities with the FOMC announcement content. If the probabilities yield an expected change in the Federal Fund Target rate and the change doesn't occur, "disagreement" is observed (this also applies vice versa).

"Disagreement" then takes the form of a dummy variable that has value 1, for every FOMC announcement where I detect disagreement and zero otherwise. The analysis is then run with a standard event-study approach, while controlling for variables that might jointly affect equity returns around the FOMC announcements days. My findings report that disagreement is associated with a statistically significant 40 basis points (bps) averagely across my whole sample period (2000–2016). My results are in line in magnitude with the pre-announcement drift of Lucca & Moench (2015). To give a reasonable basis to my findings, that position themselves between the literature of monetary economists (Cochrane & Piazzesi, 2002; Ehrmann & Fratzscher, 2004; Rigobon & Sack, 2004; Bernanke & Kuttner, 2005; Kontonikas, MacDonald & Saggu, 2013; Fausch & Sigonius, 2018) and the more recent literature on FOMC and macroeconomic announcements (Savor & Wilson, 2013; Lucca & Moench, 2015; Ai & Bansal, 2018; Wachter & Zhu, 2018), I analyse the time series of equity returns on FOMC announcement days.

To analyse the time series of equity returns on FOMC announcement days, I follow the empirical analysis of Lucca & Moench (2015) and find several interesting results: first, my disagreement variable remains a positive and statistically significant explanation for the equity excess return across the analysis. Second, FOMC returns still present an asymmetric response with respect to the unemployment rate, as found by Boyd, Hu & Jagannathan (2005). Third, the "Kuttner Surprise"[5] still represents a plausible explanation for a portion of the equity returns (in contrast with the results of Lucca & Moench, 2015). Last, FOMC equity returns are partially state dependent and influenced by the business cycle. Particularly when investors disagree with the decision of the FOMC, the equity impact is strong and negative during recession times. This last result is in line with the findings of Barsistha & Kurov (2008), Kurov (2010; 2012) and Kontonikas, MacDonald & Saggu (2013), who report a significantly different response of the market to monetary policy statements and monetary policy surprises during and just after recession events.

To further corroborate these findings, I investigate a specific setting, generally overlooked in the literature, the Neutral Monetary Policy (NMP) analysis. The NMP analysis includes all the FOMC announcements where no interest rate change occurs. The NMP analysis is a natural environment to investigate two fundamental aspects of my research questions: the power of expectations and the announcement effect. Since no interest rate change is announced, the economic condition remains unchanged. However, investors might disagree with this decision and, further, an unchanged interest rate level also implies important information on the state of the economy. When I replicated my analysis, considering only the NMP FOMC announcements, I found that disagreement around

[5] The "Kuttner Surprise" is the monetary policy surprise computed as in Kuttner (2001) and Bernanke & Kuttner (2005) and represents the unexpected component of a Federal Fund Target rate change.

FOMC meetings when no interest rate change was voted had an even stronger impact of about 50 bps. I provide two potential explanations for this additional equity premium: the first explanation looks at the interpretation that investors will give to NMP and is closely related to the information transmission theory of Tetlock (2011). As NMP FOMC announcements don't come with a "clear decision", but only with the disclosure of the economic outlook according to the FOMC, they might bring additional uncertainty to the market that results in an additional equity premium. This uncertainty will be even greater when investors disagree with the FOMC decisions and are left to wonder "when the inevitable will happen".

This additional level of uncertainty in "disagreement" with NMP FOMC announcements could be interpreted as follows. If investors were expecting a rise in interest rates, NMP could be perceived both as a sign that the economy is not sufficiently strong to absorb it and as worsening debt conditions for companies being delayed in time. Conversely, assuming markets expecting a loosening of monetary policy and a subsequent NMP takes place, the equity market reaction will be positive as investors will forecast a state of the economy that could overcome the ups and downs without central bank interest rate interventions. Moreover, disagreement around NMP leaves the debate on when the FOMC will change the level of interest rates open for discussion.

A second explanation is given by the "timing" and state dependence of NMP FOMC announcements. The NMP FOMC announcements have mainly happened after periods of crisis[6] and severe bear market conditions. As reported by Kurov (2010), investors' sentiment around monetary policy announcements has a strong impact on the stock market, particularly in bear market conditions, implying that perhaps a proportion of these equity premium might be due to the "timing" of the NMP FOMC announcements.

To analyse this aspect, I have examined the equity returns around NMP FOMC announcements and found two particularly interesting results: first returns around NMP FOMC announcements are, in line with expectations, strongly state dependent and second the magnitude of the "Kuttner Surprise" is doubled around these announcements. These two results have implications in two different directions. First, in the FOMC announcement literature this aspect should be taken into greater consideration. Lucca & Moench's (2015) findings are based on the pre-announcement stock drift, claiming that the decision of the FOMC couldn't represent a possible explanation for their findings, although perhaps the expectations of investors around NMP during the zero-lower bound period could be. The greater magnitude of the "Kuttner Surprise", combined with my disagreement variable, could all together be interpreted as the additional uncertainty surrounding these announcements, and therefore investors overreacting to it.

After having established the equity premium associated with disagreement on broad market indexes, I follow the literature and investigate whether this response is homogenous across stocks. To do so, I first investigate whether the response to disagreement is in line with the CAPM predictions and, second, whether the response is homogenous across industries.

[6] The stock market downturn of 2002 and the more recent 2008 crisis that has led to a historical zero-lower bound period.

A recent part of the literature has, in fact, found compelling evidence that the CAPM predictions work very well around macroeconomic announcements, compared to "ordinary" trading days (Savor & Wilson, 2014; Wachter & Zhu, 2018). In my analysis, I investigate the response of disagreement around FOMC announcements on equity portfolios sorted on their beta and find a high degree of proportionality in the response.

Further, following Bernanke & Kuttner (2005) and Lucca & Moench (2015) I extend the analysis to the Fama & French 10 Industries Portfolios. This last analysis allows me to both confirm the degree of proportionality of the previous analysis, but also to examine the response to disagreement across business sectors.

The response of the business sectors is quite heterogenous and interesting, with the High-Tech sector showing a strong response of around 70 bps to "disagreement" and the Durables, Energy and Wholesale/Retail sectors to "agreement" of 45, 32 and 33 bps, respectively. Although these results are slightly in contrast with my previous conclusions, they could be ascribed to the different sensitivity of the industries in relation to future expected dividends and debt conditions.

Altogether, the main contribution of this chapter is to provide an additional explanation for the excess equity returns associated with the FOMC announcements and reconcile the findings between the monetary economists and the macroeconomic announcements literature. The chapter also contributes further to the existing literature, in two other ways. First, I investigate specifically FOMC announcements where no interest rate change occurs and find that an even higher equity return is associated with these announcements, which is in line with the macroeconomic announcements' literature and partially difficult to reconcile with standard asset pricing models (Savor & Wilson, 2013; Ai & Bansal, 2018).

Secondly, I confirm the past results of Savor & Wilson (2014) and Wachter & Zhu (2018) that the CAPM, although failing to explain the cross-section of asset returns on many occasions, does a fairly good job in explaining the additional equity returns on FOMC announcement days, particularly when these announcements are not associated with a change in interest rate.

2.2 Literature Review

This chapter builds on two different strands of the literature, finding its ground first in the long-lasting debate of monetary economists on the effects of monetary policy and monetary policy shocks on asset prices and then considers the more recent literature on the information effects during macroeconomic and monetary policy announcements. The debate on the effect of monetary policy effects on stock market returns applies to the long standing research, which mainly aimed to identify the effects of monetary policy decisions on financial markets. Rozeff (1974) first presented evidence of the effect of the money growth rate on stock returns. This research also gives evidence that consistent with the Efficient Market Hypothesis, monetary policy doesn't affect stock returns with a lag. Monetary policy at the time was mainly exercised by affecting the balance of money. Subsequently, other monetary policy tools were added in the analysis of their effects on financial markets.

Hardouvelis (1987) continues the discussion by analysing the response of the term structures of interest rates to weekly Federal Reserve announcements of the Bank Reserves. He also first introduced the discussion of expected and unexpected changes in borrowed and non-borrowed reserves. Thorbecke (1997) addresses the effects of monetary policy on stock returns, by employing a series of vector autoregressive (VAR) analyses and indicating that there is a large and statistically significant relationship between negative shocks on the Federal Funds rate (or shocks to non-borrowed reserves) and a subsequent increase in stock returns. His analysis concludes that assets must pay a positive risk premium to compensate investors for their exposure to these shocks. Thorbecke (1997) extends the analysis further and provides evidence on the effects of monetary policy on small firms.

The contemporary interest in the effects of monetary policy on the financial markets has developed around the identification of monetary policy shocks and expected and unexpected changes in monetary policy. Cochrane & Piazzesi (2002) develop a series of unexpected monetary policy movements (shocks) with a high-frequency identification, to overcome endogeneity issues. Rigobon & Sack (2004), similarly use a high-frequency identification for monetary policy shocks and show that the response of asset prices to changes in monetary policy can be identified based on the increase in the variance of policy shocks that occurs on days of FOMC announcements. Ehrmann & Fratzscher (2004) acknowledge the Rigobon & Sack (2004) methodology and the pioneering work of Kuttner (2001), by introducing a discussion about the expectations of investors, and the role that they can play in the reaction to stock returns. Their methodology also employs market expectations to analyse the monetary policy shocks, retrieved from surveys of market participants. Further, they continued the discussion begun by Thorbecke (1997) and analysed the response of equity returns at a firm level. They first present evidence that firms included in the S&P500 respond to monetary policy changes heterogeneously and they then investigate the industry-specific effects, finding that cyclical sectors react in a stronger way.

Bernanke & Kuttner (2005) employ the pioneer methodology of Kuttner (2001) to investigate the effect of unexpected changes in Federal Funds rate. The methodology of Kuttner (2001) successfully disentangles the expected from the unexpected component in the interest rate changes and assesses the effects on financial markets. Bernanke & Kuttner (2005) employ this methodology and state that their analysis is complicated by the fact that the market is unlikely to respond to policy actions that were already anticipated. More recently, Kontonikas, MacDonald & Saggu (2013) employ the Bernanke & Kuttner (2005) methodology and find that the stock market reaction is somewhat stronger during a recession period. The findings of Kontonikas, MacDonald & Saggu (2013) report an important change in the effect of monetary policy in the aftermath of the 2008 financial crisis: during economic downturns unexpected interest rates cuts are negatively perceived by investors (unlike pre-crisis results) as a signal of worsening economic conditions.

This chapter builds on this stream of the literature acknowledging the effect of monetary policy on financial markets and their fundamental role in the monetary policy transmission channel. Bernanke & Kuttner (2005) primarily motivate their study by endorsing the direct effect of changes in the Federal Funds Target interest rate on the financial market. This chapter builds on this motivation and on their findings to investigate two important findings. First, monetary policy changes have important effects on stock returns and, second, that the expectations of investors in regard to monetary policy changes modulate these effects on stock returns.

A more recent strand of the literature has focused on the "announcement effect" of macroeconomic and monetary policy announcements, which are associated with a substantial risk compensation on the equity market. Savor & Wilson (2013) pointed out that average returns and Sharpe ratios are significantly higher on days where important macroeconomic news are scheduled. Their primary assumption, also fundamental for the purpose of this chapter, is that some economic information is randomly released, whereas some important macroeconomic news is released in the form of pre-scheduled announcements. Assuming that asset prices respond to the news, the risk associated with holding affected equity instruments will be higher around the announcement. Consistent with the state dependent results of Kontonikas, MacDonald & Saggu (2013), in periods of high uncertainty about the direction of the economy the difference in returns between announcement and non–announcement days is at its peak. Their results also reconcile the large increase in stock market premium with a relatively small increase in the stock market variance.

Their findings are directly linked to FOMC monetary policy announcements for two main reasons: first, FOMC announcements are pre-scheduled and investors are perfectly aware of the exact date and time of the information release. Second, FOMC announcements, not only update the public on current monetary policy, but also convey important information on the future economic outlook. Building on these assumptions and in line with the results on macroeconomic announcements Lucca & Moench (2015) found a consistent large pre-FOMC announcement drift. Their explanation is directly linked to the additional risk premium required by investors to bear undiversifiable risk on the announcement day. Another possible explanation that they attribute to this additional risk premium is given by "unexpected good news". This explanation has not been investigated further and the question of whether expectations should have any involvement in the pre-announcement stock drift remains open. In this chapter, I partly answer this question, as in my analysis the pre-announcement stock drift is in some measure included.

Motivated by this large equity premium associated with announcement days, Ai & Bansal (2018) develop a theoretical model that allows macroeconomic announcements to carry information about the prospect of future economic growth. They characterise the set of intertemporal preferences of the representative consumer under which macroeconomic announcements are associated with the realisation of the equity premium. Their continuous-time model partially explains the pre-announcement stock drift of Lucca & Moench (2015), stating that a pre-announcement drift can arise in environments in which information about the announcements is communicated to the market prior to the pre-scheduled announcement. This statement was, however, contradicted by Lucca & Moench (2015), who claimed that other information could not be disclosed to the public by policy makers the week before the FOMC announcement (the blackout period). This critical aspect is particularly relevant to the purpose of this chapter, as I will investigate the expectations of investors during the blackout period. During this specific period only non-official information should reach investors, who should have, therefore, developed their expectations on information that they have collected beforehand.

Most of these studies focus on the aggregate effect on the market. Concurrently, other studies have focused on analysing the effect on stock returns in relation to their systematic risk. Savor & Wilson (2014) find evidence that during this announcement period, in addition to significantly higher average returns for risky assets, returns patterns are much easier to reconcile with standard asset pricing theories. Savor & Wilson (2014) found that beta is a successful measure of systematic risk during macroeconomic announcement days compared to non-announcement days.

Building upon this empirical evidence, Wachter & Zhu (2018) build a frictionless model with rational investors that explains these findings. They provide, in fact, two theoretical explanations: first is a preference for early resolution of uncertainty and the second is “rare events”. The risk that is realised on announcement days concerns the probability of a rare event in the economy.

Both these explanations apply directly to the motivation of this study and the results that will be presented. The common ground between the monetary economists’ strand of the literature and the announcement effects’ strand is that FOMC announcements are associated with a drift in stock prices, to which different explanations can be given. Monetary economists attribute this additional return to the unexpected component of interest rate changes (Bernanke & Kuttner, 2005). The other strand of the literature attributes the additional returns to the premium required by equity investors for bearing non-diversifiable risk (Lucca & Moench, 2015) and the risk that is realised on announcements days, concerning the probability of a rare negative event in the economy (Wachter & Zhu, 2018). This research reconciles these findings and proposes an alternative explanation for the observed dynamics of equity returns on the FOMC announcements days.

The common ground found in this chapter is based on assumptions that apply to both strands of the literature. The main assumption and motivation of my study are that investors develop expectations on the future decision of the FOMC committee. These expectations are developed by investors previous to the meeting date and will find further confirmation (or not) when the outcome of the meeting is released. The second assumption is the announcement itself resolves the uncertainty on the market (Savor & Wilson, 2013; Ai & Bansal, 2018). Third, policy announcements come systematically with central banks updates on the economic outlook. The information content of these announcements shapes the private sector expectations on the macroeconomy and interest rates, potentially affecting the effects of monetary policy itself.

A smaller part of the literature has acknowledged both the information content of the FOMC announcement and the monetary policy changes that come with the outcome of the FOMC committee decision. This chapter relates to this side of the literature, in combining the aspect of the "pure monetary policy shock" and the "information shock". Looking at the high-frequency identification strategies, Gertler & Karadi (2015) included in their identification of the monetary policy effects, the elements of "forward guidance" that come with the economic outlook information released along with the FOMC announcements. Building on these results and assumptions, Jarocinski & Karadi (2020) provide recent evidence on the difference between "information" and "pure policy" shocks in the Eurozone. This analysis is based on the assumption that an interest rate hike, and therefore a tighter monetary policy, should negatively affect stock prices. Jarocinski & Karadi (2020) therefore postulate that a monetary policy shock is defined as a "pure policy" shock when it is followed by a decline in stock prices, conversely it is defined as an "information" shock when it is followed by a rise in stock prices.

Overall, the literature has mainly focused on the effects of monetary policy on the equity market. Some evidence has been provided on relevant excess returns on the exchange rate market. Mueller, Tahbaz-Salehi & Vedolin (2017) report recent evidence of a pre and post–

announcement effect on the exchange rates premium, partially in contrast with the findings of Lucca & Moench (2015), who only find a pre-announcement effect. They apply to the strand of the literature that links monetary policy to exchange rates (Eichbaum & Evans, 1995; Faust & Rogers, 2003; Scholl & Uhlig, 2008; Rogers, Scotti & Wright, 2018).

2.3 Hypothesis Development

Building upon two different strands of the literature, the motivation of this chapter relies on understanding the excess equity return associated with FOMC announcements. The seminal papers of Kuttner (2001) and Bernanke & Kuttner (2005) have directed the literature in understanding whether investors react to the surprise component of a change in the Federal Funds rate, rather than to the rate change itself. Their methodology effectively disentangles the expected from the unexpected (surprise) component of the interest rate changes and further evaluates the effect on stock returns.

These results feature an important finding: the expectations of investors are developed prior to the FOMC announcement. The methodology of Kuttner (2001) and Bernanke & Kuttner (2005), compute, in fact, the surprise component on the day prior to the announcement. What this methodology doesn't allow is to distinguish the FOMC announcements with respect to the expectations of investors and the outcome of the announcement. The outcome of the FOMC announcement and the announcement effect itself are, in fact, not specifically investigated in their seminal research.

On the other hand, more recent research has specifically focused on the information effect of the announcement, acknowledging that macroeconomic announcement days, are overall characterised by higher returns and generally lower volatility (Savor & Wilson, 2013; Lucca & Moench, 2015; Ai & Bansal, 2018). Their research shows that the average return on the S&P500 on days with macroeconomic announcements is around 11bps, which is considerably higher than the 1.3 bps found on non-announcement days (Ai & Bansal, 2018).

Both streams of the literature give different explanations for the excess return around announcement days and in particular the FOMC announcement. The FOMC announcement is, in fact, not only a monetary policy announcement, as it also conveys important information on the current state of the economy and the future economic outlook. To explain the motivation and the hypothesis of my study I will first recall some stylised facts that apply to both streams of the literature:

1. FOMC announcements are associated with considerably higher stock returns than the average trading day.
2. FOMC announcements convey information on the future conduct of monetary policy, as well as on the outlook of the economy.
3. FOMC announcements are (since 1994) pre-scheduled, and, among the most anticipated macroeconomic announcements.
4. The expectations on the FOMC announcements are developed in advance.
5. The reaction of investors is state-dependent.

These "*facts*" provide the ground for the the main motivation of my study. The main hypothesis of my research is, in fact, on whether the reaction of investors to FOMC announcements is given by their previous expectations on the conduct of monetary policy and further modulated by the announcement that conveys not only information about the monetary policy, but also about the current and perspective economy outlook. The "disagreement" of investors, defined as the case when the FOMC committee takes a decision regarding the future of monetary policy which is totally in contrast with the expectations of investors, might be a plausible explanation for the strong reaction on FOMC announcement days.

In order to shed light on whether the expectations of investors, combined with the outcome of FOMC announcements are the trigger of equity excess returns, I postulate the following hypothesis:

H1: The disagreement of investors regarding FOMC announcements affects stock market returns.

2.4 The Federal Reserve Communication Policy

The FOMC is the body of the US Federal Reserve System responsible for taking major decisions in regard to monetary policy. The FOMC is composed of 12 members, including the 7 members of the Board of Governors of the Federal Reserve System, the president of the Federal Reserve Bank of New York and 4 of the remaining 11 Reserve Bank Presidents. Policy decisions are taken under a majority rule during FOMC meetings.

Currently the FOMC holds 8 pre-scheduled meetings per year and less frequently unscheduled meetings are held, mostly in the form of conference calls. The FOMC gives appropriate detail of the decisions taken during the meetings, in order to enhance the accountability and transparency of the institution. Central banks worldwide have dedicated a considerable amount of time and effort in enhancing their communication policies over the last two decades, for both economic and non-economic reasons (the independence of central banks).

In regard to the FED and the FOMC this process began with the reforms in the early 1990s that progressed until the inclusion of the “Guidance” in 2003. Prior to 1994, the FOMC did not disclose policy actions and market participants had to infer them from the size and type of open market operations (OMOs). After 1994, the FOMC began to pre-schedule the meeting and the first post-meeting statement with a qualitative description of the change in policy was published. In August 1994, a rationale for the decision taken was added to the statement, and in 1995 it was finalised by including the numerical Federal Funds Target rate. The end of 1999 and the beginning of 2000 represented the first steps to enhance the transparency of the FOMC deliberations and lay the grounds for the inclusion of the "Guidance" in 2003.

In January 2000 two important steps were accomplished by the FOMC. On a January press release[7], the FOMC announced that it approved the disclosure modifications discussed in the end of 1999[8], taking effect as of the pre-scheduled FOMC meeting in February 2000. The modification in the FOMC disclosure policy included two major points: first, the committee determined that a statement will be issued to the public immediately after every FOMC meeting (the previous procedure was to release only in the event of a policy action or a major change in the committee's views). Second, the FOMC changed its language to describe future developments on the consensus around the newly approved "Balance of Risks" and the long-run goals of price stability and sustainable economic growth. The sample period that I employ in my study coincides with the approval of the revised disclosure procedure in 2000 (specifically with the pre-scheduled meeting of February

[7] Published the 19th January 2000 for immediate release. The revised disclosure procedures were proposed by the "Working Group on the Directive and Disclosure Policy," which was formed in August 1999. https://www.federalreserve.gov/boarddocs/press/general/2000/20000119/default.htm

[8] The FOMC started to publish fueller statements after their meetings in May 1999, however, the language and the procedure were not formalized until 2000.

2000) and ends in 2016. Even though a number of statement were published in 1999, I started my sample in 2000, following the formalization of the procedure[9] and the change in the language.

In 2002, the votes of the FOMC were made explicit, with the dissenters' names included in the statement. The inclusion of the "Guidance" in 2003 represented a further major step towards the level of predictability of the interest rates path, as it included clearer information on the likely directions of rates over an extended period. The Fed's communication policy has accomplished major steps in the past two decades. This was also made possible by a series of strict rules that the FOMC members had to follow when addressing the public and when divulgating information related to monetary policy and economic conditions.

This set of rules is published in the "FOMC Policy on External Communications of Committee Participants"[10] document and contains information on how FOMC members should act in regard to the disclosure of information to the public. A particularly relevant rule for the purpose of this research is included in point 7 of the "General Principles" and regulates the disclosure of information the week before a pre-scheduled FOMC meeting. This period will begin at the start of the second Saturday (midnight) Eastern Time before the beginning of the meeting and will end at midnight Eastern Time on the next day after the meeting and is named the "blackout period". During this period, committee members

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[9] Ehrmann & Fratzscher (2007) also separate the events of 1999 from 2000, pointing out that January 2000 also represented a major shift in the disclosure policy, as the statements were no longer focusing on intermeeting period but on the foreseeable future.

[10] https://www.federalreserve.gov/monetarypolicy/files/FOMC_ExtCommunicationParticipants.pdf

refrain from expressing their views about macroeconomic developments or monetary policy issues with members of the public, in order to facilitate the effectiveness of the Committee's policy deliberations and the clarity of its communications.[11]

As mention, unscheduled conference calls are much less frequent, and they have received much less acknowledgment in the literature compared to the pre-scheduled meetings.[12] Conference calls are mostly employed to review ongoing developments of the economic situation, however, in some cases they were also employed for changes in the Federal Fund Target Rate. Four interest rate cuts occurred during my sample period (2000-2016) out of 25 conference calls. Specifically, 2 in 2001 and 2 in 2008. The FOMC publishes annually a "Federal Open Market Committee Rules and Authorizations"[13] document, including guidelines for the FOMC organization and code of practice, however, conference calls are not explicitly "regulated" in terms of format or content. Conference calls are explicitly cited to allow members to participate to an unscheduled meeting in electronic forms, when the notice of the meeting was given shortly before it.

2.5 Methodology

To test my hypothesis, I need to identify investors' expectations prior to the FOMC announcement day and whether these expectations are aligned with the decision announced by the FOMC. When these expectations go against (are aligned with) the decisions of the

[11] The blackout period is explicitly set for pre-scheduled meetings, however, no specific detail is given for uncheduled conference calls.
[12] In their recent work on stock returns predictability around FOMC announcements, Du, Fung, & Loveland (2018) include the conference calls in their analysis.
[13] https://www.federalreserve.gov/monetarypolicy/files/FOMC_RulesAuthPamphlet_201601.pdf

FOMC, I define it as "disagreement" ("agreement") towards the FOMC. The decisions of the FOMC that will be considered in this research and to build this methodology are only related to the Federal Fund Target rate. My measure of "disagreement" is built in three different steps: (1) identify the investors' expectations prior to the FOMC announcements; (2) quantify these expectations in the form of a probability assigned by investors to an interest rate change and (3) combine these probabilities with the outcome of the FOMC announcement.

To identify investors' expectations, I extend the pioneer work of Kuttner (2001) and Bernanke & Kuttner (2005). The methodology of Kuttner (2001), largely known in the literature as "interest rate surprises" employs the Federal Funds Futures to investigate the surprise component of Federal Funds Target rate changes. This measure of surprise is further employed to investigate its effect on equity prices on the FOMC announcement day. I employ this measure of interest rate surprises to identify the Federal Fund Target rate expected by investors *after*[14] the FOMC announcement.

To compute the expected Federal Fund Target rate *after* the FOMC announcements I follow the methodology proposed by Owens & Webb (2001) to complete the second step of my study. Owens & Webb (2001) present a methodology to infer the probability of an interest rate change that builds on the forecasting ability of Federal Fund Futures and their deviations from the current Federal Fund Target rate. The computational details are further presented in subsection 2.5.1.

[14] By "*after*" I intend once the FOMC has announced its decision regarding the level of the Federal Fund Target rate, which normally happens at the press conference held after the FOMC meeting. Details on the FOMC communication policy can be found in section 2.4.

The probabilities computed in the second step of my study cover the entire week before the FOMC announcement day, the "blackout period". During this period, FOMC members refrain from expressing their opinions and therefore investors are left to formulate their expectations on the basis of previously acquired information and their own views. Lastly these probabilities are combined with the FOMC announcement as explained in detail in subsection 2.5.2 to build my disagreement measure.

2.5.1 Step 1 and 2: Market-Based Probabilities

To infer the expectations of investors on the outcome of the upcoming FOMC meeting I, firstly, estimate the Federal Fund Target rate *expected* by investors *after* the FOMC meeting. To compute this *expected* interest rate, I firstly compute the difference in the monthly average Effective Fed Funds Rate ($R_{s,t}$) and the Future Federal Funds rate ($f_{s,t}$):

$$\Delta r_t^e = R_{s,t} - f_{s,t} \qquad [\ 2.1\ ]$$

Where time t represents the 5 days prior to the FOMC announcement day.

Equation [2.1] takes its inspiration from the pioneer work of Kuttner (2001).[15] To infer investors' expectations, following Owens & Webb (2011), I derive the Federal Fund Target rate *after* the FOMC announcement.

The *expected* interest rate, *after* the FOMC meeting, (r_t^e) can be subsequently computed by adding the Δr_t^e component to the current Federal Fund Target rate (r_t):

$$r_t^e = \Delta r_t^e + r_t \qquad [\ 2.2\ ]$$

[15] See Section 3.2, equation (5) in Kuttner (2001)

The expected Federal Fund Target Interest rate, *after* the FOMC meeting (r_t^e), can be also re-written as the weighted probability **p** of the current rate r_t plus the average change applied by the FOMC committee (Δ_r^T) and the probability (1 – p) of the current rate remaining unchanged:

$$r_t^e = \mathbf{p}(r_t + \Delta_r^T) + (1-\mathbf{p})\, r_t \qquad [\ 2.3\ ]$$

Consequently,

$$\mathbf{p} = |(r_t^e - r_t)| / \Delta_r^T \qquad [\ 2.4\ ]$$

where **p** is essentially computed as the ratio between the Federal Target rate change, in absolute value, expected by the market (the numerator of equation [2.4]) and the average change applied by the FOMC (Δ_r^T), assumed to be on average 25 bps.[16] This last assumption, could be potentially responsible for some misspecification in the methodology, as across my sample period the changes applied by the FOMC were not only of this magnitude.[17] This last assumption was, however, based on widely used industry tools that in the past decades have become the reference point of financial market actors.[18]

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[16] The probability "**p**" is capped and ranges from 0 to 1. This assumption is reasonable to make for two main reasons. First, it is common that probabilities range from 0 to 1. Second in the further step of methodology (Step 3, combining investors' expectations with the FOMC announcements) a threshold of 50% will be applied to investigate the single days' probabilities.

[17] The misspecification associated with this assumption (0.25% the standard change applied by the FOMC) is, however, limited in terms of observation. The interest rate changes applied by the FOMC, which are different from 25 bps in absolute value represent only 10% of my sample. Over a 161 FOMC announcements' sample 27 were of the magnitude of 25 bps, 13 of 50 bps, 3 of 75 bps and 118 of 0 bps (no interest rate changes).

[18] An example of these widely used tools is the "Fed Watch Tool" provided by the CME Group (www.cmegroup.com/trading/interest-rates/countdown-to-fomc.html), which releases ahead of the FOMC the probability of a Federal Fund Target rate change, computed with a similar background methodology as the one described in this chapter (www.cmegroup.com/education/demos-and-tutorials/fed-funds-futures-

To further clarify the first two steps of my methodology and demonstrate what the output probability "**p**" looks like in practice, I show, in Figure 2.1, 4 examples of FOMC announcements: two interest rate changes (an interest rate cut in Panel A, and an interest rate hike in Panel B) and two FOMC announcements where the level of interest rates remained unchanged (Panel C and D). Along with the estimated probabilities (the grey line), I plot the expected Federal Target rate *after* the FOMC announcement (orange line), computed as in equation [2.2], and the current level of Federal Fund Target rate (blue line).

probability-tree-calculator.html. Bloomberg also offers a similar tool under the terminal function "WIRP". Both tools have been recently acknowledged by the FED in the "FEDS notes" of September 2019, after the 25 bps interest rate cut (www.federalreserve.gov/econres/notes/feds-notes/new-way-to-visualize-the-evolution-of-monetary-policy-expectations-20190920.htm).

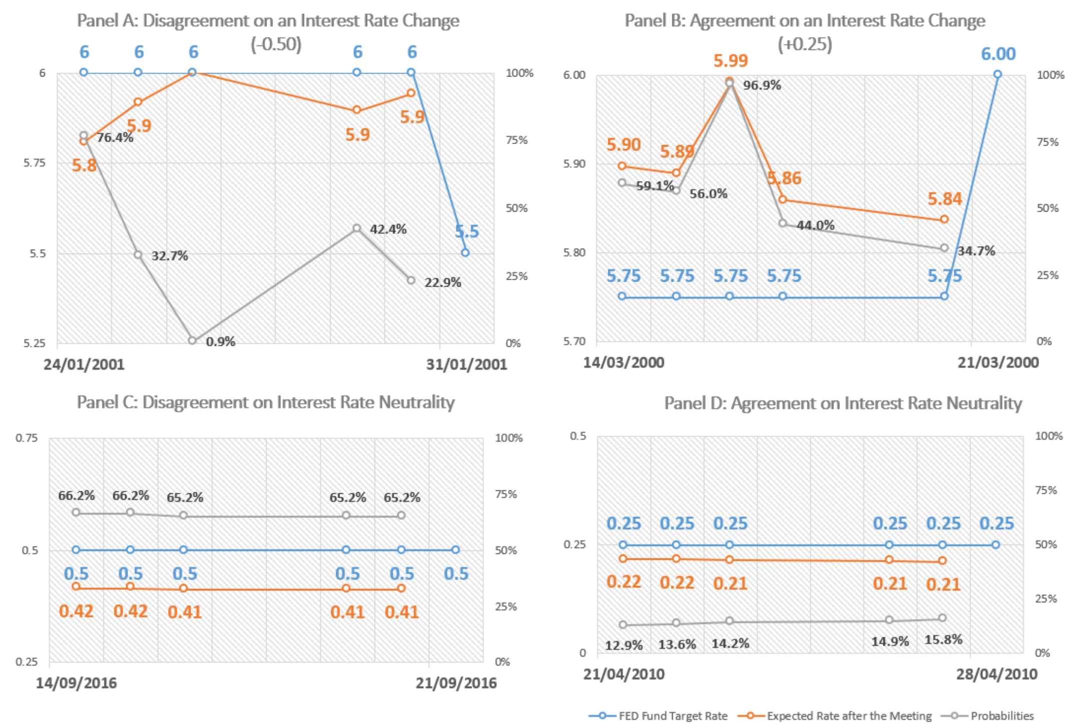

Figure 2.1: Expected FED Funds Target Interest Rate *after* FOMC announcement
The figure plots the Federal Funds Target Interest rate, the Expected Federal Funds Target Interest rate after the FOMC announcement and the related probabilities of a change in the Federal Funds Target Interest rate. There are four cases presented in the figure. Panel A presents the a case in which the market didn't expect a change in Federal Fund Target rate, conversely Panel B presents the case of an expected change. Panel C and B both present two cases where the level of the Federal Fund Target rate was left unchanged, and investors expect a change and didn't expect a change respectively.
Source: Federal Reserve Website, www.federalreserve.gov, Quandl dataset.

Panel A shows an interest rate cut of 50 bps unexpected by the market; Panel B, conversely, shows an expected interest rate hike of 25 bps. Two important elements arise from comparing these two situations: first, investors formulate their expectations relatively in advance of the FOMC announcement; second, probabilities are quite heterogeneous even in the handful of days before the announcement. The first element allows me to make a first direct comparison with the interest rate surprise methodology of Kuttner (2001). By observing Panel A, in fact, I could have infer both by including the 5 days before the announcement and by including only the day preceding the announcement that investors were not expecting an interest rate cut. Therefore, considering the overall week before the announcement, differently from Kuttner (2001) and Bernanke & Kuttner (2005), seemed fruitless. Conversely, Panel B showed an expected interest rate hike, which couldn't have been defined or expected if it wasn't for the 5th, 4th and 3rd day before of the announcement. Panel C and D shows two FOMC announcements where the level of the Federal Fund Target rate was left unchanged. There is one common element between these two cases, investors' expectations remained constant across the week ahead of the meeting. The difference among the two cases, an interest rate changes (Panel A and B) and an unchanged interest rates (Panel C and D), could also be perhaps ascribed by the context in which this announcements were carried.[19]

2.5.2 Step 3: Combining Expectations with the FOMC announcement

Last but not least, to construct my measure of disagreement ("I_t^D"), I need to combine the market expectations, computed in Step 1 and 2 as the probabilities assigned by an investor to a Federal Fund Target rate change, with the outcome of the FOMC announcement. To put it simply, disagreement is realized when investors expect (don't expect) an interest rate change (the interest rate level to remain unchanged) and the interest rate remained unchanged (the interest level is changed). My measure of disagreement ("I_t^D") takes the form of a dummy variable that has value 1 when disagreement is realised and 0 otherwise.

[19] The context in which FOMC announcements are disclosed will be further discuss in the empirical results section (section 2.7), where other variables affecting investors' behaviour (reflected in equity prices) will be investigated.

For each of the days where the probability value is over 50% I assign a value of 1 and 0 otherwise. If across the 5 considered trading days the majority of the days (3 days out 5) investors expect an interest rate change (the probability value is over 50%), I postulate that investors expect an interest rate change. In the case in which investors expect (don't expect) and interest rate change and the change doesn't (does) occur, disagreement is realised and my dummy variable ("I_t^D") takes value of 1. Conversely, my variable will take the value of 0, if investors expect (don't expect) an interest rate change and the FOMC changes (leaves unchanged) the level of the interest rate.

2.5.3 A Comparison with the "Kuttner (2001) Surprise"

As explained in the two previous sections (2.5.1 and 2.5.2), the methodology of Kuttner (2001) represents the ground methodology to infer first the Federal Fund Target rate level that investors expect to be declared during the FOMC announcement and second to compute the probability associated with expected Federal Fund Target rate. Two natural questions can arise from the previous analysis: the first is how my methodology differs from Kuttner's (2001) methodology and, second, what my variable captures that wasn't already captured by the "Kuttner Surprise"[20]. This discussion clarifies the purpose of extending a long-lasting methodology and also describes part of this chapter's contribution. To answer this question, I will refer to both the methodology of Kuttner (2001) and the results of Bernanke & Kuttner (2005) that successfully estimated the impact of the "Kuttner Surprise" on equity indexes. First, the initial purpose of the Kuttner (2001) methodology

[20] The term "Kuttner Surprise" and "Kuttner (2001) Surprise" are referring to the same methodology and will be used interchangeably throughout the document.

was to disentangle the expected from the unexpected component of a Federal Fund Target rate change across all the "potential interest rate changes".[21] The analysis employed by Bernanke & Kuttner (2005) was carried across all the FOMC announcement and identifies the response of the equity index to an unexpected component of the Federal Fund Target rate.

The purpose of my methodology is to investigate whether investors disagree (agree) with the Federal Target rate declared by the FOMC during the announcement. To do so, instead of disentangling the expected from unexpected component of a Federal Fund Target rate change, I estimate the Federal Fund Target rate that investors expect to be declared during the FOMC announcement. My purpose is to identify specifics FOMC announcements where the disagreement is realised and identify the equity index response to it. Identifying specific FOMC announcements allows me to contribute two additional elements with respect to the "Kuttner Surprise".

A second important difference with the "Kuttner Surprise" is the time frame considered in the analysis. Kuttner (2001) considers the variation in the Federal Fund Futures the day before the FOMC announcements, whereas my methodology to build a comprehensive analysis of investors' expectations includes the overall "blackout period" ahead of the FOMC announcement. This difference is heterogeneously relevant across my sample. In Figure 2.1 presented in the previous section (2.5.1) this is evident in Panel B, where the probabilities are heterogeneous across the week and less relevant in Panel C and D.

[21] I refer to "potential interest rate changes" because prior to 1994, the interest rate changes were unscheduled and investors needed to "infer" the change from interest rate movements.

The results of Lucca & Moench (2015) also report that the “Kuttner Surprise” is not a valuable explanation for the equity excess return associated with the FOMC announcement. The empirical analysis carried by Bernanke & Kuttner (2005) and Lucca & Moench (2005) are hard to compare, even though they both report an equity excess return associated with FOMC announcements. My methodology proposes a bridge between the two and allows me to partially include the analysis of Bernanke & Kuttner (2005) when investigating specific FOMC announcements.

2.6 Empirical Research Design

In this section, I present the data used in my research and the empirical methodology followed to test my hypothesis. The data and sample description will first include a description of my FOMC announcements sample, second the distribution of my disagreement measure across the FOMC announcements and lastly the equity data. The empirical methodology will include a description of the model and the settings in which I am testing my hypothesis.

2.6.1 Data and Sample Description

My sample period covers from 2000 to 2016 and includes 161 FOMC announcements. The selected time period was chosen based on the FED communication policy developments of the last two decades, as discussed in section 2.4. I retrieve data on the FOMC meeting dates and the related committee decisions from the Federal Reserve Website (www.federalreserve.gov). My sample, differently from Lucca & Moench (2015) includes both pre-scheduled meetings and conference calls held by the FOMC.[22] Table 2.1 presents the FOMC sample employed in my analysis. Column (1) presents the total number of announcements made by the FOMC, further split into Pre-Scheduled Announcements (column (2)) and Conference Calls (column (3)). Column (4) presents the FOMC announcements (including both pre-scheduled meetings and conference calls) where the Federal Target rate were maintained constant and column (5) presents the FOMC announcements where the FOMC voted a change in the level of the Federal Target rate.

By observing Table 2.1 a few elements can be immediately spotted: first the pre-scheduled meetings are a fixed number (8 meetings per year), whereas conference calls vary across the sample and are also much less frequent. Particularly in the first half of the sample, conference calls are less than an average frequency. Conference calls are included in my analysis[23] to account for the fact that during some of these events the Federal Target rate was changed, which is a relevant component of my analysis[24].

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[22] The emergency meeting held by the FOMC on 17th September in response to the terrorist attacks of the 11th September 2001 was excluded.

[23] Including conference calls in the analysis is in contrast with the seminal research on FOMC announcements of Lucca & Moench (2015)

[24] Out of 25 Conference Calls in 4 occasions an Federal Fund Target rate change was voted. Specifically, 2 occured in 2001 (03/01/2001 and 18/04/2001) and where of the magnitude of 50 bps. The remaining 2 occured in 2008 (21/01/2008 and 07/10/2008) and where of the magnitude of 75 and 50 bps, respectively.

Table 2.1: FOMC Announcements (2000–2016)					
Years	FOMC Announcements (1)	Pre-Scheduled Announcements (2)	Conference Calls (3)	Announcements with NO interest rate changes (4)	Announcements with interest Rate Change (5)
2000	8	8	0	6	2
2001	11	8	3	1	10
2002	8	8	0	7	1
2003	12	8	4	11	1
2004	8	8	0	3	5
2005	8	8	0	0	8
2006	8	8	0	4	4
2007	11	8	3	8	3
2008	14	8	6	7	7
2009	11	8	3	11	0
2010	10	8	2	10	0
2011	10	8	2	10	0
2012	8	8	0	8	0
2013	9	8	1	9	0
2014	9	8	1	9	0
2015	8	8	0	7	1
2016	8	8	0	7	1
Total	161	136	25	118	43

Note: The table presents the FOMC announcements sample employed in the analysis. Column (1) presents the number of all the "FOMC announcements" per year throughout the sample periods, inclusive of pre-scheduled and conference calls.
Columns (2) and (3) split the number of FOMC announcements presented in column (1) between "Pre-Scheduled Announcements" and "Conference Calls". The "Pre-Scheduled Announcements" are analogous to the FOMC announcements employed by Lucca & Moench (2015). Columns (4) and (5) split the sample of "FOMC Announcements" between announcements where the Federal Fund Target Rate remained unchanged ("Announcements with NO interest rate changes") and announcements where the Federal Fund Target Rate was changed ("Announcements with Interest Rate Change") respectively.
Sources: The Federal Reserve website, www.federalreserve.gov

To construct my measure of disagreement, I employ the Effective Federal Funds rates and the Federal Funds Rate Future prices. The Effective Federal Funds rates are obtained from the Federal Reserve Bank of New York (apps.newyorkfed.org) website. The daily data on Federal Funds Rate Future prices are from the Quandl Database (www.quandl.com). After computing my disagreement variable I have identified 59 meetings where the investors disagree with the FOMC meeting decisions. Table 2.2 presents the distribution of the "disagreement" and "agreement" dummy variables for both the pre-scheduled FOMC announcements (Panel A) and the conference calls (Panel B). As mentioned, the disagreement dummy variable doesn't represent the majority of the sample, but it's homogenously distributed across the sample, with the exception of the pre-scheduled meetings in 2014 (Panel A). Interestingly, the disagreement dummy variable doesn't represent the majority of "events" despite the fact that conference calls are not pre-scheduled and might therefore carry an unexpected announcement.

Table 2.2: Disagreement Dummy Variable Distribution

Panel A: Pre-Scheduled Meetings				Panel B: Conference Calls			
	(1)	(2)	(3)		(1)	(2)	(3)
Years	N	$I_t^D = 0$	$I_t^D = 1$	Years	N	$I_t^D = 0$	$I_t^D = 1$
2000	8	7	1	2000	0	0	0
2001	8	5	3	2001	3	0	3
2002	8	7	1	2002	0	0	0
2003	8	7	1	2003	4	4	0
2004	8	7	1	2004	0	0	0
2005	8	4	4	2005	0	0	0
2006	8	7	1	2006	0	0	0
2007	8	7	1	2007	3	1	2
2008	8	7	1	2008	6	3	3
2009	8	7	1	2009	3	2	1
2010	8	7	1	2010	2	2	0
2011	8	2	6	2011	2	0	2
2012	8	6	2	2012	0	0	0
2013	8	3	5	2013	1	0	1
2014	8	0	8	2014	1	0	1
2015	8	4	4	2015	0	0	0
2016	8	3	5	2016	0	0	0
Total	136	90	46	Total	25	12	13

Note: The table presents the distribution of my "disagreement" dummy variable for all the pre-scheduled meetings and conference calls held by the FOMC from 2000 till 2016. Panel A presents the data related to the pre-scheduled meetings, which are 8 per year throughout the sample and as established by the FOMC (column (1), "N"). Column (2) and (3) present the distribution of my "disagreement" dummy variable (column (3)) by comparing it to the agreement dummy variable (column (2)). The "agreement" dummy variable takes the value of 1 when the disagreement variable takes the value of 0 and vice versa. Panel B presents the data

Continued Table 2.2

for the conference calls held by the FOMC throughout the sample period 2000–2016 Differently from the pre-scheduled meetings the number of conference calls per year varies across the sample (column (1), "N"). Column (2) and Column (3) presents the distribution of the "agreement" and "disagreement" variables respectively.
Sources: The Federal Reserve website, www.federalreserve.gov, Quandl Dataset.

To analyse the impact on equity returns I compute the daily returns around the FOMC announcements included in the analysis, employing the CRSP Value-Weighted Index from the Wharton Dataset. For my empirical analysis, the equity returns are computed with the CRSP Value-Weighted Index. The data are retrieved from the CRSP dataset on the Wharton Dataset. The daily return (H_t) is computed as:

$$H_t = log\ (P_t / P_{t-1})*100 \qquad [\ 2.5\ ]$$

Where P_t is the CRSP Value-Weighted Index adjusted closing price at time "t" (the FOMC announcement date) and P_{t-1} is the CRSP Value-Weighted Index adjusted closing price the day before. The summary statistics for the market returns are presented in Table 2.3. The summary statistics reported in Table 2.3 presents the average daily returns of the CRSP Value–Weighted Index for all the FOMC announcements ("All FOMC", column (1)), in comparison to all the other days included in the sample period ("All NON FOMC", column (4)). In line with findings on macroeconomic announcements (Savor & Wilson, 2013; Ai & Bansal, 2018), FOMC announcement days are associated with substantially higher returns than non-announcement days.

Table 2.3: Summary Statistics of Equity Returns (CRSP Value-Weighted Index) with Respect to FOMC Meeting Days

	(1) All FOMC	(2) FOMC $I_t^D = 1$	(3) FOMC $I_t^D = 0$	(4) All NON FOMC
N	161	59	102	3998
µ	0.326	0.424	0.270	0.007
Σ	2.032	2.079	2.018	1.221
Median	0.209	0.113	0.307	0.045
Min	-5.818	-2.921	-5.818	-9.005
Max	5.099	5.045	5.099	11.513
Sk	0.043	0.991	-0.451	-0.012
K	3.358	1.843	4.103	8.676

Note: The table presents the summary statistics for the equity returns around "All FOMC" announcements in column (1), the FOMC announcements where disagreement is observed in column (2) ("FOMC $I_t^D = 1$"), the FOMC announcements where agreement is observed in column (3) (("FOMC $I_t^D = 0$") and the average return for all the other days included in the sample period in column (4) ("All NON FOMC"). The summary statistics presented for each sample of equity returns are the number of days considered ("N"), the simple average ("µ"), the variance ("Σ"), the median ("Median"), the minimum value ("Min"), the maximum value ("Max"), the skewness ("Sk") and the kurtosis ("K").
Sources: The Federal Reserve website (www.federalreserve.gov), CRSP Dataset, Wharton Database.

The average return on FOMC announcement days is 32 bps, whereas the returns on all the other days have an average return closer to zero. Columns (2) and (3) report the summary statistics of the equity returns around the FOMC announcements where disagreement is observed ("FOMC $I_t^D = 1$") and when agreement is observed ("FOMC $I_t^D = 0$"). Notably the average return on disagreement day is the highest, with an average return of 43 bps, followed by the overall FOMC announcements ("All FOMC") and the average returns when agreement is observed ("FOMC $I_t^D = 0$"). Considering the difference in the magnitude of average returns between FOMC announcements days and non-announcement days, I report the summary statistics per year in Table 2.4.

Table 2.4: Summary Statistics per year (2000–2016)- CRSP Value-Weighted Index											
Panel A: FOMC Announcements						Panel B: Non-Announcements					
	(1)	(2)	(3)	(4)	(5)		(1)	(2)	(3)	(4)	(5)
Year	N	μ	Max	Min	Σ	Year	N	μ	Max	Min	Σ
2000	8	0.261	2.477	-1.323	1.319	2000	242	-0.058	4.716	-5.939	1.987
2001	11	0.593	5.046	-2.427	4.871	2001	234	-0.062	4.391	-4.334	1.700
2002	8	-0.071	1.407	-2.181	1.740	2002	242	-0.093	5.752	-4.171	2.715
2003	12	0.440	1.516	-1.220	0.925	2003	240	0.082	3.553	-3.508	1.160
2004	8	0.254	1.290	-1.344	0.578	2004	239	0.035	1.622	-1.634	0.482
2005	8	-0.171	0.674	-1.011	0.414	2005	236	0.019	1.938	-1.667	0.404
2006	8	0.168	2.131	-0.639	0.775	2006	234	0.057	2.131	-1.825	0.375
2007	11	0.607	2.917	-2.524	1.847	2007	231	-0.022	2.922	-3.458	0.981
2008	14	0.216	5.099	-5.818	7.756	2008	232	-0.151	11.513	-9.005	6.407
2009	11	0.967	3.300	-1.323	2.178	2009	233	0.089	7.011	-4.861	2.708
2010	10	0.107	0.796	-0.599	2.217	2010	231	0.042	4.358	-3.866	1.305
2011	10	0.435	4.740	-2.921	4.818	2011	234	0.001	4.600	-6.667	2.088
2012	8	0.606	1.802	-0.323	0.813	2012	233	0.027	2.504	-2.475	0.624
2013	9	0.193	1.657	-1.392	1.185	2013	234	0.081	2.185	-2.503	0.445
2014	9	0.332	2.027	-1.028	0.955	2014	234	0.035	2.414	-2.296	0.509
2015	8	0.349	1.460	-1.342	0.939	2015	235	-0.018	3.910	-3.940	0.951
2016	8	-0.111	1.083	-1.089	0.531	2016	235	0.044	2.450	-3.573	0.684

Note: The table presents the summary statistics for the equity returns around "FOMC Announcements" days (Panel A) and "Non-Announcements" days (Panel B) for each year included in the sample period (2000-2016). The "FOMC Announcements" days include both pre-scheduled announcements and conference calls. The summary statistics provided for each year in both Panel A and B are: the number of considered days "N", the average return "μ", the maximum return value "max", the minim return value "min" and the variance of the returns "Σ".
Sources: The Federal Reserve website, www.federalreserve.gov, CRSP Dataset, Wharton Database.

Consistent with the findings of Kontonikas, MacDonald & Saggu (2013), the descriptive statistics are different in magnitude between pre- and post-crisis. The highest average return on FOMC announcement days is observed in 2009 (almost 1%), after a series of interest rates cuts, therefore consistent with economic theory and past findings. Similarly, during the pre-crisis period in 2005, where interest rates were consistently hiked, the FOMC announcement returns are, on average, negative. With the exception of 2005 and 2016, however FOMC announcement days show a consistently higher average return then all the other. In 2012, among the 8 pre-scheduled meetings the average return was about 60 bps, which is more in line with the magnitude found by Lucca & Moench (2015) in the 1994-2011 sample period. Conversely in 2016 the average return among the 8 pre-scheduled meetings is negative (-11 bps). Kurov, Gilbert, & Wolfe (2020) document a decline in the FOMC pre-announcement drift after the seminal paper of Lucca & Moench (2015), which is consistent with the summary statistics presented in Table 2.4.

2.6.2 Empirical Methodology

This section presents my empirical methodology to investigate the effect of my "disagreement" variable on equity returns. To investigate empirically my main hypothesis, I run the following regression model:

$$H_t = \beta_0 + \beta^D I_t^D + \beta^x X_t + \varepsilon_t \qquad [\,2.6\,]$$

The dependent variable H_t represents the 1-day return of the CRSP Value-Weighted index as computed in equation [2.5]. In the main specification, the explanatory variables are presented only by my measure of disagreement (I_t^D), which takes the form of a dummy variable and a constant term (β_0) that represents the "agreement" variable.

In additional specifications of the analysis, other control variables are included, to take into account information that might jointly affect the stock returns on the FOMC announcement days, and are denoted by the vector of controls X_t. The vector of controls includes macroeconomic and financial markets' variables following the literature.

The macroeconomic variables included are: the unemployment rate change, The National Bureau of Economic Research (NBER) variable, the "Tight Cycle" variable, the "Easy Cycle", the 12-months log change in the industrial production index and the 12-months log change in the consumer price index (CPI). The financial markets variables are the "Kuttner

Surprise", computed as in Bernanke & Kuttner (2005), and a measure of volatility represented by the level of the VIX index at the market close the day before the announcement.

The unemployment rate change is included in the analysis, following the findings of Boyd, Hu & Jagannathan (2005), which report a considerable response of the stock market to the unemployment rate monthly announcement of the Bureau of Labor Statistics. Specifically they found that bad news for unemployment normally means good news in the stock market. Further, the mandate of the FED explicitly include the objective of full employment as the second goal to be achieved after price stability. In the analysis, I include the monthly percentage change of the unemployment rate released in the announcement immediately preceding the considered FOMC announcement.[25]

The remaining listed control variables were included following the empirical analysis of Lucca & Moench (2015). The NBER dummy variable is a monthly dummy recession variable[26] that takes the value of 1 in "recession times" and zero elsewhere. The time series is an interpretation of the data provided by the NBER for the US business cycle expansion and contractions.[27]

The "Tight Cycle" and "Easy Cycle" dummy variables are two variables that I constructed considering the current level of the Federal Target rate. Specifically, the "Tight Cycle"

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[25] Summary statistics for macroeconomic variables, including the unemployment rate change, are included in Appendix A, Table A.1.

[26] The NBER dummy variable is available at a monthly frequency, on the Federal Reserve, Bank of St. Louis Economic Research dataset (Federal Reserve Economic Data, FRED, fred.stlouisfed.org/series/USREC).

[27] The distribution of the NBER dummy variable across my sample period is provided in Appendix A, Table A.2.

dummy variable takes the value of 1 during a tight monetary policy period and zero elsewhere. The cycle is considered to be “tight” when the Federal Target rate is above 2%. Conversely the “Easy Cycle” dummy variable is a variable that takes the value of 1 during an easy monetary policy period and zero elsewhere. The period is considered to be “easy” when the Federal Target rate is below 2%. I consider the 2% threshold, which is defined the equilibrium level for the Federal Target rate by the pioneer work of Taylor (1993).[28] These three variables were included to investigate whether the reaction to disagreement around the FOMC announcements is linked to the business and the monetary policy cycle. The 12-months log change of the industrial production index and of the CPI were also included following Lucca & Moench (2015).[29]

The financial markets’ variable included are the “Kuttner Surprise” as a measure of interest rate surprise, computed following the pioneer methodology of Kuttner (2001) and further employed by Bernanke & Kuttner (2005).[30] Lastly, I include a measure of volatility, represented by the level of the VIX index the day before the FOMC announcement day. All the analyses are conducted following a standard event-study approach and estimated with the OLS methodology. My analysis is carried in two specific settings, firstly including all the FOMC announcements (comprehensive of both pre-scheduled meetings and conference calls, as described in section 2.6.1) and also on the FOMC announcements

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[28] The distribution of the “Tight Cycle” and “Easy Cycle” dummy variables is included in Appendix A, Table A.3 and A.4.

[29] The 12-months log change of the Industrial production and CPI are both available on the Federal Reserve, Bank of St. Louis Economic Research dataset (Federal Reserve Economic Data, FRED, fred.stlouisfed.org). Summary statistics on the 12-months log change of the industrial production and CPI are available in Appendix A, Table A.1.

[30] Summary statistics on the “Kuttner Surprises” around FOMC announcements are provided in Appendix A, Table A.5.

where the FOMC has decided to leave the level of the Federal Target rate unchanged. This specific analysis, which I will further define as the "Neutral Monetary Policy (NMP) Analysis" is further described and explained in detail in the next subsection.

After testing empirically my hypothesis on a "general" equity index, I investigate whether the results are homogenous across less broader indexes. First, I investigate whether the response of disagreement is in line with the CAPM predictions as recent literature has found around macroeconomic announcements (Savor & Wilson, 2014; Wachter & Zhu, 2018). To do so, I employ equity returns of portfolios sorted on the betas[31] as the dependent variable of equation [2.6].

Following the findings of Bernanke & Kuttner (2005) on the Fama & French Industry portfolios, I test my main hypothesis on the Fama & French 10 Industry portfolios,[32] to investigate whether the response of disagreement is homogenous across industries. Bernanke & Kuttner (2005) found that the responses of industries was modestly in line with the industry betas and therefore perhaps in line with the CAPM predictions.

More recently, other literature findings have provided empirical evidence that the CAPM does a fairly good job in explaining equity excess returns around macroeconomic announcement days, compared to all other days. Building on these findings, I investigate

[31] The portfolios sorted on the beta are available on the CRSP, Wharton dataset; data on the returns and on the average beta are both available. Summary statistics on the portfolios are provided in Appendix A, Table A.6.

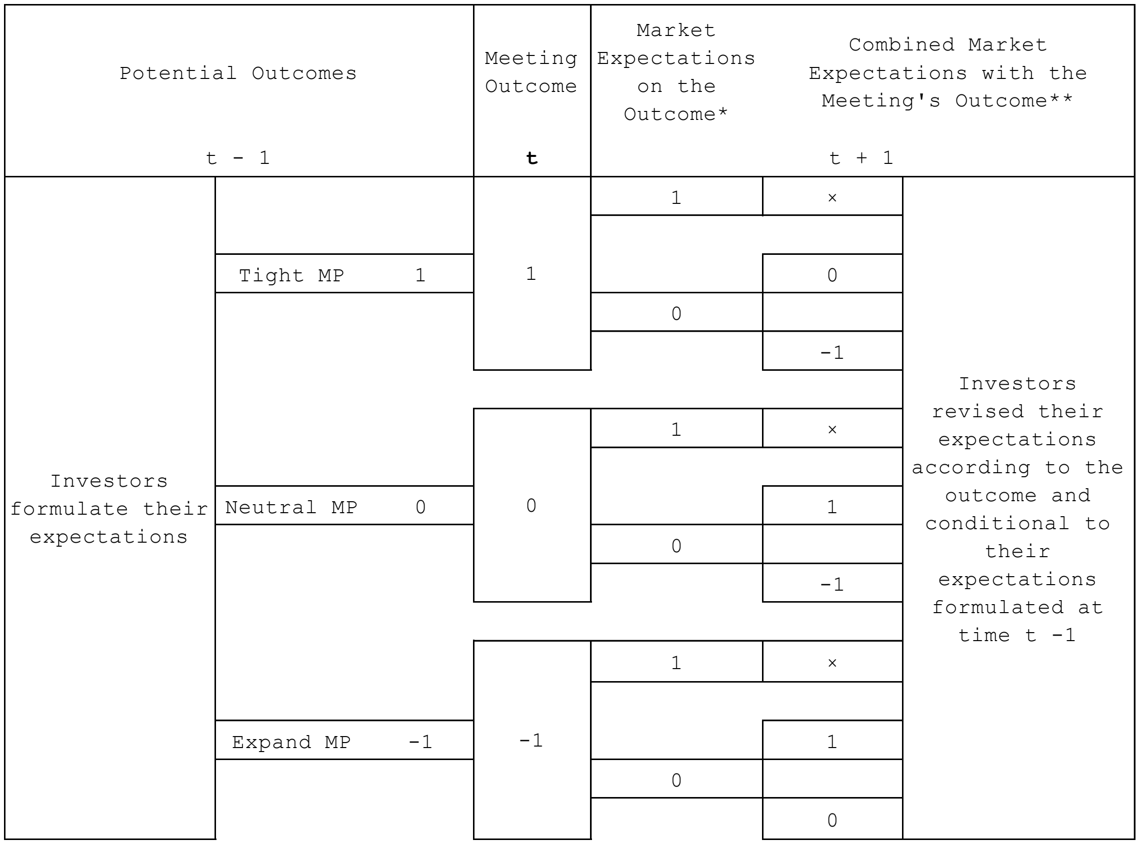
[32] The Fama & French Industry Portfolios are available from Kenneth French's webpage (mba.tuck.dartmouth.edu/pages/faculty/ken.french/). Summary statistics on the 10 Industry Portfolios are provided in Appendix A, Table A.7.

whether the response of investors to disagreement varies across equity indexes in line with the systematic risk that they bear around FOMC announcement days.

2.6.2.1 When No Action is Still an Action: The Neutral Monetary Policy Analysis (NMP)

This section presents a "special case" of my hypothesis of the "Neutral Monetary Policy Analysis" (NMP), which consists of all the FOMC announcements where the level of the Federal Fund Target rate was left unchanged. As the "information transmission literature" predicts, "no news" is still consider a signal to the market. As Tetlock (2011) shows, stale information still affects stock prices. But, are NMP FOMC announcements a "no news"? As showed by the recent literature on "information shocks" (Gertler & Karadi, 2015; Altavilla et al., 2019; Jarocinski & Karadi, 2020), FOMC announcements convey a large amount of information on the future economic outlook, which are as influential as the information regarding the level of the Federal Fund Target rate.

My claim is that NMP FOMC announcements carry an additional level of uncertainty with respect to the general FOMC announcements, particularly when investors disagree with it, due to the asymmetric component of investors' interpretations. Furthermore, investors' interpretations are not only built once the FOMC has disclosed their decision to leave the level of interest rates unchanged and the economic outlook, but also in advance when they "weight" the potential outcomes of the announcement. The reasoning behind this is summarised in Figure 2.2.



* 1 = market agrees, 0= market disagrees

**0 = market disagrees and expected neutrality, -1= market disagrees and expected a cut, 1=market disagrees and expected a hike, x = market agrees, therefore no other scenarios are in place

Figure 2.2: Monetary Policy Outcome and Market Opinions
Figure 2.2 displays, the link between FOMC meeting outcomes and investors' opinions regarding it. At t-1 investors are aware of the potential outcomes, tight monetary policy (1), expansionary monetary policy (-1) and neutrality (0). Between t-1 and t, investors formulate their opinions on the possible outcomes. At time t (the meeting date) the outcome is public. When combining market opinions with the outcomes there are two additional paths to consider, market agreement (1) and market disagreement (0). When the market agrees, we expect the reaction of the meeting to be embedded already in stock prices, therefore the node closes (x). If the market disagrees, there are two further paths to consider, related to the outcome that the market actually expected at t-1. The further market reaction is in fact based on market interpretation of the outcome at time t, conditional to expectations formulated at time t-1.

As shown in Figure 2.2, at time t-1 investors are aware of the potential outcomes, tight monetary policy (1), expansionary monetary policy (-1) and neutrality (0). The likelihood of occurrence of three possible FOMC decisions is, however, rationally distributed only on two possible combinations: a hike and neutrality, or a cut and neutrality. This assumption is based on the fact that the probability of the outcome is based also on the current state of the economy. In other words, it is highly unlikely that within the same meeting both an interest rate hike and an interest rate cut could be expected. Between time t–1 and t (the meeting date), investors formulate their opinions on the possible outcomes. At time t the outcome is public.

When combining market opinions with the outcomes there are two additional paths to consider, market agreement (1) and market disagreement (0). When the market agrees, we expect the reaction to the announcement to be embedded already in stock prices, therefore the node closes (x). If the market agrees with the outcome of the meeting the impact should be close to irrelevant, according to the Efficient Market Hypothesis (EMH), as the expectations of the market should be already embedded in the stock prices.

If the market disagrees, there are two further paths to consider, conditional to the expectations formulated at time t–1. When the FOMC committee votes an interest rate hike and the market disagrees, the alternative is that the market hoped for neutrality. Similarly, if an interest rate cut is voted, the alternative is that the market hoped for neutrality. When the market disagrees with an interest rate hike, potentially it considers the economy not yet enough "strong" to absorb less favourable debt conditions. Similarly, an "unwanted" interest rate cut could be interpreted as a current worse economic condition than expected. The first case can be positively interpreted as a better current economic condition, although worsening in the future. The second case is a worse current economic condition but a more positive forward-looking scenario. Regardless of which one is the case, both send a signal to the market on the current state of the economy and resolve the question: "When is the central bank going to change the level of interest rates?"

Conversely, disagreement on neutrality leaves investors with an additional level of uncertainty. Investors will, in fact, not only question the current and future state of the economy but also debate on when the central bank will change the level of interest rates. If the market disagrees with neutrality, two cases have to be considered. If the market was expecting an interest rate hike, and the FOMC votes for neutrality, it could be interpreted as a bad signal. In other words, the economy is not yet strong enough to absorb an interest rate hike, therefore the current situation is worse than expected and a future hike will mean even worse conditions for stock prices expected in the future. If the market was expecting a cut, but neutrality is voted, it might be considered that the current economy condition is better than expected.

To summarise, my prediction is that around FOMC announcements where the level of the Federal Fund Target rate is unchanged the equity response might differ from the other cases and be either higher or lower. From a theoretical perspective, as the level of the Federal Fund Target rate is unchanged the equity response should be driven by the economic outlook disclosed during the FOMC announcement. According to the macroeconomic announcements' literature announcements (Savor & Wilson, 2013; Ai & Bansal, 2018), the equity premium should be still higher the on "ordinary" trading days. Bernanke & Kuttner (2005) also find that "no rate change" in the interest rate is positively associated with equity returns,[33] offering as explanation that the failure to move at any specific FOMC meeting may be viewed as postponing the inevitable, which is partially in line with the additional uncertainty that I attribute to these announcements.

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[33] See Table IV in section D in Bernanke & Kuttner (2005)

To investigate this prediction, I estimate the model presented in equation [2.6] only on the FOMC announcement where the level of the Federal Fund Target rate remains unchanged, although there is an important aspect that needs to be considered in the context of my sample period (2000–2016). My sample period encompasses the so-called “zero lower–bound” period after the financial crisis (2009–2015), on top of the shortest post-crisis period (2002–2003). These two periods are also partially included in Lucca & Moench’s (2015) sample period, although the don’t attribute to the content of the announcement a potential driver of the equity premium.

Figure 2.3 shows the yearly sum of equity premium realised around FOMC announcement days included in my sample period, which both includes pre-scheduled meetings and conference calls. This figure shows the overall premium realised around all the FOMC announcements (yellow bars) and the premium realised only around the NMP FOMC announcements.[34]

[34] The entire distribution per year of the NMP FOMC announcements can be found in Table 2.1 (column 4), and shows that the concentration of NMP FOMC announcements fells in the post crisis periods. In particular, out of the 118 NMP FOMC announcements 75 occurred between 2002-2003 (18 of 75) and 2009-2014 (57 of 75).

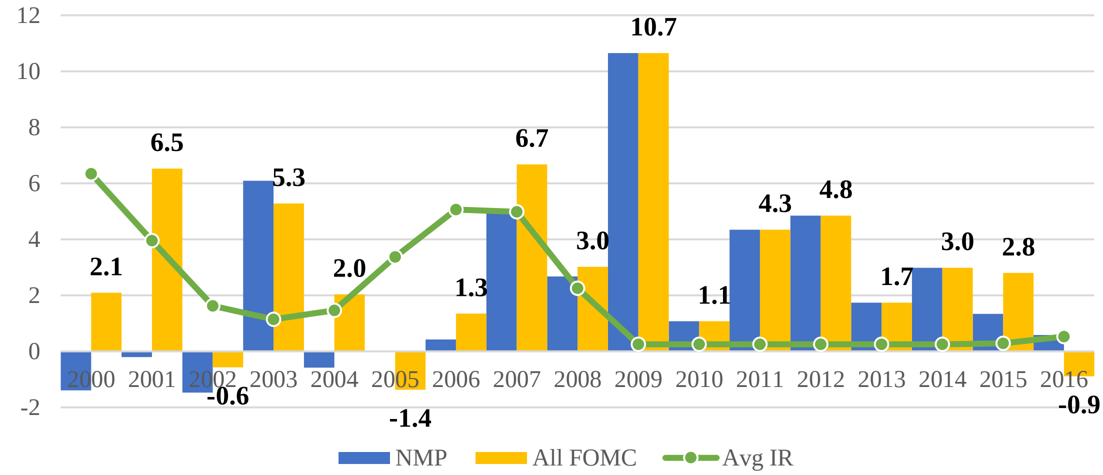

Figure 2.3: Distribution of the equity return across FOMC announcements
The graph presents the yearly cumulated returns around the FOMC announcements in my sample (2000-2016), including both pre-scheduled meetings and conference calls. The cumulated returns are computed with the 1-day return (equation [2.5]) of the CRSP Value-Weighted index. The blue bars represent the cumulated returns around FOMC where the level of the Federal Fund Target rate was left unchanged, whereas the yellow bars represent the cumulated returns across all the FOMC announcements. The data label indicates the overall cumulated returns across all the FOMC announcements. The green line describes the average Federal Fund Target rate path across my sample period.
Sources: The Federal Reserve website, www.federalreserve.gov, CRSP-Wharton Database

The blue bars represent the cumulated contribution of the NMP returns to the overall FOMC cumulated returns. Obviously, the frequency of NMP FOMC announcements determines the amount of returns associated with them. Within the post-2008 financial crisis period, notably in 2003 (also a post-crisis period) the overall positive cumulated returns are entirely made by the NMP FOMC announcement. Only one Target rate change was voted in 2003 and resulted in a negative return of 80 bps.

The proportion of NMP FOMC announcements is an important element to further interpret the empirical results related to this section. As previously mentioned and consistent with literature findings (Kurov, 2010; 2012) investors' beliefs around economic uncertainty change. Kurov (2010; 2012) claims, in fact, that the reaction to FOMC statements is state dependent and linked to forward-looking guidance of the FOMC. Kontonikas, MacDonald & Saggu (2013) also claim that the response of the market to FOMC announcements has become increasingly asymmetric during the 2008 financial crisis.

More recently, Sinha (2015) found compelling evidence that around 2012-2013 the FOMC statements that extended the zero-lower bound regime were found to increase the ex-ante uncertainty for the ten-year Treasury yield at the 30–90 day horizon. The explanation provided, in line with my previous statement, focuses on the fact that investors might have interpreted this statement as indicating a worse economic situation then expected.

2.7 Empirical Results

In this section, I present the results of the hypothesis postulated in section 2.3, following the empirical methodology outlined in section 2.6.2. First, I present the results related to my first main hypothesis, on whether "disagreement" affects equity returns around FOMC announcements. Further to this, several other empirical analyses are conducted to provide a plausible explanation for the main result and reconcile it with past findings in the literature.

2.7.1 Main Results

Table 2.5 reports the results related to the main specification of the empirical methodology presented in section 2.6.2 in equation [2.6]. The results, in line with expectations, report an additional equity premium associated with FOMC announcements where "disagreement" is realised. Furthermore, the "Constant" in my regression represents all the FOMC announcements where investors "agree" with the decision taken by the FOMC.

Table 2.5: Main Results	
I_t^D	0.423**
	(0.186)
Constant	0.268*
	(0.141)
Obsv (# FOMC meetings)	161
R^2	0.053

Note: This table presents the results for the dummy regression analysis presented in equation [2.6], excluding the vector of controls X_t. The dependent variable is represented by the daily returns on the CRSP Value–Weighted Index, computed as presented in equation [2.5]. The dummy variable (I_t^D) is computed following the methodology outlined in section 2.5. The constant represents the events where investors agree with the decision of the FOMC. The event study encompasses the 2000–2016 period and includes 161 FOMC meetings. Standard Errors are reported in brackets.
Signif. codes: '***' 0.01 '**' 0.05 '*' 0.1.
Source: Federal Reserve website, www.federalreserve.gov, Quandl dataset, Wharton-CRSP Database, US Labor Statistics websites.

My findings indicate that the FOMC decisions, which show a marked dissimilarity with investors' expectations have a significant (at 5%) and economically important excess return of 42 bps on the announcement day. The remaining events, where investors "agree" with the FOMC decisions (represented by the Constant in Table 2.5) are mildly significant (at 10%) at represent a smaller excess return of almost 27 bps. All together the results point out that, even though FOMC announcement as whole carry an important equity premium compared to non announcement days (the average non-announcement equity return is around 1bps as reported in Table 2.3), this equity premium differs across events according to expectations of investors.

The return pre-announcement drift of Lucca & Moench (2015) was reported to be around 50 bps, although the more recent findings of Kurov, Gilbert & Wolfe (2020) demonstrate that the equity premium associated with the FOMC has considerably reduced and is closer to 30 bps.[35] My findings place themeselves in the middle of these two results but they provide an additional explanation to the FOMC equity.

What my variable captures is the resolution of the uncertainty ahead of the FOMC announcements and the realisation of investors' expectations once the announcement is disclosed. Kurov, Gilbert & Wolfe (2020) claim that as investors become more accurate in estimating the next move of the FOMC and as the communication policy of central banks improves, the equity premium associated with these announcement is reduced. This last finding is consistent with the results related to the FOMC announcements where investors agree with the FOMC. In line with Kurov, Gilbert & Wolfe (2020) interpretation, FOMC announcements where perhaps investors have been more accurate in predicting the FOMC actions carried a smaller equity premium compared to the others.

My result shows that there is still room for improvement as there is still a considerable amount of uncertainty surroundings these days, that still "produces" a considerable equity premium. Nontheless, these result also highlight the progress of central banks' communication and the reduction of uncertainty, as the announcements where disagreement is realised represent only 37% of the sample.

2.7.2 Persistence

The analysis presented in the previous section (2.7.1), similar to the analysis provided by Lucca & Moench (2015), assumes that the equity returns should not be reversed on subsequent days and further are not offset by statistically significant negative returns on

[35] The analysis was also carried out on other broad equity indexes and yielded similar results. The results can be found in Appendix A, Table A.8, Panel A.

the day before, that partially also includes the pre-announcement FOMC returns. Table 2.6 summarises the results for equation [2.6], where the dependent variable is represented by the daily returns on the CRSP Value Equity Index the day before and the subsequent 3 days after the FOMC announcement day.

The results show that the variable is not statistically significant on the day before and the days after the FOMC announcement day, consistent with expectations and the past literature (Lucca & Moench, 2015). This result corroborates the findings that the additional equity returns on my "disagreement" variable are not reverse in other days around the FOMC announcement day.

Table 2.6: Persistency

Days	Const.		I_t^D		Obsv
-1	0.026	(0.161)	-0.108	(0.222)	
0	0.268^{*}	(0.141)	0.423^{**}	(0.186)	
+1	-0.033	(0.157)	-0.005	(0.216)	161
+2	-0.091	(0.131)	-0.037	(0.180)	
+3	0.041	(0.136)	0.066	(0.186)	

Note: This table reports results for the main specification of my analysis (equation [2.6]) for the returns on the CRSP Value-Weighted Index on the day prior and on the 3 days after the FOMC meeting dates. The sample ranges (2000–2016) are analogous to the main analysis. The day "0" represents the FOMC meeting date (the result presented in Table 2.5). The regression includes my "disagreement" measure (I_t^D) and a constant term. Standard Errors are presented in brackets.
Signif. codes: '***' 0.01 '**' 0.05 '*' 0.1.
Source: Federal Reserve website, www.federalreserve.gov, Quandl dataset, Wharton - CRSP Database, US Labor Statistics websites.

An important element needs to be acknowledged to correctly interpret this test. The daily stock returns are computed as shown in equation [2.5], and therefore partially include the pre-FOMC announcement drift in stock returns of Lucca & Moench (2015). The pre-announcement stock drift is, in fact, computed including the returns from 2 pm on the day before the FOMC announcement day and 2 pm on the announcement day, excluding the outcome of the meeting. My result (denoted in Table 2.6 as day "0") partially include this "pre-drift", although this is in line with my analysis, as Lucca & Moench (2015) acknowledge that this drift can be due to the resolution of uncertainty and the economic outlook that will be released on the announcement.

2.7.3 Time series analysis of the FOMC announcements

The literature provides different explanations for FOMC announcement equity returns, such as the surprise component of the interest rate changes (Ehrmann & Fratzscher, 2004; Bernanke & Kuttner, 2005; Fausch & Sigonius, 2018), the information content on the future economic outlook and realization of uncertainty (Savor & Wilson, 2013; Lucca & Moench, 2015, Ai & Bansal, 2018) and to the current state of the economy (Kontonikas, MacDonald & Saggu, 2013). In section 2.7.1, I provided empirical evidence that FOMC announcements, where disagreement is observed, are responsible for a considerable amount of the equity excess return attributed to these events. In this section I also include a series of control variables to investigate additional factors that might contribute to the result. The control variables included in the analysis (representing the vector of controls X_t in equation [2.6]) are constructed as described in detail in section 2.6.2 and include both macroeconomic and financial markets variables.

The macroeconomic variables included are: the unemployment rate change (υ_{Δ}), the NBER dummy variable (NBER), the "Tight Cycle" variable (Tight C.), the "Easy Cycle" (Easy C.), the 12-months change in the industrial production index (Δ^{12} Log (IP)) and the 12-

months change in the CPI index (Δ^{12} Log (CPI)).[36] The financial markets' variables are Kuttner Surprise (Kuttner S.), computed as in Bernanke & Kuttner (2005) and a measure of volatility represented by the level of the VIX index at the market close the day before the announcement (Vol $_{t-1}$).[37]

The results are presented in Table 2.7 and also include interaction terms between the above-mentioned variables and my measure of "disagreement". My measure of "disagreement" remains positive and statistically significant in most cases, with the only exception represented by the regression that includes the VIX index (Vol $_{t-1}$). Nonetheless the interaction variables between my "disagreement" variable and the VIX index is positive and statistically significant. This result can be ascribed to the additional volatility that might be present in the market due to the realised "disagreement" between market actors and the FOMC. The effect of volatility and volume will be more closely investigated in section 2.8.1.

The constant represents the "agreement" variable, and therefore the FOMC announcements where investors' expectations are aligned with FOMC decisions. These events represents the majority in my sample, nevertheless the constant is only positive and statistically

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[36] The macroeconomic variables were included following the empirical analysis of Lucca & Moench (2015).

[37] Lucca & Moench (2015) also include two additional financial market variables. The "SPX surprise" (see Lucca & Moench, 2015, section H, p. 355), which is the 2-3 pm FOMC announcement return on the S&P500 index and the moving average of the pre-FOMC returns over the past 8 meetings. The two variables aren't included in my analysis, for two different reasons. The SPX surprise is computed employing intra-day data, which are not currently available to me. The moving average of the pre-FOMC returns variable is in line with Lucca & Moench (2015) that includes all the FOMC announcements, although it is unfitted to the purpose of my analysis, that aims to investigate specific FOMC announcements which are not necessarily sequential.

significant in a handful of cases and consistently smaller in magnitude compared to the "disagreement" variable.

Among the variables included in the analysis, the interaction variable between the unemployment change and my measure of disagreement (I_t^D x υ_Δ, presented in Panel A, column (2)) is positive and statistically significant. The change in the unemployment rate is included because generally unemployment rate variations are reported closely to the FOMC announcements and it is known both in the industry and in the literature to be one of the most influential macroeconomic announcements. Boyd, Hu & Jagannathan (2005) analysed the effect of unemployment news, finding a strong positive reaction of stock returns on rising unemployment during economic expansion and a negative reaction during economic contractions. Unemployment rate announcements are particularly relevant for the US economy as the mandate of the FED explicitly includes "full employment" as the second goal to be achieved after the inflation target. A rise in unemployment during a contractionary state of the economy could potentially lead to an interest rate cut and more favourable discount rate conditions in the future. The uncertainty related to a positive change in the unemployment rate, which by construction of the variable would have been disclosed before the upcoming FOMC announcement, could be consistent with investors revising their expectations in light of macroeconomic news.

The interaction variable between the disagreement measure and the NBER dummy is negative and statistically significant. The NBER dummy, the recession variable, takes a value of 1 during recession periods and zero elsewhere. The relationship between recession and disagreement has a strong negative impact on equity returns. This result is in line with the discussion of Kurov (2010: 2012) and Kontonikas, MacDonald & Saggu (2013), who point out that during recession period traders rely on institutions to support the economy through financial markets. If investors expect to be supported by institutions and this is not the case the economic impact is negative and bigger in magnitude than the equity premium associated with the FOMC announcement itself (about 50 bps).

Another interesting result is related to the Kuttner Surprise, which I expected to be correlated with my disagreement measure as the Kuttner (2001) methodology represents the first step in building my variable. The Kuttner Surprise is per se statistically insiginificant; on the contrary, the interaction variable with my measure of "disagreement" is strongly significant and negative. The Kuttner Surprise remains therefore a valuable explanation for the equity excess returns associated with the FOMC announcements, although limited to the FOMC announcements where investors' expectations are in contrast with the FOMC decisions.

Overall, the analysis confirms that FOMC announcements where disagreement is observed are associated with a positive and significant equity return even when controlling for macroeconomic and financial market factors that might jointly affect equity returns around the announcement days. To summarise, the other three relevant results, in line with the literature, are related to the change in the unemployment rate, recession times and the Kuttner Surprise. Disagreement and a change in the unemployment rate are associated with a positive impact on equity prices, in line with the findings of Boyd, Hu & Jagannathan (2005). A negative news on unemployment during uncertainty is a positive news for stock prices, as it might lead to an interest rate cut. Second, during a time of recession, monetary policy announcements have a stronger impact on financial markets (Kontonikas, MacDonald & Saggu, 2013), particularly because investors expect support from the institutions. Lastly the Kuttner Surprise remains a valuable explanation for the equity return associated with the FOMC announcements. A positive surprise (interest rate hike) combined with the disagreement of investors in regards to the interest rate hike is associated with a negative impact on stock price of almost 40bps.

Table 2.7: Time Series Analysis of FOMC Meetings' Returns

Panel A

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
I_t^D	0.440**	0.493**	0.401**	0.508**	0.487**	0.398*	0.249	0.545
	(0.201)	(0.202)	(0.203)	(0.213)	(0.207)	(0.226)	(0.282)	(0.411)
υ_Δ	0.009	-0.053						
	(0.034)	(0.050)						
I_t^D x υ_Δ		0.119*						
		(0.069)						
NBER			0.215	0.520				
			(0.305)	(0.360)				
I_t^D x NBER				-1.083*				
				(0.649)				
Tight C.					-0.238	-0.419		
					(0.262)	(0.317)		
I_t^D x Tight C.						0.575		
						(0.565)		
Easy C.							0.238	0.419
							(0.262)	(0.317)
I_t^D x Easy C.								-0.575
								(0.565)
Const.	0.226*	0.192	0.179	0.119	0.291*	0.340**	0.053	-0.071
	(0.146)	(0.146)	(0.156)	(0.160)	(0.163)	(0.171)	(0.235)	(0.266)
Obsv.								161
R^2	0.056	0.104	0.059	0.069	0.058	0.092	0.058	0.092

Panel B

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
I_t^D	0.428**	0.416**	0.086	-0.644	0.516**	0.430*	0.470**	0.441**
	(0.198)	(0.194)	(0.326)	(0.530)	(0.210)	(0.243)	(0.193)	(0.205)
Kuttner S.	-0.079	0.048						
	(0.067)	(0.080)						
I_t^D x Kuttner S.		-0.386***						
		(0.141)						
Vol $_{t-1}$			0.016	0.003				
			(0.012)	(0.014)				
I_t^D x Vol $_{t-1}$				0.048*				
				(0.027)				
Δ^{12} Log (CPI)					-0.027	-0.041		
					(0.028)	(0.035)		

Continued Table 2.7

I_t^D x Δ^{12} Log (CPI)						0.042		
						(0.059)		
Δ^{12} Log (IP)							-0.071	-0.081
							(0.055)	(0.060)
I_t^D x Δ^{12} Log (IP)								0.064
								(0.155)
Const.	0.212	0.227	-0.157	0.145	0.339^{**}	0.375^{**}	0.269^{*}	0.269^{*}
	(0.144)	(0.141)	(0.318)	(0.360)	(0.157)	(0.166)	(0.139)	(0.139)
Obsv.								161
R^2	0.05	0.077	0.053	0.068	0.058	0.061	0.062	0.064

Note: The table presents the results of the regressions described in equation [2.6], including the vector of controls X_t. The variables included in the analysis are both macroeconomic and financial market variables. Panel A presents the analysis that includes: the unemployment rate change (υ_Δ), the NBER dummy variable (NBER), the "Tight Cycle" variable (Tight C.), the "Easy Cycle" (Easy C.) and interaction variables between my measure of disagreement (I_t^D) and the control variables (I_t^D x υ_Δ, I_t^D x NBER, I_t^D x Tight C. and I_t^D x Easy C.). Panel B presents the analysis that includes: the Kuttner Surprise (Kuttner S.), the volatility level the day before the announcement, represented by the level of the VIX index at the market close the day before the announcement (Vol $_{t-1}$), the 12-months log change in the industrial production index (Δ^{12} Log (IP)) and the 12-months log change in the CPI index (Δ^{12} Log (CPI))[38], and interaction variables between my measure of disagreement (I_t^D) and the control variables (I_t^D x Kuttner S., I_t^D x Vol $_{t-1}$, I_t^D x Δ^{12} Log (CPI), I_t^D x Δ^{12} Log (IP)). The dependent variable, H_t, is represented by the 1-day return of the CRSP Value–Weighted Index computed as presented in equation [2.5]. Standard Errors are presented in brackets. The sample period is (2000–2016).

Signif. codes: '***' 0.01 '**' 0.05 '*' 0.1 .

Source: Federal Reserve website, www.federalreserve.gov, Quandl dataset, Wharton-CRSP Database, Federal Reserve Bank of St.Louis-Economic Research website, fred.stlouisfed.org

2.7.4 The Neutral Monetary Policy (NMP) Analysis

As discussed in subsection 2.6.2.1 there are a number of reason for which exploring separately the FOMC announcements where interest rates were left unchanged is in line with the purpose of this chapter. In a nutshell, NMP FOMC announcements give me the chance to study the impact of the FOMC statements aside from the economic impact of

[38] The macroeconomic variables were included following the empirical analysis of Lucca & Moench (2015).

changes in interest rates. The response to NMP FOMC announcements should therefore revolve around the economic outlook normally disclosed by the FOMC in the form of forward-guidance to the public.

As previously clarified, these announcements, might reflect an additional level of uncertainty, experienced by investors, because of their non-decisional aspect. Sinha (2015) reports this additional uncertainty during the zero-lower bound period (2012-2013), which was reflected in the 10-year short term treasury yield. Bernanke & Kuttner (2005) report a positive effect of "no change" in interest rates, explaining that the market was mildly responding to "inactions" and interpreting them as "postponing the inevitable".

A drawback of this analysis is related to when these FOMC announcements normally take place. As previously discussed, the NMP FOMC announcements are mostly concentrated right after crisis periods including, therefore, a state dependent element. The results of Kurov (2012) and Kontonikas, MacDonald & Saggu (2013) report, in fact, that the response to monetary policy statements and monetary policy surprises is strongly affected by the business cycle. These last elements of the discussion should therefore be taken into consideration when interpreting the results related to this sub-sample of FOMC announcements.

In Table 2.8, I report the results related to NMP FOMC announcements, which display a higher magnitude and statistical significance of the equity premium, compared to the main results in Table 2.5, associated with disagreements around these announcements.[39] These

[39] The analysis was also carried out on other broad equity indexes and yielded similar results. The results can be found in Appendix A, Table A.8, Panel B.

result is in line with the expectations and confirms a higher degree of uncertainty around these announcements.[40] The constant, representing the "agreement" variable remains mildly significance and considerably smaller also in this case.

Table 2.8: NMP Analysis (2000–2016)

I_t^D	0.495*** (0.184)
Const.	0.245* (0.133)
Obsv.	118
R^2	0.082

Note: This table presents the results for the dummy regression analysis presented in equation [2.6]. The dependent variable is represented by the daily returns on the CRSP Value-Weighted Index, computed as presented in equation [2.5]. The dummy variable (I_t^D) is computed following the methodology outlined in section 2.5. The event study encompasses the 2000–2016 period and includes only the FOMC meetings, where no interest rate change occurred, the NMP analysis. For completeness, the number of meetings where disagreement is observed is reported.
Standard Errors are presented in brackets.
Signif. codes: '***' 0.01 '**' 0.05 '*' 0.1.
Source: Federal Reserve website, www.federalreserve.gov, Quandl dataset, Wharton-CRSP Database, US Labor Statistics websites.

To answer the question on whether this uncertainty is merely related to the "timing" and therefore state dependent, I replicate the analysis of Table 2.7 and investigate other possible explanations for this equity premium around the NMP FOMC announcements. The results are presented in Table 2.9.

[40] The "Persistency" analysis of section 2.7.2 to assess whether the equity premium associated with disagreement around the FOMC announcements was not reversed on subsequent or previous days has been also carried out on the NMP FOMC announcements' subsample and confirms the previous findings. The results can be found in Appendix A, Table A.9.

At first glance, a particularly important control variable to investigate whether the equity premium around NMP FOMC announcements is the NBER recession dummy. The NBER recession dummy variable takes the value of 1 during a recession period and zero otherwise. The unemployment rate change, the 12-months logarithm change in the CPI and industrial production index are also all macroeconomic variables that could potentially shed light on how investors interpret the economic outlook disclosed around the announcements. First, it needs to be acknowledged that this equity premium is partially state dependent, due to the positive significance of the NBER dummy (NBER), and particular the negative effect associated with the interaction between the NBER variable and my disagreement dummy. The “Kuttner Surprise” (Kuttner S.) mimics the results of Table 2.7 in terms of statistical significance, although the interaction variable is also statistically insignificant.

An interesting result, different from the general case is related to the industrial production index (Δ^{12} Log (IP)), which presents an interesting asymmetric result. In columns (7) and (8) in Panel B the two regressions are presented, including first the industrial production index variable, and second the regression including the industrial production index variable and the interaction between my disagreement measure and the industrial production index variable. The industrial production variable is associated per se with a negative equity premium. It needs to be recalled that the industrial production index is a 12-months change of the log of the index, which means that a positive change in the 12-months industrial production index is associated with a negative equity premium. Conversely, disagreement and positive news on industrial production is associated with a positive equity premium around NMP FOMC announcements.

Table 2.9: Time Series Analysis of NMP FOMC Meetings' Returns

Panel A

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
I_t^D	0.498**	0.473**	0.423**	0.566***	0.518***	0.494**	0.227	-0.135
	(0.203)	(0.224)	(0.183)	(0.186)	(0.189)	(0.188)	(0.332)	(0.826)
υ_Δ	0.006	0.021						
	(0.039)	(0.054)						
I_t^D x υ_Δ		-0.045						
		(0.080)						
NBER			0.623*	1.176***				
			(0.320)	(0.363)				
I_t^D x NBER				-1.984**				
				(0.690)				
Tight C.					-0.380	-0.357		
					(0.312)	(0.337)		
I_t^D x Tight C.						-0.172		
						(0.915)		
Easy C.							0.380	0.357
							(0.312)	(0.337)
I_t^D x Easy C.								0.172
								(0.915)
Const.	0.250*	0.257*	0.154	0.075	0.314**	0.304**	0.027	0.064
	(0.138)	(0.141)	(0.140)	(0.138)	(0.147)	(0.149)	(0.269)	(0.284)
Obsv.								118
R^2	0.082	0.083	0.112	0.172	0.092	0.093	0.089	0.091

Panel B

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
I_t^D	0.479***	0.471**	-0.337	-0.377	0.464**	0.339	0.509***	0.532***
	(0.185)	(0.185)	(0.330)	(0.458)	(0.195)	(0.212)	(0.182)	(0.186)
Kuttner S.	0.063	0.665						
	(0.153)	(0.587)						
I_t^D x Kuttner S.		-0.645						
		(0.608)						
Vol $_{t-1}$			0.028**	0.017				
			(0.012)	(0.016)				
I_t^D x Vol $_{t-1}$				0.003				
				(0.026)				
Δ^{12} Log (CPI)					0.002	-0.005		
					(0.027)	(0.035)		
I_t^D x Δ^{12} Log (CPI)						0.017		
						(0.055)		
Δ^{12} Log (IP)							-0.104**	-0.132**
							(0.049)	(0.053)
I_t^D x Δ^{12} Log (IP)								0.201
								(0.132)
Const.	0.241*	0.225	-0.379	-0.122	0.250*	0.285*	0.245*	0.245*
	(0.134)	(0.136)	(0.299)	(0.400)	(0.142)	(0.147)	(0.131)	(0.131)

Continued Table 2.9

Obsv.								118
R^2	0.084	0.088	0.123	0.134	0.082	0.089	0.117	0.135

Note: The table presents the results of the regressions described in equation [2.6], including the vector of controls X_t. The variables included in the analysis are both macroeconomic and financial market variables. Panel A presents the analysis that includes: the unemployment rate change (υ_Δ), the NBER dummy variable (NBER), the "Tight Cycle" variable (Tight C.), the "Easy Cycle" (Easy C.) and interaction variables between my measure of disagreement (I_t^D) and the control variables (I_t^D x υ_Δ, I_t^D x NBER, I_t^D x Tight C. and I_t^D x Easy C.). Panel B presents the analysis that includes: the Kuttner Surprise (Kuttner S.), the volatility level the day before the announcement is represented by the level of the VIX index at the market close the day before the announcement (Vol $_{t-1}$), the 12-months log change in the industrial production index (Δ^{12} Log (IP)) and the 12-months log change in the CPI index (Δ^{12} Log (CPI)), and interaction variables between my measure of disagreement (I_t^D) and the control variables (I_t^D x Kuttner S., I_t^D x Vol $_{t-1}$, I_t^D x Δ^{12} Log (CPI), I_t^D x Δ^{12} Log (IP)). The dependent variable, H_t, is represented by the 1-day return of the CRSP Value-Weighted Index computed as presented in equation [2.5]. Standard Errors are presented in brackets. The sample period is (2000–2016) and includes only the FOMC announcements where the interest rate level has remained unchanged.
Signif. codes: '***' 0.01 '**' 0.05 '*' 0.1.
Source: Federal Reserve website, www.federalreserve.gov, Quandl dataset, Wharton - CRSP Database, Federal Reserve Bank of St.Louis – Economic Research website, fred.stlouisfed.org

This asymmetric response is in line with the results on the state dependent response to monetary policy announcements and monetary policy surprises. A positive news on industrial production might lead to a future increase in the Federal Fund Target rate, whereas if disagreement is realised, it means that investors perhaps expected an interest rate hike, and positive news on industrial production makes this event more likely to happen.[41]

[41] The distribution of disagreement on the NMP FOMC announcements is quite heterogeneous, with a preponderance of disagreement about interest rates cuts within the 2008 crisis and post-crisis period, whereas expectations towards an interest rate hike are related to the 2000, 2005 and 2007 years and after 2015.

2.7.5 Portfolios Analysis

Early studies (Black, 1972; 1993; Black, Jensen & Scholes, 1972; Fama & French, 1993) find a very small relation between equity excess returns and the beta, even though the beta should be an important determinant of the risk premium. Bernanke & Kuttner (2005) also propose an analysis on industry portfolios (Fama & French Industry Portfolios) around monetary policy announcements, although they don't find a strong relationship with the average portfolios' beta and the response to interest rate change surprises.

On the contrary, more recent studies on macroeconomic announcements find that the behaviour of asset prices during these days is much easier to reconcile with standard asset pricing theories. Savor & Wilson (2014) found compelling evidence that stock market betas are strongly economically and statistically significantly related to returns around macroeconomic announcement days and specifically on pre-scheduled FOMC announcements. More recently, Wachter & Zhu (2018) developed a theoretical model to explain this relationship and propose a different explanation. They infer that as macroeconomic announcements convey information on the economic outlook, this additional information updates investors on future economic risk. Investors require, therefore, an additional risk premium to hold the equity during these days. A second explanation proposed is that these days might themselves create the risk by reflecting the competence of the Federal Reserve. They conclude that the security market line appears on days with macroeconomic announcements. Building on these findings, I investigate my main hypothesis (equation [2.6]) on equity portfolios sorted based on their betas and on the Fama & French 10 industry portfolios.

2.7.5.1 Beta Portfolios

This section presents the results for equation [2.6] where the dependent variable H_t is represented by the daily returns of ten equity portfolios sorted on beta deciles.[42] The results of this analysis are presented in Table 2.10. Regression estimates to the I_t^D variable show a high level of proportionality in the disagreement response. In particular, when the coefficients from the 7th to the 1st decile portfolios are estimated, both the magnitude and statistical significance are almost monotonically aligned with CAPM predictions and so proportional to portfolio market beta. This result is in line with the findings of Savor & Wilson (2014), who demonstrate that the CAPM holds well for FOMC announcements.

The results in Table 2.10 show that in line with the literature and expectations the response of equity returns to FOMC announcements is strongly related to the stock betas. Column (1) reports the average returns for the portfolios on FOMC announcement days, column (2) reports the average portfolios' betas. The coefficients for my test (equation [2.6]) are presented in column (3). In line with expectations and the literature, the magnitude of the response is strongly related to the average portfolios' beta, although, variable I_t^D shows a higher statistical significance on low betas portfolios, along with a higher difference with the overall returns of the FOMC announcements. This result can be ascribed to the interpretation of the I_t^D variable itself.

[42] The portfolios' returns, sorted in stock betas, are available on the CRSP Wharton Dataset, and are computed with the same data of the CRSP Value-Weighted Index. Data on the average portfolios' beta are also available.

Table 2.10: Beta Portfolio Analysis - Whole Sample (2000–2016)

	(1)	(2)	(3)		(4)			
Port.	μ	Β	Const.		I_t^D		R^2	Obsv
			Est	*SE*	*Est*	*SE*		
1	0.704	1.7	0.528*	(0.277)	1.084***	(0.372)	0.072	161
2	0.571	1.4	0.441*	(0.221)	0.884***	(0.288)	0.078	
3	0.435	1.2	0.344*	(0.190)	0.662***	(0.248)	0.063	
4	0.398	1.0	0.331*	(0.174)	0.610***	(0.227)	0.064	
5	0.321	0.9	0.225	(0.156)	0.572***	(0.205)	0.059	
6	0.299	0.8	0.216	(0.138)	0.497***	(0.181)	0.060	
7	0.264	0.7	0.205	(0.125)	0.447***	(0.164)	0.053	
8	0.201	0.6	0.137	(0.104)	0.391***	(0.140)	0.049	
9	0.138	0.4	0.068	(0.070)	0.282***	(0.092)	0.061	
10	0.142	0.2	0.060	(0.052)	0.289***	(0.069)	0.107	

Note: This table presents the results of the dummy variable regression reported in equation [2.6] where the dependent variable is represented by the returns on the CRSP Value-Weighted Market Portfolios sorted on their beta. The portfolios are ordered from the 1st till the 10th beta deciles. The control variables are represented by my measure of disagreement ("I_t^D"), in column (4), and constant ("Const") in column (3). The "*Est*" column presents the estimate of the coefficients, along with the significant code for both column (3) and (4). The column *SE* presents the standard error of the estimate in brackets. Along with the empirical results, the average returns on the FOMC meeting dates are reported in column (1) for comparison, along with average portfolio beta in column (2). The sample period (2000–2016) includes all the FOMC meeting dates.
Signif. codes: '***' 0.01 '**' 0.05 '*' 0.1.
Source: Federal Reserve website, www.federalreserve.gov, Quandl dataset, Wharton - CRSP Database, US Labor Statistics websites.

When disagreement is observed ($I_t^D = 1$) investors have to re-update their beliefs on the future economic outlook, which they would also do around all the FOMC announcements. The main difference between these two situations is that, if disagreement is observed, investors have wrongly interpreted the information collected before the meeting on the state of the economy, which could result in them perceiving additional risk that could be reflected in future expectations on the risk–free rate and expectations on future companies' cash flows (Kontonikas, MacDonald & Saggu, 2013). This result can also be ascribed to the high idiosyncratic risk, that could result in stocks being more impacted by future uncertain expectations on cash flows.

This explanation is supported by the difference between the average FOMC announcements returns (column (1)) and FOMC announcements returns when $I_t^D = 1$ (column (4)). On average the magnitude of the coefficients when $I_t^D = 1$ is higher on average, although the difference between the two is particularly prominent on low beta portfolios. Portfolio 10 has an average return around FOMC announcements ("μ") of 14 bps, whereas for FOMC announcements where $I_t^D = 1$ the coefficient is around 30 bps.

In line with the findings of Savor & Wilson (2014), who build their findings across all major macroeconomic announcement days, I also find some degree of response to the "agreement" measure (represented by the constant) in high-beta (and therefore more responsive) portfolios. The magnitude of the response is considerably smaller (about a half of the bps compared to the disagreement measure) and only mildly significant.

Further to this, to investigate the "announcement effect", I replicate the work on the NMP analysis. The results of this test are presented in Table 2.11. This test confirms the results of Table 2.10, showing, however, a much stronger response in the magnitude of the coefficients. In column (1), I report the average FOMC announcement return around the NMP analysis. The magnitude in the difference between the average FOMC announcements' return and the FOMC announcement where disagreement is observed is higher with respect to the previous results (Table 2.10), ranging between 20 to 40 bps. Again the I_t^D variable is statistically significant across all the portfolios, although more strongly in low beta portfolios.

A further relevant difference with the previous analysis (Table 2.10) is that the "agreement" measure is only mildly significance in the first portfolio (Port. 1), confirming previous results (Tables 2.5 and 2.8) and providing empirical evidence that across NMP FOMC announcements, "agreement" around NMP reduces uncertainty and resolves into the absence of a statistically significant equity premium.

Table 2.11: Beta Portfolio Analysis - NMP (2000–2016)

	(1)	(2)	(3)	(4)	(5)	(6)		
Port.	µ	B	Const.		I_t^D		R^2	Obsv
			Est	*SE*	*Est*	*SE*		
1	0.733	1.7	0.485	(0.311)	1.145***	(0.421)	0.078	118
2	0.564	1.4	0.347	(0.247)	0.889***	(0.335)	0.075	
3	0.457	1.2	0.275	(0.211)	0.735**	(0.286)	0.069	
4	0.412	1.0	0.239	(0.192)	0.670**	(0.263)	0.067	
5	0.356	0.9	0.181	(0.172)	0.617***	(0.235)	0.067	
6	0.340	0.8	0.207	(0.149)	0.576***	(0.204)	0.078	
7	0.286	0.7	0.165	(0.137)	0.497***	(0.188)	0.068	
8	0.221	0.6	0.101	(0.117)	0.424***	(0.160)	0.063	
9	0.143	0.4	0.042	(0.083)	0.318***	(0.114)	0.065	
10	0.108	0.2	0.017	(0.066)	0.279***	(0.090)	0.077	

Note: This table presents the results of the dummy variable regression reported in equation 2.6 where the dependent variable is represented by the returns on CRSP Value–Weighted Market Portfolios sorted on their beta. The portfolios are ordered from the 1st till the 10th beta deciles. The control variables are represented by my measure of disagreement ("I_t^D"), in column (4), and constant ("Const") in column (3). The "*Est*" column presents the estimate of the coefficients, along with the significant code for both column (3) and (4). The column *SE* presents the standard error of the estimate in brackets. Along with the empirical results, the average returns on the FOMC meeting dates are reported in column (1) for comparison, along with average portfolio beta in column (2). The sample period (2000–2016) includes all the FOMC meeting dates where no interest rate change occurred, the NMP analysis.
Signif. codes: '***' 0.01 '**' 0.05 '*' 0.1.
Source: Federal Reserve website, www.federalreserve.gov, Quandl dataset, Wharton - CRSP Database, US Labor Statistics websites.

Overall, the results feature two important findings. First, in line with the literature and expectations, the response of equity returns to FOMC announcements shows a high degree of proportionality with respect to the market beta (Savor & Wilson, 2014; Wachter & Zhu, 2018). Second, FOMC meetings where disagreement is observed show an even higher degree of response, particularly in the NMP analysis. Last, but not least, the impact of disagreement is statistically more significant in stocks, bearing a plausible higher idiosyncratic risk, showing that investors require an additional premium for bearing additional risk on stocks with a higher likelihood of uncertainty on future cash flows (Jensen & Mercer, 2002; Ehrmann & Fratzscher, 2004).

2.7.5.2 Fama & French Industry Portfolios

Following the reasoning of the previous section on the results of Bernanke & Kuttner (2005), I replicate the previous analysis of the 10 Fama & French industry portfolios.[43] The results of the analysis covering all the FOMC announcements are presented in Table 2.12, whereas Table 2.13 presents the results when only the NMP FOMC announcements are considered.

Bernanke & Kuttner (2005) found that the most responsive industries to interest rate surprises are high-tech and telecommunications. In Table 2.12 I presents the average returns for FOMC announcements' days (column (1)), the average beta of the portfolios (column (2)), computed as in Bernanke & Kuttner (2005) by regressing the returns of the industry portfolios over the CRSP Value-Weighted Index returns, a constant term (column (3)) and the coefficients for my dummy variable I_t^D, along with standard errors (column (4)).

This analysis, compared to the previous one, allows me to make inference not only on the proportionality of the industry, but also to investigate the response across business sectors. At first glance, I also find some degree of proportionality in the industry response (e.g. the highest premium is associated with the high-tech industry, which also shows the highest

[43] The Fama & French Industry Portfolios are available from Kenneth French's webpage (mba.tuck.dartmouth.edu/pages/faculty/ken.french/). The betas of the portfolios are estimated by regressing the portfolios returns over the market returns, represented by the CRSP Value-Weighted Index (Bernanke & Kuttner, 2005).

beta among the others). In line with the results of Bernanke & Kuttner (2005) the high-tech is the most responsive industry in regard to my "disagreement" measure, although I find also some degree of response to the "agreement" measure (also represented in this case by the constant term). For instance, durables see a positive equity premium of 45 bps only around "agreement", similar to energy and health-care sectors. What is a plausible explanation for these findings?

These results can, perhaps, be ascribed to the disagreement around changes in expected future dividends and changes in the companies' debt conditions, as suggested by Bernanke & Kuttner (2005). The explanation of these results relies again, perhaps, in the middle between monetary economists and the announcement effect. Future expectations on the dividend are surely relevant in interpreting the overall responses of industry portfolios to monetary policy, although the difference among the average return on all the FOMC announcements days, compared to when disagreement is realised, has to be ascribed to other elements. Sectors which have been more largely impacted by the financial crisis respond perhaps more harshly to monetary policy uncertainty and institutions' decisions (Kontonikas, MacDonald, & Saggu, 2013), given the information conveyed on the future economic outlook (Savor & Wilson, 2013). Conversely, sectors that benefit from stability and continuity in monetary policy would respond positively to FOMC decisions which are in line with expectations and therefore a revision of the expectations is not necessary.

Table 2.12: Fama & French industry Portfolios Analysis-Whole Sample (2000–2016)

	(1)	(2)	(3)		(4)			
Port.	μ	B	Const.		I_t^D		R^2	Obsv
			Est	*SE*	*Est*	*SE*		
High – Tech	0.458	1.20	0.325	(0.214)	0.758***	(0.282)	0.048	
Durables	0.337	1.16	0.450**	(0.191)	0.348	(0.251)	0.018	
Other	0.420	1.16	0.413**	(0.196)	0.547**	(0.257)	0.029	
Energy	0.263	0.99	0.312*	(0.164)	0.160	(0.216)	0.011	
Manufacturing	0.299	0.98	0.342**	(0.138)	0.342**	(0.181)	0.029	161
Telecommunications	0.191	0.98	0.144	(0.154)	0.339*	(0.203)	0.017	
Wholesale / Retail	0.315	0.86	0.332**	(0.145)	0.400**	(0.191)	0.035	
Health Care	0.199	0.73	0.238	(0.157)	0.159	(0.154)	0.018	
Utilities	0.112	0.66	0.126	(0.131)	0.119	(0.173)	0.004	
Non-Durables	0.090	0.61	0.105	(0.101)	0.081	(0.133)	0.003	

Note: This table presents the results related to the main hypothesis on the Fama & French 10 Industry portfolios. Column (1) reports the average returns around my NMP FOMC announcements sample for each industry ("μ FOMC").The betas of the portfolios are estimated by regressing the portfolios returns over the market returns, represented by the CRSP Value-Weighted Index and reported in column (2). This analysis is comparable to the Bernanke & Kuttner (2005) analysis. The control variables are represented by my measure of disagreement (I_t^D), in colum 4, and a constant ("Const."), in column (3). For both the control variables the coefficients estimates ("*Est*") is presented along with the significant code. The column *SE* presents the standard error of the estimate in brackets. The sample period (2000–2016) includes all the FOMC meeting dates.
Signif. codes: '***' 0.01 '**' 0.05 '*' 0.1.
Source: Federal Reserve website, www.federalreserve.gov, Quandl dataset, French website (mba.tuck.dartmouth.edu/pages/faculty/ken.french/), CRSP Database, Wharton.

It needs to be said that the response to "disagreement" is among all the statistically significant cases always bigger in magnitude compared to "agreement".

I investigate further the response of the industries around NMP FOMC announcements. Although in section 2.7.4 the limitations of this specific subsampling are made explicit, I believe the response of single industries to the NMP and to the economic outlook disclosed by the FOMC is relevant. In such times (after 2001 and after 2008), the response to the economic outlook could definitely shed some light on how industries responded to expectations on future dividends and debt conditions.

Table 2.13: Fama & French industry Portfolios Analysis - NMP analysis - 2000 - 2016

	(1)	(2)	(3)		(4)			
Port.	μ	β	Const.		I_t^D		R^2	Obsv
			Est	*SE*	*Est*	*SE*		
High-Tech	0.446	1,20	0.392**	(0.161)	0.601***	(0.220)	0.099	
Durables	0.367	1,16	0.398*	(0.205)	0.284	(0.286)	0.039	
Other	0.456	1,16	0.333*	(0.198)	0.698**	(0.272)	0.074	
Energy	0.357	0,99	0.281	(0.174)	0.554**	(0.238)	0.057	
Manufacturing	0.301	0,98	0.246*	(0.145)	0.401**	(0.198)	0.056	
Telecommunications	0.213	0,98	0.096	(0.153)	0.406*	(0.212)	0.034	118
Wholesale / Retail	0.279	0,86	0.258*	(0.139)	0.343*	(0.190)	0.054	
Health Care	0.269	0,73	0.196	(0.124)	0.368**	(0.170)	0.055	
Utilities	0.244	0,66	0.171	(0.134)	0.392**	(0.184)	0.042	
Non-Durables	0.150	0,61	0.128	(0.105)	0.180	(0.144)	0.026	

Note: This table presents the results related to the main hypothesis on the Fama & French 10 Industry portfolios. Column (1) reports the average returns around my NMP FOMC announcements sample for each industry ("μ FOMC").The betas of the portfolios are estimated by regressing the portfolios returns over the market returns, represented by the CRSP Value-Weighted Index and reported in column (2). This analysis is comparable to the Bernanke & Kuttner (2005) analysis. The control variables are represented by my measure of disagreement (I_t^D), in colum 4, and a constant ("Const."), in column (3). For both the control variables the coefficients estimates ("*Est*") is presented along with the significant code. The column *SE* presents the standard error of the estimate in brackets. The sample period (2000–2016) includes all the NMP FOMC meeting dates.
Signif. codes: '***' 0.01 '**' 0.05 '*' 0.1.
Source: Federal Reserve website, www.federalreserve.gov, Quandl dataset, French website (mba.tuck.dartmouth.edu/pages/faculty/ken.french/), CRSP Database, Wharton

The response around NMP FOMC announcements is virtually similar to the response related to the overall FOMC announcements, showing the same asymmetries around sectors. One relevant difference is represented by the energy industry, which in the general case was not responsive with respect my disagreement variable. Around NMP, the energy sector not only shows a positive equity premium with respect to disagreement of about 55 bps. The average response to NMP FOMC announcements "μ" (column (1)) of the energy sector is slightly above 35 bps, which means that disagreement is associated with an additional 25 bps equity premium.

A similar tale can be observed in the case of the health care sector that shows a positive statistically significant equity premium associated with disagreement around NMP FOMC announcement. The response to agreement is, however, lower then the average response to the FOMC announcements (“μ”), whereas disagreement presents a 10 bps premium compared to the overall FOMC announcements (“μ”). A more homogenous industry response to FOMC announcements around NMP (energy, health-care and high-tech) can be perhaps ascribed to “timing” of NMP previously discussed and strongly correlated to post-crisis periods.

2.7.6 Discussion

In the previous subsections, several analyses were presented to validate the hypothesis postulated in section 2.3. In this section, I summarise the interpretations and possible explanations for the results. The main result, shown in Table 2.5, points out a relevant equity premium associated with FOMC announcement days, where the market disagrees with the outcome decided by the FOMC. The dummy model shows an average of 42 bps returns around these days, in comparison to the 32 bps yield on normal FOMC announcement days. The FOMC announcements where investors agree with the FOMC decisions present an equity premium of around 27 bps and mildly significant (at 10%).

Lucca & Moench (2015) found that the pre-announcement stock drift, which materialises during the trading day before the actual meeting time (they include intra-day return 24 hours before the meeting time, which on average occurs around 2 pm), is of about 50 bps. They associate the announcement stock drift with several explanations that could apply also to the present study. Lucca & Moench (2015) infer that the additional equity premium associated with the upcoming FOMC announcement is explained by the additional information, conveyed in the announcements on the future economic outlook and the additional risk compensation that investors require to hold the stock during these days. To interpret my results in relation to their findings, I analyse the time series of FOMC announcements returns against a series of economic, monetary policy surprises and financial market-based variables. The result presented in Table 2.7 feature important findings which are partly in line with the findings of Lucca & Moench (2015) and partly in line with the findings of the seminal paper of Bernanke & Kuttner (2005).

When analysing the whole returns' series, I find some evidence that FOMC returns, are state dependent and influenced by the economic outlook disclosed by the FOMC and by the current economic conditions (these results are inferred from the unemployment change variable and the NBER dummy variable). My disagreement variable remains positive and statistically significance throughout the analysis, featuring two important results. First, the FOMC announcements equity premium might not be associated with "any" FOMC announcements as could be inferred from the results of Lucca & Moench (2015). Second, the premium associated with the realization of investors' expectations around the announcement are an important driver of the FOMC equity premium. A possible explanation for this result can be found in the literature on disagreement among investors and its effect on stock market prices, trading volume and volatility.

Investors update their beliefs upon information arrival (French & Roll, 1986), although FOMC announcements are among the most highly anticipated announcements around the world, leading one to infer that investors would also react to the content of the announcements influenced by their prior beliefs. An extensive theoretical literature on disagreement (Varian, 1985; 1989; Abel, 1989) implies that disagreement and divergence of opinions should lead to a positive risk premium. Carlin, Longstaff & Matoba (2014) find recent empirical evidence that disagreement among financial market participants is associated with higher expected return, volatility and trading volume. The literature on macroeconomic announcements (Savor & Wilson, 2013; Lucca & Moench, 2015) doesn't provide evidence of additional market volatility during FOMC announcements. On the contrary, my analysis of the FOMC announcement returns shows that, when subsampling the time series with respect to the expectations of market participants, the volatility variable shows an interesting asymmetric result, more in line with the results of Carlin, Longstaff & Matoba (2014).

These results are further bolstered by the work on the "NMP analysis". This analysis is novel in the literature on macroeconomic announcements (Savor & Wilson, 2013; Lucca & Moench, 2015; Ai & Bansal, 2018), which differentiates among macroeconomic and monetary policy announcements, although FOMC announcements haven't been analysed on the basis of the FOMC decision. The NMP analysis represents a natural setting to investigate the announcement effect, without any change in the current economic condition. My results on this subsample feature a higher equity premium associated with these days. When investors disagree with the FOMC on neutrality, the equity premium associated with these announcements is on the magnitude of 50 bps, similar in magnitude to the findings of Lucca & Moench (2015).

Bernanke & Kuttner (2005) partially analysed the effect of "no change" in the Federal Fund Target rate level and suggested that the market was reacting to the FOMC failing to take action and just "postponing the inevitable". Compared to their study, my sample period encompasses both the post-crisis years of 2000–2001 and the more prolonged zero-lower bound after the 2008 financial crisis. These should be taken into consideration when interpreting the additional equity premium associated with NMP FOMC days, considering also earlier findings in the literature (Barsistha & Kurov, 2008; Kurov, 2012; Kontonikas, MacDonald & Saggu, 2013) who suggested that the response to monetary policy statements and suprises is state dependent and stronger during a recession period.

Overall, these results contribute also to the stream of literature that analyses the communication policy of institutions. Kurov, Gilbert & Wolfe (2020) claim, in fact, that since the end of Lucca & Moench's (2015) sample of analysis (2011), the pre-announcement drift has started to progressively "disappear", consisent with the explanation of reduced uncertainty. Ultimately, this "reduced uncertainty" is linked to the "communication reform" begun many years ago for the FED (1994) and still continuing (Blinder, et al. 2001; 2008; Faust and Svensson, 2001), with the precise aim of being as transparent as possible with regards to the public and improve the accountability of the FOMC actions.

My results on portfolio analysis are in line with the findings of Savor & Wilson (2014) and Wachter & Zhu (2018). I find a high degree of proportionality in the equity response with respect to their systematic risk factor, in line with CAPM predictions. The magnitude of the response is in line with past findings, although the significance of the response shows a relevant asymmetry between high and low beta portfolios. This result is marginally also in line with the findings on sector analysis. The response of portfolios sorted by sector (the Fama & French 10 Industry Portfolios) is heterogeneous and not consistently in line with the average beta of the portfolio. This asymmetry could perhaps be imputed to the considered sample (2000–2016) that encompasses the financial crisis and the subsequent zero-lower bound interest rate period. Industries who have been more impacted by the financial crisis would react more strongly to upcoming information (even more disappointing information) on the future of monetary policy. The findings of Boyd, Hu & Jagannathan (2005), Barsistha & Kurov (2008), Kurov (2012) and Kontonikas, MacDonald & Saggu (2013), in fact link the equity reaction on macroeconomic announcements to the state of the economy and the business cycle. This explanation applies specifically to industry sectors and even more to those sectors characterised by seasonality in cash flows (Ehrmann & Fratzscher, 2004).

To summarise the results show, in line with the explanations provided in the literature, that the expectations of investors on the content of the FOMC announcements and realised on the announcement day play an important role in the equity premium associated with these days.

2.8 Robustness

2.8.1 Liquidity and Volatility Risk

Lucca & Moench (2015) assess the role of volatility and liquidity, with the specific purpose of understanding why most of the returns are realised in advance of the announcement. My sample period (2000–2016) partially includes the pre-announcement effect. I, therefore, also assess the role of the liquidity and volatility risk. My explanation for this additional equity premium is given by the expectations of investors, formulated prior to the meeting. I, therefore, decompose the measures of liquidity and volatility into an innovation given by these expectations and a t–1 measurable component using simple univariate AR(1) models. The results of this analysis are shown in Table 2.14.

Table 2.14: Liquidity and Volatility Risk				
	(1)	(2)	(3)	(4)
I_t^D	0.380**	0.384**	0.371**	0.394***
	(0.167)	(0.167)	(0.167)	(0.138)
Vix Lag	0.005**		0.006**	0.010***
	(0.002)		(0.002)	(0.002)
Vix I_t^D Inn				-0.418***
				(0.010)
Volume Lag		0.003	-0.100	-0.127
		(0.099)	(0.108)	(0.089)
Volume I_t^D Inn				-0.056
				(0.170)
Constant	-0.091*	-0.011	0.795	0.948
	(0.049)	(0.893)	(0.950)	(0.784)
R^2	0.002	0.001	0.002	0.320
Observations				4157

Note: The table presents the results for the regression in equation [2.6], at a daily frequency, when controlling for measures on liquidity and volatility. Column (1) presents the results for the time series daily analysis including the disagreement dummy variable (I_t^D) and the "Vix Lag", which is the lagged value of the Vix on the previous day. Column (2) presents the results for the regression including my the disagreement dummy variable (I_t^D) and the "Volume Lag", which denotes the logarithm of the trading volume on the day before. Column (3) presents the regression analysis that includes the disagreement dummy variable (I_t^D) and both the "Vix Lag" and the "Volume Lag". Column (4) presents the regression that includes all the variables included in column (3), plus the "Vix (I_t^D inn)" and "Volume (I_t^D inn)" variables. The "Vix (I_t^D inn)" is the residual from an AR(1) regression of the daily Vix Index on a constant, the value of the Vix the day before and the disagreement dummy variable (I_t^D). The ". The "Volume (I_t^D inn)" is the residual from an AR(1) regression of the logarithm of the daily volume on a constant, the logarithm of the volumes the day before and the disagreement dummy variable (I_t^D). Standard Errors are presented in brackets.
Signif. codes: '***' 0.01 '**' 0.05 '*' 0.1.
Source: Federal Reserve website, www.federalreserve.gov, Quandl dataset, Wharton-CRSP Database, US Labor Statistics websites, Bloomberg.

As a benchmark in this time series analysis, the dummy variable I_t^D is positive and statistically significant at a 5% confidence level with an average response of 38 bps, in line with previous results. The "Vix Lag" is the level of the VIX index on the before the trading day, similarly the "Volume Lag" is the logarithm of the total volume of the day before. The variables "Vix I_t^D Inn" and "Volume I_t^D Inn" are the decomposed measures of innovation for volatility and liquidity, respectively. The two measures of innovations are both statistically significant, negative in the case volatility and positive in the case of volumes.

The two variables show that part of the returns associated with FOMC announcements, conditional to the expectations on such announcements, is explained by lower volatility and higher market liquidity. The asymmetric results between the "Vix Lag" and the "Vix I_t^D Inn" are in line with the findings of Lucca & Moench (2015). The higher volatility associated with the day before the announcement ("Vix Lag") is in line with the Lucca & Moench (2015) stock drift and possibly explained by the attendance created around the outcome of the FOMC announcement. Consequently, the realization of the expectations is associated with lower volatility on the announcement day and higher liquidity, which is consistent with investors re-updating their beliefs and revising their positions.

2.8.2 Endogeneity

Given the forward-looking nature of monetary policy and the contemporaneity of effects between monetary policy and macroeconomic variables, endogeneity is one of the main issues in the literature, when studying these relationships. As my empirical strategy is constructed to analyse the influence of pre-event expectations to post-event equity returns, endogeneity doesn't affect my results for three main reasons. First, there is no evidence in the literature of a simultaneous effect between stock prices and monetary policy. For example, there is no clear cut evidence that a drop in equity prices leads to an interest rate cut (Bernanke & Kuttner, 2005). Secondly, I control for several macroeconomic and financial market variables that might affect the equity premium and investors' expectations around FOMC announcements. Third, the literature has frequently discussed issues of using monthly data and the conjoint effect of more than one meeting per month. In my analysis, I imply the 1-day return on the meeting date. Therefore, I can infer that the impact is strongly associated with the specific event.

2.9 Limitations

This chapter aims to contribute to the literature on investigating the effects of monetary policy on the equity market and provide an additional explanation of the average returns observed in the equity market around macroeconomic announcement days. To do so, inspired by the seminal methodology of Kuttner (2001) and then Bernanke & Kuttner (2005) I developed a dummy variable model that differentiates the FOMC announcements' days with regard to the expectations of investors formulated prior to the announcement and realised on the announcement day.

The first limitation of this study is related to my methodology. To infer the expectations of market participants I employ Federal Funds rate futures (as in Kuttner, 2001), which is an efficient mechanism to infer whether or not investors expected a change in the interest rate. This approach is, however, inefficient in inferring the precise direction of the expectations of investors in regard to the interest rate level, which could be analysed by employing an option-based methodology. Although Federal Funds Rate Futures represent a "good enough" instrument to gauge future FOMC policy actions (Krueger & Kuttner, 1996; Owens & Webb, 2001; Gürkaynak, 2005; Gürkaynak, Sack, & Swanson, 2006) options on Federal Funds Rate Futures can give superior information on the distribution of investors beliefs around FOMC announcement.

Carlson, Melick & Sahinoz (2003) at the time that these options become available on the market, showed that an option-based methodology was superior in providing information on the probability of the magnitude of the interest rate change (or no change), which I have assumed to be 25 bps in my methodology. Carlson, Melick, & Sahinoz (2003) show that the presence of alternative strike prices is representative of the distribution of the underlying opinions, that might be more varied than "no change" or a "25 bps change" (regardless of whether there is a cut or a hike) and perhaps include also the possibility of other magnitudes in the change (50 bps). Option-based methodologies are largely employed in the industry[44] to infer the probabilities that investors assign to different future levels of the interest rate. The availability of option metrics would, therefore, complete this analysis, by giving more precise estimates on the expectations of investors with respect to the Federal Fund Target rate.

The study of Lucca & Moench (2015) also highlighted a relevant price drift before the actual FOMC announcement. Their results partially reflect mine, although it would be beneficial to investigate the equity returns just after the FOMC announcement which usually occurs in the middle of the trading day, around 2 pm.[45] In this study the equity returns are computed as the 1-day return of the CRSP Value-Weighted Index (equation [2.5]), therefore including part of the pre-announcement drift and the also the return realised just after the announcement. Investigating the intra-day trading activity of investors with respect to pre- and post-announcements will definitely be of great interest to enhance the accuracy of the analysis in regard to the expectation of investors and the realization of these expectations.

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[44] The very well–known news data and quotes' provider Bloomberg employs an option-based methodology to infer the probability assigned by market participants to the future level of interest rates prior to the FOMC announcement.

[45] Lucca & Moench (2015) provide specific details in their study of FOMC announcements' timing from 1994 to 2011.

The last limitation is linked to the role of media and information providers around these events. The week before the announcement is defined as a “blackout period”, therefore policy makers are not allowed to disclose any information on the upcoming meeting or on the state of the economy. This “blackout” obviously doesn’t apply to media providers and other relevant individuals commenting on the upcoming decision of the FOMC. It will be therefore interesting to control for the information that hit the market from different resources in the week previous to the meeting and how this further affected the shaping of expectations.

2.10 Conclusions

This chapter shows in a novel way how disagreement regarding FOMC committee decisions can impact the equity markets. When the market agrees with FOMC decisions I find a small or no significant impact on stock market excess returns. We can think of these cases as FOMC meetings being similar to the “anticipated events” that we observe in many other instances in the continuous evolution of financial markets. Thus, consistent with market efficiency theory as well as with a vast empirical literature, information contained in the FOMC subsequent meeting release is largely incorporated in equity returns, resulting in no meaningful consequences on market outcomes. However, when investors disagree with FOMC committee decisions I find the effects on stock excess returns highly significant. Furthermore, my results highlight that market expectations will play an important role in the post–meeting reaction, rather than a monetary policy innovation. This result is particularly evident when analysing the NMP analysis. Although no action is taken from the FOMC committee, the impact is strong and consistent when the market was actually expecting them to take a stand. The NMP analysis is a natural experiment that further confirms predictions of the EMH. As no change in interest rates occurs, the effects I find are entire to be credited to ex-ante price quality and investors' information set. As this chapter shows, anticipated information doesn't have a significant impact on financial market metrics. Thus, central bank institutions could improve their disclosure policy particularly during economic downturns, when the risks of announcing unexpected decisions could bring unpleasant consequences on financial market stability and investors' trust.

Chapter 3

The Effect of Monetary Policy Shocks on Macroeconomic Variables: Evidence from the Eurozone[46]

3.1 Introduction

Uncovering the effects of monetary policy on real and nominal macroeconomic variables has been a long-debated challenge in the literature and practitioners. Policy makers and industry practitioners, especially in the past decade, have allocated a large amount of resources in estimating the effect of monetary policy for two main purposes: evaluating the efficacy of monetary policy and predicting its future effects on the economy. This chapter analyses the response of industrial production (output) and inflation (prices) to monetary policy shocks by exploiting new sample data from the European Central Bank (ECB).

[46] A different version of this research has been published in *Economic Letters*, reference can be found at L.M.Murgia (2020) https://doi.org/10.1016/j.econlet.2019.108803.

Following the narrative approach of Romer & Romer (2004) and gathering a novel dataset of macroeconomic forecasts, I derive a new measure of monetary policy shocks for the Eurozone across the 2000–2016 sample period.

Consistent with the existing literature, I find that output is more responsive to monetary policy shocks, having a decline of over 0.5% and starting its downward path 10 months after a 100 basis points shock. Conversely, the response of inflation to a monetary policy shock is very weak and unstable. My results on output are in line with earlier findings that used data from central banks in the United Kingdom (UK) (Cloyne & Hürtgen, 2016), United States (US) (Romer & Romer, 2004) and Canada (CA) (Champagne & Sekkel, 2018). On the other hand, the response of inflation is weaker when compared to studies in the UK and the US.

I also find evidence of the heterogeneous response of single Eurozone countries' output and a homogenous response in prices. The overall responses among the single Eurozone countries (Germany, France, Spain, Italy and Portugal) show a decline of inflation between 0.1% and 0.2%, with the only exception being represented by Greece. The overall responses of industrial production range from an overall decline of 0.5% (Germany, Italy and Greece) with peaks around almost 1% for Portugal, France and Spain. Overall the paths show similar tendencies, although their volatility shows a high degree of heterogeneity among the countries. This level of heterogeneity in their responses is particularly relevant from the policy makers' perspective, considering that the ECB deliberates on monetary policy with the intent of homogenously affecting all the countries in the union.

To investigate these effects, I first estimate the monetary policy shocks series, following closely the methodology of Romer & Romer (2004) and also employed by Cloyne &

Hürtgen (2016) for the Bank of England (BOE) and Champagne & Sekkel (2018) for Bank of Canada (BOC). To compute the monetary policy shocks I collect the forecasts for inflation and GDP from the Survey of Professional Forecasters (SPF), to construct the information set of policy makers at the meeting date. The forecasts are carefully matched with the ECB monetary policy meeting dates, following the "information availability concept" first proposed by Romer & Romer (2004). Constructing this information set poses one main challenge, also reported by Romer & Romer (2004), Cloyne & Hürtgen (2016) and Champagne & Sekkel (2018): there are more intended interest rate changes then forecasts. The "information availability concept" assigns every forecast that was released before the considered meeting date to ensure that it wasn't already influenced by the current policy decision. To extract the monetary shock series, I then run a first-stage regression, where the monetary policy shock series is represented by the residual of a restricted VAR that includes all the variables composing the information set of policy makers.

Past studies have used different VAR approaches to estimate the monetary policy shocks and overcome the endogeneity issue of monetary policy and macroeconomic variables (Christiano, Eichenbaum & Evans, 1996; 1999; Uhlig, 2005). These studies find very little effect of monetary policy on macroeconomic variables in terms of magnitude. On the contrary, Romer & Romer (2004) present evidence of significant effects of monetary policy shocks on macroeconomic variables in the United States. Their approach, unlike previous studies, estimates monetary policy shocks that are orthogonal with respect to the information set available to policy makers at the decision time. The orthogonality of the shock series resolves both the issue of endogeneity and anticipatory movements. Coibion (2012) finds a middle ground between earlier results and Romer & Romer (2004). In his study he compares the large effects on output and prices found by Romer & Romer (2004), who found a decrease of almost 4% in output, and the more modest results found earlier in the literature: Christiano, Eichenbaum & Evans, (1999) found a mild decrease in output of about 70 bps by re-estimating the effects on output and prices.

Coibion (2012) attributes the differences in the results to three different factors: the different contractionary "impetus" (in other words, the size of the shocks estimated with the different methodologies), the lag-length selection and the period of reserves targeting by the FOMC. The lag-length selection might represent a potential limitation in the comparison between my results and earlier results, given the smaller sample size employed in my analysis.

A more recent strand of the literature has proposed a monetary policy shock series for the Eurozone by employing financial market-based methodologies. Jarocinski & Karadi (2020) provide a recent series of monetary shocks for the Eurozone, following the approach of Gertler & Karadi (2015) and imposing sign restrictions on the series to disentangle the "Pure Policy Shock" from the "Information Policy Shock". Altavilla et. al (2019) also employed a similar approach and extensively analysed the monetary policy conduct in the Eurozone.

To estimate the impulse responses of inflation and industrial production, I follow two different methods. First, I estimate the impulse response functions with a classical baseline VAR approach to make my results as comparable as possible with other empirical studies. Second, as my sample is considerably smaller than that of the existing research in other countries, I rely on a more flexible methodology: local projections *á la* Jordà (2005).

The chapter contributes to the literature in three different ways. First, to best of my knowledge, I propose a new monetary policy shock series for the ECB, following the methodology of Romer & Romer (2004) and therefore taking the perspective of the policy makers. Second, I provide empirical evidence of the effects of monetary policy shocks on the Eurozone at both an aggregate level and at a country level. The overall negative effect on output is confirmed at a country level with very heterogenous volatility in the path. Third, I also document a rise in the case of both output and prices, when employing the interest rate changes as a measure of monetary shocks. This puzzling result is ultimately resolved when employing my new monetary shock series.

3.2 Literature Review

The accuracy of the estimates of the effects of monetary policy on macroeconomic variables depends essentially on the adequacy of the measure of monetary policy. Identifying the adequate measure of monetary policy has become increasingly challenging, due to the multiple conventional and unconventional monetary policy instruments employed by central banks and monetary policy institutions to influence the economy. Conventional measures are subject to two important flaws, which represent big challenges for researchers when estimating the effects of monetary policy: endogeneity and anticipatory effects. Monetary policy instruments, interest rates and macroeconomic variables are, in fact, determined simultaneously, resulting in a challenge for econometricians to identify the causality effects among them. Furthermore, monetary policy is, by nature, a forward-looking instrument, and influences the economy with a “lag”

(Svensson, 2003). Therefore, monetary policy makers are likely to respond to future economic conditions rather than ex-post information.

A large number of empirical studies has attempted to overcome these challenges using VAR methodologies by following the lead of Sims (1972; 1980; 1986). Among the first results on the effect of contractionary monetary policy shocks were initial anomalies, further coined as a "Price Puzzle". In fact, Sims (1992) found initially that the price level would rise after two years of contractionary monetary policy shock. However, Christiano, Eichenbaum & Evans (1996), by employing a similar identification strategy for monetary shocks found very opposite results. They, in fact, found a sharp and persistent decline in real GDP, employment, retail and nonfinancial corporate profits. They ascribe this result to the assumption that monetary authorities include commodity prices in their information setting. In their seminal work, they include two monetary policy instruments: non-borrowed reserves and the Federal Funds rate.

Bernanke & Mihov (1998) argued that there is no consensus on the size and direction of the changes in monetary policy. They pointed out that changes in the stock of money were not adequate since the growth rate of monetary aggregates also depends on non-policy influences. They employ a "semi-structural VAR" approach to evaluate and develop measures of monetary policy based on reserve market indicators. Following the inflationary events of the 1970s, Christiano, Eichenbaum & Evans (1999) address the question of how institutions should respond to these economy shocks. Their recursive VAR assumptions aim to investigate the effect of monetary policy shocks with a two-step procedure. At the end of the 1990s, they assessed that the literature was in a "healthy state" to tackle the questions with the appropriate tools and wisdom from the "Volcker recession".

Some facts are therefore acknowledged from this era: first, the identification strategy of monetary policy shocks is crucial in correctly assessing the effects of monetary policy (Christiano, Eichenbaum & Evans, 1996). Second, attention has moved from reserves and money growth to the Federal Funds rate (Bernanke & Blinder 1992; Bernanke & Mihov, 1998). Last, according to conventional wisdom, contractionary monetary policy shocks should lower prices and reduce real output. Whenever this is not the case, the results are defined as a "puzzle" (Sims, 1992).

Building on these findings and on the "conventional wisdom"[47] that impulse responses that are inconsistent with the theory should be excluded (Christiano, Eichenbaum & Evans, 1999), Uhlig (2005) developed a model by imposing sign-restrictions to impulse responses. Uhlig' s (2005) methodology confirms the results that had been demonstrated so far in the literature and found very gradual small effects on prices and ambiguity regarding the effects on output (declines ranging from 0.3% to 1%).

Aside from this literature, Romer & Romer (1989) firstly introduce a "narrative identification" strategy by reading the minutes of the FOMC discussions. This narrative identification, based on historical records, departed from the existing statistical literature, tackling the question on the effects of monetary policy from a different perspective. This methodology posed two important problematics however, first the isolation of monetary shocks, second whether the identified shocks were followed by unusual output movements. The definition of "shocks", in this specific case, is given by episodes in which the Federal

[47] The term "conventional wisdom" refers to the fact that monetary contractions should raise the federal funds rate, lower prices and reduce real output. See section I, p. 383 of Uhlig (2005).

Reserve has attempted to exert a contractionary influence in order to reduce inflation. The reasoning behind the employment of this methodology was to analyse what the Federal Reserve *said* rather than the outcome of their actions.

Romer & Romer (2004) then applied their narrative identification to the historical records of the Federal Open Market Committee (FOMC) “Greenbook” to construct a series of changes in interest rates and further isolate the shocks with the identification strategy first proposed by Christiano, Eichenbaum & Evans (1996). Their “narrative” approach, unlike previous studies, estimated monetary policy shocks that were orthogonal, with respect to the information set available to policy makers at the decision time. The “orthogonality” of the shock series resolved both the issue of endogeneity and the anticipatory effects. Unlike the traditional statistical approaches, the results of Romer & Romer (2004) estimated an overall impact of about -4% on both prices and output.

The magnitude of their results is therefore significantly different than that of previous studies. Coibion (2012) finds a middle ground between past results and Romer & Romer (2004) and the earlier results. He highlights three important key elements that account for the difference in the magnitude of the results: first, the shocks estimated by Romer & Romer (2004) are much larger then with recursive VAR approaches. Second, the period in which the Federal Reserve abandoned targeting the Federal Funds Rate between 1979 and 1982 plays an important role in the difference among the results. Last, Romer & Romer (2004) is sensitive to the lags’ specification. Coibion (2012) extracted a measure of monetary policy shocks from an estimated Taylor Rule, with time-varying parameters, which yielded results in the middle between Romer & Romer (2004) and the earlier statistical methodologies.

More recently, the methodology of Romer & Romer (2004) has been applied to investigate the effect of monetary policy shocks in other countries. Cloyne & Hürtgen (2016) fill the gap in the literature on other country applications. The UK represents a natural setting for developing this methodology as BOE releases the forecasts of policy makers in its quarterly "Inflation Report", which are virtually similar to the information contained in the FOMC Greenbook. The results of Cloyne & Hürtgen (2016) are similar in magnitude to the results of Coibion (2012) and Romer & Romer (2004) finding an overall reduction of 0.5% in industrial production and close to 1% in inflation, but much delayed in time.

Champagne & Sekkel (2018) extend the discussion and provide narrative evidence for CA. Similarly to BOE and the FOMC, BOC releases the forecasts of policy makers. Unlike from Romer & Romer (2004) and Cloyne & Hürtgen (2016), they directly examine the effects of real GDP, as BOC provides a monthly series of GDP ex-post data. They find that output declines about 1% in the 18 to 24 months after the shock and that the inflation response is weaker and reaches a peak decline of about 0.4% after 3 years. Additionally, they highlight the importance of accounting for other information to correctly isolate the shocks. In fact, they control for US interest rates as well as the exchange rate as part of the information set of policy makers. They also account for structural breaks in the conduct of monetary policy.[48]

This chapter applies to this strand of the literature and aims to identify a series of monetary policy shocks for the ECB, following the seminal approach of Romer & Romer (2004) and

[48] In 1991, the BOC joined the inflation targeting framework. For further details, see section 2.1 in Champagne & Sekkel (2018)

extending it to account for the unconventional monetary policies put in place by the Governing Council for the ECB in the past decade. Burriel & Galesi (2018) estimate the effects of unconventional monetary policies with a VAR methodology by including as a variable of interest the total assets of the ECB. I follow their reasoning and include the total assets in my analysis. Champagne & Sekkel (2018) account for structural breaks in the conduct of monetary policy. The structural break considered by them is the "advent" of the IT framework, joined by BOC in 1991. The ECB also has joined the IT framework in 2003. I don't account for structural breaks in this case as my sample period ranges only from 2000 until 2016, and so the IT framework still represents the majority of my sample.

Excluding the studies of Cloyne & Hürtgen (2016) and Champagne & Sekkel (2018), most of the evidence is provided on the US, although recently some evidence has been provided in the Eurozone and the ECB by a different strand of the literature. Jarocinski & Karadi (2020) provide recent evidence of a monetary shock series for the ECB by applying a financial market-based measures VAR methodology. Financial market-based measures have been largely employed since the pioneer methodology of Kuttner (2001) that aims to identify the monetary policy shock by disentangling the expected from the unexpected component of the interest rate change. This long standing literature (Faust, Swanson & Wright, 2004; Bernanke & Kuttner, 2005; Gürkayanak, Sack & Swanson, 2005; Wingender, 2011; Barakchian & Crowe, 2013; Gertler & Karadi, 2015) has provided compelling evidence of the effects of monetary policy shocks on the stock market.

The novel findings of Jarocinski & Karadi (2020) is linked to the sign restrictions methodology. They define as a "pure-policy shock" a shock followed by a decline in the stock price, and vice versa they define as an "information-shock" a shock followed by a rise in the stock price. They provide evidence that a contractionary monetary policy shocks and the stock market response are highly informative of the future negative response of the economy. Furthermore, the information-shock, a contraction in monetary policy followed by a rise in the stock price, could account for the so-called "price puzzle". They also support the communication transparency of the ECB with respect to the US, denoted by the higher number of information-shocks in the Eurozone sample, which are caused by the information on the future economic outlook conveyed in the announcements. Altavilla et. al (2019) also provide very recent evidence of the Eurozone monetary policy by mapping the ECB policy communication into yield curve changes and study their information flow on policy dates. Although they don't provide evidence on real economy variables, their contribution to the literature is fundamental in tackling high-frequency data about Eurozone monetary policy surprises.

3.3 Methodology

3.3.1 Data

3.3.1.1 Dataset Construction for the First Stage Analysis

To construct the dataset for the first stage of the analysis the variables forming the information set of policy makers need to be matched with the intended policy rate variable. The first stage of the analysis is run at a meeting-by-meeting frequency. To correctly match the data, it is fundamental to be clear on the definition of the monetary policy decision point ("meeting", for short). At its inception in 1999, the ECB Governing Council took policy decisions twice a month, whereas a press conference took place only once a month, on the first meeting of the month.[49] During 1999 ECB decisions regarding interest rates are published under two different press releases, called “Monetary Policy Decisions” and “Decisions on ECB Interest Rates”, which have been further combined under the “Monetary Policy Decisions” appellation in the second half of 1999.[50] As a young institution the ECB has gone through several changes across the years to improve its communication policy. For the purpose of my analysis, I have started the sample in 2000 where the denomination of the “meeting” was homogenised.

Over the sample period 2000–2016, I gathered data on 187 monetary policy meetings. To build the set of information of policy makers I have collected the gross domestic product (GDP) and inflation forecasts, available at a quarterly frequency, from the Survey of Professional Forecasters (SPF) and the Economic Bulletin of the ECB. The SPF, included in the quarterly bulletin of the ECB, is analogous to the Staff forecasts included in the Greenbook and used by Romer & Romer (2004). Similarly, Cloyne & Hürtgen (2016) used the Inflation Report, issued by the BOE, whereas Champagne & Sekkel (2018) used the staff economic projections issued by the BOC.

The issue faced, first by Romer & Romer (2004) when matching the data, is that staff projections are often available at a quarterly frequency, although interest rate changes and policy makers meetings might occur more often. To match the data, I followed Romer & Romer (2004) and assign to the considered meeting the last available forecast before the meeting to avoid endogeneity of forecasts to the policy change. To control for the current

[49] The meeting dates and the appropriate details are available on the ECB website (www.ecb.europa.eu).
[50] For details see the press releases named “Decisions on ECB interest rates” on 07/01/1999, 21/01/1999 and 18/01/1999.

state of the economy, the interest rate level two weeks before the meeting is included, along with the unemployment rate and the total assets of the ECB (all available at a monthly frequency from the ECB Statistical Data Warehouse). Since these data are available monthly, the last data issued before the meeting was considered. Table 3.1 presents an example of the matching methodology applied to the sample for the first-stage analysis.

Table 3.1: Assigning Forecasts and Economic Variables to the Interest Rate Decision

	(1)		(2)		(3)		(4)	
	01/02/2001 [Q1:2001]		01/03/2001 [Q1:2001]		11/04/2001 [Q2:2001]		10/05/2001 [Q2:2001]	
Name	Source	Forecast /Data	Source	Forecast /Data	Source	Forecast /Data	Source	Forecast /Data
1Y Inflation	Jan Pr	Jan-01	Jan Pr	Jan-01	Apr Pr	Mar-01	Apr Pr	Mar-01
2Y Inflation	Jan Pr	Jan-01	Jan Pr	Jan-01	Apr Pr	Mar-01	Apr Pr	Mar-01
1Y Inflation Rev.	Oct Pr	Oct-00	Oct Pr	Oct-00	Jan Pr	Jan-01	Jan Pr	Jan-01
2Y Inflation Rev.	Oct Pr	Oct-00	Oct Pr	Oct-00	Jan Pr	Jan-01	Jan Pr	Jan-01
1Y GDP	Jan Pr	Jan-01	Jan Pr	Jan-01	Apr Pr	Mar-01	Apr Pr	Mar-01
2Y GDP	Jan Pr	Jan-01	Jan Pr	Jan-01	Apr Pr	Mar-01	Apr Pr	Mar-01
1Y GDP Rev.	Oct Pr	Oct-00	Oct Pr	Oct-00	Jan Pr	Jan-01	Jan Pr	Jan-01
2Y GDP Rev.	Oct Pr	Oct-00	Oct Pr	Oct-00	Jan Pr	Jan-01	Jan Pr	Jan-01
Unemployment rate	RT	Jan-01	RT	Feb-01	RT	Mar-01	RT	Apr-01
Interest rate	RT	Jan-01	RT	Feb-01	RT	Mar-01	RT	Apr-01
Total Asset	RT	Jan-01	RT	Feb-01	RT	Mar-01	RT	Apr-01

Note: The table presents 4 examples of ECB "meeting dates". Columns (1) and (2) present two meeting dates related to the first quarter of 2000, 1st February and 1st March, respectively. Columns (3) and (4) present two meeting dates related to the second quarter of 2001. The dates were randomly chosen to show how the matching of the data was carried across two different quarters and two different meeting dates within the same quarter. The data matched with the meeting dates are the 1st and 2nd consecutive years Inflation forecasts (1Y Inflation and 2Y Inflation), the revisions of these forecasts (1Y Inflation Rev. and 2Y Inflation Rev.), the 1st and 2nd consecutive years GDP forecasts (1Y GDP and 2Y GDP), the revisions of these forecasts (1Y GDP Rev. and 2Y GDP Rev.), the current monthly unemployment rate (Unemployment Rate) the level of the interest rate (MRO interest rate) 2 weeks before the meeting date, and the monthly Total Assets of the ECB. In each column is presented first the source of the data with the month in which the data were published and whether the data were projections (Pr.) or real time data (RT), second the month and year to which they refer.
Source: The Survey of Professional Forecasters, the ECB Statistical Data Warehouse (sdw.ecb.europa.eu)

3.3.1.2 Summary Statistics

The present section presents the summary statistics of the first and the second stage of the analysis. The summary statistics are presented in Table 3.2: Panel A presents the summary statistics for the first stage of the analysis and Panel B presents the summary statistics for the second stage of the analysis. In Panel A, the data are divided between "Forecasts" and "Ex-Post" to distinguish between the forecasts retrieved from the SPF of the ECB and the ex-post data retrieved from the ECB Statistical Data Warehouse.

Table 3.2: Descriptive Statistics on the Sample (2000–2016)

		Avg	St.Dev	Median	Min	Max	Freq	N
Panel A: Forecasts	GDP 1Y	1.169	1.463	1.500	-4.600	3.500	Q	188
	GDP 2Y	1.755	0.658	1.800	0.000	3.200	Q	
	GDP 1Y Revision	-0.613	1.467	-0.200	-5.000	1.600	Q	
	GDP 2Y Revision	0.071	0.636	0.100	-1.800	1.400	Q	
	Inflation 1Y	1.752	0.791	2.000	0.000	3.500	Q	
	Inflation 2Y	1.671	0.339	1.700	1.000	2.600	Q	
	Inflation 1Y Revision	0.551	1.366	0.450	-1.600	5.400	Q	
	Inflation 2Y Revision	-0.094	0.601	0.000	-1.400	1.200	Q	
Panel B: Ex-Post	MRO	2.062	1.457	2.000	0.000	4.750	D	
	Log of Total Assets	1.414	0.108	1.486	1.193	1.537	M	
	Unemployment Rate	9.069	1.020	9.100	6.800	11.000	M	
	Commodity Index	93.753	17.399	86.805	65.890	129.310	M	204
	Industrial Production	96.953	4.766	96.550	84.500	108.600	M	
	HICP	89.817	8.156	91.285	75.130	101.130	M	

Note: The table presents the summary statistics for the data employed in my analysis. For each variable is presented: the average ("Avg", the standard deviation ("St.Dev"), the median ("Median"), the minimum ("Min"), the maximum ("Max"), the frequency at which data are sourced ("Freq") and the number of observation included in the analysis ("N"). The frequency at which data are sourced is either quarterly ("Q"), monthly ("M") or daily ("D"). The forecasted data included in the analysis are the 1 and 2 years ahead GDP and Inflation forecasts ("GDP 1Y", "GDP 2Y", "Inflation 1Y" and "Inflation 2Y") and the revisions of the forecasts for both 1 and 2 years ahead ("GDP 1Y Revision", "GDP 2Y Revision", "Inflation 1Y Revision" and "Inflation 2Y Revision"). The ex-post data included in the analysis are the interest rate level ("MRO"), the logarithm of the ECB total assets ("Log of Total Assets"), the level of the unemployment rate ("Unemployment Rate"), the ECB Commodity Index ("Commodity Index"), the ECB industrial production index ("Industrial Production index") and the Harmonised Index of Consumer Prices (HICP). Additional information on the sources and how the indexes are computed are available in Appendix B.1.
Source: The Survey of Professional Forecasters, the ECB Statistical Data Warehouse (sdw.ecb.europa.eu)

As mentioned, the first stage analysis is conducted at a meeting-by-meeting frequency, whereas the second stage of the analysis is conducted at a monthly frequency. The macroeconomic variables included in the second-stage analysis, are all available in index form at a monthly frequency and therefore, no transformation has been run on these variables. The industrial production is included in the analysis to represent output, as GDP level or growth is only available at a quarterly frequency. Cloyne & Hürtgen (2016) follow the same approach for the UK and include the industrial production index as a measure of output. Champagne & Sekkel (2018) were able to include a monthly frequency GDP level, as the BOC produces these data.

3.3.2 First Stage Analysis: The Monetary Shocks Series

3.3.2.1 The Identification Strategy

The identification strategy I adopt in my research has been proposed by Christiano, Eichenbaum & Evans (1996) and assumes that the intended change in interest rate, S_t, is the combination of a systematic component ($f(\Omega)$), which is a function of the information set, available to policy makers at the decision point,[51] and an unexpected component ε_t. Equation [3.1] formalises the function for S_t :

$$S_t = f(\Omega_t) + \varepsilon_t \quad [3.1]$$

The narrative approach of Romer & Romer (2004) aims to identify the component ε_t, which should be exogenous with respect to the information set available to policy makers at the

[51] By "decision point" I mean the meeting date, when policy makers have to deliberate on the interest rate level.

meeting time (t). Following Romer & Romer (2004), I estimate a reduced form VAR regression, to separate the systematic component $f(\Omega_t)$ from the unexpected component ε_t.:

$$\Delta_{im} = \alpha + \beta_1 \Psi_{(1y)m} + \beta_2 \Psi_{(2y)m} + \beta_3 \Delta \Psi_{(1y)[m-(m-1)]} + \\ + \beta_4 \Delta \Psi_{(2y)[m-(m-1)]} + \beta_5 \Pi_{(1y)m} + \beta_6 \Pi_{(2y)m} + \\ + \beta_7 \Delta \Pi_{(1y)[m-(m-1)]} + \beta_8 \Delta \Pi_{(2y)[m-(m-1)]} + \beta_9 \upsilon_m + \beta_{10} i_{(m-14)} + \beta_{11} A_m + \varepsilon_m \quad [3.2]$$

All the variables in equation [3.2] are at a meeting-by-meeting frequency, as defined in the subscript *m*. The detailed description of the variables included in equation [3.2], is provided in Table 3.3.

Table 3.3: Variables' Description

(1)	(2)	(3)
Symbol	Name	Description
Δ_{im}	Interest Rate change (MRO Interest Rate)	The change in the MRO rate of ECB at the meeting date ($\Delta_{im} = i_m - i_{m-1}$)
$\Psi_{(1y)m}$	1 Year ahead Inflation Forecasts	The inflation forecast level for 1 year ahead
$\Psi_{(2y)m}$	2 Years ahead Inflation Forecasts	The inflation forecast level for 2 years ahead
$\Delta \Psi_{(1y)[m-(m-1)]}$	1 Year ahead Inflation Forecasts Revision from the previous meeting	The revision of 1 year ahead inflation forecast from the previous meeting ($\Psi_{(1y)m} - \Psi_{(1y)m-1}$)
$\Delta \Psi_{(2y)[m-(m-1)]}$	2 Years ahead Inflation Forecasts Revision from the previous meeting	The revision of 2 years ahead inflation forecast from the previous meeting ($\Psi_{(2y)m} - \Psi_{(2y)m-1}$)
$\Pi_{(1y)m}$	1 Year ahead GDP Forecasts	The GDP forecast level for 1 year ahead
$\Pi_{(2y)m}$	2 Years ahead GDP Forecasts	The GDP forecast level for 2 years ahead
$\Delta \Pi_{(1y)[m-(m-1)]}$	1 Year ahead GDP Forecasts Revision from the previous meeting	The revision of 1 year ahead GDP forecast from the previous meeting ($\Pi_{(1y)m} - \Pi_{(1y)m-1}$)
$\Delta \Pi_{(1y)[m-(m-1)]}$	2 Years ahead GDP Forecasts Revision from the previous meeting	The revision of 2 years ahead GDP forecast from the previous meeting ($\Pi_{(2y)m} - \Pi_{(2y)m-1}$)
υ_m	Unemployment Rate	The unemployment rate level at the meeting date
$i_{(m-14)}$	MRO Interest Rate Level	The interest rate level two weeks before the meeting date
A_m	Total Asset	The logarithm of the Total Assets of the ECB

Note: The table presents the details of the variables included in equation [3.2]. In column (1) presented the symbol that links the included variables to equation 3.2 ("Symbol"), column (2)

Continued Table 3.3

names the variables ("Name") and column (3) ("Description") provides a short description of the variable.
Source: The Survey of Professional Forecasters, The ECB Statistical Data Warehouse (sdw.ecb.europa.eu).

The variables included in the information set of monetary policy makers are the forecasts for inflation and GDP for two years ahead. The change in forecasts from the previous meeting is also included to control for the policy makers' expectation revisions. The interest rate level two weeks prior to the meeting and the current unemployment rate are included as state of the economy controls. Differing from the original methodology of Romer & Romer (2004), the logarithm of the total assets of the ECB was included to control for the unconventional monetary policies put in place by the Governing Council of the ECB. The total assets were included following Burriel & Galesi (2018), who investigate the effect of unconventional monetary policies.

3.3.2.2 The Determinants of the Change in the ECB Policy Rate

Table 3.4 presents the results of equation [3.2] and provides novel evidence on the interest rate determinants of the ECB. The sample period 2000–2016 was broken down into a subsample crisis (2008–2016) and pre-crisis (2000–2007) sample with the purposes of investigating the interest rate determinants in the different business cycles.

Considering statistically significant estimates, my results imply that longer-term forecasts on output and shorter-term forecasts on prices are what monetary policy makers focus on when voting through monetary policy innovations. Interestingly, the results show that for the 2000–2016 period the monetary policy has been a-cyclically conducted. The forecast coefficients for outputs are positive, implying a 14 positive bps reaction of the interest rate, whereas the short-term revisions in output are negative and statistically significant, suggesting that a positive revision in output is associated with a 10 bps cut in the interest rate level. The sum of the revision coefficients shows an impact of only 4 bps, although the coefficient related to the revision of the two-years forecast is insignificant and therefore unstable.

Table 3.4: Determinants of the Change (Δ) in the Policy Rate

	(1)		(2)		(3)	
	Whole Sample		**Pre-Crisis Sample**		**Post-Crisis Sample**	
	2000–2016		2000–2007		2008–2016	
	Coeff	SE	Coeff	SE	Coeff	SE
Δ Interest Rate	0.077	(0.093)	-0.219*	(0.121)	0.016	(0.152)
Output						
Forecast (1y)	-0.015	(0.017)	0.003	(0.051)	-0.024	(0.022)
Forecast (2y)	0.144**	(0.055)	0.307***	(0.097)	0.053	(0.083)
Forecast Δ (1y)	-0.115**	(0.046)	0.160	(0.119)	-0.079	(0.051)
Forecast Δ (2y)	0.072	(0.087)	0.035	(0.147)	0.033	(0.078)
Inflation						
Forecast (1y)	0.097**	(0.043)	0.218**	(0.099)	0.166***	(0.051)
Forecast (2y)	0.063	(0.075)	0.041	(0.119)	-0.006	(0.107)
Forecast Δ (1y)	-0.005	(0.018)	0.036	(0.041)	-0.012	(0.021)
Forecast Δ (2y)	0.033	(0.057)	0.133	(0.091)	0.046	(0.066)
Unemployment Rate	0.004	(0.017)	-0.175	(0.13)	-0.030	(0.023)
Interest Rate$_{(t-14)}$	-0.067***	(0.023)	-0.187***	(0.063)	-0.126**	(0.054)
Total Assets	0.864*	(0.513)	-0.670*	(4.536)	-0.219	(1.861)
Observations	187		90		97	
R^2	0.34		0.46		0.51	

Notes: The table presents the results of equation [3.2] for the whole sample (“Whole Sample”, 2000–2016) in column (1), for the pre-crisis sample (“Pre-Crisis Sample”, 2000–2007) in column (2) and for the post-crisis sample (“Post-Crisis, 2008–2016) in column (3). Equation [3.2] is estimated with a reduced form VAR. The detailed variables included in the analysis are presented in Table 3.2. The dependent variable is represented by the interest rate change (MRO). Robust White Standard errors in parenthesis; asterisks indicate statistical significance i.e. (***:p<0.01,**:p<0.05,*:p<0.1).
Source: SPF, Survey of Professional Forecasters, Economic Bulletin, ECB Statistical Data Warehouse, ECB Website.

The coefficients related to inflation (forecasts and revisions) on the whole sample are less informative as only the 1-year forecast is positive and statistically significant, suggesting that a 1% increment in prices forecasts is associated with an interest rate hike of about 10 bps. Statistically significant and with a negative sign is the interest rate level 14 days before the meeting, which suggests a sort of mean-reverting behaviour when voting through an interest rate change.

The comparison between the pre-crisis and post-crisis period shows interesting asymmetries with the 2-years forecast in output being only significant during the pre-crisis sample and the 1-year revision forecasts in output becoming insignificant. A 1% positive "longer-term" forecast in output is associated in the pre-crisis sample with a contraction in the interest rate of over 30 bps. The short-term inflation forecasts (1-year forecast) remains the only variable positive and statistically significant throughout the analysis. This result is in line with expectations, since IT and price stability has been the first pillar of the ECB monetary strategy since 1999 when it was combined with reserves targeting and further when the inflation target was redefined to be close to but below 2% in 2003. The coefficient on short-term inflation forecasts is statistically significant at 1% during the post-crisis period and only at 5% during the pre-crisis period, with a mild difference of 5 bps between the two.

The variable presenting the logarithm of the total assets of the ECB, included to account for the unconventional monetary policy put in place by the Governing Council of the ECB during the sample period is statistically significant across the whole sample period, showing a positive 86 bps reaction in the interest rate for a variation in total assets. The variable is, however, only mildly significant (at 10%) and negative during the pre-crisis period and is insignificant in the post-crisis period, when the unconventional monetary policy was put in place.

The interest rate 14 days before the meeting date remains negative and strongly significant (at 1%) in the pre-crisis period and significant in post-crisis period (at 5%). Both the coefficients show a mean-reverting behaviour, also confirmed by the mildly statistical significance of the lagged variable during the pre-crisis period (Δ Interest Rate). A 1% change in the interest rate was associated with a future reduction of the almost 20 bps, which perhaps could be interpreted as an interest rate "smoothing" behaviour of the ECB. As a preceding interest rate rise is associated with a reduction in the interest rate, it can be inferred that the ECB is willing to maintain a certain balance in the official interest rate. This result is in line with the findings of the seminal work of Clarida, Gali & Gertler (1998), who find that the interest rate path for European countries could have been well described by adding a "smoothing factor" to the Taylor Rule.

The pre-crisis sample is comparable to other studies conducted under different institutional settings: in the United Kingdom by Cloyne & Hürtgen (2016) and Champagne & Sekkel (2018) and in Canada by Champagne & Sekkel (2018). These two studies also document an a-cyclical behaviour in the conduct of monetary policy. In line with the results of Romer & Romer (2004) the R^2 for the whole sample analysis shows that a third of the decisions regarding the ECB interest rate levels have been taken based on forecasts. The comparison between my results and those of Romer & Romer (2004) is far from perfect. Their study encompasses, in fact, very different economic cycles and further benefits from a larger sample size. Nonetheless, the results on output in particular are similar in magnitude to what they found in the US (Romer & Romer, 2004 found a response of almost 30 bps to a 1% positive change in output, similar to what I find in the pre-crisis period).

3.3.2.3 Analysing the New Shocks Series

The residuals of equation [3.2] represent the component ε_t of equation [3.1], and therefore my new measure of exogenous monetary shocks for the Eurozone. Following Romer & Romer (2004), I convert the monetary shock series from a meeting-by-meeting frequency to a monthly frequency, by assigning each shock to the month in which the corresponding meeting occurred and 0% for each month where no meeting had occurred. It needs to be recalled that in other countries' samples, the frequency of the meetings is closer to quarterly, rather than monthly. The months where a 0% shock was assigned are fewer in the case of the ECB, compared to the FED, BOE and BOC. The new monetary policy shock series is plotted in Figure 3.1.

The series of monetary policy shocks shows a high level of volatility around the period of the 2008 financial crisis and a more modest level of volatility in the pre-crisis period and across the last part of the sample. Several facts need to be recalled to correctly interpret the series. First, after the 2008 financial crisis, the ECB put in place unconventional monetary policy programmes, differing from the countries included in past studies (Cloyne & Hürtgen, 2016; Champagne & Sekkel, 2018). Second, the 2011 crisis undoubtedly had a greater impact on the Eurozone than on other economic areas. Third, previous studies include different sample periods, which makes comparisons less reliable. Cloyne & Hürtgen (2016) do not include the 2008 financial crisis in their sample while Champagne & Sekkel (2018) include the years 2008–2014 in their sample, although they found greater volatility in the monetary shocks series between 1974 and 1994.

The sharp increase and then decline of the interest rate between 2000 and 2004, is responsible for the sustained volatility of the shock series in the pre-crisis period. For most of the monetary policy institutions around the world interest rates have been, on the aftermath of the financial crisis, maintained steadily low and combined with other monetary policies. The persistence of negative shocks in the last part of the sample (particularly after 2014) could be due to the presence of these additional unconventional monetary policy programmes.

To the best of my knowledge, this is the first monetary shock series computed for the ECB with this specific methodology. Other recent studies have produced monetary shock series for the Eurozone employing different methodologies, mostly with financial markets-based variables. Recently Altavilla et al. (2019) and Jarocinski & Karadi (2020), building on the methodology of Gertler & Karadi (2015), built two different monetary shock series for the

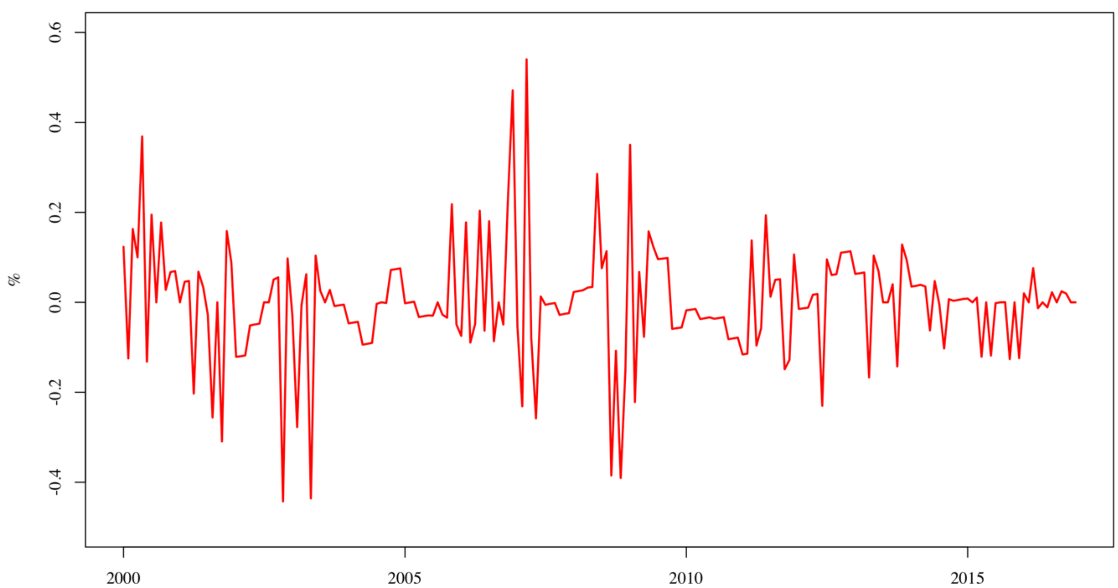

Figure 3.1. Exogenous Monetary Shocks for the ECB
Notes: Figure 3.1 presents my new monthly shock series for the Eurozone, computed following the methodology of Romer & Romer (2004) and presented in section 3.3.2. The monetary shocks series is represented by the residual term of equation 3.2. As the analysis was conducted at a meeting by meeting frequency, to convert my monetary shocks series into a monthly shocks series, I have assigned 0% for every month where no ECB meeting was held. Sample: 2000–2016

Eurozone based on financial markets' variables and both follow a sign-restriction methodology.[52] These monetary shock series are, however, derived with a very different procedure that makes them less comparable to my monetary shocks series[53].

3.3.2.4 The Unpredictability of the Monetary Shocks Series

Following Coibion (2012) and then Cloyne & Hürtgen (2016) and Champagne & Sekkel (2018), I test whether my new measure of monetary policy shocks is unpredictable. To do so, I run a series of Granger tests against additional macroeconomic variables. The monthly series of monetary policy shocks is regressed against a set of lagged macroeconomic variables. In particular, I include the unemployment rate, the change in industrial production, the money supply, the Produce Price Inflation (PPI) index and inflation (CPI). Equation [3.3] summarises the test:

$$\varepsilon_t = c + \Sigma_{(i=1)} \gamma_i \kappa_{t-I} \qquad [3.3]$$

Under the null hypothesis that ε_t is unpredictable, the γ_i are jointly equal to 0. Table 3.5 presents the F-statistics and P-Value for the test. The shock series shows a high degree of unpredictability, which allows me to employ it to estimate the response of inflation and output.

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[52] The sign-restriction methodology, as previously mentioned, allowed the authors to identify "Pure Policy Shocks" and "Information Shocks". "Pure Policy Shocks" are monetary policy shocks, followed by a decline in equity prices. Vice versa "Information Shocks" are followed by a rise in stock prices. A similar methodology was first proposed by Uhlig (2005) and further re-defined by Gertler & Karadi (2015).

[53] To the best of my knowledge, this chapter presents the first monetary shocks series for the ECB computed with a narrative methodology.

Table 3.5: Predictability of the Monetary Policy Shocks Series

	(1)		(2)	
	I = 3 lags		I = 6 lags	
Variable	*F*	*P-value*	*F*	*P-value*
Unemployment Rate	0.531	0.662	0.954	0.457
Change in Industrial Production	0.596	0.618	1.519	0.173
Money Supply	0.634	0.594	0.438	0.852
PPI	0.325	0.807	0.517	0.794
CPI	1.281	0.282	0.598	0.731
Commodity Index	0.481	0.696	0.446	0.846

Note: The table presents the results for equation [3.3] and represents a series of Granger test with 3 and 6 lags, respectively, which I have run to confirm the unpredictability of monetary series. The variable included in the analysis are the unemployment rate, the change in the industrial production index, the log of the money supply, the PPI index, the CPI index and the ECB commodity index. The dependent variable is represented by the measure of monetary shocks, computed in equation [3.2]. Column (1) presents the results related to the 3 lags and the related F-test and P-Value of the test. Column (2) presents the same tests, but computed with 6 lags.
Source: SPF, Survey of Professional Forecasters, Economic Bulletin, ECB Statistical Data Warehouse, ECB Website.

3.3.3 Second-Stage Analysis: VAR and Local Projections

The next stage of my analysis aims to identify the effects of the monetary shocks series on the Eurozone economy. To do so, I employ two different methodologies: VARs and Local Linear Projections (LPs) *á la* Jordà (2005). The studies of Romer & Romer (2004), Cloyne & Hürtgen (2016) and Champagne & Sekkel (2018) all include parsimonious VARs with large lags, which have become a standard in empirical macroeconomic research since Sims (1980).

LPs differ from VARs mainly in their estimation methodology: they can be estimated by simple least squares, they are robust to the data generating process (whereas VARs may be a significantly misspecified as a representation of the data generating process) and they easily accommodate experimentation with highly non-linear specifications.

The suggestion of Jordà (2005) on why LPs are preferable to VARs when estimating impulse responses revolves around the key insight in the estimation of the impulse responses with a model based on the sample, such as a VAR. A VAR represents a linear global approximation of the data generating process, optimal for a 1-period ahead forecast, even when the model is misspecified. Jordà (2005) argues that as impulse responses are a function of forecasts at increasingly distant horizons and misspecifications errors are compounded with the forecasts horizon, LPs are therefore preferable as they represent a collection of local projections to each forecast horizon. Furthermore, Jordà (2005) points out that since LPs are based on sequential regressions of the endogenous variable shifted several steps ahead, they are more similar to multi-step direct forecasts rather then iterated forecasts.

Recently, LPs have been challenged by Plagborg-Møller & Wolf (2019), who claim that LPs and VARs produce a similar impulse response function, arguing against the robustness of LPs to model misspecifications compared to VARs. Their findings are, however, strongly linked to unrestricted lag lengths. In simple terms, iterated VAR(∞) forecasts coincide with direct LP forecasts. Therefore, if the results differ between the two methodologies, it is due to lags restrictions. They also acknowledge, that empirically, researchers working with a "smaller" sample size are going to be limited in the lags number and, therefore, will obtain different impulse response from the two methodologies.

The first methodology employed is the parsimonious VAR, which includes only 4 variables at a monthly frequency: the log of the industrial production index (IP index), the log of the harmonized index of consumer prices (HICP index), the log of the ECB commodity price index and my measure of monetary policy shocks. The estimated second-stage VAR is:

$$Z_t = P(L)\, Z_{t-1} + \varepsilon_t \qquad [\ 3.4\ ]$$

where $P(L)$ is a lag polynomial with 5 lags, including a constant and a time trend.

The main specification of my VAR includes the vector of observable Z_t defined as: $[\ Y_t,\ P_t,\ P.Com_t,\ C.shock_t\ ]$ and a constant and a trend. Y_t is the log of the IP index, P_t is the log of the HICP index, $P.Com_t$ is the log of the ECB commodity index and $C.shock_t$ is my measure of monetary policy shocks. The macroeconomic variables included in the analysis are all in the form of the variable "level", not the change. Therefore, I cumulate my measure of monetary shocks[54] and order it last in the VAR.

The lags were chosen by conducting different lag length tests. When setting the maximum lag length at 12, the Akaike Information Criterion (AIC) suggests 7 lags, whereas the Schwarz Criterion (BIC) suggests 5 lags. As my sample is rather small, I rely on the BIC test. Romer & Romer (2004) include 36 lags in their VAR, whereas Cloyne & Hürtgen (2016) and Champagne & Sekkel (2018) include 24 lag. These large lags VARs are not suitable for my sample size. The impulse responses, which represents the main results of this chapter are all presented in subsection 3.4.1.

Alternatively to the VAR methodology, I estimate and model LPs. Cloyne & Hürtgen (2016) and Champagne & Sekkel (2018) add the estimations with local projections to their results, finding them in line with the VAR, although slightly stronger. Fieldhouse, Martens & Ravn (2018) recently applied this methodology and also followed a narrative

[54] I followed the same approach as Romer & Romer (2004) and the more recent Cloyne & Hürtgen (2016) and Champagne & Sekkel (2018)

identification strategy to investigate the portfolio activity of federal housing agencies and its impact on mortgage markets and the economy.

In particular, I estimate the following local projection model:

$$x_{t+h} - x_t = c + P(L)Z_{t-1} + \beta_h \, C.shock_t + \varepsilon_{t+h} \quad [\ 3.5\ ]$$

where h = 0,1,2,…24.

The variable of interest is x, P(L) is a polynomial lag operator, Z_{t-1} is a vector of controls, which includes the same variables included in the VAR (equation [3.4]). $C.shock_t$ is my measure of cumulated monetary policy shocks. The same number of lags was included in the analysis, as in the previous VAR methodology. The impulse responses produced from this analysis are presented in subsection 3.4.2.

3.4 Empirical Results

This section presents the results of the second-stage analysis presented in subsection 3.3.3. The results, represented by the impulse responses of inflation and industrial production, are firstly estimated with a promiscuous VAR and secondly with the LPs methodology. The VAR analysis is further extended to additional macroeconomic variables and trade variables. The HICP index employed in the analysis to investigate the response of inflation to monetary shocks is the weighted average of the HICP indexes of the single Eurozone countries. Even though it is highly representative of the inflation response across these countries, I investigate the responses of the single country HICP indexes to shed light on eventual asymmetries. Clarida, Gali & Gertler (1998) firstly analyse the asymmetries among the (now defined) Eurozone countries and the different effects of the conduct of monetary policy.

The 2011 sovereign debt crisis has also highlighted important imbalances among countries. Shedding light on these imbalances indirectly tests the efficiency of the ECB in supporting the economy of the single countries. Building on this reasoning, I also investigate the response of the output of single Eurozone countries.

Given the additional flexibility of the LPs methodology and the suitability for smaller samples, I estimate a quarterly specification of equation [3.5] to investigate the effects directly on the GDP. Romer & Romer (2004) as well as Cloyne & Hürtgen (2016), employ industrial production as a measure of output, given the fact that GDP is not available at a monthly frequency. Champagne & Sekkel (2018) are able to directly analyse the response of GDP as the BOC provides a monthly frequency estimate of real GDP. Lastly, to corroborate my results I investigate whether employing the narrative approach resolves the "Price Puzzle" firstly documented by Sims (1992).

3.4.1 VAR

3.4.1.1 Eurozone: Inflation and Industrial Production

Figure 3.2 presents the impulse responses to my monetary shock series for prices (inflation) in Panel A and output (industrial production) in Panel B, computed from the second-stage VAR presented in equation [3.4]. The VAR includes the HICP index, the industrial production index, the ECB commodity index, my measure of monetary shocks,[55]a constant

[55] The impulse responses to a 100 bps monetary shocks for all the 4 variables included in the analysis are presented in appendix B.2.

and a trend.[56] The impulse responses are plotted along with 95% bootstrapped confidence bands and are not statistically significant. Panel A documents a weak and statistically insignificant response of inflation with a very modest decreasing tendency at the end of 24 months. The weak response of inflation is also documented by Champagne & Sekkel (2018), who find a modest 0.4% decline after 36 months. The studies that analyse other countries (Romer & Romer, 2004; Cloyne & Hürtgen, 2016; Champagne & Sekkel, 2018) are able to retrieve longer estimates of the responses (36 months), with much larger lags selection thanks to the size of their sample.

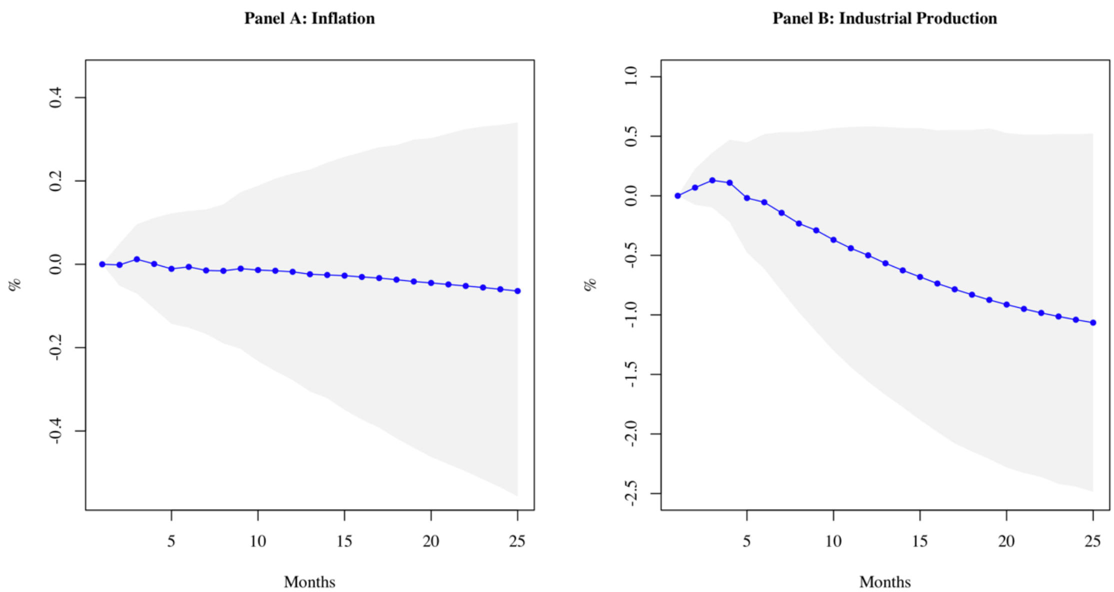


Figure 3.2 The Response Functions to a Monetary Policy Shock.
Note: In Panel A, the blue path corresponds to the impulse response of prices (inflation) to a 100 bps contractionary monetary policy shock, plotted along with 95% bootstrapped confidence bands (grey area). In panel B, the blue path corresponds to the impulse response of output (industrial production index) to a 100 bps contractionary monetary policy shock, plotted along with 95% bootstrapped confidence bands (grey area). P= 5, 2000 repetitions. Sample: 2000–2016.

[56] A robustness check was carried excluding the constant and the trend and the results are qualitatively identical. The impulse responses can be found in appendix B.3.

Panel B presents the response function of industrial production to a 100 bps contractionary monetary shock. In the first 5 months output, represented by industrial production, shows a small increment of about 0.15% and starts its downward path after 10 months. The decline persists for 24 months, reaching -0.5% after 15 months and peaking around -1% at the end of the path (24 months). Similarly, Cloyne & Hürtgen (2016) and Champagne & Sekkel (2018) find that output declines consistently up to -1%, around 18 to 24 months after the shock. Even though the response of output is closer to the lower bound the results are still statistically insignificant at 95% confidence level. Additional explanations for this result will be provided with the LPs' analysis and the analysis of single Eurozone countries.

3.4.1.2 Eurozone: Comparisons with the Romer & Romer (2004) Shocks Series

To construct my new measure of shocks series I extend the narrative identification of Romer & Romer (2004) and include the total assets of the ECB, following Burriel & Galesi (2018) to account for all the unconventional monetary policy programmes put in place by the Governing Council of the ECB. I also re-estimate the monetary shocks series, mirroring Romer & Romer (2004) and therefore excluding the total assets from the first-stage VAR. I estimate the impulse responses with respect to this monetary shock series and plot the results in Figure 3.3,[57] along with the impulse responses presented in Figure 3.2. The response is weaker in the case of output and stronger in the case of inflation. The impulse

[57] The variables included in the VAR are the one described in equation [3.4], including a constant and a trend. The impulse response for all the variables included in the analysis (equation [3.4], where the monetary shocks series was computed by excluding the logarithm of the total assets of the ECB) are presented in Appendix B.7.

responses produced in this analysis show are also statistically insignificant as in the previous case.

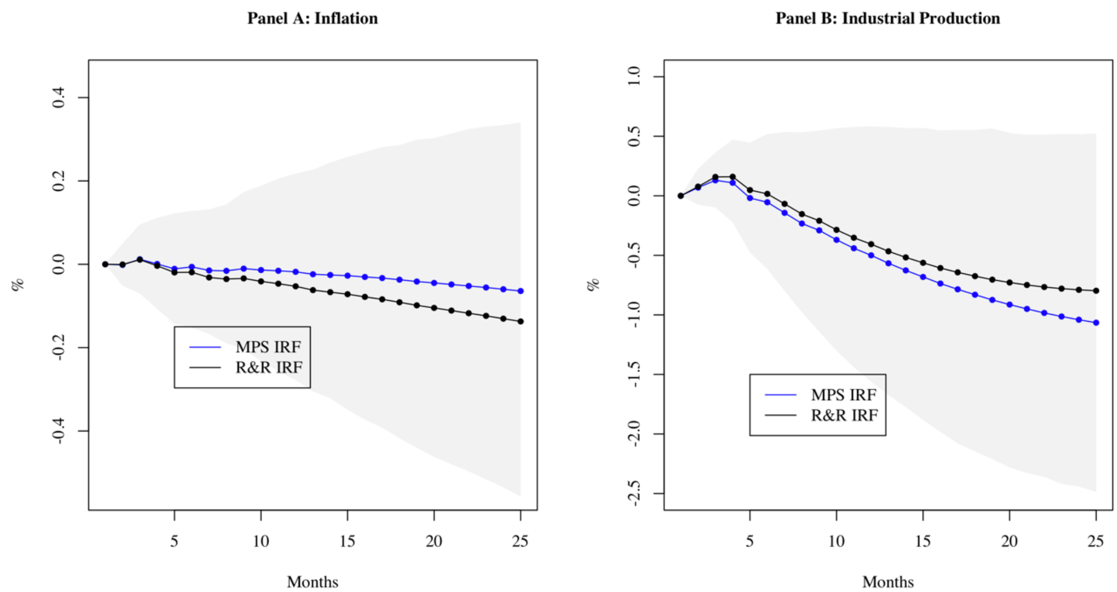


Figure 3.3 The Response Functions to a Monetary Policy Shock comparison with the Romer & Romer (2004) series

Note: In Panel A, the blue path corresponds to the impulse response of inflation to a 100 bps contractionary monetary policy shock, plotted along with 95% confidence bands (grey area). In panel B, the blue path corresponds to the impulse response of output to a 100 bps contractionary monetary policy shock, plotted along with 95% confidence bands (grey area). The black dotted line corresponds to the impulse responses of inflation and output (Panel A and B, respectively) to a 100 bps monetary policy shock, computed with the traditional methodology of Romer & Romer (2004) in the first-stage regression. P= 5, 2000 repetitions. Sample: 2000–2016.

These controversial results can be partially ascribed to the heterogeneity in the results found by Burriel & Galesi (2018) in the response of single Eurozone countries to unconventional monetary policy programmes. Unconventional monetary policies have a stronger effect on inflation, as reported by Burriel & Galesi (2018), showing a defined decline at the end of the path, unlike to conventional monetary policy shocks. The response of output is also stronger but displays a relevant initial positive peak similar to the findings in figure 3.2 and the more pronounce initial peak in Figure 3.3. Overall, the results are virtually similar, and in both cases lies on the same confidence bands.

3.4.1.3 Additional Macroeconomic Variables

In this section, I present the results for an extended second-stage VAR analysis, including additional macroeconomic variables. Specifically, compared to the VAR described in equation [3.4], I add the PPI index and the unemployment rate. The VAR includes 7 lags, as suggested by the BIC tests when adding these two additional variables.

The responses resulting from this VAR are presented in Figure 3.4.[58]

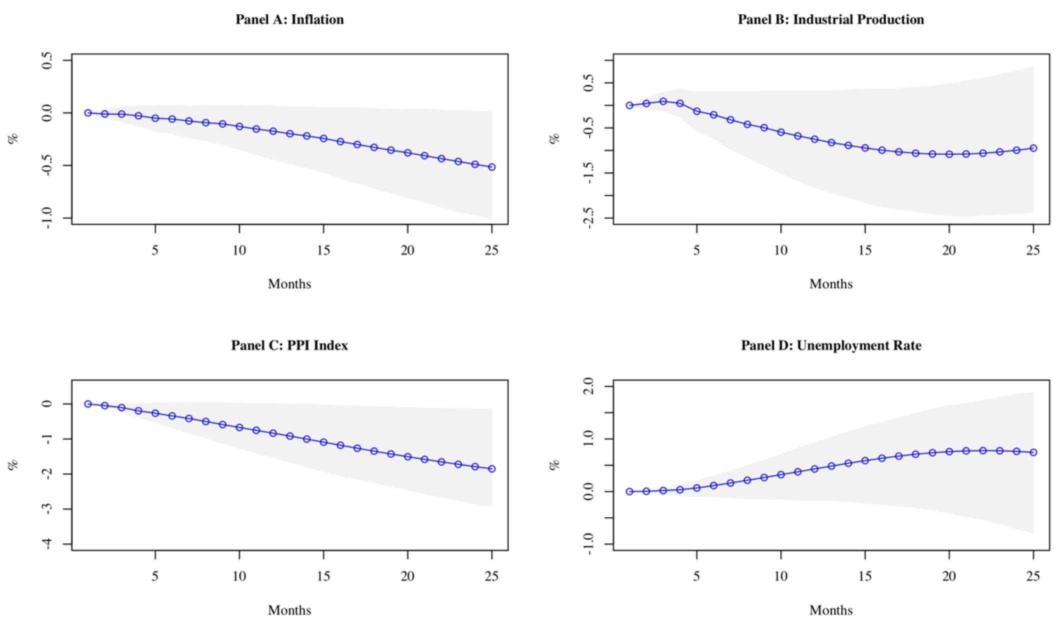


Figure 3.4 VAR Additional Macroeconomic variables.
Note: The Figure presents the impulse responses of an extended VAR that includes all the variables described in equation [3.4] plus the log of the PPI index and the unemployment Rate. Panel A, B, C and D present the response of 100 bps monetary policy shocks of log of (inflation), output (the industrial production index), the PPI index and the unemployment rate, respectively. The impulse responses are plotted along with the 95% confidence bands. P= 7, 2000 repetitions. Sample: 2000–2016.

[58] The impulse response of all the variables included in the analysis can be found in Appendix B.4.

Champagne & Sekkel (2018) also include additional variables in their analysis. They include the unemployment rate and find an increase of 0.5% 2 years after the shock. The unemployment rate, similar to the findings of Champagne & Sekkel (2018) increase by almost 1% after 18 months. The tendency is increasing throughout the response of the unemployment rate but remains constant after reaching its peak. The PPI index experiences a strong decline, starting immediately and being almost monotonic until its statistically significant peak after 24 months. When adding these two additional variables the dynamics of inflation and industrial production also slightly change. Both the responses of industrial production and inflation show a more marked decline, more evident in the case of inflation. However, as for the previous analysis the impulse responses are not statistically significant at 95% confidence level.

3.4.1.4 Additional Macroeconomic Variables – Trade Variables

For completeness, I also estimate an extended VAR including trade variables. Similar to Champagne & Sekkel (2018), I estimate an extended VAR that includes the variable of equation [3.4], the exchange rate EUR/USD, the import index and the export index.[59] Champagne & Sekkel (2018) find a decrease in the exchange rate USD/CAD and a decrease both in the case of import and export, starting after 12 months.

The results are essentially similar to my findings for the Eurozone, finding an mildly statistically significant appreciation of the Euro, after 100 bps contractionary monetary policy shocks and a persistent decline in imports and exports, starting 5 months after the

[59] The responses of all the variables included in the analysis to a 100 bps monetary shocks are reported in Appendix B5.

shocks in both cases. The import index, although, more similar to the path followed by industrial production, has an initial rise of 0.25%, before starting the decline after 7 months. Industrial production index and inflation results remain similar to the original VAR results.

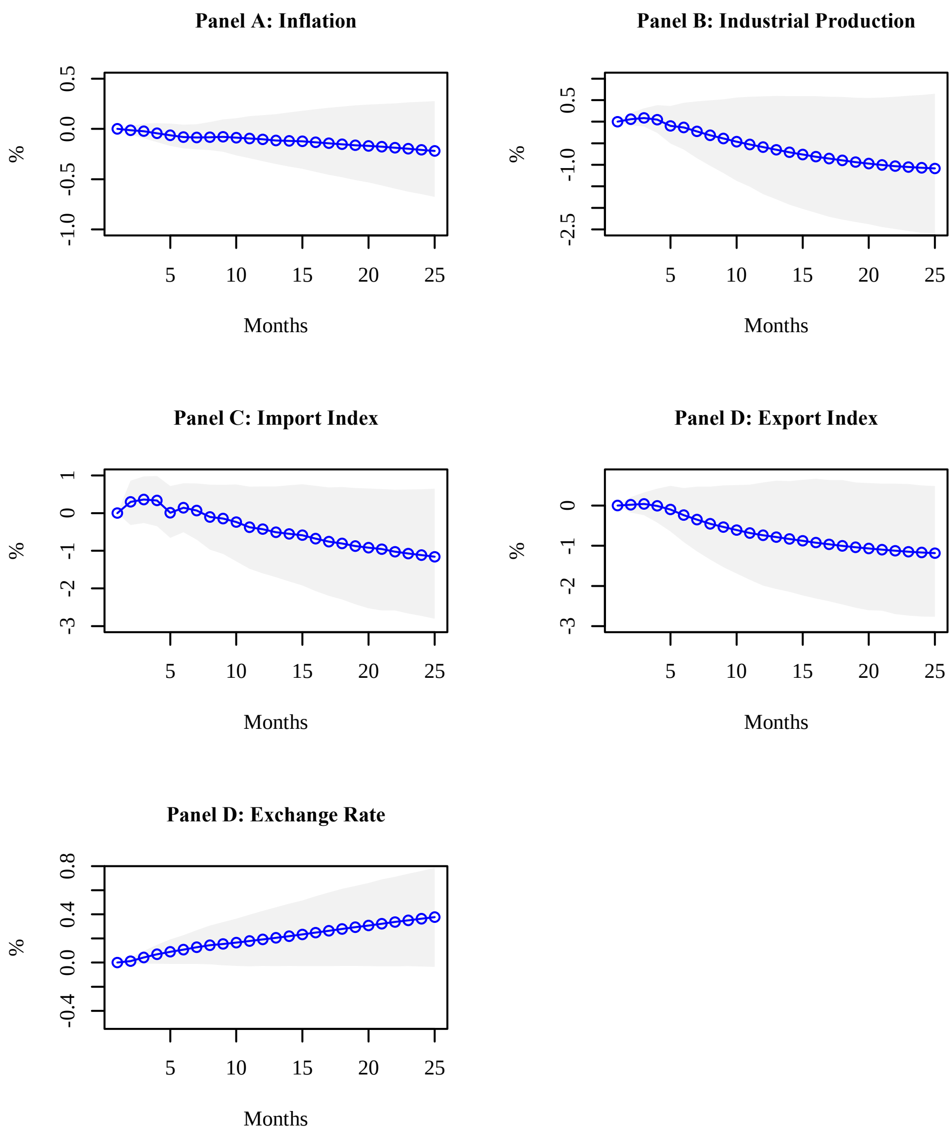


Figure 3.5 VAR Additional Macroeconomic variables – Trade Variables

Note: The Figure presents the impulse responses of an extended VAR that includes all the variables described in equation [3.4] plus the log of the Import index, the Export index and the exchange rate. Panel A, B, C, D and E present the response of 100 bps monetary policy shocks of log of inflation, output, the log of the Import Index, the Export index and the exchange rate, respectively. The impulse responses are plotted along with 95% confidence bands. P=7, 2000 repetitions. Sample: 2000-2016

3.4.2 Local Projections

This section presents the impulse responses estimated following equation [3.5] and employing LPs *á la* Jordà (2005). First, I will present a replication of the analysis previously conducted with the second-stage VAR analysis, which has quantified the effect of my new series of monetary shocks primarily on Eurozone prices (HICP index) and output (industrial production index) and then on other macroeconomic variables of interest. The results have partially mirrored the results previously found in the literature, providing empirical evidence of a weak unstable response of prices and more pronounced effect on output. Second, I will present an additional analysis, intended to investigate the different response of prices and output across the Eurozone countries, specifically Germany, France, Spain, Greece, Italy and Portugal.[60]

The analysis on the single Eurozone countries is specifically conducted with the LPs' methodology for two main reasons: first the results on different macroeconomic variables of the previous subsection (3.4.1) were rather unstable. Second, as previously mentioned in the methodology section 3.3.3 the LPs' methodology normally yields more "detailed" paths compared to the VARs, given how the forecasts are computed. Since the Eurozone countries indexes are the "components" of the overall Eurozone HICP and the industrial production indexes, I expect to find some similarities in the responses but also differences, which can be better highlighted by the more detailed path produced by LPs.

[60] For completeness the analysis was conducted also with the VAR presented in equation [3.4] for all 6 Eurozone countries. The impulse responses for all the variables for each country are presented in Appendix B (B.17, B.18, B.19, B.20, B.21, and B.22). The impulse responses estimated with the VAR present qualitatively very similar paths to the one estimated with LPs, although less "specified".

3.4.2.1 Eurozone: Inflation and Industrial Production

Figure 3.6 shows the impulse responses to a 100 bps contractionary monetary policy shock computed with the local linear projections of prices (inflation) and output (industrial production index).[61] The results for industrial production and inflation are similar in tendency to the one obtained with the baseline VAR methodology, although as expected the path obtained with LPs is much more volatile than the one obtained with the VAR, given also the specification of the model. The response of output shows a more consistent rise in the first stage of the period, rising about 0.25% after 5 months. The downward path of the output begins after 10 months, consistent with the VAR estimate, and continues till the 24th month, although the estimate only predicts an overall decline of 0.5%.

The decline starts after 10 months with quite a sharp decrease from about +0.15% to –0.25. The response of inflation is more pronounced than the estimations obtained with the VAR, showing a more marked downward tendency after 5 months and terminating after 24 months with an overall decline of 0.05%. In line with the VAR results and past studies, output still remains more responsive than inflation to monetary shocks. Different from the results estimated in the VAR, the response of output is statistically significant after 10

[61] The impulse responses of all the variables included in the analysis can be found in Appendix B.8.

months when the proper decline starts, whereas it remains insignificant for inflation throughout the periods.

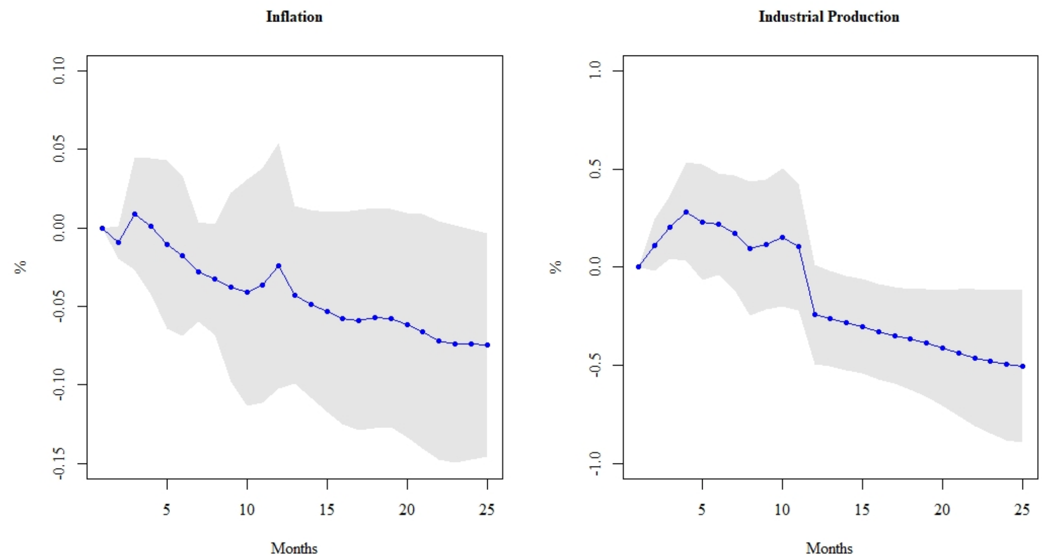


Figure 3.6 Impulse Responses to Monetary Policy Shocks – Local Projections
Note: The figure presents the impulse responses of inflation and output (respectively) to a 100 bps contractionary monetary policy shock, plotted along with the 95% confidence intervals (the grey area). The impulse responses are computed with local projections *á la* Jordà (2005) from the model presented in equation [3.5]. P=5, 2000 repetitions. Sample: 2000-2016

3.4.2.2 Countries' Specifications: Inflation and Industrial Production

In this section, I investigate whether the response of industrial production and inflation varies across the Eurozone countries. In particular, I investigate the response of Germany, France, Spain, Italy, Portugal and Greece. Previous studies conducted in Canada (Champagne & Sekkel, 2018) and the UK (Cloyne and Hürtgen, 2016) analysed the effects of monetary shocks on small open economies. Differently from BOE and BOC, the decisions of the ECB affect a number of deeply diverse countries. Clarida, Gali & Gertler (1998) analysed the monetary policy of European countries and found different effects on them.

Since their seminal studies, less has been investigated on the Eurozone given its “young” age and therefore the lack of historical data. Even less has been said on the single Eurozone countries, even though the 2011 Sovereign Debt Crisis has highlighted the differences among countries. Figures 3.7–3.12 present the impulse responses for the Eurozone countries, plotted along with the impulse response for the overall Eurozone for comparison. To analyse the countries difference I employ the LPs methodology to obtain a more precise path to compare with the overall path of the Eurozone.

Germany

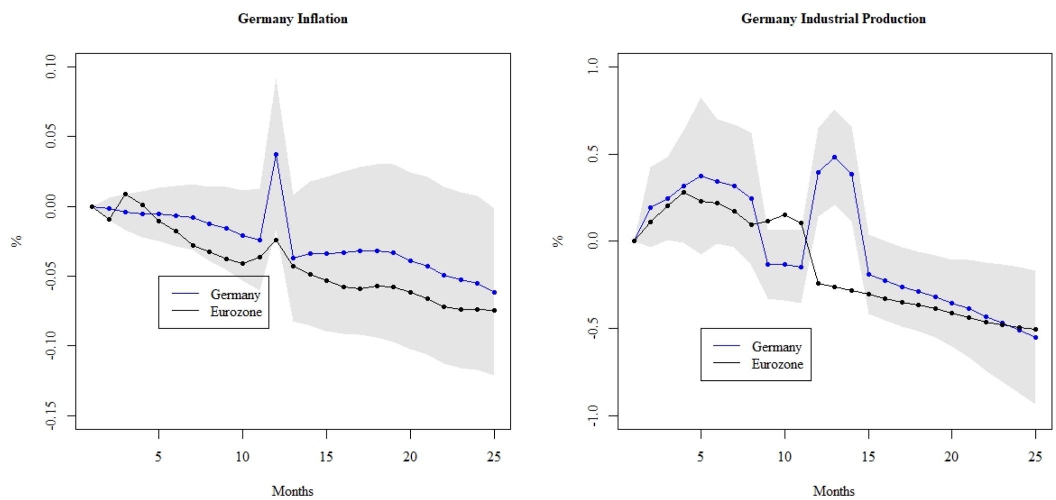


Figure 3.7 LP - Germany
Note: The figure presents the impulse responses of inflation and output to a 100 bps contractionary monetary policy shock, plotted along with the 95% confidence intervals (the grey area). The blue line represents the impulse responses for Germany, whereas the black line represents the impulse responses for the whole Eurozone. The impulse responses are computed with local projections *á la* Jordà (2005) from the model presented in equation [3.5]. P=5, 2000 repetitions. Sample: 2000-2016

Figure 3.7 presents the impulse responses for Germany of inflation and industrial production respectively.[62] The impulse response of German inflation is essentially in line with the response of the Eurozone, excluding a more marked peak between 10 and 15 months. The decline is less pronounced, although persistence until the end of the 24th month. The decline in output starts at a later time, after 15 months, whereas the initial peak is characterised by a higher volatility. Between the 10th and 15th month I observe a second peak that reaches almost +0.5%. The overall effect on the macroeconomic variables is

[62] The impulse responses of all the variables included in the analysis can be found in Appendix B.9.

virtually the same at the end of the periods, the path to reach it is similar in tendency in the case of inflation and very divergent in the case of the output, especially in the first half.

France

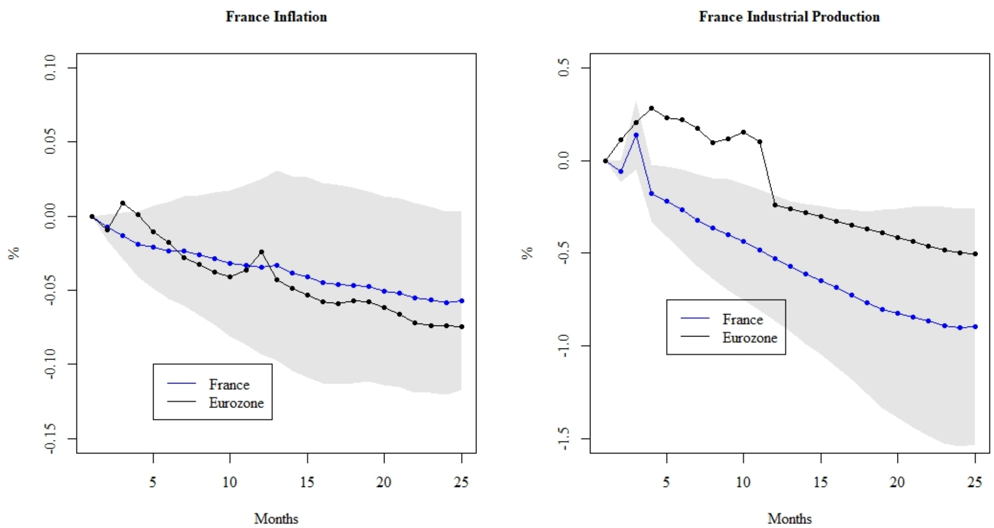


Figure 3.8 LP - France
Note: The figure presents the impulse responses of inflation and output to a 100 bps contractionary monetary policy shock, plotted along with the 95% confidence intervals (the grey area). The blue line represents the impulse responses for France, whereas the black line represents the impulse responses for the whole Eurozone. The impulse responses are computed with local projections *á la* Jordà (2005) from the model presented in equation [3.5]. P=5, 2000 repetitions. Sample: 2000-2016

Figure 3.8 presents the impulse responses for inflation and industrial production in the case of France.[63] Differently from the previous results in Germany, the responses of France are more "linear" compared to both Germany and the overall Eurozone. The response of inflation is a consistent decline that culminates in an overall –0.05%, in line with the overall Eurozone. The result of industrial production is in line with this tendency, although the response is overall stronger compared to the overall Eurozone. The industrial production

[63] The impulse responses of all the variables included in the analysis can be found in Appendix B.10.

in France declines by an overall 0.8%, consistently higher then the overall response of the Eurozone and Germany. Furthermore, the initial peak of the industrial production is practically non–existent in the case of France with a peak of only about 0.1% initially and ending before 5 months.

Spain

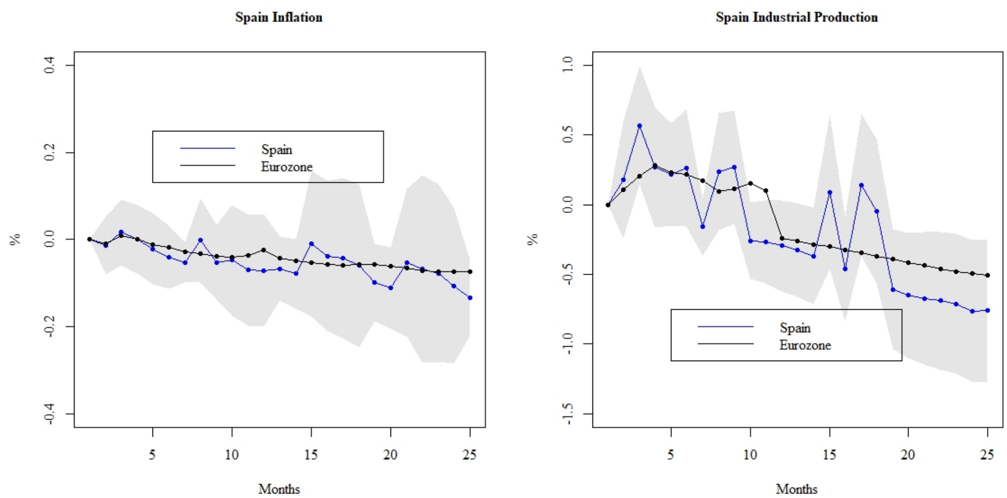


Figure 3.9 LP - Spain
Note: The figure presents the impulse responses of inflation and output to a 100 bps contractionary monetary policy shock, plotted along with the 95% confidence intervals (the grey area). The blue line represents the impulse responses for Spain, whereas the black line represents the impulse responses for the whole Eurozone. The impulse responses are computed with local projections *á la* Jordà (2005) from the model presented in equation [3.5]. P=5, 2000 repetitions. Sample: 2000-2016

Figure 3.9 shows the impulse responses of inflation and industrial production of Spain.[64] The paths of both macroeconomic variables are both more volatile then the overall response of the Eurozone macroeconomic variables. The overall decline of inflation is volatile and culminates in an overall decrease of 0.1%. The path of Spain industrial

[64] The impulse responses of all the variables included in the analysis can be found in Appendix B.11.

production is different from the overall Eurozone and the other countries. The tendency of the industrial production response is negative, although the constant decline starts only at the 18th month.

The volatility of the initial peaks continues and reflects more the response observed in that of France. Similarly, the overall decline is stronger than the overall Eurozone (0.75% approximately against the 0.5%).

Italy

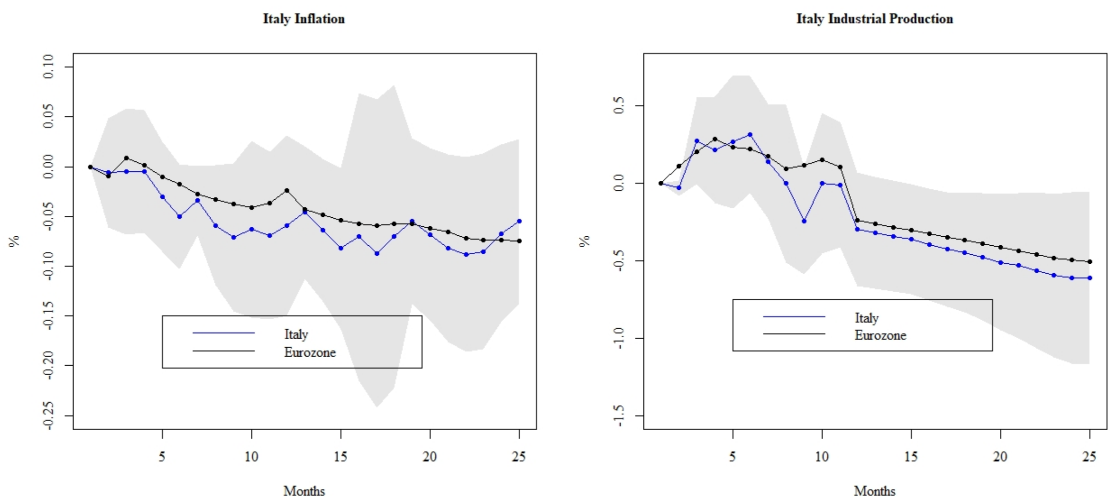


Figure 3.10 LP - Italy
Note: The figure presents the impulse responses of inflation and output to a 100 bps contractionary monetary policy shock, plotted along with the 95% confidence intervals (the grey area). The blue line represents the impulse responses for Italy, whereas the black line represents the impulse responses for the whole Eurozone. The impulse responses are computed with local projections *á la* Jordà (2005) from the model presented in equation [3.5]. P=5, 2000 repetitions. Sample: 2000-2016

Figure 3.10 presents the impulse responses of inflation and industrial production of Italy.[65] The path followed by both macroeconomic variables is volatile in the case of inflation and

[65] The impulse responses of all the variables included in the analysis can be found in Appendix B.12.

more linear in the case of industrial production. The path followed by inflation shows a slightly stronger decline throughout the period, although it culminates in a lower decline than the overall Eurozone. Throughout the path, the decline is closer to a –0.1% reduction. After 22 months inflation starts to rise and partially recovers some of the decline. The industrial production path shows a tendency very close to the overall Eurozone path. The initial peak lasts for 12 months (as for the overall Eurozone), although it presents a slightly more volatile path, showing an initial decline before 10 months and a small increase lasting only 2 months. The overall decline is in line with the Eurozone response.

Portugal

Figure 3.11[66] presents the impulse responses of inflation and industrial production for Portugal. The response of inflation is more linear and slightly stronger, culminating in an overall decline of 0.1%, similar to the path observed in the case of Spain.

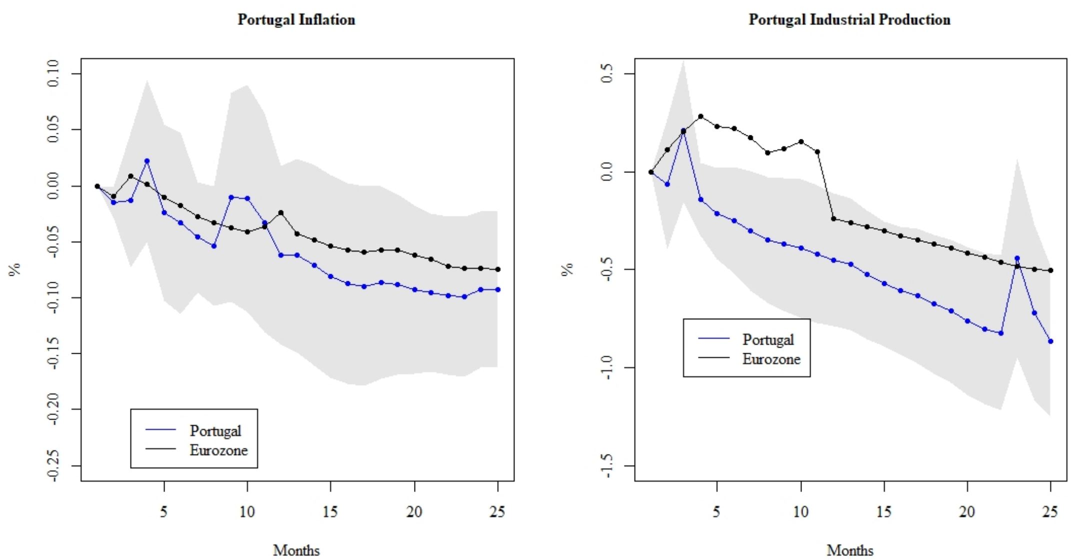


Figure 3.11 LP - Portugal
Note: The figure presents the impulse responses of inflation and output to a 100 bps contractionary monetary policy shock, plotted along with the 95% confidence intervals (the grey area). The blue line represents the impulse responses for Portugal, whereas the black line represents the impulse responses for the whole Eurozone. The impulse responses are computed with local projections *á la* Jordà (2005) from the model presented in equation [3.5]. P=5, 2000 repetitions. Sample: 2000-2016

The response is moderately more volatile then in the overall Eurozone response. The response of industrial productions mimics more the path followed in the case of France. Similarly to the industrial production of France, the initial peak lasts for less than 5 months. The only relevant difference with both the path in France and the Eurozone is an isolated

[66] The impulse responses of all the variables included in the analysis can be found in Appendix B.14.

peak after 20 months, which cancels out relatively quickly and confirms an overall decline of almost 1%.

Greece

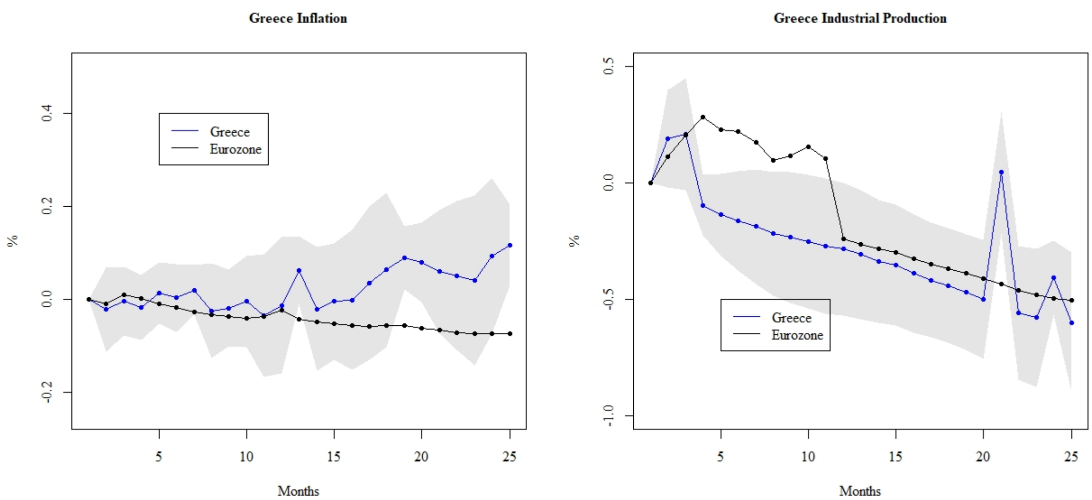


Figure 3.12 LP - Greece
Note: The figure presents the impulse responses of inflation and output to a 100 bps contractionary monetary policy shock, plotted along with the 95% confidence intervals (the grey area). The blue line represents the impulse responses for Greece, whereas the black line represents the impulse responses for the whole Eurozone. The impulse responses are computed with local projections *á la* Jordà (2005) from the model presented in equation [3.5]. P=5, 2000 repetitions. Sample: 2000-2016

Figure 3.12[67] shows the impulse responses for inflation and industrial production, which perhaps represent the two most heterogeneous paths, in comparison with the overall Eurozone indexes and also with the other countries, particularly in the case of inflation. Inflation, in the case of Greece, rises almost 0.2% at the end of the 24 months. The path is moderately volatile, with a marked positive tendency. The path of the overall Eurozone lies in the very lower confidence band and sporadically lies outside of it. The path of industrial production is similar to the response of Portugal and Spain, showing a shorter

[67] The impulse responses of all the variables included in the analysis can be found in Appendix B.13.

initial peak and a consistent decline till the 18th month. The last six months of the period display a volatile path with an important peak across the 20th month that immediately cancels out. These last two peaks represent perhaps two outliers, as the overall decline is in line with the response of the Eurozone as whole.

Comparison among countries

The overall responses among the single Eurozone countries show a homogenous overall decline of inflation between 0.1% and 0.2%, with the only exception represented by Greece. The overall responses of the industrial production range among an overall decline of 0.5% with peaks around almost 1% for Portugal, France and Spain. Overall the paths show similar tendencies, although the volatility in the paths shows a high degree of heterogeneity among the countries. Overall, in line with the responses of the Eurozone (as a whole), the responses of industrial production are mostly robust at the 95% confidence band, especially when the persistent decline starts. On the contrary the results on inflation remain very weak and unstable. This level of heterogeneity in the responses is particularly relevant from a policy makers' perspective, considering that the ECB deliberates on monetary policy with the intent of homogenously affecting all the countries in the union.

The present research doesn't intend to provide an explanation for the lack of homogeneity in the responses of inflation and industrial production in the Eurozone countries. However, the heterogeneity in the responses of the single countries, might be a further interesting aspect to investigate and potentially a source of concern for policy makers. Burriel and Galesi (2018) assess the effects of unconventional monetary policy shocks among all the countries in the monetary, finding that countries with a more "fragile" banking system benefitted less from unconventional monetary policies and output gains. The heterogeneity of these effects can, therefore, lead to the ineffectiveness of monetary policy measures across the Eurozone countries.

3.4.2.3 GDP Quarterly Specification

Champagne & Sekkel (2018) are able to provide directly real GDP as a measure of output, as the BOC provides a monthly series of GDP. The ECB doesn't provide a monthly series for GDP and therefore, similarly to Romer & Romer (2004) and Cloyne & Hürtgen (2016), I employ the industrial production index as a measure of output. In this section, I provide a quarterly analysis to investigate the effects of monetary policy shocks on the real GDP. I estimate the impulse responses with LPs, as the sample period is even further reduced when considering a quarterly frequency, and therefore inadequate for the VAR methodology.

The results on GDP analysis, presented in Figure 3.13,[68] are stronger with respect to industrial production, which is in line with the previous studies in other countries. Both Romer & Romer (2004) for the US and Cloyne & Hürtgen (2016) for the UK, find a starker decline for GDP compared to industrial production.

To investigate the response of the real GDP, I estimate a quarterly local projection model (equation [3.5]) including the log of the HICP Index, the log of real GDP, the log of the commodity index and the quarterly cumulated monetary policy shocks series. Similar to the response of industrial production path, during the first 4 quarters GDP has a peak of

[68] The impulse response of all the variables included in the analysis are available in Appendix B.15.

almost a 2% rise, followed by a sharp decline that peaks over –2%. The decline starts therefore after more than a year from the 100 bps shock and starts to recover after 2 years.

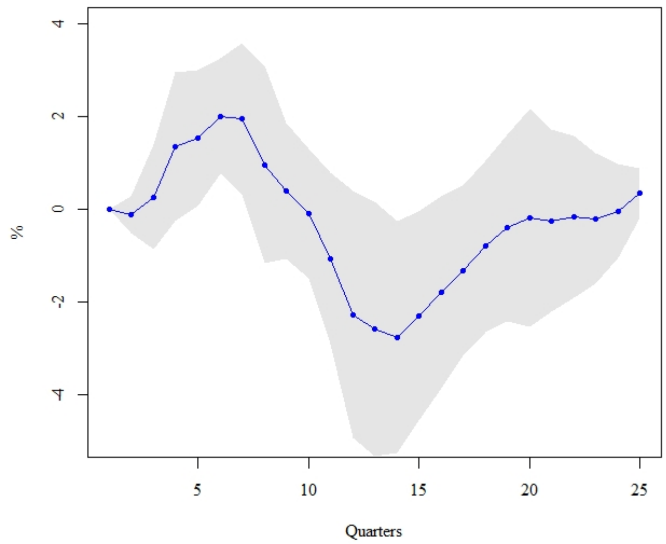


Figure 3.13 LP – GDP Quarterly Specifications
Note: The Figure presents the impulse response of output, represented by the GDP of the Eurozone to a 100 bps contractionary monetary policy shock, plotted along with the 95% confidence intervals (the grey area), and computed with local projections *á la Jordà* (2005). In the local projection model (analogous to the model presented in equation [3.5]), were included the log of the quarterly HICP Index, the log of the real GDP, the quarterly log of the Eurozone commodity index and the quarterly cumulated series of monetary policy shocks. P=5. Sample: 2000–2016

3.4.3 The "Price Puzzle"

Sims (1992) found compelling evidence of high interest rates predicting a rise in inflation, which he defined as "hard to reconcile" with effective monetary policy. These results, where a contraction in monetary policy raises macroeconomic variables, such as inflation, has been defined a "puzzle result" and further commonly called the "Price Puzzle" among the literature. The "Price Puzzle" has been widely discussed in the literature and also documented by Romer & Romer (2004) and further by Cloyne & Hürtgen (2016) and Champagne Sekkel (2018).

Romer & Romer (2004) document a rise in inflation after a contractionary monetary shock when employing the changes in the actual Federal Funds rate as a shocks series. Cloyne & Hürtgen (2016) and Champagne & Sekkel (2018) found qualitatively similar results when employing the Bank Rate as measure of shocks in the UK and in Canada respectively. In all these studies, employing the monetary shocks series computed with the narrative methodology resolves the puzzle and produces results which are easier to reconcile with standard theory predictions.

The present section aims to investigate two elements: first, whether estimating the effect of monetary policy contractions using the changes in the interest rates produces a "puzzle" in the case of the ECB and second, whether this "puzzle" is eventually resolved by the monetary shocks series estimated with the narrative methodology. To provide this empirical evidence I need to compare the results previously presented in Figure 3.2, with a VAR estimated by employing the changes in interest rates (the MRO) as shocks series.

Figure 3.14 presents the impulse response of prices and output for this last VAR, along with the VAR results previously presented in Figure 3.2. The blue line represents the impulse response computed with the interest rate changes as a shocks series, whereas the black line plots the responses of Figure 3.2.

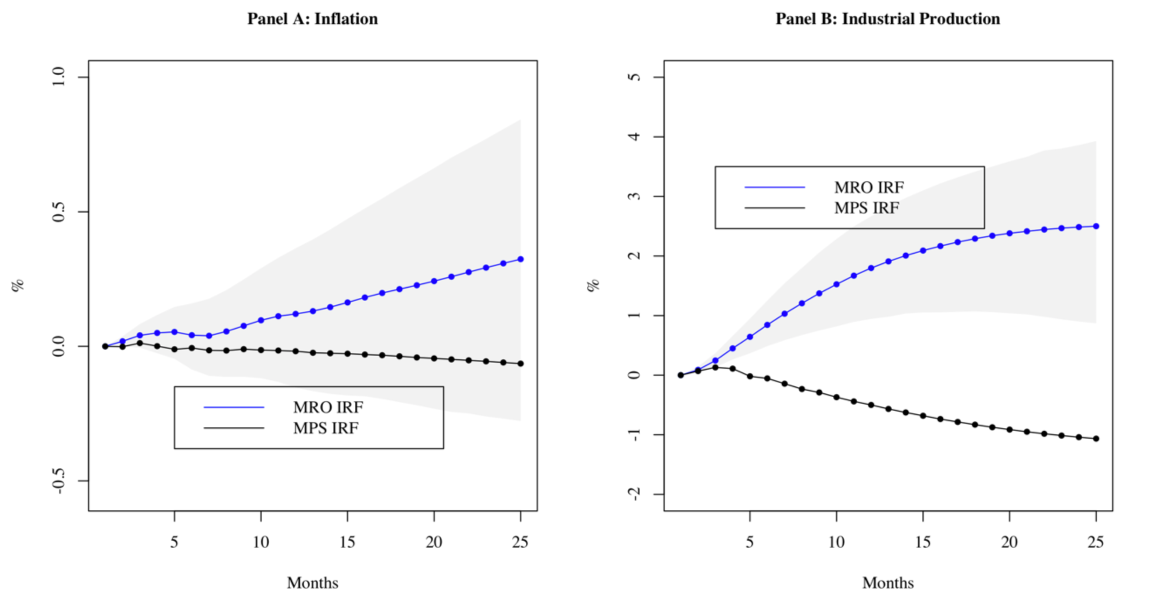


Figure 3.14 VAR with ECB Policy Rate.
Note: In Panel A, the blue path corresponds to impulse response of inflation to a 100 bps contractionary change in the interest rate, computed with the variables presented in equation [3.4] and the change in the MRO changes as measure of shocks (MRO IRF). The black line corresponds to impulse response of output to a 100 bps contractionary monetary policy shock computed with the variables presented in equation [3.4] and my new measure of monetary shocks (MPS IRF).Analogously, in panel B, the blue path corresponds to impulse response of output to a 100 bps contractionary change in the interest rate computed with the MRO changes as a measure of monetary shocks (MRO IRF), and the black line corresponds to impulse response of inflation to a 100 bps contractionary monetary policy shock computed with my new measure of monetary shocks (MPS IRF). The 95% confidence bands (the grey area) refer in both panels to the impulse response computed with the MRO changes. P=5, 2000 repetitions. Sample: 2000-2016.

The output presents a large stable increase, peaking after 24 months at 2%, whereas inflation presents a milder increase of 0.2%. Output remains more responsive and statistically significant than inflation, in line with previous results. The impulse responses clearly show that when estimating the effect of contractionary monetary shocks with changes in the interest rates, as a shocks series, I find "puzzling" results. In other words, both prices and output respond positively to a contractionary monetary shocks. Compared to the impulse responses computed in the previous section with my monetary shocks series the effects are qualitatively very different. My monetary shocks series shows a downward path, particularly in the case of output, which is easier to reconcile with standard theory expectations, although the effect estimated with the change in interest rate show a more robust path. The same cannot be said about inflation, where the effect estimated with interest rate changes still remains unstable in both cases.

3.5 Robustness

The present section proposes some robustness exercises to further validate the main results presented in section 3.4. First, as the monetary policy shocks series should be orthogonal and independent, I order the shock series first in the VAR (equation [3.4]) and in the LP model (equation [3.5]). Second, even though the lags were established on the basis of the "BIC test", I investigate whether enlarging the lags and therefore estimating more parameters yields consistent results with respect to the previous results presented. Studies in other countries included larger VAR specifications, due to their extended sample sizes.

3.5.1 Monetary Policy Shocks ordered first

A fundamental condition for the correct estimation of the effects of monetary policy shocks on macroeconomic variables is that the monetary shock series employed in the analysis should be orthogonal and "unpredictable". These two conditions ensure the absence of endogeneity and anticipatory effects, which are the main challenges in the literature, when estimating the effects of monetary policy on the economy.

In subsection 3.3.2.4, I performed a Granger test to investigate the predictability level of my new shocks series. The Granger test showed a high degree of unpredictability of my shocks series, allowing me to employ it in the second stage of the analysis. To further corroborate the results of the Granger test I place my monetary shocks series first in the VAR (equation [3.4]) and in the LPs' model (equation [3.5]). The intuition behind this is that, if my monetary shocks series is definitely orthogonal its place in the vector of controls in equation [3.4] shouldn't matter and the impulse responses estimated from it should remain unchanged from the one previously presented in Figure 3.2.

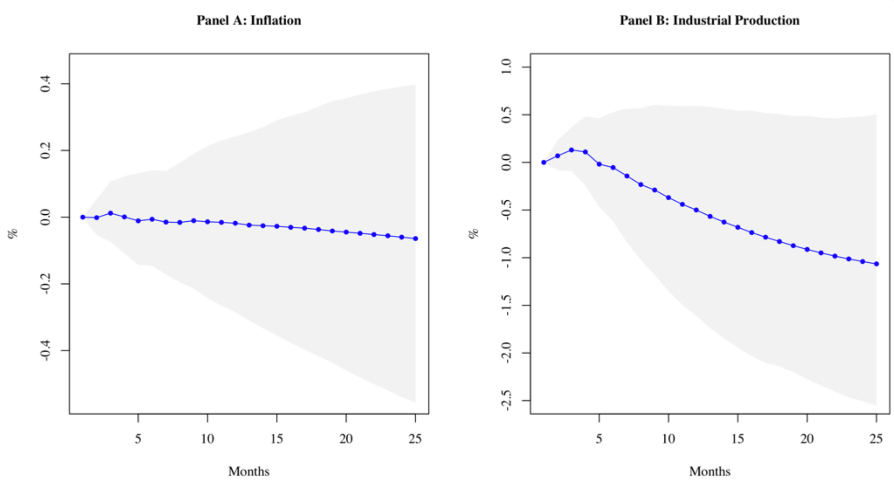


Figure 3.15 VAR – MPS ordered first

Note: In Panel A, the blue path corresponds to the impulse response of inflation to a 100 bps contractionary monetary policy shock, plotted along with 95% confidence bands (grey area). In panel B, the blue path corresponds to the impulse response of output to a 100 bps contractionary monetary policy shock, plotted along with 95% confidence bands (grey area). Monetary policy shocks were ordered first in the baseline VAR in equation [3.4]. P=5, 2000 repetitions. Sample: 2000–2016.

In my main specification, the vector of observable Z_t was defined as: [Y_t , P_t , $P.Com_t$, $C.shock_t$]. In this robustness checks Z_t is defined as: [$C.shock_t$, Y_t , P_t , $P.Com_t$] and also includes a constant and a trend.[69] The impulse responses, plotted in figure 3.15,[70] are estimated with the same parameter as the previously presented in Figure 3.2.

The same exercise is repeated on the LPs model and the response functions are presented in figure 3.16[71]. Both the figures show that the results are unchanged with respect to the order of the shocks series in the model, confirming the orthogonality of the shocks series.

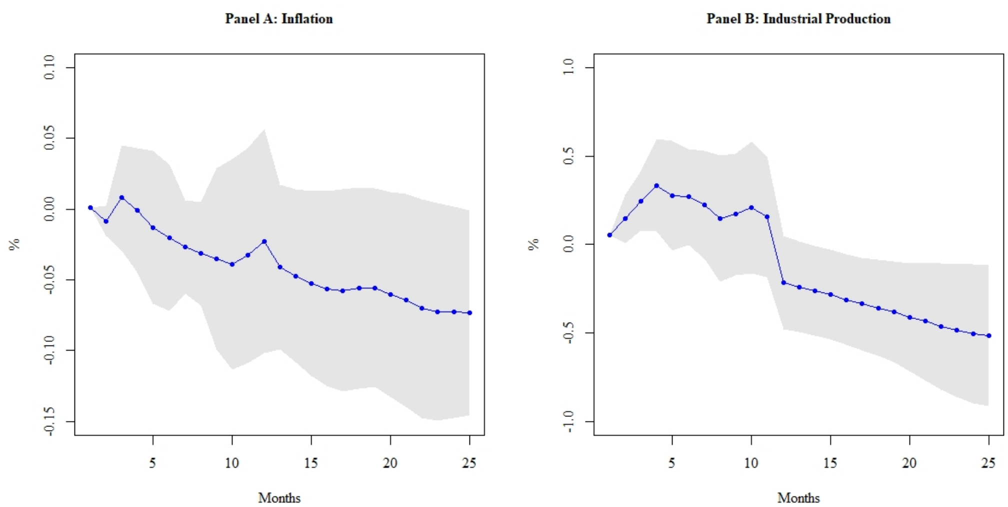


Figure 3.16 LP – MPS ordered first
Note: In Panel A, the blue path corresponds to the impulse response of inflation to a 100 bps contractionary monetary policy shock, plotted along with 95% confidence bands (grey area). In panel B, the blue path corresponds to the impulse response of output to a 100 bps contractionary monetary policy shock, plotted along with 95% confidence bands (grey area). Monetary policy shocks were ordered first in the LPs' model (equation [3.5]). P=5. Sample: 2000–2016.

[69] The same reasoning is applied to the vector of controls in the LPs model in equation [3.5].
[70] The impulse responses of all the variables included in the analysis are available in Appendix B.6.
[71] The impulse responses of all the variables included in the analysis are available in Appendix B.16.

3.5.2 Different VAR Specifications

In this section, I analyse the VAR results yielded with different lags specifications. I enlarge the lag and estimate the VAR (equation [3.4]) with 12 lags, which is originally the maximum lag length used to perform the lag selection. The purpose of this test is to investigate whether a larger number of parameters yields fundamentally different results with respect to those previously presented. The impulse responses from this enlarged VAR are presented in Figure 3.17. The response of industrial production is virtually similar in the negative trend. However, consistent with the previous analysis, both impulse responses are not statistically significant.

Past studies have employed large lags VAR (24 lags in Cloyne & Hürtgen, 2016; and Champagne & Sekkel, 2018; 36 in Romer & Romer, 2004), with larger sample periods. Coibion (2012) criticises the large number of lags employed in Romer & Romer (2004), arguing that stronger results might be perhaps ascribed to the model construction. Following the critics of Coibion (2012) I have employed a smaller number of lags, more suitable to the smaller sample size included in my study. This robustness exercise confirms Coibion (2012)'s criticism that stronger results might be caused by the number of parameters estimated.

The most relevant differences are represented by the initial peak shown in the previous results, which are sensibly smaller in this case and by the overall stronger response. The response of industrial production, in fact, shows a consistent decline that culminates with an overall reduction of almost 2%. The response of inflation is also stronger, showing an overall reduction of inflation of 0.2%. The responses therefore coincide in trend with the previous results although show both overall stronger declines.

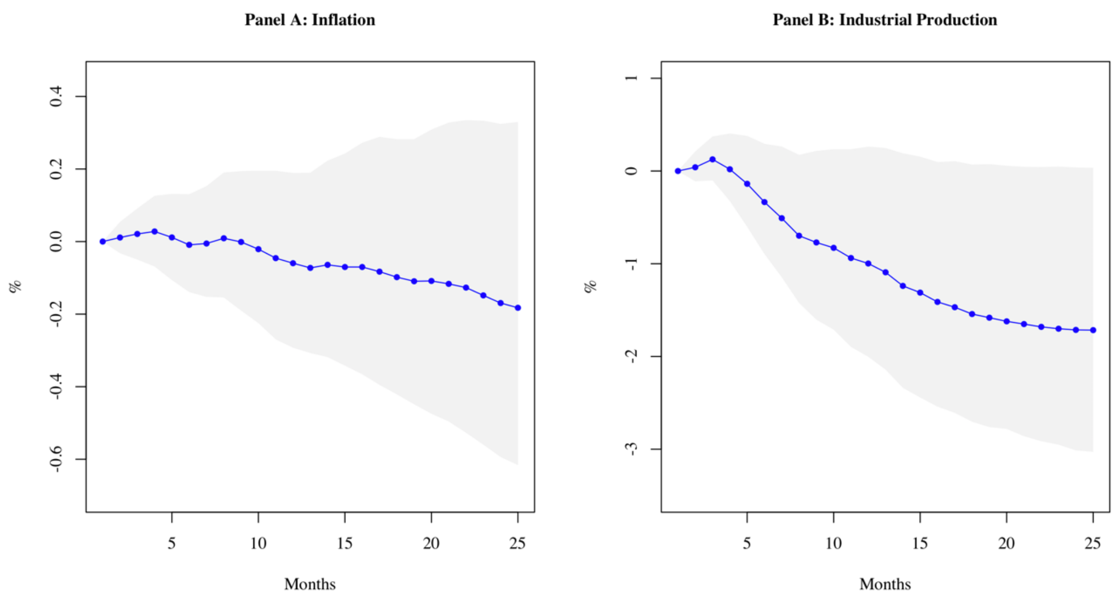


Figure 3.17 12 Lags' VAR
Note: In Panel A, the blue path corresponds to the impulse response of inflation to a 100 bps contractionary monetary policy shock, plotted along with 95% confidence bands (grey area). In panel B, the blue path corresponds to the impulse response of output to a 100 bps contractionary monetary policy shock, plotted along with 95% confidence bands (grey area). P=12, 2000 repetitions. Sample: 2000–2016.

3.6 Limitations

This chapter suffers from three important limitations. First, in the first stage of the analysis, it only includes an additional variable (total assets) to enlarge the information set of policy makers at the “decision point”. As more recent literature (Gertler & Karadi, 2015; Jarocinski & Karadi , 2020) have pointed out, financial market-based measures are also a fundamental piece of information around monetary policy announcements. Champagne & Sekkel (2018) make the case for exchange rates and include the exchange rate USD/CAD in their first-stage analysis. Although many academics have argued against the influence of the financial markets in the policy makers’ decision-making process, it would perhaps be interesting to include financial market variables in the policy makers’ information set to investigate whether it yields different results. Second, the sample period is an evident limitation of the study. The “young age” of the ECB doesn’t allow it to have extended time series. Research in the future will, therefore, be able to successfully overcome this issue.

Third, there is an additional lack of data. The forecasts included to construct the first stage regression are retrieved from the Survey of Professional Forecasters data, which are only available quarterly. This limitation was overcome with the matching methodology proposed by Romer & Romer (2004) and also applied to more recent studies. However, other sources of forecasts data have recently become available at a monthly frequency, which could increase the precision in estimating the information set available to policy makers at the meeting date. Among others, “Economic Consesus Data”, provide monthly frequency forecasts, that could increase the precision of the estimates of the information set available to policy makers at the meeting date.

3.7 Conclusions

Measuring the effect of monetary policy and monetary policy shocks is one of the most debated questions in macroeconomics. This chapter presents fresh evidence on the effects of a new measure of monetary policy shocks in the Eurozone. In line with the existing literature, and by adopting a narrative approach, I present empirical findings of monetary policy shocks on Eurozone output and inflation. The monetary policy shocks series is estimated following the seminal work of Romer & Romer (2004) and carefully matching the information available to policy makers at the decision point to extract an orthogonal shocks series. The narrative methodology of Romer & Romer (2004), unlike with the more standard statistical approaches employed previously, yielded starker results with respect to the US economy and overcame the issue of endogeneity and anticipatory effects. Unlike the existing literature, the second stage of the analysis is performed with an additional methodology, local linear projection *à la* Jordà (2005). My results are in line with evidence found in other countries for output and slightly milder for inflation.

Specifically, my results show that output is more responsive to monetary policy shocks, with an overall decline of 1%, compared to inflation that shows an overall unstable decline of only 0.1%. I also document a price and an output puzzle when estimating the response with the interest rate instead of the new measure of monetary policy shocks. Additional macroeconomic variables are included in the analysis. In particular, trade variables are strongly affected by monetary shocks: both the import and export indexes are negatively impacted by contractionary monetary policy shocks.

I further provide evidence of the heterogeneous effects of monetary shocks among Eurozone countries on inflation and industrial production. The heterogeneity in the effects of monetary policy shocks on single Eurozone countries is a potential source of concern for policy makers, as it could lead to ineffective monetary policy. Overall, my findings offer new results on the response of the Eurozone economy to monetary policy shocks and acknowledge the importance of understanding the determinants of interest rate changes to correctly assess their impact.

Chapter 4

Forecasts Targeting and Financial Stability: Evidence from the European Central Bank and Bank of England

4.1 Introduction

Should a central bank include financial markets stability in its mandate? Has financial stability already entered the discussions of policy makers? These questions are frequently debated among academics and practitioners, and they remain an unresolved topic, particularly in the aftermath of the 2008 financial crisis. In this chapter, I present evidence that financial markets stability matters to monetary policy makers in the context of the European Central Bank (ECB) and Bank of England (BOE) by using an *Augmented* Taylor (1993) Rule. Although many have discussed this matter, most of the literature has focused on the Federal Reserve (FED), whereas less has been documented on the ECB and BOE.

Bernanke (2011) has stated that the 2008 financial crisis has reminded monetary policy makers of their responsibility of maintaining financial stability, as an equally important element in their mandate as price stability and economic growth. Bernanke (2011) also asserts the importance of financial stability, although he does not propose specific guidelines or elaborate on how the two key aims of the central bank should interact. Kuttner (2011) revisited Bernanke & Gertler (1999), pointing out that financial stability and asset prices stability should be pursued to the extent which supports the pursuing of inflation stability. Oet & Lyytinen (2017) show that the discussion on financial stability has entered the topics of the FOMC committee, although with differing opinions across recent years. More importantly, they point out that a Tri-Mandate Taylor Rule better explains the FED monetary policy conduct after 2008.

In this chapter, I depart from the existing academic evidence and viewpoints of policy makers and investigate two research questions within the well-known Taylor (1993) Rule framework. First, I assess whether financial market stability played any role in the ECB and BOE interest rate setting during the 2003–2018 sample period. Second, I investigate whether the ECB and BOE follow a "forward-looking" or a "simple-feedback" Taylor Rule, to empirically support the theoretical critiques of Svensson (2003, 2010, 2019), who argues that a "forward-looking" monetary policy rule is needed, given the fact that monetary policy affects the economy with a lag and therefore "ex-post" data are not a suitable information with which to decide on an interest rate change. The terms "forward-looking" and "simple-feedback" were also reiterated on various occasions by Bernanke (2004), who focused on the need for a forward-looking monetary policy rule.

My chapter contributes to the existing literature primarily by showing that financial market stability is a source of concern for policy makers and can explain the deviations of realised interest rates from the predicted values of the Taylor (1993) Rule. Additionally, I support the theoretical critiques of Svensson (2003, 2010, 2019) in showing that monetary policy makers follow a forward-looking Taylor (1993) Rule. Two other contributions emerge from my study. First, I provide empirical evidence that the financial market stability of the United States affects the decision of the ECB policy makers. Second, I provide an effective comparison between the monetary policy conduct of the ECB and BOE, which operate in different economic environments, although pursuing the same mandate of price stability and economic growth.

To estimate the ECB and BOE Taylor (1993) Rules, I address most of the methodological criticisms raised during the years to this framework. The Taylor (1993, 1999a) Rule, as a very straight-forward and computationally easy rule, has been criticised partly for its simplicity and the lack of inclusion of potentially relevant information for policy makers when assessing the level of the interest rate. To address these critiques I first, fix the reaction coefficients that are commonly used in Taylor-type Rules studies following the approach of Clark (2012) and Oet & Lyytinen (2017). Second, I include real-time forecasted data available to monetary policy makers, addressing the critique of Orphanides (2001), who claims that the Taylor Rule is not robust for minor variations in data sources. Lastly, following Oet & Lyytinen (2017) and unlike Clarida, Gali & Gertler (1998) and Rudebusch (2006), I don't estimate an "inertial" Taylor-type Rule. As my objective is to establish the size of the explanatory power of omitted variables in the Taylor Rule, adding an interest rate "inertia" variable (e.g interest rates' smoothing variables) in my model could potentially hide the variations resulting from omitted variables.

The Taylor-type Rules are, then, estimated following an OLS approach as in Oet & Lyytinen (2017). The Taylor Rule has been mostly estimated using a Generalised Methods of Moments (GMM) methodology (Clarida, Gali & Gertler, 1998) and Non-Linear Square (NLS) estimates (Gorter, Jacobs & De Haan, 2008). The GMM and the NLS estimates could, however, be biased by the starting parameters employed in the analysis, which are arbitrarily estimated. Recently, Carvalho, Nechio & Tristao (2018) find empirical evidence that the OLS methodology is statistically efficient to estimate the Taylor Rule, compared to other methodologies such as Instrumental Variables (IV). Lastly, given the major changes in the economic environment, also driven by the financial crisis, I test my Taylor–type Rules on regime samples, following the Bai-Perron structural break analysis (Bai & Perron, 1998, 2003).

My empirical analysis points to several novel findings. First, financial market stability plays a crucial role in setting interest rates. Although financial markets are a fundamental channel in transmitting monetary policy decisions, they also represent a concern for policy makers. Second, in line with evidence in Gerlach (2007) and Gorter, Jacobs & De Haan (2008) a forward-looking Taylor, dominates a traditional ex-post data Taylor (1993) Rule across the whole sample period 2003–2018 for both the ECB and BOE. Both banks care about the outlook on economic growth as well as the forecasted inflation gap. In line with expectations, both conclusions from the empirical literature and the mandates of the central banks imply that inflation is a key factor in interest rate setting. Moreover, the analysis of different regimes indicates that after the 2008 financial crisis the Taylor Rule Augmented version, which includes financial market stability, dominates the traditional Taylor (1993) Rule version.

Oddly, when considering the forward-looking vs ex-post data across regime samples which include financial market stability, ex-post data models dominate forward-looking models. There are two possible explanations for this result. First, when considering regime sample analysis, the forecasted macroeconomic variables have a lower frequency then ex-post data. Second, the inflation and output gap computed with forward-looking data display a lower variability in the time series across the whole sample period 2003–2018, which can potentially introduce a bias when analysing shorter subsample periods.

A novel result which emerges from my research, is the joint importance of both European and US financial market stability in affecting monetary policy makers. To further explore the role of financial market stability, I add a measure of financial market stability slack (FMSS) for the US stock market. This result can be interpreted as the joint effort of monetary policy makers in re-establishing trust among investors and towards institutions in the aftermath of the financial crisis. However, when I analyse BOE monetary policy, the variable related to the US financial market stability never enters with a statistically significant estimate.

The interconnection among central bank monetary policies is an established empirical fact. Caputo & Herrera (2017) found that the Federal Reserve played a "leader role" among several international institutions in the setting of monetary policy. Moreover, Bekaert, Hoerova & Lo Duca (2013) show that US financial market volatility strongly co-moves with the measure of US monetary policy. Therefore, there is compelling evidence to suggest that the ECB has certainly been taking into account US financial market stability and monetary policy during the 2003–2018 time period. US financial market volatility is represented, in the study of Bekaert, Hoerova, & Lo Duca (2013), by the VIX index. I also use the VIX index to compute the measure of financial market stability slack for the US financial market.

4.2 Literature Review

Friedman & Kuttner (2010) rightly note that most of the literature has debated how central banks *should* optimally set interest rates, while much less attention has been directed to the more important question on how they actually *do set* them. Thus, the second question remains an open and unsolved one in central bank monetary policy literature. Particularly in the past two decades, monetary policy makers have been affected by many big changes affecting their decision process: from technology innovations to the impact of the financial crisis and economic recessions and to the fundamental forces that influence the way financial market activity is conducted. Some consequences have been a switch in financial regulation as well as the adoption of new policies and tools affecting markets and intermediaries.

Thus, central banks started to acknowledge that they no longer have a significant influence on market rates by relying on conventional monetary policy tools. Before the "advent" of the IT Framework most of the monetary policy institutions, specifically the ECB, between 1999 and 2003, influenced the level of interest rate by influencing the level of reserves (4% as a target in the case of the ECB). Most of the central banks have committed to IT, which has proven to be an efficient tool in interest rate setting (Svensson, 2010).

Within this framework, the Taylor (1993) Rule has given the first "computationally easy" monetary policy tool to link the level of interest rates to the inflation target and economic slack. In the last two decades, several central banks have been using Taylor (1993) Rule guidance when setting interest rates, although in an informal way. The Taylor (1993) Rule, including some alternative versions, has been quite successful in explaining how Eurozone monetary policy has been conducted. Clarida, Gali & Gertler (1998) show that an interest rate smoothing version of the Taylor Rule is capable of interpreting short-term interest rate dynamics in a G-3 country sample (Germany, Japan, US).

Along the same lines, there is evidence in Gerlach & Schnabel (2000) showing that short-term interest rates in the Euro Area in the 1990s were consistent with a simple Taylor (1993) Rule with a coefficient of 0.5 on the output gap and 1.5 on inflation. Taylor (1999b) proposed a revision of his own Rule, which adjusted to exchange rates, and which is well suited to ECB monetary policy. Taylor (2001), moreover, suggested that more research and empirical evidence is needed on the influence of exchange rates on monetary policy rules. Lubik & Schorfheide (2007), following the Taylor (1993) Rule framework, found evidence that in the specific case of the BOE, exchange rates played an important role in the setting of interest rates, empirically supporting Taylor (2001).

However, the original version of the Taylor (1993) Rule has been frequently criticized, and its main prescriptions extended to better "fit" a central bank monetary policy path. For example, Gorter, Jacobs & De Haan (2008) take Svensson's (2003) critiques and estimate a Eurozone Taylor (1993) Rule by relying on Consensus Economic data for expected inflation and output growth in the pre-crisis period of 1999–2006. Svensson (2019) is a prominent and recent critique of the Taylor (1993,1999a) Rule in the context of US monetary policy. Svensson (2019) argues that monetary policy is more effective in fulfilling its mandate if it is guided by forecasts rather than by current data. And this is even more persuasive when considering the forward-looking nature of monetary policy and the fact that such policy tends to influence economic activity and prices with a lag (see also Svensson, 2010). Thus, a Rule supported by acceptable forecasts is better suited compared to a standard Taylor-type Rule, as it benefits from all the currently available information and could be adapted to news as well as to changes of circumstances. My chapter aims to enter this debate by providing fresh evidence in support of Svensson (2003, 2010, 2019) and using ECB and BOE monetary policy data as an out-of-sample experiment. In the end, this essay investigates whether a central bank monetary policy follows a "forward-looking" or a "simple-feedback" Rule.

To add complexity to my study, the unique event of the 2008 financial crisis has to enter my research design. The 2008 financial crisis shook monetary policy equilibria around the world and left academics and practitioners with additional doubts on whether and how financial market stability should be included in the central bank mandate. Bernanke & Gertler (1999) propose that central banks should respond to asset prices' volatility as the unintended outcomes in the financial sector could affect aggregate price levels and generate macroeconomic imbalances. Kuttner (2011) revise the Bernanke & Gertler (1999) prescription, by proposing macro prudential policies and regulation as more efficient tools for designing a monetary policy which also looks also at financial market stability. Kuttner (2011) is unconvinced that relying only on interest rate setting could be effective in achieving the central banks' goals when considering the influence that financial markets have on the economy.

Bernanke (2011) revises the doctrine and practice of central banks in light of the 2008 financial crisis experience. He emphasises that the financial crisis reminded central bankers of their responsibility to maintain financial market stability. He argues that, ahead of the 2008 financial crisis, central bankers and academics achieved a high degree of consensus on an effective institutional framework for monetary policy, characterised by committing to price stability and transparency in central banking communication policy. However, it is fair to note that the existing literature is far from agreeing on a common ground for monetary policy tools. Oet & Lyytinen (2017) find recently that financial stability did matter to the FOMC committee in setting the interest rates between 1992 and 2012 and that a Tri-Mandate Taylor-type Rule better explains the conduct of US monetary policy.

4.3 Hypothesis Development

I start from the first Taylor (1993) Rule which links the current level of interest rates to the equilibrium interest rate, inflation gap and the economic slack (or output gap). The Taylor (1993) Rule, is presented in equation [4.1]:

$$r_t = r^* + k_\pi(\pi_t - \pi^*) + k_y(y_t - y^*) \qquad [\ 4.1\ ]$$

Where, r^* represents the interest rate level in equilibrium, k_π and k_y represents the coefficient values for the inflation and output gap. Taylor (1993) suggested that the interest rate level in equilibrium is equal to 2%, and the coefficient values for the inflation gap (k_π) and output gap (k_y) are 1.5 and 0.5 respectively. The inflation gap is computed as the current level of inflation (π_t) and the target inflation (π^*), which is set to be the 2% target. Similarly, the output gap is computed as the difference between the current level of output y_t growth and the output growth at the economy's full potential.

A second version of the Taylor (1999a) Rule proposed the unemployment rate as a measure of output growth, consistent with the FED mandate to pursue "full employment". However, both the ECB and BOE maintain that the secondary stated monetary policy objective should be economic growth. My chapter adopts the Taylor (1993) Rule in its first version, as the empirical analyses of Clarida, Gali & Gertler (1998) and Gerlach & Schnabel (2000) have shown that it is the original model that better explain short-term interest rates in the

Eurozone. Specifically, Gerlach & Schnabel (2000) find that in the 1990s average short-term interest rates in the euro area can be described by a simple Taylor Rule with a coefficient of 0.5 on the output gap and 1.5 on inflation. Subsequently, Taylor (1999b) recommends that the ECB should also adopt exchange rates in monetary policy.

One of the fundamental positive aspects of the Taylor Rule is its simplicity and computationally easy nature. Contemporary this is also one of its most discussed drawback. Specifically, its computationally easy aspect is given by the reduced number of variables included in its equation, which implies a limited amount of information included in the setting of the official interest rate level. In an unprecedented event such as the 2008 financial crisis, the financial stability goal has been found to play a crucial role in monetary policy decisions. Kuttner (2011) has been a prominent voice on the importance of financial stability in monetary policy. He proposes to revise Bernanke & Gertler's (1999) monetary policy framework by adding financial stability to their mandate, as the financial markets' channel is now acknowledged in the literature to be a fundamental factor in maintaining stability in the price level. Oet & Lyytinen (2017) provide a theoretical underpinning and evidence to suggest that a "Tri-Mandate Taylor-type Rule" was guiding the FED monetary policy in the aftermath of the 2008 Financial Crisis.

I take stock of the reviewed theoretical as well as empirical literature and establish my first hypothesis for the conduct of the ECB and BOE as follows:

H I: Financial market stability matters to monetary policy makers and explains the deviation of realised interest rates from the predicted values of the Taylor (1993) Rule.

This chapter's goal is to investigate whether an Augmented Taylor (1993) Rule, better explains interest rate setting in the case of the ECB’s and BOE’s observed decisions concerning monetary policy. Unlike most of the augmented versions of the Taylor Rule and similar to the one proposed by Oet & Lyytinen (2017), financial market stability is also represented by a “Financial Market Stability Slack” (FMSS). In the spirit and logic of the Taylor Rule, the FMSS variable doesn’t only convey information on the health of the financial system, but also on its distance from the optimum, which is consistent with the forward-looking nature of monetary policy and the critique raised by Svensson (2003, 2010, 2019).

In addition, the Svensson (2003) critique argues that more relevant information should enter into interest rate setting, and he develops a theoretical model that links the optimal level of interest rates to *forecasts* of inflation and output. Svensson (2003, 2010) argues that as monetary policy affects the economy with a “lag” and market interest rates are naturally forward-looking, a simple-feedback rule would not be adequate. Following this critique, Gorter, Jacobs & De Haan (2008) estimated a forward-looking Taylor Rule for the ECB, providing empirical evidence that for the pre-crisis period (1997–2006) a forward-looking Taylor Rule, better explains the monetary policy conduct of the ECB. A particularly relevant critique of monetary policy rules has been raised by Svensson (2019), who argues that a forward-looking monetary policy rule, although potentially more complicated to implement, should be the appropriate guide for monetary policy rules. Looking at the available evidence, macroeconomic projections seem to be a more reasonable set of information to be included in a monetary policy decision, taking into account the parallel aspects of being on the one hand forward-looking but on the other impacting the economy with a time lag (Svensson, 2003, 2010, 2019).

Based on these findings I postulate my second hypothesis:

H II: Monetary policy makers follow a forward-looking Taylor Rule, which is a more reasonable set of information for interest rate setting compared to "ex-post" data.

This further research question aims, therefore, to investigate further the types of information that are the main drivers of monetary policy makers.

4.4 Methodology

4.4.1 Data

The data included in the analysis are retrieved from the ECB and BOE websites for the inflation and GDP forecasts. In particular, the ECB forecasts are retrieved from the Survey of Professional Forecasters (SPF), whereas the forecasts of the BOE are retrieved from the Inflation Reports. The monthly data on the unemployment rate and inflation are retrieved from the OECD website. GDP growth is available at a quarterly frequency also from the

OECD website.[72] Financial markets volatility data are retrieved from Bloomberg for both the EU and UK financial markets.[73]

My sample period for both the institutions covers 2003–2018. This sample choice was made for one main reason: the ECB gave the definition of the inflation target to be "below but close to 2%" in 2003[74]. The primary objective of the ECB monetary policy, as stated in Art. 2 of the Statute of the ECB, is maintaining price stability in the Eurozone and consequently enhancing economic growth and job creation. In the case of the BOE, the government settled the 2% target, in 1992, and the Monetary Policy Committee (MPC) is in charge of maintaining the level of inflation and price stability and give appropriate notice to the government when it misses its target.

4.4.2 Variables' Construction

This section will give appropriate details on the construction of the dataset and variables for both the ECB and BOE.

[72] Quarterly forecasts were transformed to monthly, reversing the methodology of Gorter, Jacobs & De Haan (2008)

[73] A detailed description of the data sources and descriptive statistics included in the analysis are provided in Appendix C, Table C.1 and Table C.2, respectively.

[74] In a speech on 4th May 2018, Vítor Constâncio (at the time Vice President of the ECB) identified the period between 1997 and 2003 as the period before the "revision of the monetary policy strategy", where the monetary aggregate M3 was still the first pillar of the ECB monetary strategy. The IT framework with the definition of the target below but close to 2% was published with the review of the monetary framework in May 2003. Reference can be found at Vítor Constâncio,"Past and future of the ECB monetary policy", 4th May 2018, www.ecb.europa.eu/press/key/date/2018/html/ecb.sp180504.en.html.

4.4.2.1 The Inflation Gap

The inflation gap is the difference between the level of inflation (current or forecasted) and the target level of inflation, set to be 2% for both institutions.

$$\mathbf{\Pi}_t = \pi_t - \pi^* \qquad [4.2]$$

where $\mathbf{\Pi}_t$ is the inflation gap, π_t is the current or forecasted level of inflation, and π^* is the inflation target. Both institutions share the common policy of price stability and IT. Figure 4.1 shows the inflation gap computed with both ex-post and forecasted data for the ECB (Panel A) and BOE (Panel B).

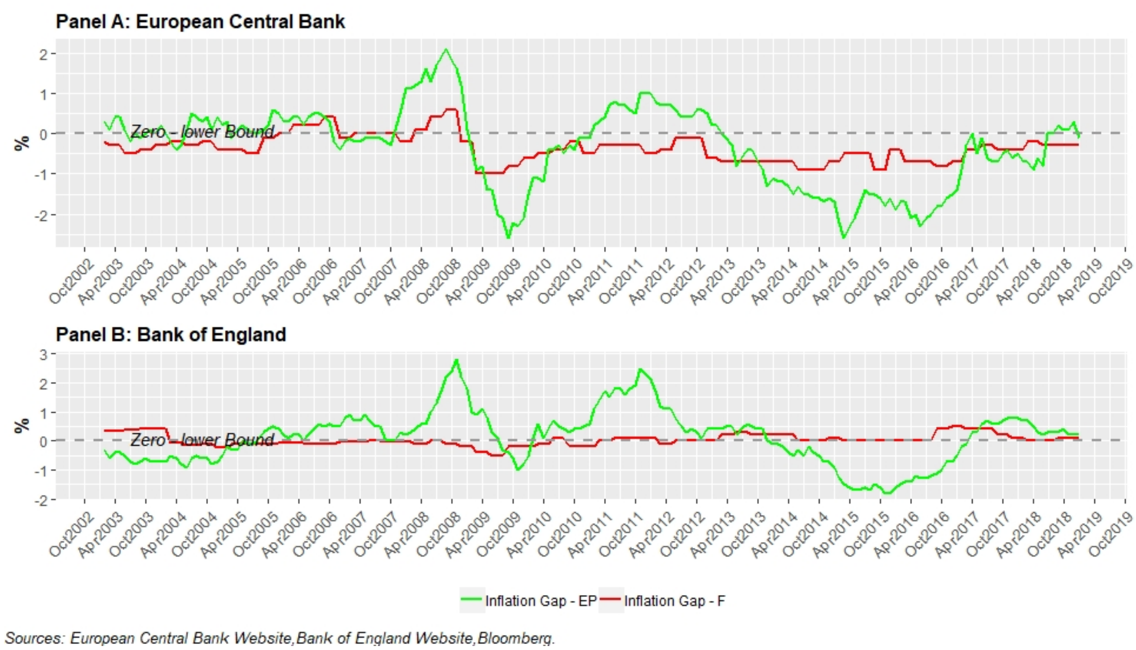


Figure 4.1: Inflation Gap
The figure presents the inflation gap, computed with both ex-post and forecast data for the ECB (Panel A) and BOE (Panel B). The inflation gap is computed has shown in equation [4.2]. The inflation gap is the difference between the inflation (ex-post or forecasts) and the inflation target, set to be at 2% for both central banks. The green line (in both panels) represents the inflation gap computed with ex-post data and the red line represents the inflation gap computed with forecasts. Sample period is (2003–2018) and includes192 monthly observations.

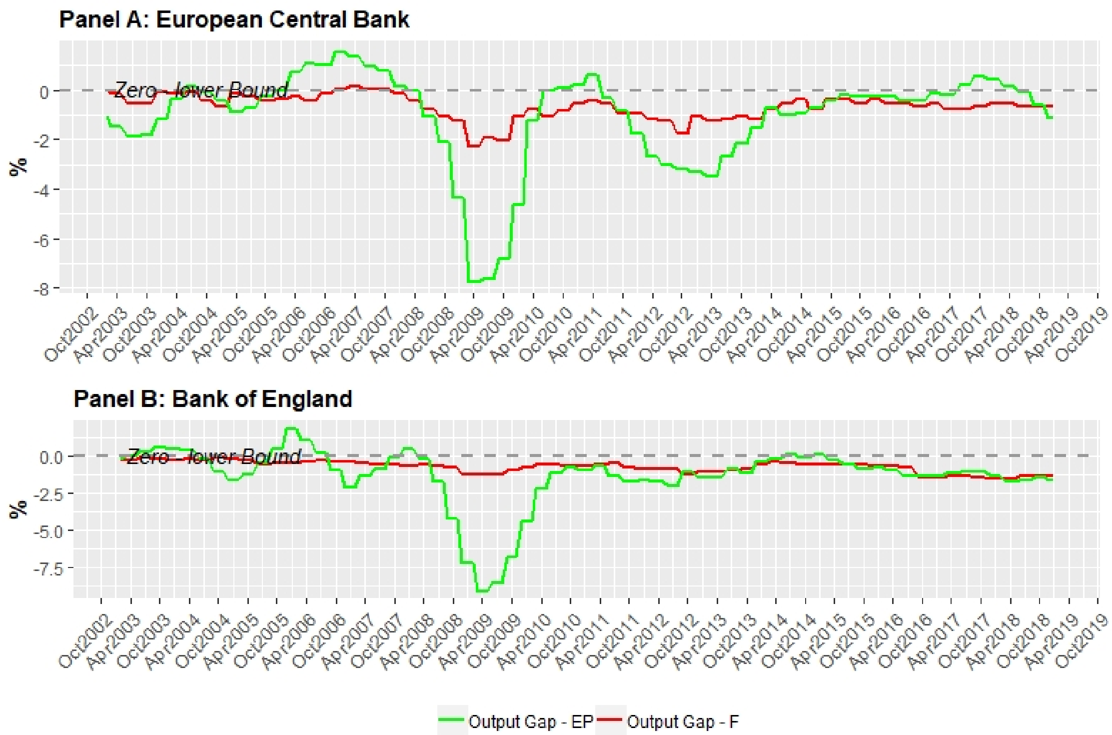
Through an initial inspection of Figure 4.1, it appears clear that the inflation gap time-series dynamics of the two banks, computed with both ex-post and forecasted data, are rather different. In the case of the ECB, the trend between the ex-post and forecasted inflation gap follows a similar trend, although the magnitude of the inflation gap, computed with ex-post data is higher compared to the forecasted inflation gap.

4.4.2.2 The Economic Slack

Taylor (1993) Rule defines "economic slack" or the output gap as the difference between GDP quarterly growth and its "potential" growth. As a measure of potential growth, Taylor suggests the GDP growth rate which can be achieved at its full potential. Equation [4.3] describes this idea and measures the output gap $\mathbf{Y}_t$ as the difference between y_t and y^*, computed considering both ex-post and forecasted data.

$$\mathbf{Y}_t = y_t - y^* \qquad [\ 4.3\ ]$$

As measure of "potential growth" y^*, I employ a rudimental measure of the average GDP growth in the Eurozone (2.25%) and in United Kingdom (UK) (3%) between 2000 and 2007. This measure might include some potential biases. First a look-head bias is represented by the fact that the estimated potential growth using data from 2000-2007 is also employed to retrieve the output gap around the first 4 years of the sample (2003-2007). Second, this measure also assumes that the output growth estimated with the 2000-2007 sample period is a reliable measure for the (2008–2018). The 2000-2007 sample period is also assumed to be a booming economy cycle, which is not entirely accurate in period around 2000–2001[75].Figure 4.2 displays the whole (2003–2018) time-series behaviour of output slack, Panel A for the ECB and Panel B for the BOE.



Sources: European Central Bank Website,Bank of England Website,Bloomberg.

[75] In future research, I aim to include more measures of the output gap, including a compounded measure and a ready available data series. For example, Cooper & Priestley (2009) employed three different "computed" measures of the output gap relying on the work of Clarida, Gali, and Gertler (2000). The measure first proposed by Clarida, Gali and Gertler (2000) is the most commonly used in the macroeconomics literature and employs a de-trended series of the GDP. Both Clarida, Gali and Gertler (2000) and Cooper & Priestley (2009) also employed the already available data from the Congressional Budget Office (CBO). Recently two other series have become available in the industry from the International Monetary Fund (IMF) and from the Organisation for Economic Co-operation and Development (OECD). Taylor (1999a) rule employs a different measure of output gap, built with the unemployment rate. This measure of output gap is consistent with second mandate of the FED (full employment) and less consistent with the ECB and BOE. Clark (2012) shows that the FED monetary policy conduct can be better explain with the output gap computed as the difference between the normal long-run unemployment rate (set to be 6% in his case) and the current unemployment rate. Oet & Lyytinen (2017) also provide a measure of the output gap with the unemployment rate and employ the CBO measure of long-run unemployment rate, consistent with the inflation remaining stable over time. For completeness. I will also provide a measure of the Taylor (1999a) rule and employ a measure of output gap estimated with the unemployment rate. This measure of unemployment rate and computational details can be found in Appendix C.1.

Figure 4.2: Output Gap
The figure presents the time series for the output gap, in Panel A for the ECB and in Panel B for the BOE. The output gap is computed as in equation [4.3], and it is the difference between the ex-post (green line) or forecast (red line) of the economic growth and economic growth potential. Sample period is (2003–2018) and includes192 monthly observations.

Output slack significantly decreases during financial crisis years for both banks, and never entirely recovers afterwards.

4.4.2.3 Financial Market Stability Slack

The FMSS is computed as the difference between the long-run "stability state" (Σ) and the current financial markets condition (σ_t) as presented in equation [4.4]:

$$FMSS_t = \Sigma - \sigma_t \qquad [\ 4.4\ ]$$

This variable is constructed following Oet & Lyytinen (2017), who compute their stability gap measure as the difference between an estimated upper threshold for the long-run normal range of financial system stress the current financial system stress. During conditions of unusually high stress the stability gap measure fells below 0[76]. My measure of the estimated upper threshold (Σ) is computed by following the same economic logic as for the potential growth (y*), considering the average financial market volatility in the pre-crisis period (2000–2007). I consider the financial market volatility (represented by the VSTOXX for the ECB and VFTSE for the BOE) in a "normal market condition" to be the average financial market volatility during the pre-crisis period[77]. The time series of my

[76] A detailed discussion on the variable construction see Section 4, pp. 411 of Oet & Lyytinen (2017).
[77] The values obtained for the Eurozone (average monthly VSTOXX between 2000 and 2007) is 23.717%, whereas the value obtained for the UK (average monthly VFTSE between 2000 and 2007) is about 19.624%. To the best of my knowledge no measure of FMSS are readily available in the industry.

FMSS is plotted in figure 4.3 both for the ECB and BOE. As expected, and similar to the output gap trend, the time series shows a downward path around the 2008 financial crisis. Compared to the output gap series, it shows a much higher volatility for both institutions.

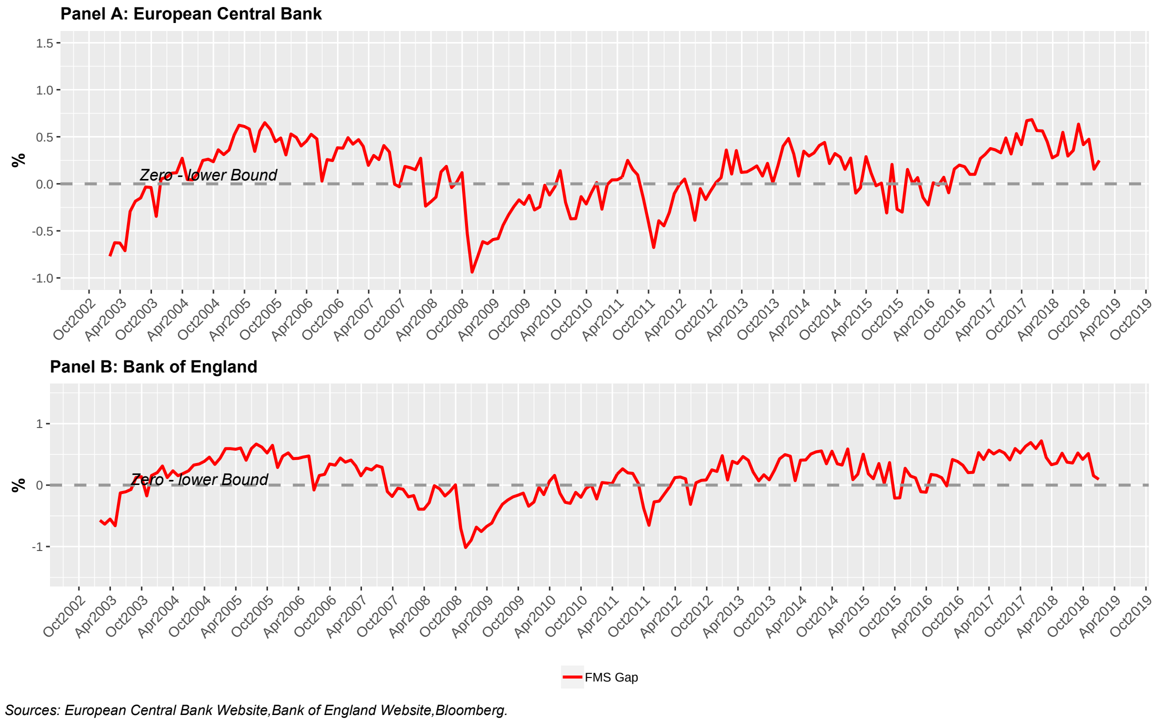


Figure 4.3: Financial Markets Stability Slack
The figure presents the FMSS variable, computed following equation [4.4] for the ECB (Panel A) and BOE (Panel B). Sample period is (2003–2018) and includes192 monthly observations.

Empirical evidence in Bekaert, Hoerova & Lo Duca (2013) shows a significant correlation between the VIX Index, as a measure of risk aversion and uncertainty in financial markets, and the monetary policy stance. They decompose the VIX into a measure of risk aversion and expected stock market volatility and find that a lax monetary policy decreases both. Based on Bekaert, Hoerova & Lo Duca's (2013) evidence, my empirical strategy computes FMSS using VSTOXX for the ECB, the volatility index of the European Stocks Index, and VFTSE for BOE, the volatility index for the UK stock index. Both VSTOXX and VFTSE are computed following the VIX Index computational method, that uses S&P500 options implied volatility as proxy for financial markets conditions. Oet & Lyytinen (2017) consider different factors in building their financial stability variable. They point out that up to 1998 most discussions over financial market stability revolved around financial market factors such as exchange rates, as well as to the real estate market. Subsequently, attention has been directed to specific financial instruments, such as credit market securities which were increasingly appearing in global markets. Oet & Lyytinen (2017) develop a time regime analysis. They show that in the pre-crisis period (2001 – 2006) five factors were constantly considered at time of FOMC discussion: the financial market and its condition as whole, equity market, foreign exchange, the mortgage market, the non-financial sector debt and mutual funds. In the post-crisis period, three more factors are added: corporate bonds, treasury securities and liquid deposits. A volatility index summarises most of this information by providing an indicator of the level of "fear" in the financial markets, which could have a significant impact on the financial stability literature (Whaley, 2000).[78]

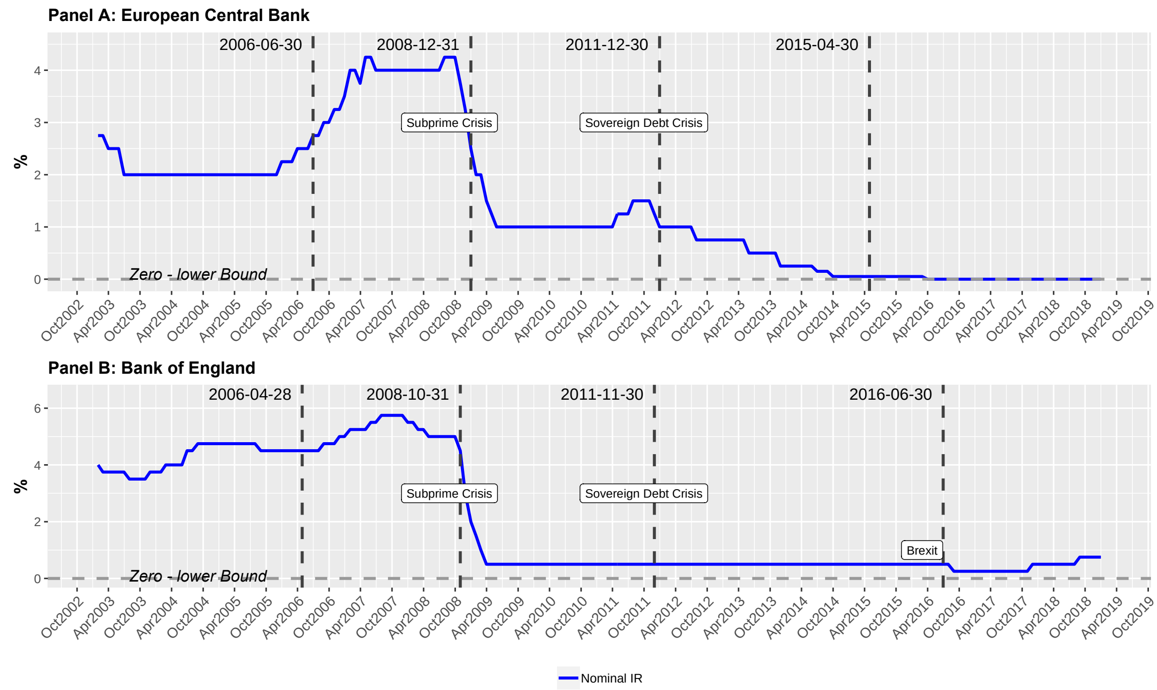
4.4.3 Structural Breaks' Analysis

My empirical analysis covers the whole sample period (2003–2018), but as in Oet & Lyytinen (2017), I test for the presence of time series structural breakpoints using the Bai & Perron (1998) method. A minimum permissible length of the observation segment of $h = \varepsilon * T$, where $\varepsilon = 15\%$ and T is the total number of observations. The structural breaks

[78] Although the volatility indexes could be representative of most of the information regarding Oet & Lyytinen (2017) financial stability measure, a further version of this research could benefit from a more detailed measure of "Financial Stability Slack".

found for the ECB were on 06/2006, 12/2008, 12/2011 and 04/2015. The structural breaks for BOE were identified on 06/2006, 10/2008, 11/2011 and 06/2016.

The first two structural breaks coincided with the raising of interest rates in Europe and then the cutting of interest rates following the crisis events in 2008. Subsequently, a third structural break for the ECB was identified in 2011, during the sovereign debt crisis, and at the end of April 2015, when ECB further cut interest rates and started the Eurozone QE program. The 3rd break for BOE was analogously identified at the end of 2011. Differently, the BOE 4th break was identified as 06/2016, after the Brexit vote.



Sources: European Central Bank Website,Bank of England Website,Bloomberg.

Figure 4.4: Structural Breaks Analysis

The figure presents the structural break analysis for the ECB (Panel A) and BOE (Panel B). The structural break analysis was conducted for both institutions following the Bai-Perron (1998) test on the overnight interest rates for the ECB (Euribor) and BOE (Libor), respectively. A minimum permissible length of the observation segment of $h = \varepsilon * T$, where $\varepsilon = 15\%$ and T is the total number of observations. The breaks are shown on the Nominal Interest rate. Sample period is (2003–2018) and includes192 monthly observations.

Figure 4.4 Panel A, displays the ECB Nominal Rate, along with the regimes identified with the structural break analysis. In Panel B, I similarly present the same data pattern for the BOE. Figure 4.4 shows that the first two regime samples are almost parallel in time. Across the whole period, the structural break analysis indicates when in 2006 the two central banks started to raise interest rates, to counteract higher economic growth and potential deflationary inflationary pressures. The second and the third structural breaks, both coincides (for both institutions) with the 2008 turmoil and the 2011 sovereign debt crisis.

4.4.4 The Taylor-Guide Rule

In this section, I estimate the predicted interest rate values following the traditional framework of the Taylor (1993, 1999a) Rules both with ex-post and forecasted data. These estimates present a descriptive analysis to show the deviation of the realized interest rates from the predicted values of the Taylor (1993, 1999a) Rules. These deviations are the primary motivation for my study. The "traditional" Taylor (1993) Rule, presented in equation [4.1], links the current level of the Federal Fund Target rate to an equilibrium interest rate level, the current inflation and output gap. Since the development of this first model (Taylor, 1993), many other versions of this rule have been developed to describe the monetary policy conduct of different central banks. Oet & Lyytinen (2017) in their empirical analysis estimate a "Taylor-type" Rule, adjusting the reaction coefficients according to Clark (2012). Clark (2012) proposes a modified version of the traditional Taylor (1993,1999a) Rules presented in equation [4.1]. Clark (2012) shows how a Taylor-type rule better explained the conduct of monetary policy in the US during the monetary policy tightening period around 2004–2006. The coefficients of Clark (2012) also include the previous period level of the interest rate. As shown in equation [4.5]:

$$r_t = 0.8(r_{t-1}) + 0.2(r^* + k_\pi(\pi_{t-1} - \pi^*) + k_y(y_{t-1} - y^*)) \quad [4.5]$$

Where k_π is the coefficient value for the inflation gap and is set to be 1.5 and k_y is the coefficient for the output gap and in this case is set to be 2 (differently from the Taylor (1993) Rule, where the output gap coefficient is 0.5). r_{t-1} represents the previous period level of the nominal interest rate, whereas r^* represents the equilibrium level of the nominal interest rate, set to be 2%.

This Taylor-type Rule takes strongly into account the prior period level of interest rates, and for this reason I don't include a "smoothing factor" as in Clarida, Gali & Gertler (1998) and Rudebusch (2006), in order to further capture the explanatory power of omitted variables. Equation [4.5] is employed to estimate the Taylor (1993, 1999a) rules for both the ECB and BOE. The Taylor-type (1993, 1999a) Rules will be estimated with both ex-post and forecast data and the interest rate (r_{t-1}) will be the Nominal Interest Rate for both institutions.[79]

In Figure 4.5, I present estimates of Taylor (1993, 1999a) Rules for the ECB (Panel A) and the BOE (Panel B) with ex-post data, along with the patterns of Nominal Interest Rates. The ex-post Taylor (1993, 1999a) Rules convey important information about ECB and BOE monetary policy rules. At a first glance, as in Oet & Lyytinen (2017), the Taylor (1993, 1999a) Rules explain well the pre-crisis monetary policy conduct. However, by the end of the second regime in 2008, which is October for the BOE and December for the ECB, both Taylor Rule (1993) and (1999a) depart from the Nominal Interest Rates.

It's interesting to note that the Taylor (1993, 1999a) Rules both depart from the Nominal Interest Rate in a symmetrical way and for both central banks. The Taylor (1993) Rule (shown as the green line in both Panel A and B), largely *underestimates* the level of interest rates within the third regime, whereas the Taylor (1999a) Rule (shown as the violet line in both Panel A and B) *overestimates* the level of interest rates. In the ECB case (see Panel A), following the Taylor (1993) Rule interest rates should have been at a zero level much

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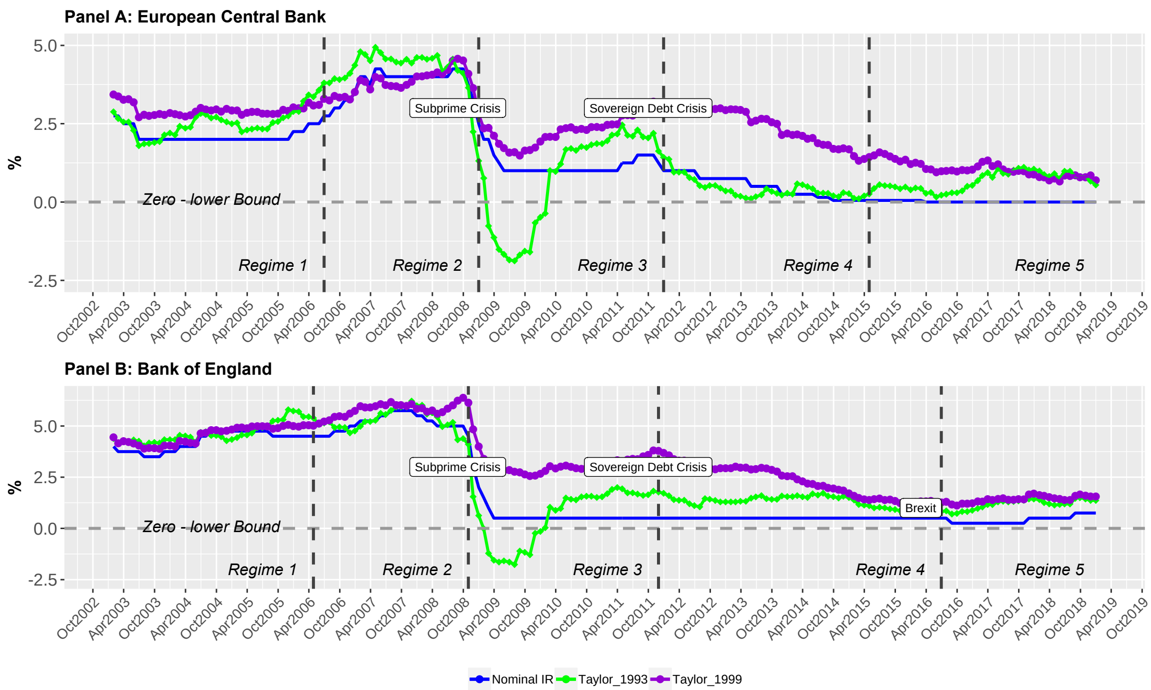
[79] Following partly the criticism of Wu & Xia (2016) I also estimate the Taylor Rules with Overnight Interest rates, to take into account the zero-lower bound time period of the ECB. The descriptive analysis is available in Appendix C.2.

earlier, whereas observing Taylor (1999a) Rule the level of Nominal Interest Rate should have been settled slightly higher at time of economic recovery in 2009, and potentially back to the pre-crisis level by 2010.



Sources: European Central Bank Website,Bank of England Website,ECB Statistical Data Warehouse,Office for National Statistics,Bloomberg.

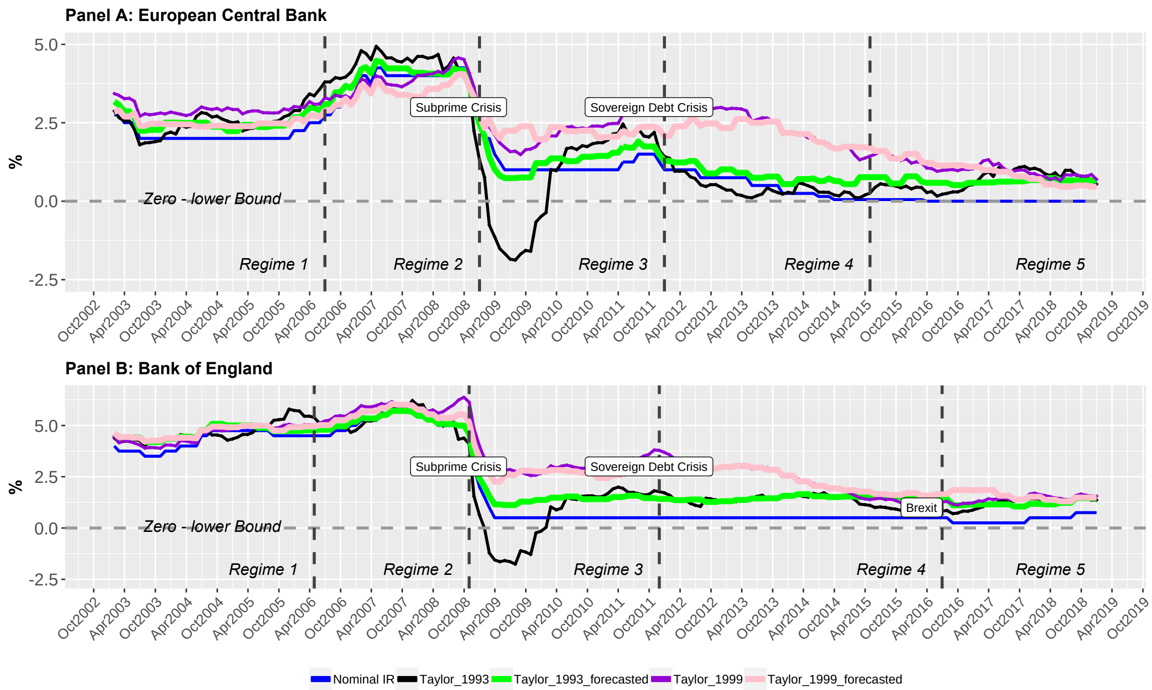
Figure 4.5: Ex-Post Data Taylor Rule
The figure presents the Taylor Rule for the ECB (Panel A) and BOE (Panel B) computed using ex-post data. The estimation of the Taylor (1993, 1999a) Rules, following Oet and Lyytinen (2017), is conducted as Taylor-type Rule, as suggested by Clarke (2012) and as described by equation [4.5]. The Nominal Interest rates are plotted along to the ex-post data Taylor (1993, 1999a) Rules. The regime samples computed with Bai-Perron (1998) are also plotted for both institutions. Sample period is (2003–2018) and includes192 monthly observations.

Furthermore, the Taylor (1999a) Rule suggests a "smoother" cut of interest rates during the 4th regime. The two Taylor Rules converge after 2017 (the 5th regime), even though both overestimate interest rates. Similarly, for the BOE, the two Taylor (1993, 1999a) Rules overestimate interest rates by settling above the Bank Rate at all times. Only the Taylor (1993) Rule, as happens for the ECB, underestimate the level of interest rate in the first half of the 3rd regime. In the case of the BOE, the two Taylor (1993, 1999a) Rules converge in the second half of the 4th regime and smoothly decline into the 5th regime.

Summing up, and for both central banks, Taylor (1993, 1999a) Rules do a good job in explaining the path of Nominal Interest Rates up to the surge of the 2008 financial meltdown. However, when the Eurozone had to encounter the sovereign debt crisis in 2011, I observe a significant difference in the path of Nominal Interest Rates between the ECB and BOE. On the other hand, the BOE had its own unique event at the time of the 2016 Brexit referendum, which affected its monetary policy.

Furthermore, I estimate the predicted value of the official interest rate for both institutions with forecasted data. Figure 4.6 shows those estimates along with Figure 4.5's ex–post and Nominal Interest Rate series. It's clear that adding macroeconomic forecasts to Taylor (1993) Rule estimates for both central banks we obtain a better explanation of the path of Nominal Interest Rates. Taylor (1993) Rule doesn't underestimate the level of interest rate when the 3rd regime begins, but overestimates the level of interest rate after the second half of the 3rd regime, particularly in the case of the BOE. On the other hand, the Taylor (1999a) Rule systematically overestimates the level of rates for both institutions.

Lastly, I employ the Taylor (1993) Rule, with forecasted data, to estimate the level of the interest rates implied by my Augmented Taylor Rule. To compute my Augmented Taylor Rule, I extend equation [4.5] to include my measure of FMSS and I assign to it the same coefficient assigned to the output gap (the coefficient for the output gap is equal to 2). As shown in Figure 4.7 (Panel A: ECB, Panel B: BOE), the Augmented Taylor Rule does a much better job in tracking the path of interest rates of the two central banks. This finding parallels the results shown in Oet & Lyytininen (2017), where the Augmented Taylor Rule explains the deviations of interest rates from those implied by the Taylor (1993) Rule, particularly during the turbulent times of the 2008 financial crisis.



Sources: European Central Bank Website,Bank of England Website,ECB Statistical Data Warehouse,Office for National Statistics,Bloomberg.

Figure 4.6: Forecasted Data Taylor Rule
The figure presents the Taylor Rule for the ECB (Panel A) and BOE (Panel B) computed using forecasts. The estimation of the Taylor (1993, 1999a) Rules, following Oet and Lyytinen (2017), is conducted as Taylor-type Rule, as suggested by Clarke (2012) and as described in equation [4.5]. The Nominal Interest Rate series is plotted along both for the ECB and BOE. The regime samples computed with Bai-Perron (1998) are also displayed for both institutions. Sample period is (2003–2018) and includes192 monthly observations.

This study partially departs from the study of Oet & Lyytininen (2017) and I don’t employ the Taylor (1999a) Rule to estimate my Augmented Taylor Rule, as in the two previous estimates. This (1999a) version of the Taylor Rule overestimates the level of official interest rates, regardless of the type of data involved (ex-post or forecasted). It seemed natural to exclude this version of the Taylor Rule for the Augmented Taylor Rule, as the second mandate of both the ECB and BOE is not the full employment objective but the economic growth implied by the output gap. In figure 4.7, I have plotted the Taylor (1993) rule computed forecast data, along with its Augmented version, to show the "progression" of the explanatory power of my FMSS variable.

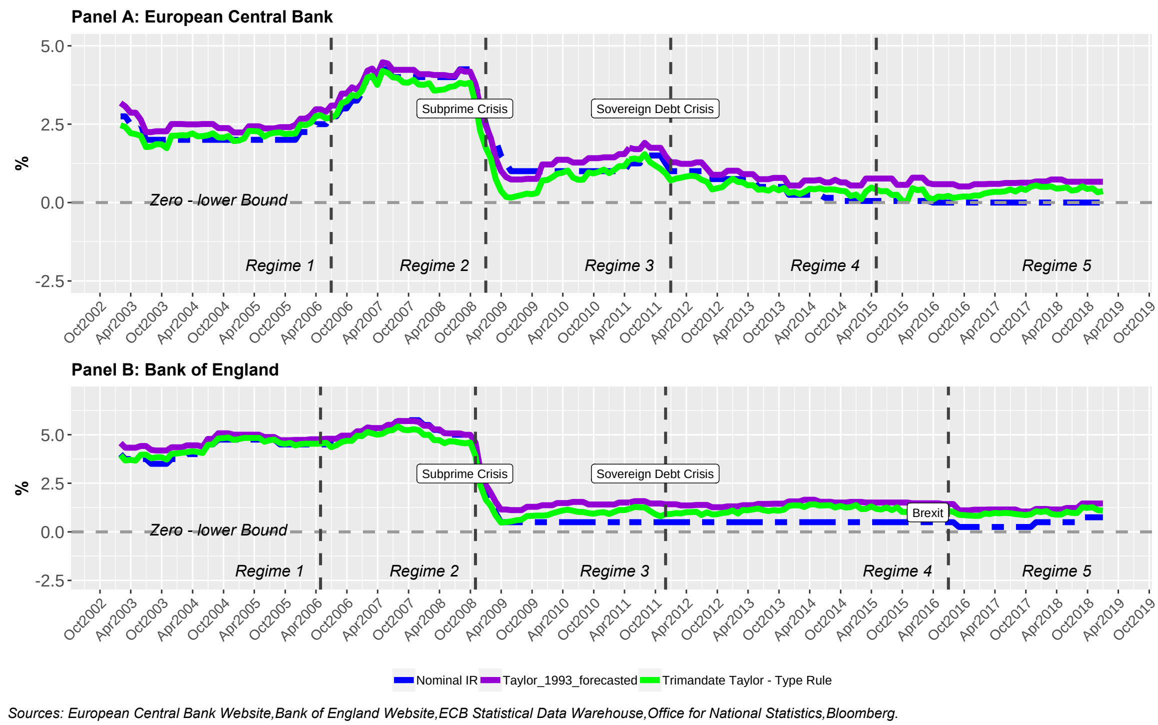


Figure 4.7: The Augmented Taylor Rule
The figure presents the Augmented Taylor Rule for the ECB (Panel A) and BOE (Panel B) computed using forecasts. The Augmented Taylor Rule is computed following the Taylor (1993) Rule and adding the FMSS variable (computed as shown in equation [4.4]). The Augmented Taylor Rule is computed with a Taylor-type Rule, as suggested by Clarke (2012) and as shown in equation [4.5]. The coefficient for the FMSS variables is equal to the coefficient of the output gap. The Augmented Taylor Rules are computed with forecasts. The Nominal Interest Rates is plotted along both for the ECB and BOE. The regime samples computed with Bai-Perron (1998) are also displayed for both institutions. Sample period is (2003–2018) and includes192 monthly observations.

Two important aspects emerge from Figure 4.7. First, although the Taylor (1993) Rule computed with forecasted data does a better job in explaining the path of interest rates compared to the Taylor (1993) rule estimated with ex-post data, both the specification of the Taylor (1993) Rule still overestimate the path of interest rate. Second, when including the FMSS variable, the Augmented Taylor Rule mimics the path of the interest rates more precisely then both the other specification of the Taylor (1993) Rule. Interestingly in the case of the BOE, in the 5th regime (after the Brexit vote) the predicted level of interest rates accordingly to the Augmented Taylor Rule should have been maintained lower for a longer period. In the case of the ECB (Panel A), it still looks as if the Augmented Taylor Rule overestimates the level of Nominal Interest Rates.

The focus of the results in Oet & Lyytininen (2017) is on the performances of their Augmented Taylor Rule in the after-crisis period, however my descriptive analysis shows that my Augmented Taylor Rule does a decent job in explaining the Nominal Interest Rate's path also in pre-crisis period, particularly in the case of BOE. When considering the first regime, the BOE Nominal Interest Rate place itself just between the Taylor (1993) Rule with forecasted data and the Augmented Taylor Rule. Moving on to the second regime, the Augmented Taylor Rule clearly suggests a lower level of the Nominal Interest Rate, whereas the path is almost perfectly explained by the Taylor (1993) Rule with forecasted data. These results obviously suggest the forward-looking nature of BOE monetary policy conduct, but perhaps they weren't yet particularly concerned about financial markets' stability.

In the case of the ECB, the paths suggested by the both the Augmented and the Taylor (1993) Rule with forecasted data are slightly more volatile. The Nominal Interest Rate in the 1st regime place itself just below both the Taylor rules, suggesting perhaps an even more precautionary attitude from the ECB. On the contrary, during the 2nd regime, just in the pre-crisis period the Nominal Interest rate is also almost perfectly explained by the Taylor (1993) rule and sets above the Augmented Taylor Rule. This result, common to both the ECB and BOE could potentially suggest that the FMSS was mildly predicting what was about to come.

4.5 Empirical Results

Motivated by the hypothesis outlined in section 4.3 and the descriptive analysis in section 4.4.4, in this section I present the empirical tests to investigate whether an Augmented forward-looking Taylor Rule better describes the realised interest rates paths for both the ECB and BOE. First, I present my empirical research design and second the related results for the whole sample (2003–2018) and the regime subsamples.

4.5.1 Empirical Research Design

Equations [4.6], [4.7], [4.8] and [4.9] outline the regression models I adopt to test the hypotheses of section 4.3:

$$r_t = r^* + k_\pi(\mathbf{\Pi}_t) + k_y(\mathbf{Y}_t) \quad [4.6]$$

$$r_t = r^* + k_\pi(\mathbf{\Pi}^f_t) + k_y(\mathbf{Y}^f_t) \quad [4.7]$$

$$r_t = r^* + k_\pi(\mathbf{\Pi}_t) + k_y(\mathbf{Y}_t) + k_{FMSS}(\text{FMSS}) \quad [4.8]$$

$$r_t = r^* + k_\pi(\mathbf{\Pi}^f_t) + k_y(\mathbf{Y}^f_t) + k_{FMSS}(\text{FMSS}) \quad [4.9]$$

Where my dependent variable is the level of the Nominal Interest Rate (r_t) and the explanatory variables are the inflation gap, ex-post ($\mathbf{\Pi}_t$) and forecasted ($\mathbf{\Pi}^f$), the ex-post and forecasted output gap ($\mathbf{Y}_t$ and $\mathbf{Y}^f_t$) and the FMSS (equations [4.8] and [4.9]).

The explanatory variables are computed as shown in equation [4.2] in the case of the inflation gap, equation [4.3] for the output gap and equation [4.4] for the FMSS variable.

The analysis is conducted for both institutions for the whole sample period (2003–2018) and also across the subsamples computed with the structural breaks' analysis (section 4.4.3). The purpose of this analysis is to estimate the coefficients k_{π}, k_y and k_{FMSS} to investigate which factors better explain the monetary conduct of the ECB and BOE. The factor $r*$ represents the interest rate "in equilibrium" and is a constant factor of value 2%. The coefficients of the Taylor Rules are estimated with an OLS methodology, following Oet & Lyytinen (2017). OLS estimation of monetary policy can potentially produce imprecise estimations of policy parameters, because of endogeneity issues between the macroeconomic variables and monetary shocks. Recently, though, Carvalho, Nechio & Tristao (2018) find empirical evidence that the OLS methodology is statistically efficient to estimate the Taylor Rule, compared to other methodologies such as Instrumental Variables (IV). They argue that since the shocks only explain a small fraction of the variance of the regressors, the endogeneity bias is small.

Clarida, Gali & Gertler (1998), use a GMM methodology to estimate monetary policy rules for the G-3 and E-3 countries and show that the observed monetary policy is consistent with a "smoothing" parameter for the actual level of interest rates. Gorter, Jacobs, & De Haan (2008) use a NLS estimation, even though this methodology could potentially yield results that are arbitrarily dependent on the starting values of the non-linear procedure. Oet & Lyytinen (2017) use an OLS methodology to estimate the Taylor Rule.

4.5.2 Results

This section presents empirical findings when testing hypotheses as in section 4.3, and following the empirical methodology outlined in section 4.5.1.

4.5.2.1 Whole Sample Results (2003–2018)

Panel A of Table 4.1 presents the ECB results and Panel B shows the findings for the BOE. "EP" columns (1, 3, 5 and 7) are regression models that use ex-post data, whereas "F" columns (2, 4, 6 and 8) use forecasts. Columns (3) and (4) for the ECB and (7) and (8) for the BOE present regression results when the financial market stability variable is included. The results in Table 4.1 are for the 2003–2018 time series. In both central banks' cases, they show clearly that by using forecasts we may better explain the observed interest rate pattern. For the ECB case (see Panel A), the estimate of forecasted inflation is three times higher than the coefficient of ex-post inflation, the regression R^2 is consistently higher, and RMSE is much lower. Interestingly, the results of both equations [4.6] and [4.7] show that the output variable, either observed or forecasted, is statistically insignificant. Estimates of regressions [4.8] and [4.9] indicate that the FMSS coefficient is positive and statistically significant, as is the economic slack. For the BOE case (see Panel B), the estimate for the k_π ex-post coefficient is positive, whereas the estimate for the forecasted k_π is negative. The estimated coefficients for the k_y coefficient are statistically significant for both banks, although the size of forecasted variables estimates are much higher than in the case of ex-post data. Similar to Gerlach (2007), the results of columns 1 and 2 highlight that expectations about output growth play an important role in the ECB interest rate decisions. Gorter, Jacobs, & De Haan (2008) also find similar results in the case of the ECB, whereas the results in columns (5) and (6) shed new light on the conduct of monetary policy in the BOE.[80] Consistent with Svensson's critiques (2003, 2010, 2019) both institutions follow a forward-looking (Bernanke, 2015) monetary policy. Similarly, to the ECB, the explanatory power of forecasted data is higher, as testified by the R^2 of the equations [4.6]

[80] To the best of my knowledge, there aren't any studies which effectively compare ex-post and forecasted data in the context of BOE monetary policy.

and [4.8]. Interestingly, the FMSS coefficient is significant, in the case of the BOE only when considering ex-post data. These results can be due to the closer attention that the BOE gives towards forecasted economic variables, in particular to inflation, given the strict commitments that the BOE has towards the government in maintaining a stable inflation rate.

Table 4.1: Results - Whole Sample: 1:2003–12:2018

$Y = r_t$	*Panel A: ECB*				*Panel B: BOE*			
	EP (1)	F (2)	EP (3)	F (4)	EP (5)	F (6)	EP (7)	F (8)
$r*$	0.870***	1.345***	0.936***	1.520***	1.280***	2.321***	1.426***	2.327***
	(0.052)	(0.073)	(0.058)	(0.077)	(0.090)	(0.138)	(0.108)	(0.140)
k_π	0.980***	3.067***	0.953***	3.032***	0.480***	-1.805***	0.437***	-1.762***
	(0.092)	(0.263)	(0.091)	(0.248)	(0.168)	(0.637)	(0.167)	(0.659)
k_y	0.037	0.278	0.104*	0.642***	0.266***	3.129***	0.359***	3.129***
	(0.047)	(0.179)	(0.055)	(0.184)	(0.078)	(0.333)	(0.086)	(0.334)
k_{FMSS}			0.747**	1.292***			1.158**	0.098
			(0.314)	(0.257)			(0.488)	(0.371)
R^2	0.656	0.711	0.666	0.745	0.567	0.697	0.580	0.697
MAPE	2.535	4.249	2.653	4.755	1.908	1.453	1.800	1.461
RMSE	1.223	1.122	1.205	1.054	2.047	1.713	2.017	1.712
Obsv	192							

Note: Table 4.3 presents the results for both hypotheses, across the whole sample period. Panel A presents the results related to the ECB and Panel B presents the results related to BOE. The dependent variable (r_t) is represented by the monthly time series of the EURIBOR and LIBOR for the ECB and BOE respectively. Estimates for the inflation gap (k_π) are presented for both institutions, computed with both ex-post and forecasted data. Similar estimates are made for the economic slack (k_y) and financial market stability slack (k_{FMSS}). Panel A presents the results for the ECB, Panel B presents the results for the BOE. In Panel A, columns (1) and (3) present the results of equations [4.5] and [4.7], computed considering ex-post data, whereas columns (2) and (4) present the results of equations [4.6] and [4.8] computed considering forecasted data. Columns (3) and (4) present the results including the FMSS variable. Similarly, Panel B, columns (5) and (7) presents the results of equations [4.5] and [4.7], computed considering ex-post data, whereas columns (6) and (8) present the results of equations [4.6] and [4.8] computed considering forecasted data. Columns (7) and (8) present the results including the financial market stability variable. Standard errors for the estimates are presented in brackets. For each regression, the R^2, the Mean Absolute Percentage Error (MAPE) and the Residual Mean Square Error (RMSE) are presented.
Signif. codes: '***' 0.01 '**' 0.05 '*' 0.1
Source: ECB website (www.ecb.europa.eu), ECB statistical Data Warehouse (sdw.ecb.europa.eu), BOE website (www.bankofengland.co.uk), The Office for National Statistics Website (www.ons.gov.uk), the OECD Website (www.oecd.org) and Bloomberg.

Overall, comparing the results between the two institutions, it's clear that Financial Market Stability (FMSS*) played a role in the setting of monetary policy for the ECB and partly for the BOE. The stronger result in the case of the ECB could be due to the 2011 sovereign debt crisis, which certainly was an unprecedented experience in the management of Eurozone monetary policy. My results are also aligned with findings in Botzen & Marey (2010), who show that the ECB responded to stock market prices even prior to the financial crisis. The coefficient related to the equilibrium interest rate (r^*) remains positive and statistically significant in all my regression models. Although I haven't included any interest rates smoothing factor as in Clarida, Gali & Gertler (1998), this result clearly states that institutions are concerned about the equilibrium level of interest rates and will consider the current level of such interest rates when deciding a monetary policy innovation.

4.5.2.2 Regime Samples Analysis

Table 4.2 presents empirical results across different regimes samples. In order to discover the explanatory power of different monetary policy rules, in Table 4.2, I compare the R^2 of equations [4.6], [4.7], [4.8] and [4.9] across different regime samples. Time regime samples were constructed using the Bai–Parron (1998) method. They find that the FOMC changed their way of conducting policy so that different monetary policy rules explain differently the conduct of US monetary policy. Panel A of Table 4.2 presents results for the ECB and Panel B for the BOE. In columns (1) and (5) are reported the coefficients' estimates of equation [4.6] using ex–post data, whereas, in columns (2) and (6), I present regression estimates for equation [4.7], which is run using forecasted data. Estimates of equation [4.8] are displayed in columns (3) and (7), while equation [4.9] results are reported in columns (4) and (8).

The results related to the ECB (Panel A) show clearly multiple deviations in the preferences of the ECB monetary policy makers. Specifically, the regression model in column (4) (equation [4.7]) R^2 is highest in the first regime sample which spans the time period 2003 to the middle of 2006. This result is consistent with the ECB decision to join the IT framework. However, column (4) R^2 is decreasing across the regime samples. Focusing on the last 3 years of monetary policy (the 5th regime sample), the traditional Taylor (1993) Rule explains less the 70% of interest rate variations. Similarly, the traditional Taylor (1993) Rule loses some of its explanatory power in the case of BOE with 1st regime R^2 at 0.99 compared to a 5th regime an R^2 of 0.95.

To put these results in the right perspective we have to interpret the difference between the inflation gap computed using either historical data or forecasts. As shown in Figure 4.1, Panel A, the ECB inflation gap when considering historical data ranges from -2% to +2%, which means that the ECB has missed its target by the same amount of the actual target. For the BOE (see Panel B), I observe a similar pattern with the inflation gap ex- post data, which ranges from -2% to +3%. What is different between the two banks is the forecasts for the inflation gap. In the case of BOE, the forecasted inflation gap is more frequently closed to 0. These differences support the view that the ECB forecasts are closer to the realised data then the BOE forecasts. A possible explanation of these differences could be linked to the BOE's stricter regulation in missing the inflation target. As inflation forecasts are known in advance of BOE policy decisions, the "notice" obligation could have an influence in opinions of the forecasters, whenever the inflation target might be missed.

Turning to the role of the FMSS, two results are common for the two banks: the variable is statistically significant in explaining their monetary policy at times of the 3rd regime. As shown in Table 4.2, the R^2 of equation [4.8] is the highest across the last three regime samples. Surprisingly, when inserting the FMSS, forecasts of macroeconomic variables lose their explanatory power. There could be alternative explanations for this result. First, forecasts of macroeconomic indicators, even though they are transformed, are conceptually at a lower frequency and variability then ex-post data.

Table 4.2 : Regime Samples Analysis - Results

	Panel A: ECB				Panel B: BOE			
	EP (1)	F (2)	EP (3)	F (4)	EP (5)	F (6)	EP (7)	F (8)
	Regime 1: M1:2003-M6:2006				*Regime 1: M1: 2003 - M4:2006*			
R2	0.992	0.994	0.993	**0.995**	0.993	0.998	0.997	**0.998**
MAPE	0.069	0.059	0.063	0.059	0.071	0.039	0.049	0.034
RMSE	0.210	0.177	0.188	0.154	0.365	0.197	0.253	0.173
	Regime 2: M7:2006 - M12:2008				*Regime 2: M5: 2006 - M10:2008*			
R^2	0.987	0.983	**0.987**	0.983	0.991	0.997	0.995	**0.997**
MAPE	0.094	0.116	0.094	0.115	0.079	0.040	0.060	0.039
RMSE	0.492	0.563	0.490	0.561	0.533	0.296	0.418	0.285
	Regime 3: M1:2009 - M12: 2011				*Regime 3: M11:2008 - M11: 2011*			
R^2	0.949	0.870	**0.966**	0.908	0.932	0.899	**0.953**	0.917
MAPE	0.168	0.360	0.161	0.294	0.224	0.281	0.161	0.283
RMSE	0.270	0.431	0.222	0.363	0.280	0.342	0.232	0.310
	Regime 4: M1:2012 - M4:2015				*Regime 4: M12:2011 - M6:2016*			
R^2	0.970	0.887	**0.973**	0.938	0.960	0.943	**0.968**	0.957
MAPE	0.390	0.542	0.370	0.496	0.163	0.153	0.149	0.151
RMSE	0.147	0.285	0.138	0.211	0.129	0.154	0.116	0.134
	Regime 5: M5:2015 - M12 2018				*Regime 5: M7:2016 - M12: 2018*			
R^2	0.678	0.552	**0.700**	0.553	0.957	0.944	**0.960**	0.957
MAPE	1.029	2.207	1.144	2.233	0.172	0.205	0.158	0.160
RMSE	0.149	0.175	0.144	0.175	0.116	0.132	0.111	0.116

Note: Table 4.4 presents the results of the model horse race across the regime samples analysis for the ECB and BOE. Panel A presents the results for the ECB and Panel B presents the results for the BOE. The regime sample analysis is based on the structural breaks' analysis conducted as explained in detail in section 4.4.3. The regime sample analysis was conducted setting a minimum segment length of $h * N$, where h is a parameter of 0.15 and N is the total number of observations. In Panel A, columns (1) and (3) present the results of equations [4.6] and [4.8] (ex-post data), whereas columns (2) and (4) present the coefficients' estimates for equations [4.7] and [4.9] (forecasted data).. Columns (3) and (4) present the results including the FMSS. Similarly, Panel B, columns (5) and (7) presents the results of equations [4.6] and [4.8] (ex-post data), whereas columns (6) and (8) present the results of equations [4.7] and [4.9] (forecasted data). Columns (7) and (8) present the results including the FMSS. For each regime sample analysis, the R^2, the Mean Absolute Percentage Error (MAPE) and the Residual Mean Square Error (RMSE) are presented. The R^2 coefficients highlighted in **bold** represent the highest R^2 within the regime.
Source: ECB website (www.ecb.europa.eu), ECB statistical Data Warehouse (sdw.ecb.europa.eu), BOE website (www.bankofengland.co.uk), The Office for National Statistics Website (www.ons.gov.uk), the OECD Website (www.oecd.org) and Bloomberg Terminal.

Second, as I noted earlier, the historical inflation gap time series has higher volatility (Figure 4.1), which may affect the consistency of regression estimates. The third motive for my finding may be linked to the behavior of forecasters specifically at the time of economic shocks. Lansing & Pyle (2015) have studied FOMC members' economic forecasts and observed that their economic growth forecasts have been systematically high and revised afterwards. Although I have no knowledge of empirical evidence on the ECB and BOE monetary policy member forecast ability,[81] a possible explanation of my results could be similar to the American case, and so during downturns, macroeconomic expectations are systematically overestimated and revised afterwards when more hard data become available.

4.5.2.3 Dissecting Financial Market Stability

In this section, I examine whether further financial market factors have a significant influence on the two banks decision making process. In particular, other factors could be the dynamics of international financial markets and exchange rates. There are a few reasons to think that this could be the case. First, in Taylor (1999b), the exchange rates' market has been given its importance in central banking in the setting of the interest rate. Taylor (2001) asserts that more research is needed to understand the implication of monetary policy rules that directly target exchange rates.

Lubik & Schorfheide (2007) found evidence that the BOE and BOC included nominal exchange rates in their policy rule, whereas the central banks of Australia and New Zealand

[81] To the best of my knowledge

do not target exchange rates. Second, as ECB President Mario Draghi announced in the famous statement of July 2012, there has been a strong commitment to supporting Eurozone economies through both conventional and unconventional central banking policies. Third, as I mentioned earlier, there is evidence that the FED has an impact on the monetary policy of other central banks (Caputo & Herrera, 2017).

Further support of the idea that financial markets are key to central banking is the study of Bekaert, Hoerova, & Lo Duca (2013) who find a high correlation between the FED monetary policy and the VIX Index. Thus, to take into account all the above I add to my regression models the FMSS variable for the US[82], in order to analyse whether outcomes from international financial markets have any influence on the two banks' monetary policy decision makers.

In what follows, I set-up equations [4.10] and [4.11] to formally test those intuitions:

$$r_t = r^* + k_{\pi}(\mathbf{\Pi}_t) + k_y(\mathbf{Y}_t) + k_{FMSS}(\text{FMSS}) + k_{FMSS\_US}(\text{FMSS\_US}) + k_{EX}(\text{EX}) \qquad [\ 4.10\ ]$$

$$r_t = r^* + k_{\pi}(\mathbf{\Pi}^f_t) + k_y(\mathbf{Y}^f_t) + k_{FMSS}(\text{FMSS}) + k_{FMSS\_US}(\text{FMSS\_US}) + k_{EX}(\text{EX}) \qquad [\ 4.11\ ]$$

where the variables included in both equations are the same as the one include in equations [4.8] and [4.9], plus the "FMSS_US" which is the FMSS variables for the US and EX is

[82] The FMSS variable for the US is built following the same logic as the FMSS variable employed for both the ECB and BOE. Specifically, the deviation FMSS is computed as the deviation of the current financial markets condition (σ_t) and their long-run "stability state" (Σ) as presented in euqation [4.4]. Where the Σ is computed as the average level of the VIX index in the pre-crisis period (2000-2007) and σ_t as the current level of the VIX index.

the exchange rate between either EURO and USD (for the ECB) or GBP and USD (for the BOE). The results for equations [4.10] and [4.11] are presented in Table 4.3.

Consistent with my previous results, when forecasts are added to the regression models explanatory power of ex–post data changes when analysing the whole sample or regime samples. Again, this result could be explained by a small sample bias which originates from the low frequency of the forecast data. Regression models in Table 4.3 highlight the significant impact of the exchange rates market in monetary policy decisions. As Ball (1999) proposes, in small open economies, adding exchange rate dynamics in central banking decisions, could help improve macroeconomic performances.

On the other hand, Taylor (1999b) has found that in the case of ECB adding exchange rates in the multi-country model doesn't dominate the baseline model. Consistent with Taylor's (1999b) findings, although the exchange rate (Euro-US Dollar Exchange Rate) is statistically significant and the coefficient is the greatest in magnitude, the results related to the inflation and output gaps (ex-post and forecasted) remain robust. Differently, in the case of the BOE, when adding the exchange rate as a control variable the coefficient related to the forecasted inflation gap remains robust, whereas the forecasted output slack is not statistically significant. A possible explanation for such a result can be the additional protection that the BOE had to dispose for the British Pound, particularly during the recent events regarding Brexit.

The coefficients of the "FMSS_US" variable represent an important and interesting result. The FMSS_US variable is statistically significant for the ECB, both when analyzing ex-post and forecasted macroeconomic variables. The financial market stability variable of the EU becomes statistically insignificant when combined with the US variable. On the other hand, in the case of the BOE, when considering forecasted variables, the US financial market stability is not statistically significant. This result can be interpreted as a greater concern of the ECB for the US financial markets compared to the BOE

Table 4.3 : Dissecting Financial Market Stability - 1:2003–12:2018

	Panel A: ECB		*Panel B: BOE*	
	EP (1)	F (2)	EP (3)	F (4)
r^*	0.685^{***}	1.238^{***}	1.496^{***}	1.397^{***}
	(0.077)	(0.073)	(0.061)	-0.11
k_π	0.678^{***}	2.226^{***}	0.112	1.159^{**}
	(0.092)	(0.207)	(0.096)	-0.495
k_y	0.239^{***}	1.266^{***}	0.047	-0.249
	(0.053)	(0.155)	(0.053)	-0.308
k_{EX}	-4.262^{***}	-5.096^{***}	-8.325^{***}	-9.215^{***}
	(0.793)	(0.593)	(0.420)	(0.600)
k_{FMSS}	0.044	0.253	1.423^{**}	1.196^{*}
	(0.612)	(0.466)	(0.705)	(0.710)
$k_{\text{FMSS\_US}}$	1.099^{*}	1.189^{***}	-1.294^{*}	-0.982
	(0.599)	(0.451)	(0.722)	(0.713)
R^2	0.733	0.845	0.867	0.878
MAPE	2.675	2.34	1.134	1.123
RMSE	1.079	0.821	1.211	1.168
Observations				192

Note: The table presents the results for both hypotheses, across the whole sample period. Panel A presents the results related to the ECB and Panel B presents the results related to the BOE. The dependent variable (r^*) is represented by the monthly time series of the EURIBOR and LIBOR for the ECB and BOE respectively. Estimates for the inflation gap (k_π) are presented for both institutions, computed with both ex-post and forecasted data. Similarly estimates for the economic slack (k_y), the exchange rate slack (k_{ER}), financial market stability slack (k_{FMSS}) and the US financial market stability slack ($k_{\text{FMSS\_US}}$). Panel A presents the results for the ECB, Panel B presents the results for the BOE. In Panel A, columns 1 presents the results of equation [4.10] (ex-post data), whereas column (2) presents the results of equation [4.11] (forecast data). In Panel B, column (3) presents the results of equation [4.10] (ex-post data), whereas column (4) presents the results of equation [4.11] (forecast data). Standard errors for the estimates are presented in brackets. For each regression, the R^2, the Mean Absolute Percentage Error (MAPE) and the Residual Mean Square Error (RMSE) are presented.
Signif. codes: '***' 0.01 '**' 0.05 '*' 0.1
Source: ECB website (www.ecb.europa.eu), ECB statistical Data Warehouse (sdw.ecb.europa.eu), BOE website (www.bankofengland.co.uk), The Office for National Statistics Website (www.ons.gov.uk), the OECD Website (www.oecd.org) and Bloomberg Terminal.

Overall, regression models which include forecasts dominate models that rely on historical data, which further confirms empirical results of the previous section. The evidence is particularly stronger in the case of the ECB when focusing on the two models different R^2: 0.73 when using ex-post data and 0.85 when including forecasts. In the case of the BOE, that difference is smaller although even for the BOE the forecasted inflation rate remains highly significant. Lastly, financial market stability remains a matter of concern for the two central banks, although in a different way. The ECB and BOE are certainly keen to manage their currencies and maintain financial market stability. Moreover, "international" financial market stability also plays a role in interest rates' setting, particularly at the ECB. This result can be reconciled with the willingness of the institutions, in the aftermath of the financial crisis, to re-establish trust among investors and financial institutions.

4.6 Limitations

This chapter suffers from three important limitations. First, it doesn't address two important elements of the conduct of the ECB monetary policy: first, no measure of unconventional monetary policy has been taken into account in my empirical design. Follow-up research could focus on identifying high-quality variables that may well depict the ECB's unconventional monetary policy measures adopted in the last decade. Second, another factor that added to Eurozone financial market instability has been the sovereign debt crisis of 2010–2011. That event requires that appropriate proxies of European fixed income market dynamics be identified. Carrying out that research could help shed some light on the factors that affected Eurozone financial market volatility in 2011, and what role the ECB played in heavy market intervention.

Furthermore, the analysis of the present chapter is run by adapting quarterly and monthly data, with a potential bias arising from the different sample data frequencies. Recently, other monthly forecasted data have become available. Datasets such as the "Consensus Economic Forecasts" from Bloomberg are forecasts data from professional forecasters and market participants and are available at a monthly frequency. These data could help enhance the precisions of the estimates. Even though the OLS methodology has proven to be adequate for the investigation of this research question, perhaps additional estimation with a more complete dataset would further corroborate the findings of this chapter.

Last but not least, the FMSS variable only considers a source of financial instability. It would, however, be beneficial for the relevance of the research to further expand the definition to financial stability. Oet & Lyytinen (2017) include several measures of financial stability, including all those discussed in the minutes of the FOMC. The same sources of financial stability could be retrieved for both the ECB and BOE, validating the results and deepening the analysis.

4.7 Conclusions

In this chapter, I contribute to the debate on central banking by proposing a forward-looking Augmented Taylor (1993) Rule to investigate the conduct of monetary policy for the ECB and BOE. My study covers a long time series, 2003–2018, which encompasses both the US financial crisis of 2008 and the Eurozone sovereign debt crisis of 2011. The question on whether financial market stability, as a subset of financial stability, should be included in the mandate of central banks, has been largely discussed among academics and practitioners ever since the aftermath of the 2008 financial crisis. Many studies have argued theoretically and empirically on this matter, although no definitive consensus has been reached. Furthermore, monetary policy makers have put a great deal of efforts in the last decade into producing and communicating macroeconomic forecasts to clarify the conduct of monetary policy. My results highlight two important findings, first, the Augmented Taylor (1993) Rule dominates the traditional version of the Taylor (1993) Rule. Furthermore, a forward-looking version of the Taylor (1993) Rule also better explains the monetary policy conduct of both institutions across the whole sample period (2003–2018). The Augmented version of the Taylor (1993) Rule dominates the traditional version of the rule across regime samples, particularly after the 2008 financial crisis, confirming for both ECB and BOE the available evidence for the FED as in Oet & Lyytinen (2017). Thus, also in the case of the ECB and BOE, in the aftermath of the financial crisis, financial stability variable explains the deviations of the realised interest rates from the interest rates implied by the traditional Taylor (1993) Rule. The case of ECB is particularly interesting, where I find that not only the EU financial market stability matter but also the US financial market stability. This may also be an indication of both the large openness of Eurozone economies compared to the US economy but also of its dependence on the US economy. Bekaert, Hoerova, & Lo Duca (2013) have hinted that such a relation is showing up in the data: they found that the US stock market volatility co-moves with the measure of US monetary policy. Furthermore, Caputo & Herrera (2017) found that IT central banks respond to the movement of the FED interest rate. My results reconcile that evidence when I find that the US financial market stability variable, proxied by the deviation of the VIX Index from its long-term pre-crisis mean, mattered in the ECB monetary policy decisions.

My results are in line with those of Gorter, Jacobs, & De Haan (2008), showing that an extended forward-looking Taylor (1993) Rule dominates the traditional version of the Taylor (1993) Rule. These findings are also consistent with Svensson's (2003, 2010, 2019) critiques, who has been arguing for more forward-looking macroeconomic variables in assisting central bank decisions. However, when I subject my regression models to different regime samples, forward-looking regression models do not supersede models that rely on ex-post data. A possible explanation for this result is a small sample bias and the less variability of forecasted data with respect to ex-post data.

Chapter 5

Conclusions

5.1 Summary and Implications

This thesis deals with three issues related to the reciprocal influence between monetary policy and financial markets. The first chapter introduces the motivation to my study and gives and overview of my research questions and contributions to the literature. The second chapter analyses the expectations of investors with regards to FOMC monetary policy announcements and how these expectations influence their reaction once the announcements reach the equity market. To infer the expectations of market participants I extended the pioneer methodology of Kuttner (2001) and computed the daily probabilities, assigned by market participants, of interest rate changes. Further, I combined these probabilities with the outcome of the announcements, to investigate whether the outcome was in line with the expectations of market participants.

The analysis suggests that financial market participants react strongly to FOMC announcements that are not in line with their expectations, whereas the reaction to expected outcomes is already embedded in equity prices. In addition, the empirical analysis focuses on specific FOMC announcements where no interest rate change is voted by the committee, to corroborate the previous results, by showing that the expectations of investors on the outcome are the drivers of their reactions and not the outcome itself. Equity investors display, in fact, an even strong reaction when they disagree with neutral monetary policy outcomes, which can be explained by the additional uncertainty that arises when the FOMC decides to leave the level of interest rates unchanged.

These findings offer significant implications for a broad range of financial applications and policy makers' guidance. My results provide an alternative explanation to the equity premium, documented by the literature around macroeconomic announcements. Monetary economists attribute the premium to the unexpected component of interest rate changes, which, however, doesn't entirely explain the reaction to the announcement, where no interest rate is voted. My results provide an explanation that satisfies both the monetary economist and macroeconomic announcements literature streams, by attributing the equity effect to the expectations of investors, postulated prior to the announcement and realised on the announcement day. Furthermore, although central banks and monetary policy institutions' communication has largely improved in the past two decades, the fact that investors still strongly react to monetary policy and macroeconomic announcements shows that the alignment of investors' expectations with monetary policy conduct can be improved. Lastly, my results provide evidence that the response of equity to the announcement is in line with the CAPM predictions.

The third chapter investigates the effect of the ECB monetary policy shocks on Eurozone macroeconomic variables. Earlier studies failed to correctly investigate the effect of monetary policy on the economy, because of the concurrence of effects. Monetary policy is affected by the economy, as macroeconomic variables are the main drivers of policy makers' decisions. At the same time, the conduct of monetary policy conduct affects the economy. Researchers face two econometric challenges when investigating the effects of monetary policy on the economy: endogeneity and anticipatory effects.

I overcome these issues by applying the narrative methodology of Romer & Romer (2004) and providing a new series of monetary shocks for the ECB. I depart from their methodology by adding an unconventional monetary policy control variable to take into account the unconventional monetary policies put in place by the ECB in the past two decades. The monetary shocks series is estimated by identifying the unexpected component of the main refinancing operations' (MRO) interest rate changes. To do so, I collect a novel database of forecasts and real-time variables to disentangle the expected component, represented by the information set of policy makers at the meeting date, and the unexpected component. The unexpected component is extracted with a first-stage VAR regression.

I also estimate the effects on Eurozone inflation and industrial production and I find that industrial production is more responsive then inflation and displays an overall decline of almost 1% 24 months after the shock. The response of inflation is weaker with an overall decline of 0.05%. The effects are estimated with a second-stage VAR, to make my results as comparable as possible to the literature, and with linear local projections (LPs) to overcome the data constraints of my small sample. I further estimate the effects of the shocks on the inflation and industrial production of single members of the Eurozone: Germany, France, Spain, Italy, Greece and Portugal. Overall the results on single countries inflation and industrial production are rather heterogeneous, which is relevant for policy makers, as they aim to affect the Eurozone economy homogenously.

These results offer a direct implication for the Eurozone economy and show the potential medium-term effects of a contractionary monetary policy. Although the response of inflation is close to 0, the heterogeneity of the effects among the countries, offers an important implication. Heterogeneous effects show that monetary policy makers should acknowledge countries' differences when deciding towards a monetary policy innovation and that single country data should be taken into consideration along with whole union data.

The fourth chapter takes the opposite angle from the second and the third chapters, and analyses the influence of financial markets on monetary policy makers' decisions. In particular, I investigate whether financial market stability has been a source of concern for both the ECB and BOE. To do so, I show that the Augmented Taylor (1993) Rule, which includes a financial markets' stability variable, better explains the path followed by the ECB and BOE interest rate across the 2003–2018 sample period. The question as to whether financial markets stability should be a source of concern has been long debated among both academics and practitioners. This chapter doesn't aim to assess whether it is efficient for monetary institutions to include financial markets' stability. On the contrary, it aims to assess whether it has already entered their discussions.

The Taylor (1993) Rule framework represented the first computationally "easy" Rule that directly linked the value of inflation and economic growth to the interest rate level. The Taylor (1993) Rule has been unofficially used by many institutions worldwide, although largely criticised for the limited amount of information that is included in its formula.

Taylor (1999b) provided a revised version of his formula, extending it to include exchange rates, which are also included in my empirical analysis. I estimate the predicted values of interest rates for both the ECB and BOE according to the Taylor (1993) Rule, showing descriptively that the deviations from realised interest rates can be explained by including a financial market stability slack (FMSS) variable. Additionally, following the critiques raised by Svensson (2003, 2010, 2019) I provide descriptive and empirical evidence that monetary policy makers are driven by forecasts when deciding about monetary policy innovations.

The results show a direct implication on the influence that financial markets stability can have on the decision of policy makers. As can be inferred from the predicted values of the Taylor (1993) Rules, interest rate, particularly in the aftermath of the 2008 financial crisis, could have been maintained fairly higher in the case of both the ECB and BOE. In fact, the overall turmoil of international financial markets convinced monetary policy makers worldwide to make a joint effort in re-establishing trust in the institutions and boosting the economy with both conventional and unconventional monetary policies. Overall, this leads to the conclusion that despite the lack of "official recognition" financial market stability has already entered the discussion of monetary policy makers.

5.2 Directions for Future Research

All three chapters deal with the mutual influence between financial markets and monetary policy. The empirical findings and limitations reported in each chapter identify areas for future research and extension. The second chapter infers the expectations of investors extending the methodology of Kuttner (2001) that computes the difference between the

FED Funds Futures and the Effective Federal Funds rate. This analysis yields efficient results to investigate the expectations about future interest rate changes, although is inefficient in providing information on the “expected direction” of interest rate changes. A more complete analysis of market expectations would be subject to the availability of high-frequency and option metrics’ data.

An additional source of concern is the additional macroeconomic announcements that arise in the closed time-window around the announcement and can potentially bias market expectations. My methodology extends Kuttner’s (2001) work by including the whole week of data before the announcement to infer investors’ expectations. Although this presents a contribution to the methodology, it could also raise potential doubts on the information that reaches investors throughout the week. On the positive side, investors’ expectations are more representative by including more data, as the set of information of investors is obviously larger. It would be interesting, however, to investigate further the set of information available to investors during the week that precedes the announcement. Furthermore, my analysis is limited to the US financial market and the FOMC announcements. Further research might wish to explore similarities in results in other countries.

The third chapter also offers different angles for future research. The main limitation of this chapter is the lack of data given the “young age” of the ECB. Future research can overcome these data constraints and provide a more complete and precise analysis on the long-term effects of monetary shocks on macroeconomic variable. A further limitation of my study is the use of Survey of Professional Forecasters data, which are only available quarterly. Recently, other source of forecasts data have become available at a monthly frequency, which could increase the precision in estimating the information set available to policy makers at the meeting date. The analysis could be executed by accessing the Economic Consensus Data available on Bloomberg.

The fourth and final chapter also offers several opportunities for future research. Similarly to the third chapter, this research suffers from data availability limitations, which are more compelling when comparing forecasts with ex-post data. Also, in this case, Consensus Economic data will largely improve the precision of the empirical analysis along with the inclusion of a variable that represents unconventional monetary policies in the Taylor (1993) Rule framework.

A further important limitation of this chapter that I plan to tackle in the future is extending the research to “financial stability”, instead of financial markets stability and provide a more comprehensive analysis of the sources of financial stability, that affect the decisions of the ECB and BOE monetary policy makers. Oet & Lyytinen (2017) include several variables in their analysis. The definition of “financial stability” is rather broad, although financial market stability is instead limited.

Appendices

Appendix A – Chapter 2

Table A.1 – Macroeconomic Variables Summary Statistics

The table presents the summary statistics for the macroeconomic variables included in the empirical analysis section 2.6.2. The variables included are the unemployment rate, the 12-months change in the industrial production index and the 12-month change in the CPI. The summary statistics presented for each sample of equity returns are the number of days considered ("N"), the simple average ("μ"), the variance ("Σ"), the median ("median"), the minimum value ("min) and the maximum value ("max"). Values are presented in percentage(%).
Sources: FRED Economic Data, fred.stlouisfed.org.

	N	μ	median	max	min	Σ
Unemployment rate	161	6.253	5.700	9.900	3.900	3.061
Unemployment rate (Δ)	161	0.134	0.000	12.308	-7.463	9.948
Industrial Production index (12-months log change)	161	0.172	0.929	3.292	-7.161	4.206
CPI (12-months log change)	161	2.755	2.605	11.108	-6.953	15.979

Table A.2 –NBER Dummy Variable

The table presents the time series of the "NBER dummy variable" included in my analysis, across the 2000–2016 sample period. This time series is an interpretation of US Business Cycle Expansions and Contractions data provided by The National Bureau of Economic Research (NBER). The NBER identifies months and quarters of turning points without designating a date within the period that the turning points occurred. A value of 1 is a recessionary period, while a value of 0 is an expansionary period.
Sources: FRED Economic Data, fred.stlouisfed.org

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000		0	0		0	0		0		0	0	0
2001	0		0	1	1	1		1		1	1	0
2002	0		0		0	0		0	0		0	0
2003	0		0	0	0	0		0	0	0		0
2004	0		0		0	0		0	0		0	0
2005		0	0		0	0		0	0		0	0
2006	0		0		0	0		0	0	0		0
2007	0		0		0	0		0	0	0		0
2008	1		1	1		1	1	1	1	1		1
2009	1	1	1	1		1		0	0		0	0
2010	0		0	0	0	0		0	0	0	0	0
2011	0		0	0		0		0	0		0	0
2012	0		0	0		0		0	0	0		0
2013	0		0		0	0	0		0	0		0
2014	0		0	0		0	0		0	0		0
2015	0		0	0		0	0		0	0		0
2016	0		0	0	0		0		0		0	0

Table A.3 – Tight Cycle Dummy Variable

The table presents the time series of the "Tight Cycle Dummy Variable" employed in my analysis across the 2000–2016 sample period. This time series is a dummy variable, similar to the one employed by Lucca & Moench (2015), constructed on the basis of the average level of the Federal Funds Target Rate. The variable takes value 1, on the months where the average level of Federal Funds Target Rate is above 2%. The 2% threshold is based on the assumption of Taylor (1993), who stated that 2% is the equilibrium interest rate level for the United States.

Sources: Federal Reserve website (www.federalreserve.gov)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000		1	1		1	1		1		1	1	1
2001	1		1	1	1	1		1		0	0	0
2002	0		0		0	0		0	0		0	0
2003	0		0	0	0	0		0	0	0		1
2004	1		1		1	1		1	1		1	1
2005		1	1		1	1		1	1		1	1
2006	1		1		1	1		1	1	1		1
2007	1		1		0	0		0	0	0		0
2008	0		0	0		0	0	0	0	0		0
2009	0	0	0	0		0		0	0		0	0
2010	0		0	0	0	0		0	0	0	0	0
2011	0		0	0		0		0	0		0	0
2012	0		0	0		0		0	0	0		0
2013	0		0		0	0	0		0	0		0
2014	0		0	0		0	0		0	0		0
2015	0		0	0		0	0		0	0		0
2016	0		0	0	0		0		0		0	0

Table A.4 – Easy Cycle Dummy Variable

The table presents the time series of the "Easy Cycle Dummy Variable" employed in my analysis across the 2000–2016 sample period. This time series is a dummy variable, similar to the one employed by Lucca & Moench (2015), constructed on the basis of the average level of the Federal Funds Target rate. The variable takes the value 1, in the months where the average level of the Federal Funds Target rate is below 2%. The 2% threshold is based on the assumption of Taylor (1993), who stated that 2% is the equilibrium interest rate level for the United States.
Sources: Federal Reserve website (www.federalreserve.gov)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000		0	0		0	0		0		0	0	0
2001	0		0	0	0	0		0		1	1	1
2002	1		1		1	1		1	1		1	1
2003	1		1	1	1	1		1	1	1		0
2004	0		0		0	0		0	0		0	0
2005		0	0		0	0		0	0		0	0
2006	0		0		0	0		0	0	0		0
2007	0		0		1	1		1	1	1		1
2008	1		1	1		1	1	1	1	1		1
2009	1	1	1	1		1		1	1		1	1
2010	1		1	1	1	1		1	1	1	1	1
2011	1		1	1		1		1	1		1	1
2012	1		1	1		1		1	1	1		1
2013	1		1		1	1	1		1	1		1
2014	1		1	1		1	1		1	1		1
2015	1		1	1		1	1		1	1		1
2016	1		1	1	1		1		1		1	1

Table A.5 – Kuttner Surprise

The table presents the Kuttner (2001) surprises across the whole sample period (2000–2016) and for each of the 161 FOMC announcements included in my analysis. The surprises are computed following the pioneer methodology of Kuttner (2001) and further employed by Bernanke & Kuttner (2005).
Sources: Federal Reserve website (www.federalreserve.gov) and Quandl Database.

	Jan	Feb	Mar	Apr	May	Jun
2000		-0.054	-0.031		0.052	0.075
2001	-5.347		0.060	-0.205	-0.078	0.072
2002	0.000		-0.031		0.000	0.000
2003	-0.077		0.063	0.128	0.075	-0.180
2004	0.375		0.093		0.012	3.300
2005		-0.108	0.327		-0.022	5.115
2006	6.200		1.912		-0.266	1.500
2007	-0.465		0.033		-0.049	0.290
2008	-4.482		0.448	-1.500		-0.450
2009	0.209	-0.013	-0.012	0.300		0.054
2010	0.073		0.057	0.000	-0.018	-0.021
2011	0.000		-0.005	-0.145		-0.037
2012	0.052		0.018	0.000		0.000
2013	-0.620		0.000		-0.008	0.086
2014	-0.039		0.006	0.037		0.013
2015	-0.150		0.000	0.225		0.023
2016	0.580		0.005	0.109	0.018	
	Jul	Aug	Sep	Oct	Nov	Dec
2000		-0.017		0.000	0.000	0.058
2001		0.015		-0.069	-0.100	0.000
2002		0.035	0.025		-0.195	0.000
2003		0.034	0.225	0.155		-0.021
2004		-0.103	0.183		-0.202	0.064
2005		0.049	0.045		0.253	0.141
2006		-0.067	-0.129	-0.052		0.026
2007		-0.068	0.952	0.930		0.209
2008	0.199	-0.054	-2.941	-2.453		-0.093
2009		-0.020	-0.032		-0.017	-0.010
2010		0.000	0.058	-0.005	0.017	-0.009
2011		0.037	0.025		-0.108	-0.018
2012		-0.028	0.023	-0.022		0.020
2013	-0.155		-0.006	-0.155		0.012
2014	-0.078		0.000	0.039		0.022
2015	0.155		-0.058	-0.075		-0.150
2016	0.073		-0.033		0.015	-0.234

Table A.6 – “Beta-Sorted” Portfolios Summary Statistics

The table presents the summary statistics for the daily equity returns of the portfolios sorted according to their market beta. The daily equity returns considered are the ones around the 161 FOMC announcements included in my sample period (2000-2016). The portfolios were directly sourced from the CRSP Wharton dataset. Panel A presents the summary statistics for the whole FOMC announcements sample. Panel B presents the summary statistics for the NMP FOMC announcements subsample. The summary statistics presented for each sample of equity returns are the number of days considered (“N”), the simple average (“μ”), the standard deviation (“σ”), the median (“median”), the minimum value (“min”), the maximum value (“max”), the skewness (“Sk”) and the kurtosis (“K”). *Sources:* CRSP- Wharton Database.

Panel A: FOMC Whole Sample (2000-2016)								
	N	μ	σ	median	min	max	Sk	K
port1	161	0.744	2.784	0.590	-7.000	13.945	0.856	3.306
port2	161	0.611	2.218	0.503	-5.594	11.666	1.007	4.427
port3	161	0.470	1.905	0.293	-4.905	10.322	1.129	5.340
port4	161	0.433	1.747	0.296	-3.946	10.115	1.410	6.410
port5	161	0.353	1.573	0.251	-3.890	9.009	1.254	6.136
port6	161	0.320	1.388	0.197	-3.519	8.196	1.381	6.954
port7	161	0.279	1.259	0.212	-2.816	7.904	1.648	8.650
port8	161	0.215	1.054	0.155	-2.695	6.871	1.706	10.079
port9	161	0.147	0.713	0.063	-1.168	5.408	2.876	17.728
port10	161	0.144	0.537	0.062	-1.236	3.067	1.326	5.391
Panel B: FOMC NMP Subsample (2000-2016)								
	N	μ	σ	Median	min	max	Sk	K
port1	118	0.720	2.698	0.643	-7.000	13.945	0.914	4.349
port2	118	0.550	2.148	0.556	-5.594	11.666	1.034	5.635
port3	118	0.448	1.835	0.353	-4.309	10.322	1.226	6.351
port4	118	0.404	1.691	0.331	-3.946	10.115	1.572	8.272
port5	118	0.348	1.512	0.334	-3.306	9.009	1.545	7.999
port6	118	0.335	1.316	0.301	-2.928	8.196	1.756	9.693
port7	118	0.281	1.210	0.279	-2.624	7.904	2.008	11.971
port8	118	0.213	1.034	0.172	-2.218	6.871	2.140	13.157
port9	118	0.138	0.738	0.095	-1.168	5.408	3.233	20.456
port10	118	0.108	0.589	0.010	-1.236	3.067	1.434	5.055

Table A.7 – Fama & French 10- Industries Portfolios Summary Statistics

The table presents the summary statistics for the daily equity returns of Fama & French 10 Industries Portfolios. The daily equity returns considered are the ones around the 161 FOMC announcements included in my sample period (2000-2016). Panel A presents the summary statistics for the whole FOMC announcements sample. Panel B presents the summary statistics for the NMP FOMC announcements subsample. The summary statistics presented for each sample of equity returns are the number of days considered ("N"), the simple average ("μ"), the standard deviation ("σ"), the median ("median"), the minimum value ("min"), the maximum value ("max"), the skewness ("Sk") and the kurtosis ("K").
Source: Kenneth French's webpage (mba.tuck.dartmouth.edu/pages/faculty/ken.french/)

Panel A: FOMC Whole Sample (2000-2016)								
	N	μ	Σ	Median	min	max	Sk	K
Non-Durables	161	0.096	1.017	0.110	-3.120	2.900	-0.111	0.622
Durables	161	0.412	1.920	0.300	-6.360	6.430	0.106	1.973
Manufacturing	161	0.342	1.390	0.290	-5.050	5.160	0.147	2.401
Energy	161	0.282	1.657	0.150	-5.640	4.730	-0.187	1.013
High – Tech	161	0.504	2.168	0.380	-5.960	16.040	2.498	17.099
Telecommunications	161	0.216	1.556	0.180	-5.230	8.050	0.501	4.858
Wholesale / Retail	161	0.357	1.459	0.280	-5.100	5.280	0.408	1.955
Health Care	161	0.209	1.183	0.120	-3.340	3.910	-0.106	0.985
Utilities	161	0.123	1.321	0.170	-4.300	4.530	-0.214	1.108
Other	161	0.462	1.971	0.270	-8.330	8.030	0.450	4.372
Panel B: FOMC NMP Subsample (2000-2016)								
	N	μ	Σ	Median	min	max	Sk	K
Non-Durables	118	0.146	0.918	0.175	-2.390	2.740	-0.080	-0.003
Durables	118	0.358	1.800	0.190	-5.620	6.430	0.271	2.291
Manufacturing	118	0.294	1.264	0.255	-3.670	5.140	0.295	1.873
Energy	118	0.345	1.522	0.165	-4.040	4.730	0.110	0.887
High – Tech	118	0.436	1.406	0.500	-3.990	4.690	-0.117	0.907
Telecommunications	118	0.204	1.342	0.185	-5.230	4.620	-0.311	2.238
Wholesale / Retail	118	0.277	1.214	0.245	-2.620	4.840	0.416	1.251
Health Care	118	0.259	1.085	0.170	-3.280	3.780	-0.142	1.148
Utilities	118	0.230	1.173	0.210	-2.630	4.530	0.276	0.859
Other	118	0.446	1.733	0.300	-4.680	7.050	0.855	3.057

Table A.8 – Robustness Check: Alternative Equity Indexes in the Main Specification and in the NMP subsample.

The table presents the results for the main analysis and the robustness check on different equity indexes. The main analysis refers to the empirical analysis presented in section 2.6.1.The analysis is conducted on the SP500 index daily returns and the CRSP Equally-Weighted Index daily returns. Panel A presents the analysis considering the whole sample of FOMC meetings across (2000–2016), which accounts for 161 meetings. Panel B only considers the FOMC meetings where no interest rate change has occurred in the NMP analysis, which accounts for 118 meetings across the (2000–2016) period.

Panel A: Whole Sample (2000 -2016)		
	SPX Returns	CRSP Equally-Weighted Index
I_t^D	0.092	0.463**
	(0.089)	(0.205)
Const.	0.056	0.346**
	(0.067)	(0.156)
R^2	0.000	0.058
Obsv.		161
Panel B: Neutral Monetary Policy - Whole Sample (2000 -2016)		
	SPX Returns	CRSP Equally-Weighted Index
I_t^D	0.258	0.399**
	(0.166)	(0.214)
Const.	0.191	0.219
	(0.224)	(0.166)
R^2	0.026	0.061
Obsv		118

Signif. codes: '***' 0.01 '**' 0.05 '*' 0.1 ' ' 1
Source: Federal Reserve website, www.federalreserve.gov, Quandl dataset, Wharton - CRSP Database.

Table A.9 – Persistency Analysis on Neutral Monetary Policy

The table presents a robustness test for the "persistency analysis" across the NMP FOMC announcements. By "persistency analysis" I intend the effect of disagreement, represented by the dummy I_t^D variable. The results presented in section 2.7.2 show that the effect of disagreement towards the FOMC decision is not reversed to statistically significant negative returns the day after or before the FOMC meeting day. The dependent variable is presented by the CRSP Value-Weighted Index daily returns, computed the day before (-1), the day after (+1), two days after (+2) and three days after (+3) the FOMC announcement date. Consistent with past results neither the variables are statistically significant, in line with past findings on the FOMC announcements. The additional return observed on the market is not reversed on the subsequent days, nor on the day before.

	-1	1	2	3
I_t^D	-0.124	0.058	0.147	0.021
	(0.228)	(0.269)	(0.194)	(0.237)
Const.	-0.032	-0.125	-0.050	0.166
	(0.166)	(0.196)	(0.142)	(0.173)
Obsv.				118

Signif. codes: '***' 0.01 '**' 0.05 '*' 0.1.
Source: Federal Reserve website, www.federalreserve.gov, Quandl dataset, Wharton - CRSP Database, US Labor Statistics websites.

Appendix B – Chapter 3

B. 1 Dataset Description for the second stage analysis – (VARs and Local Projections)

Monthly Variables:

- **The Harmonised Indices of Consumer Prices (HICP)** – The Harmonised Indices of Consumer Prices measures the changes over time in the prices of consumer goods and services acquired by households.

The countries' specifications are the HICP Index for single Eurozone countries.

Source: ECB Statistical Data Warehouse
https://sdw.ecb.europa.eu/browse.do?node=9691135

- **Industrial production (Excluding Construction) -** Industrial production refers to the output of industrial establishments. It is expressed as a seasonally adjusted index based on 2015=100.

The countries' specifications are the Industrial Production Index for single Eurozone countries.

Source: ECB Statistical Data Warehouse
https://sdw.ecb.europa.eu/browse.do?node=9691135

- **Commodity Index** – ECB Commodity Price index Euro-denominated, import weighted, Total non-energy commodity; European Central Ban; It is expressed as a seasonally adjusted index based on 2015=100.

Source: ECB Statistical Data Warehouse
https://sdw.ecb.europa.eu/browse.do?node=9691135

- **Unemployment Rate** – The Unemployment rate is the number of unemployed people as a percentage of the labour force, where the latter consists of the unemployed plus those in paid or self-employment. Unemployed people are those who report that they are without work, that they are available for work and that they have taken active steps to find work in the last four weeks.

Source: ECB Statistical Data Warehouse
https://sdw.ecb.europa.eu/browse.do?node=9691135

- **Exchange Rate - EURUSD**

Source: ECB Statistical Data Warehouse
https://sdw.ecb.europa.eu/browse.do?node=9691135

- **Producer price index (PPI)** - Producer price index in manufacturing measures the rate of change in prices of products sold as they leave the producer. It excludes any taxes, transport and trade margins that the purchaser may have to pay.

Source: OECD (2019), Producer price index (PPI) (indicator).
doi: 10.1787/a24f6fa9-en.

- **Import price Index -** The industrial import prices index shows the development of prices of goods imported by enterprises which are used as intermediate products in their production process, as capital goods or as goods to be resold to consumers. This index excludes construction. It is expressed as a seasonally adjusted index based on 2015=100.

Source: ECB Statistical Data Warehouse
https://sdw.ecb.europa.eu/browse.do?node=9691135

- **Export price Index -** The industrial import prices index shows the development of prices of goods imported by enterprises which are used as intermediate products in their production process, as capital goods or as goods to be resold to consumers. This index excludes construction. It is expressed as a seasonally adjusted index based on 2015=100.

Source: ECB Statistical Data Warehouse
https://sdw.ecb.europa.eu/browse.do?node=9691135

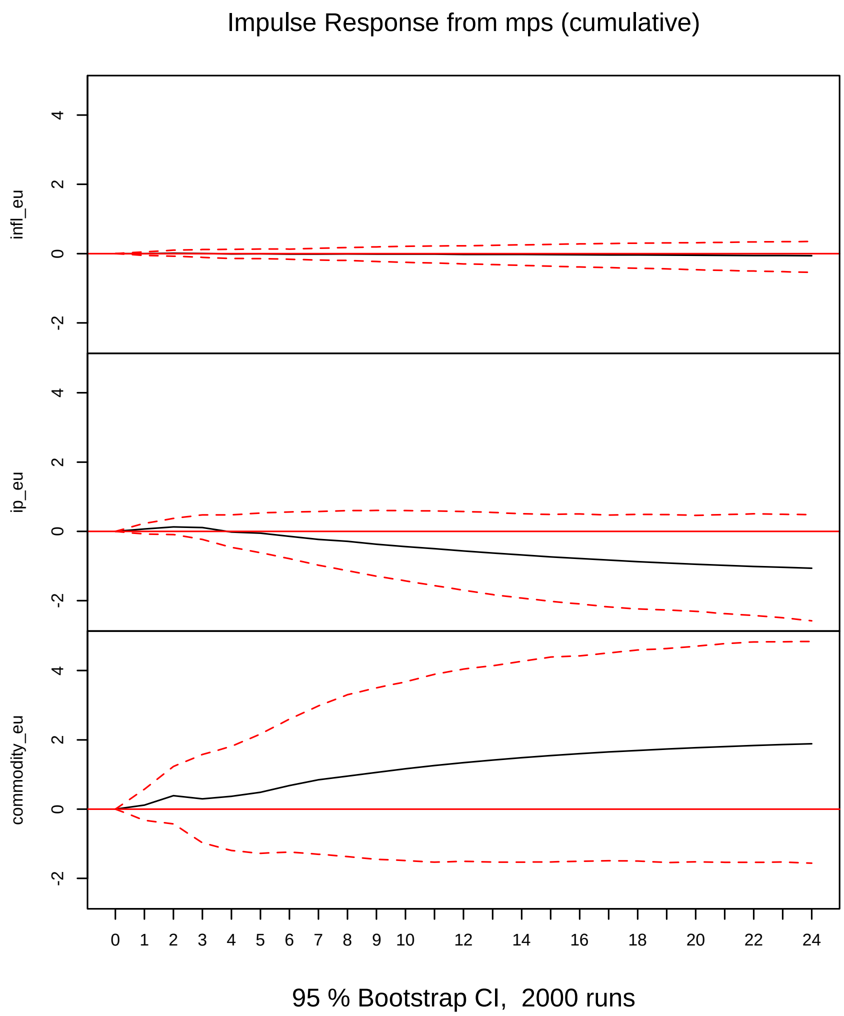
Quarterly Variables:

- **Gross Domestic Product (GDP)** - Gross domestic product (GDP) is the standard measure of the value-added created through the production of goods and services in a country during a certain period. GDP is expressed as a change from the previous period.

Source: OECD (2019), Quarterly GDP (indicator).
doi: 10.1787/b86d1fc8-en

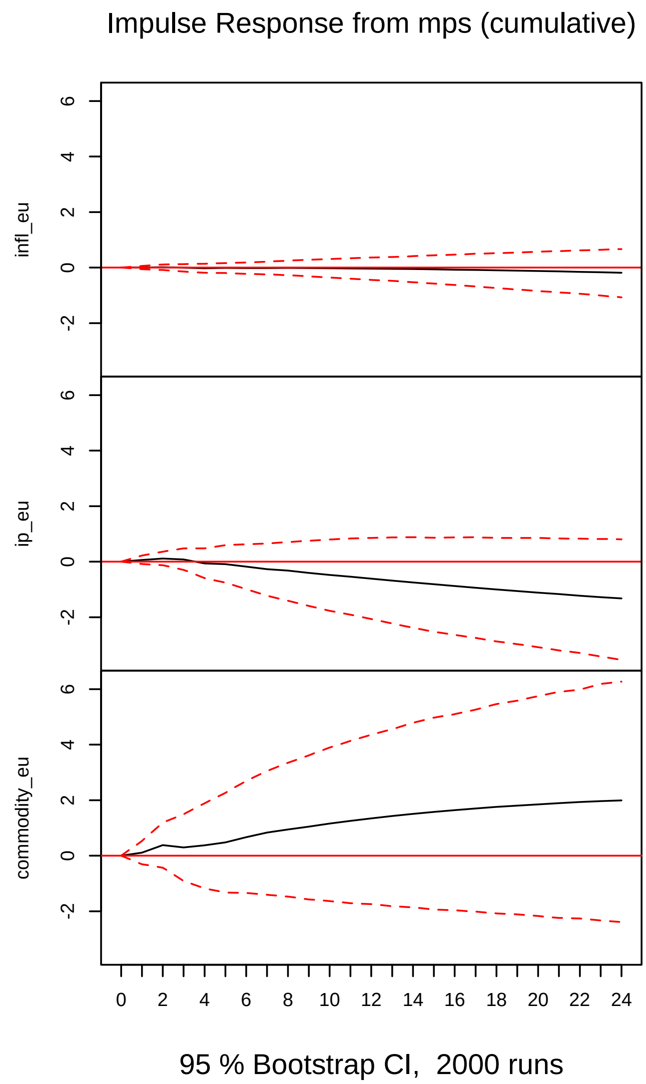
B.2 VAR – Eurozone Analysis

The figure shows the impulse response functions of the endogenous variables retrieved from the VAR presented in section 3.3.3, equation [3.4]. The impulse responses are also presented in section 3.4.1. The paths correspond to the impulse response of output to a 100 bps contractionary monetary policy shock, plotted along with 95% bootstrapped confidence bands. The VAR includes 5 lags and the impulse responses are computed with 2000 repetitions. Sample: 2000–2016.



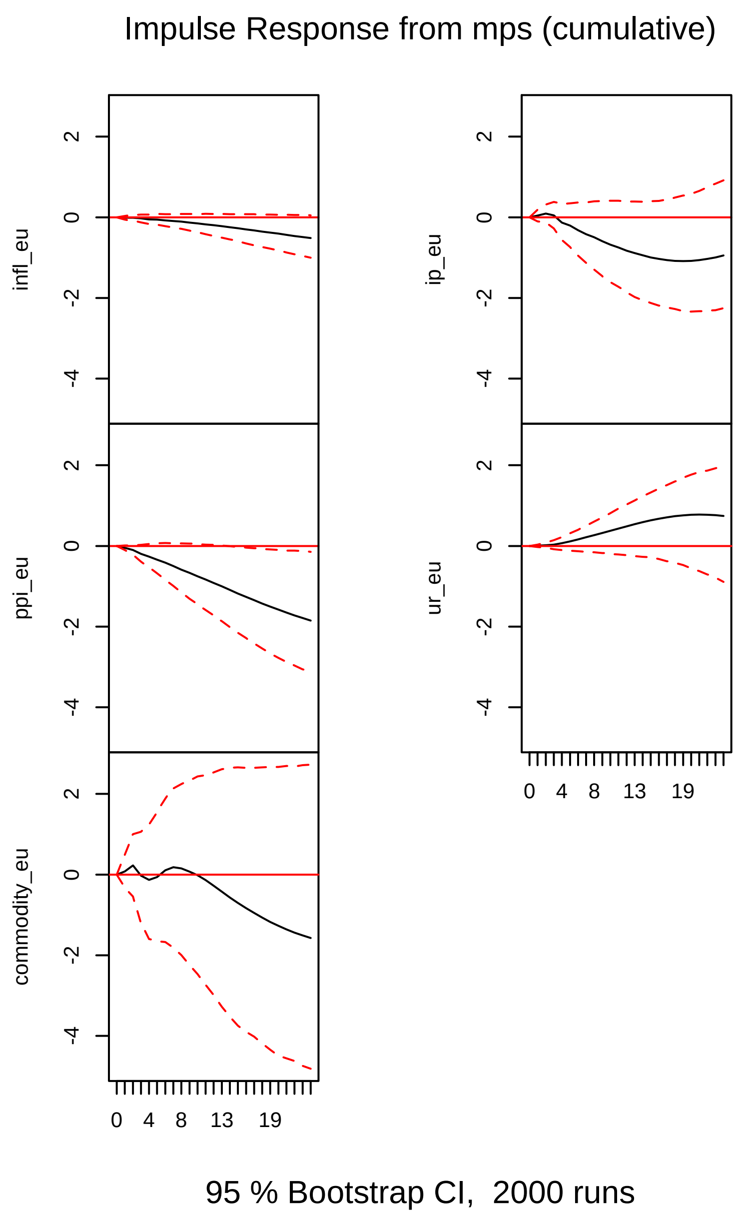
B.3 VAR – Eurozone Analysis – Excluding Trend and Constant

The figure shows the impulse response functions of the endogenous variables retrieved from the VAR presented in 3.3.3, equation [3.4]. The impulse responses are also presented in section 3.4.1. The paths correspond to the impulse response of output to a 100 bps contractionary monetary policy shock, plotted along with 95% bootstrapped confidence bands, excluding the trend and the constant. The VAR includes 5 lags and the impulse responses are computed with 2000 repetitions. Sample: 2000–2016.



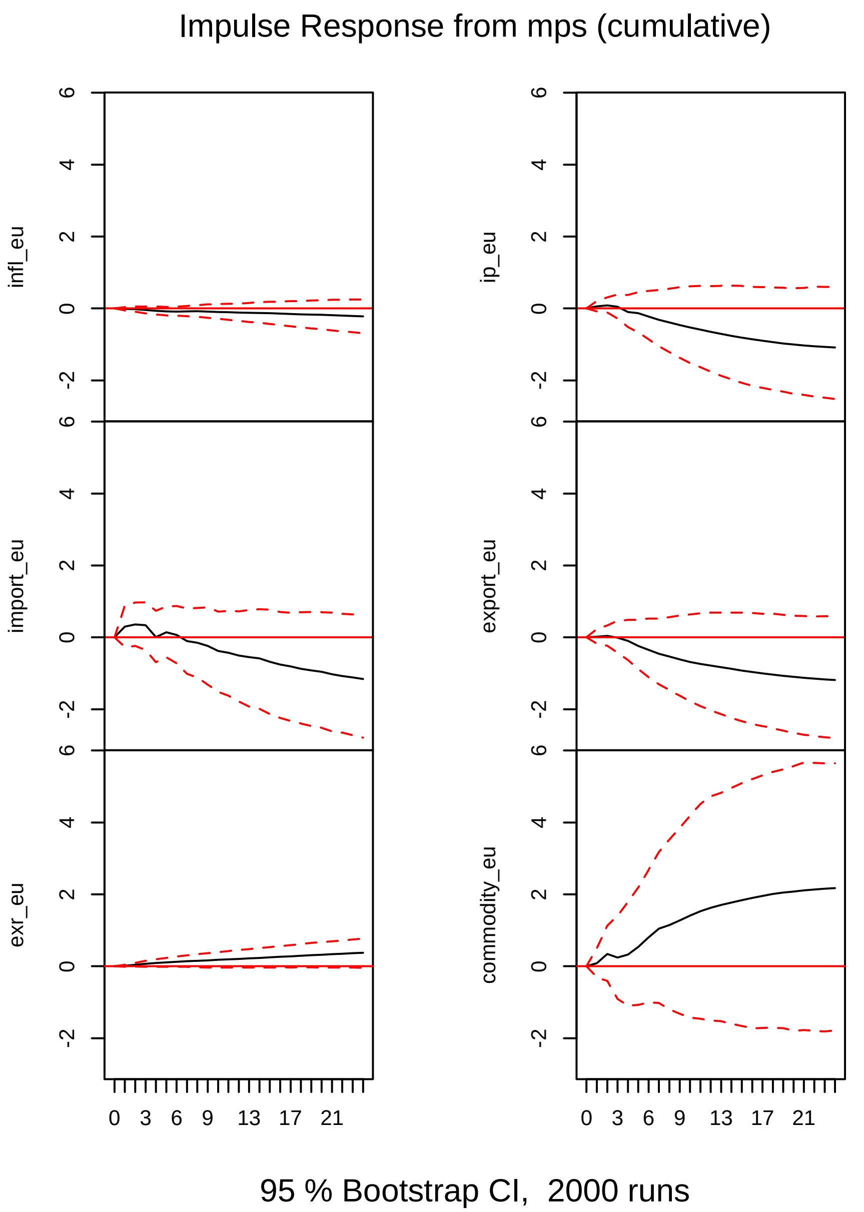
B.4 VAR – Eurozone Analysis –Additional Macroeconomic Variables

The figure shows the impulse response for all the variables included in the VAR presented in 3.3.3, equation [3.4], when adding additional macroeconomic variables. The additional macroeconomic variables included in the analysis are the PPI index and the unemployment rate for the Eurozone. The paths correspond to the impulse response of output to a 100 bps contractionary monetary policy shock, plotted along with 95% bootstrapped confidence bands. The VAR includes 7 lags and the impulse responses are computed with 2000 repetitions. Sample: 2000–2016.



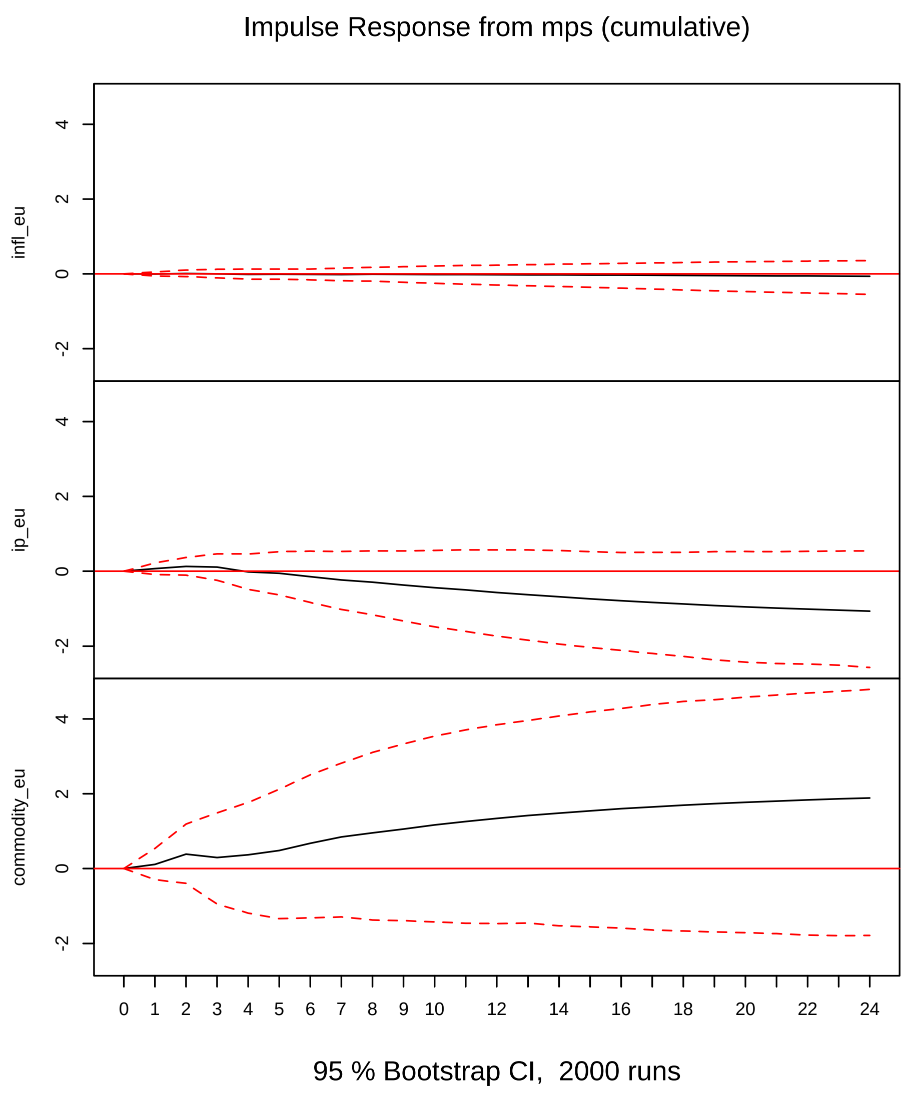
B.5 VAR – Eurozone Analysis –Additional Macroeconomic Variables – Trade Variables

The figure shows the impulse response for all the variables included in the VAR presented in section 3.3.3 equation [3.4], when adding additional macroeconomic trade variables. The additional macroeconomic variables included in the analysis are the Import and Export Indexes and the EURUSD exchange rate for the Eurozone. The paths correspond to the impulse response of output to a 100 bps contractionary monetary policy shock, plotted along with 95% bootstrapped confidence bands. The VAR includes 7 lags and the impulse responses are computed with 2000 repetitions. Sample: 2000–2016.



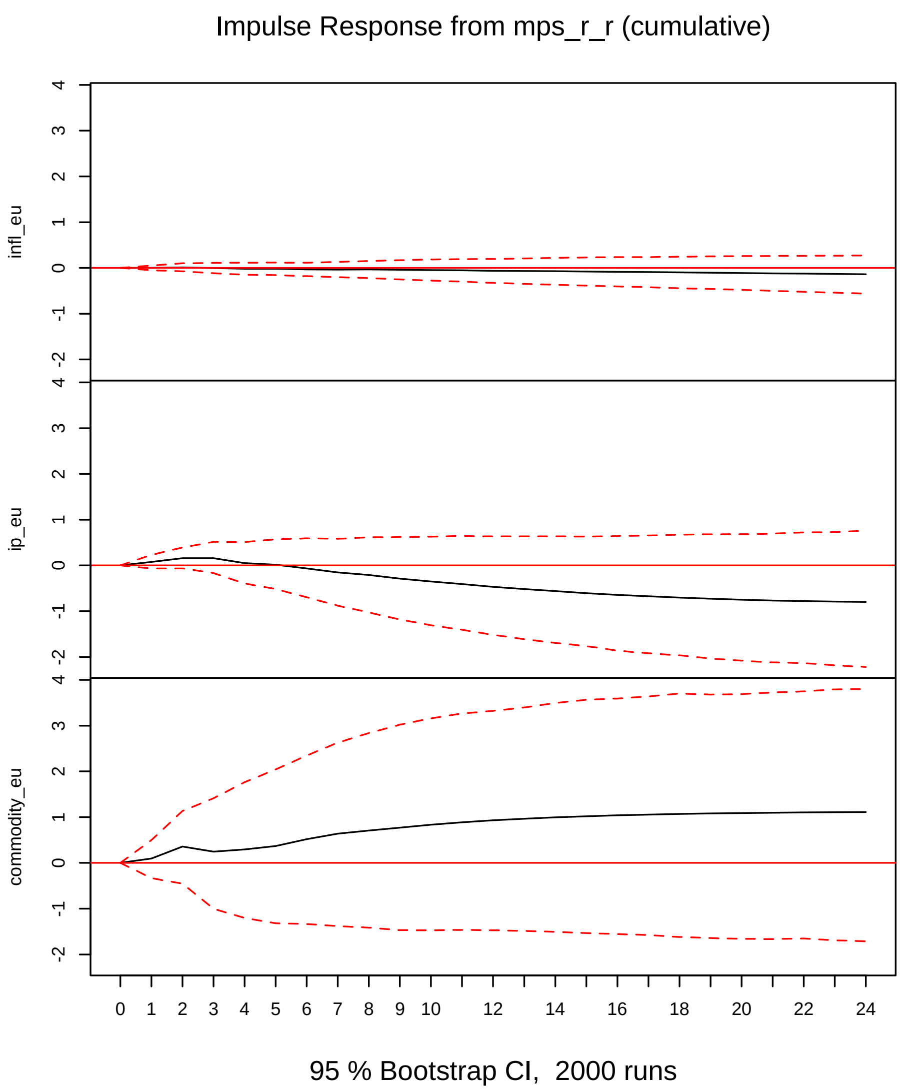
B.6 VAR – Eurozone Analysis – MPS ordered first in VAR

The figure shows the impulse response functions of the endogenous variables retrieved from the VAR presented in section 3.3.3, equation [3.4], when the monetary shocks series is ordered first in the VAR. The impulse responses are also presented in section 3.4.1. The paths correspond to the impulse response of output to a 100 bps contractionary monetary policy shock, plotted along with 95% bootstrapped confidence bands, The VAR includes 5 lags and the impulse responses are computed with 2000 repetitions. Sample: 2000–2016.



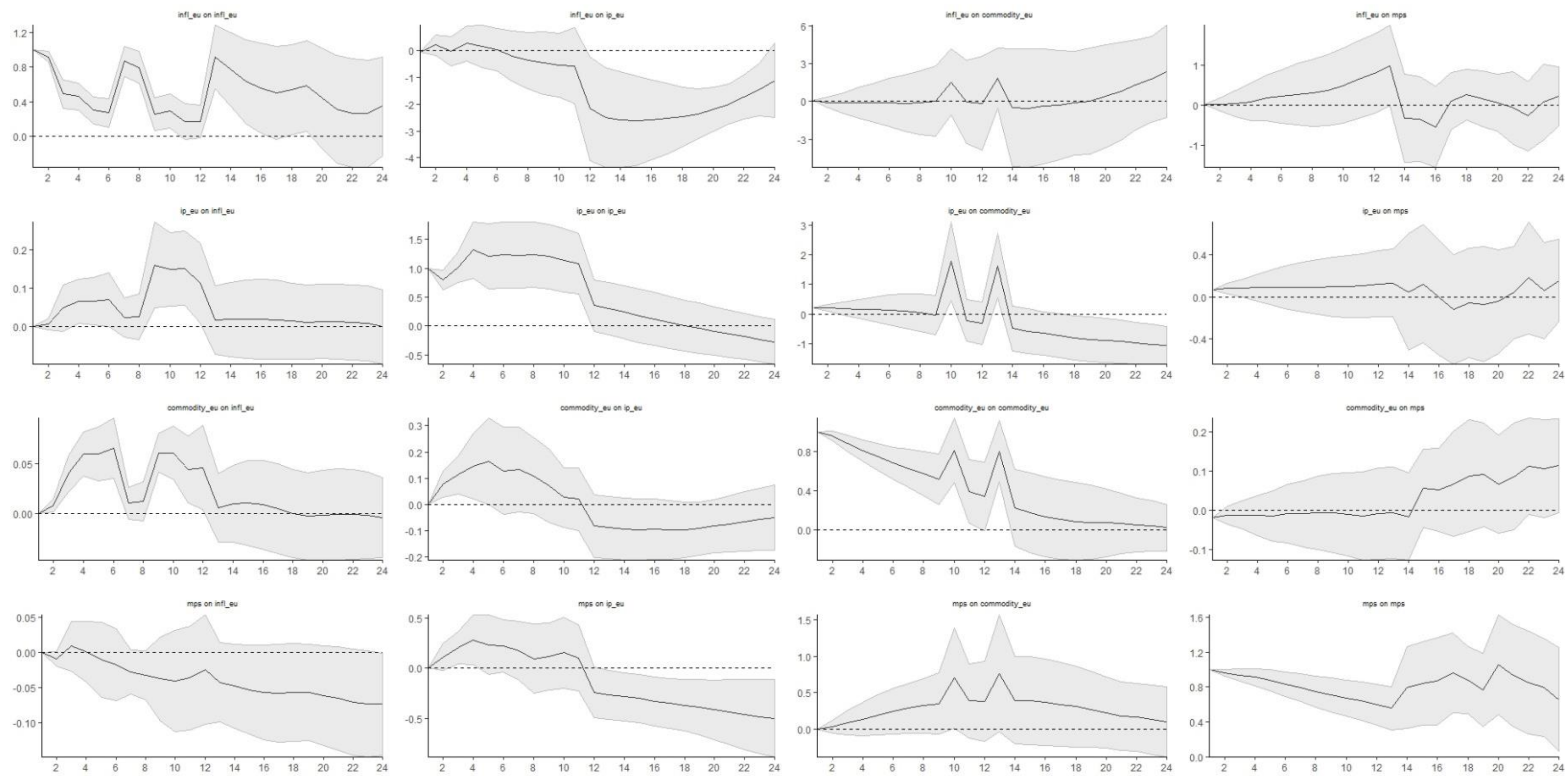
B.7 VAR – Eurozone Analysis – R&R (2004) Shocks Series

The figure shows the impulse response functions of the endogenous variables retrieved from the VAR presented in section 3.3.3, equation [3.4]. The monetary shocks series was computed following the methodology of Romer & Romer (2004) in the first-stage analysis, excluding the logarithm of the total assets. The impulse responses are also presented in section 3.4.1. The paths correspond to the impulse response of output to a 100 bps contractionary monetary policy shock, plotted along with 95% bootstrapped confidence bands. The VAR includes 5 lags and the impulse responses are computed with 2000 repetitions. Sample: 2000–2016.



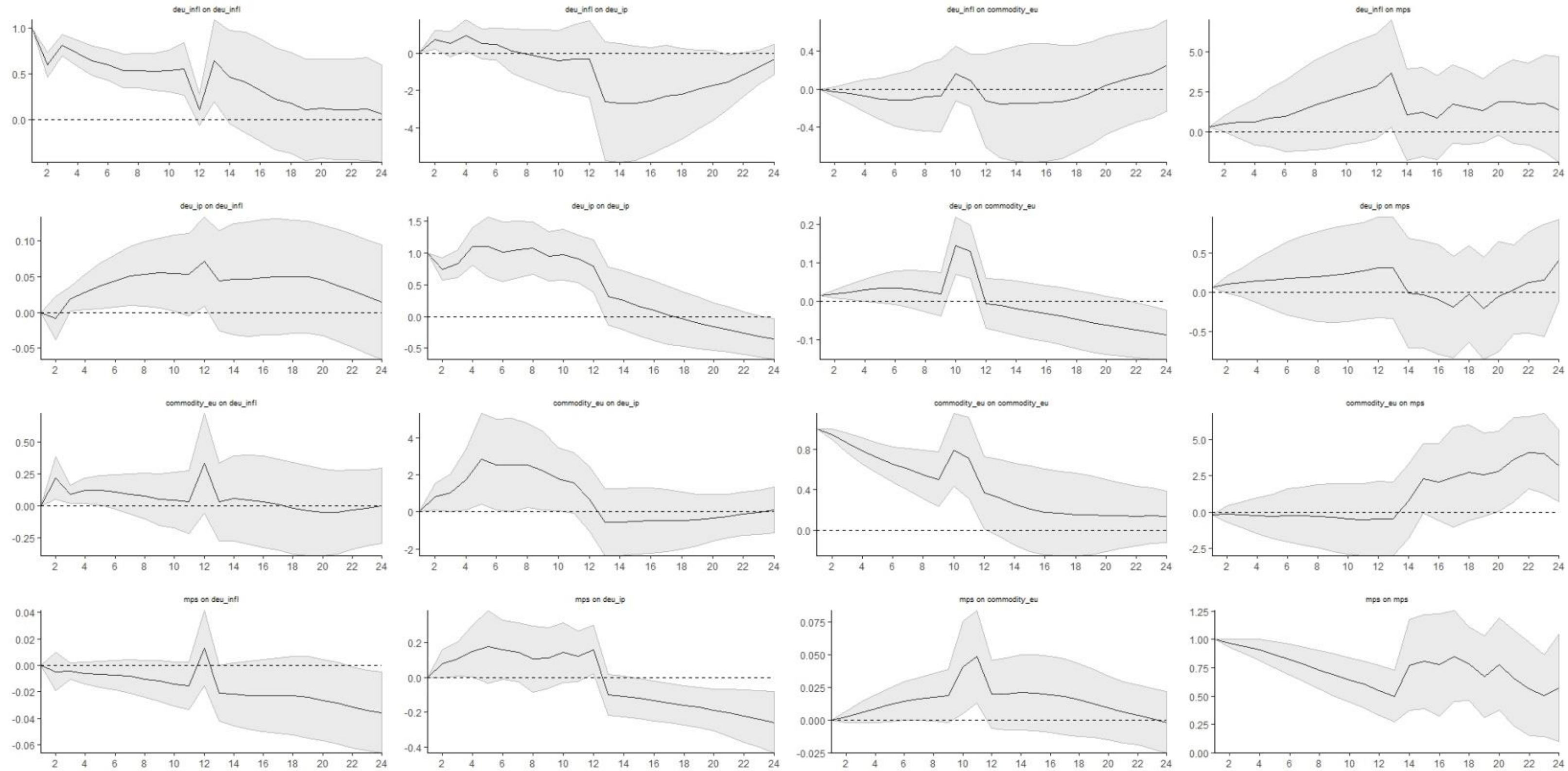
B.8 Local Projections – Eurozone Analysis

The figure presents the impulse responses for the local linear projection model, estimated following Jordà (2005) and presented in section 3.3.3, equation [3.5]. The variables included with the analysis are the inflation rate, the industrial production index, the ECB commodity index and my monetary shocks series ordered last in the model. The impulse responses are estimated with 5 lags and plotted along 95% confidence bands.



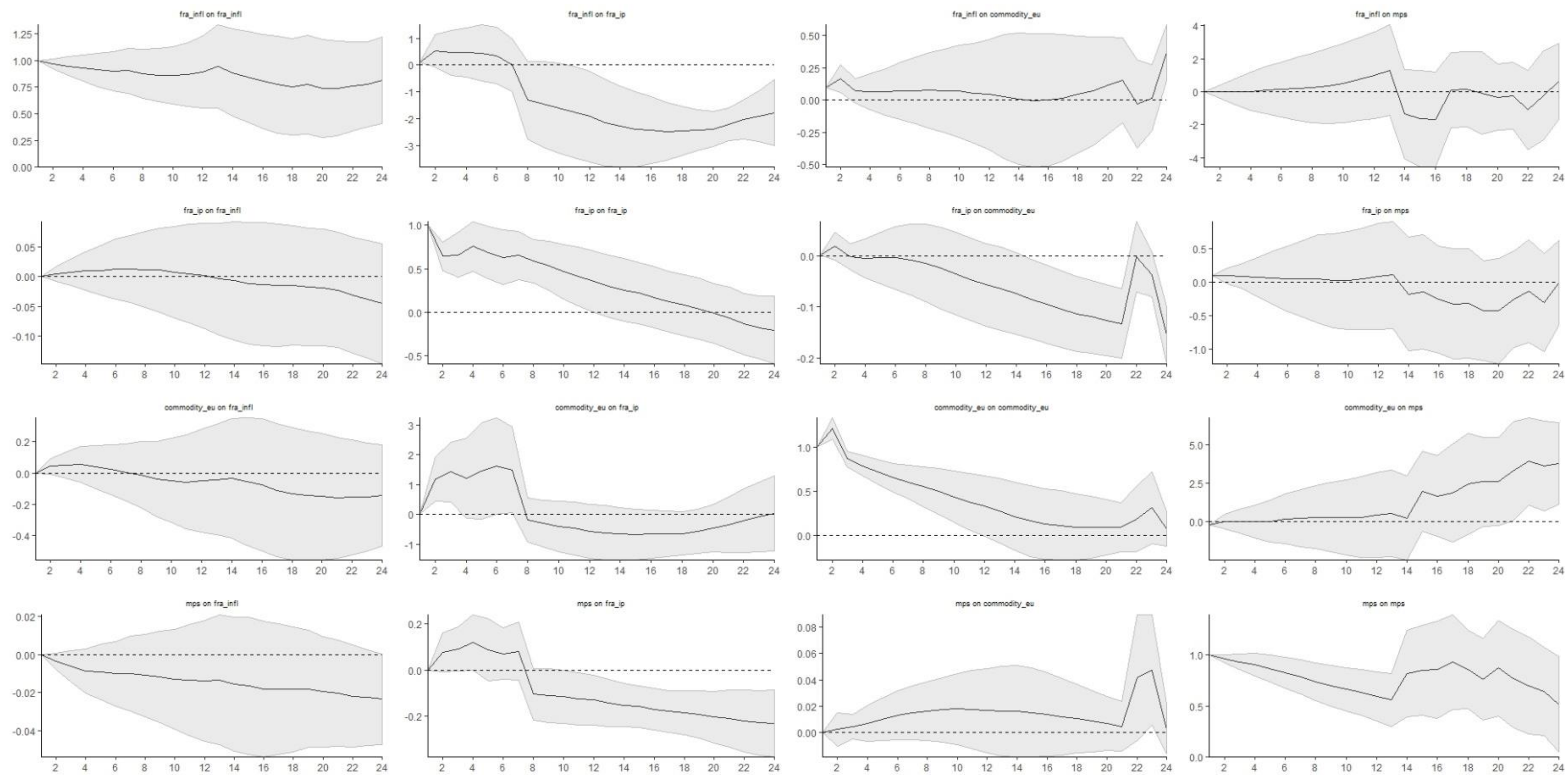
B.9 Local Projections – Eurozone Countries Specification – Germany

The figure presents the impulse responses for the local linear projection model, estimated following Jordà (2005) and presented in section 3.3.3, equation [3.5]. This specification specifically investigates the effects of the monetary shocks series on the German inflation and industrial production. The variables included in this analysis are the inflation rate and industrial production index of Germany, the ECB commodity index and my monetary shocks series ordered last in the model. The impulse responses are estimated with 5 lags and plotted along with 95% confidence bands.



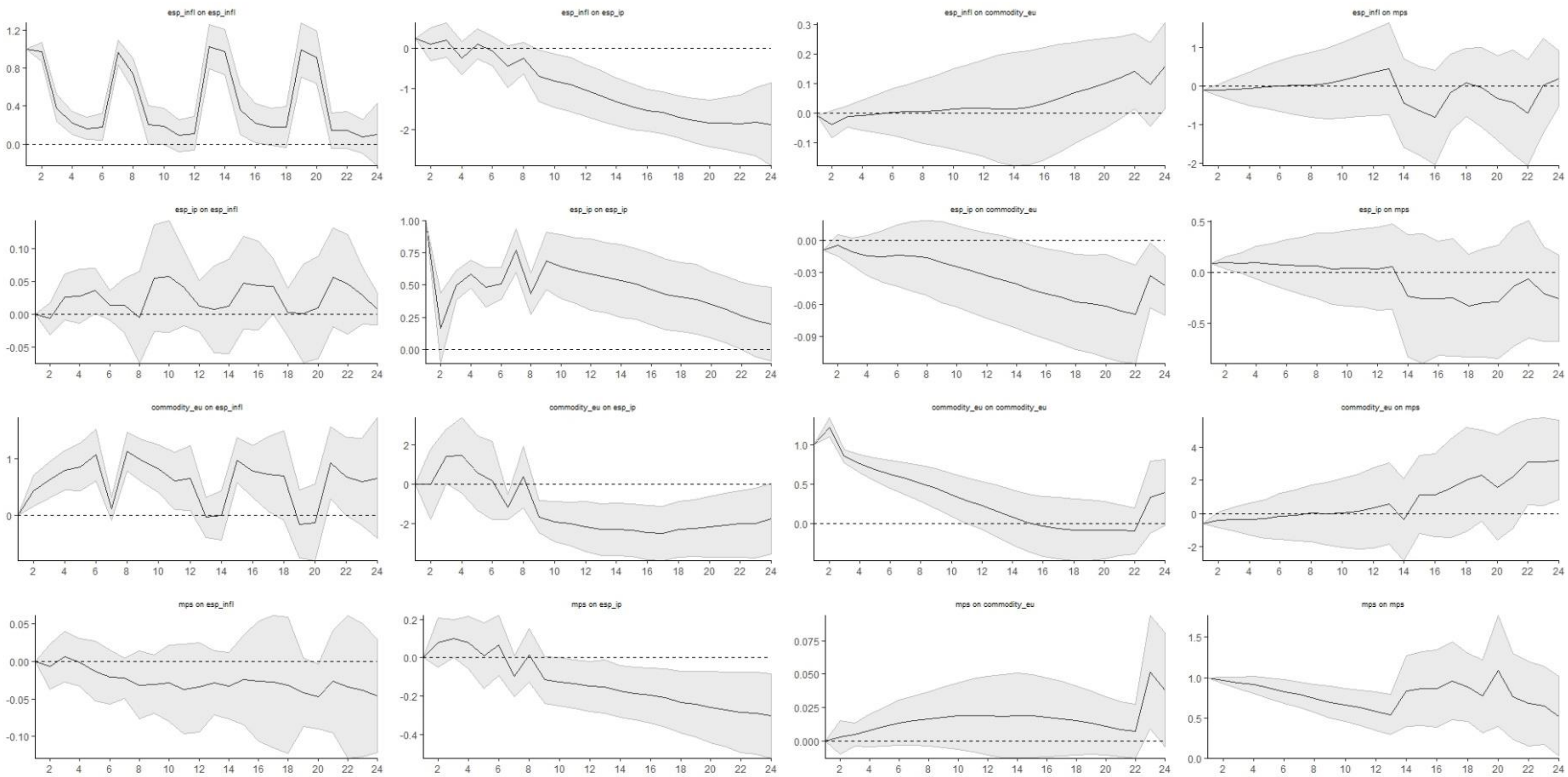
B.10 Local Projections – Eurozone Countries Specification – France

The figure presents the impulse responses for the local linear projection model, estimated following Jordà (2005) and presented in section 3.3.3, equation [3.5]. This specification specifically investigates the effects of the monetary shocks series on the French inflation and industrial production. The variables included in this analysis are the inflation rate and industrial production index of France, the ECB commodity index and my monetary shocks series ordered last in the model. The impulse responses are estimated with 5 lags and plotted along with 95% confidence bands.



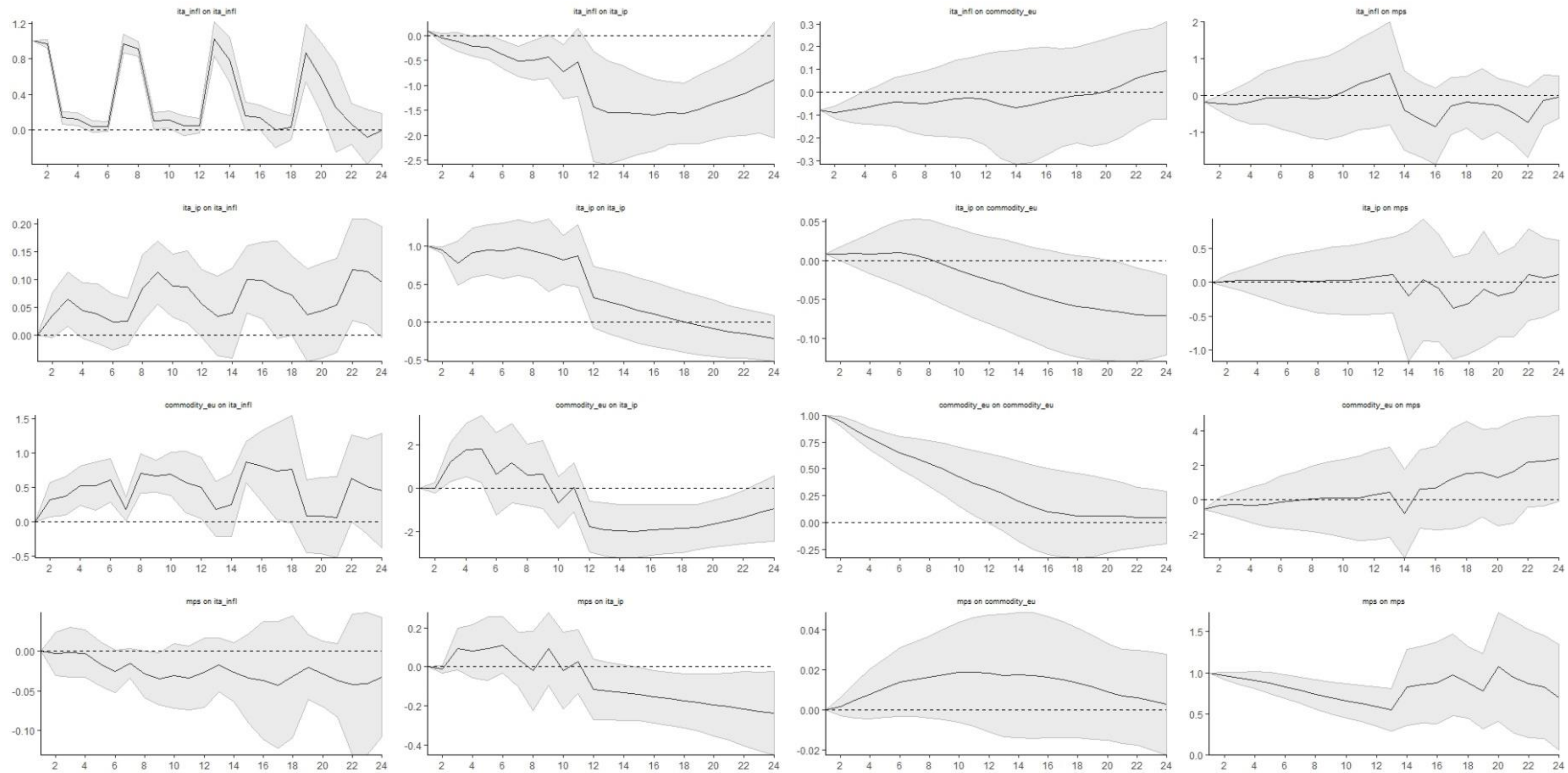
B.11 Local Projections – Eurozone Countries Specification – Spain

The figure presents the impulse responses for the local linear projection model, estimated following Jordà (2005) and presented in section 3.3.3, equation [3.5]. This specification specifically investigates the effects of the monetary shocks series on the Spanish inflation and industrial production. The variables included in this analysis are the inflation rate and industrial production index of Spain, the ECB commodity index and my monetary shocks series ordered last in the model. The impulse responses are estimated with 5 lags and plotted along with 95% confidence bands.



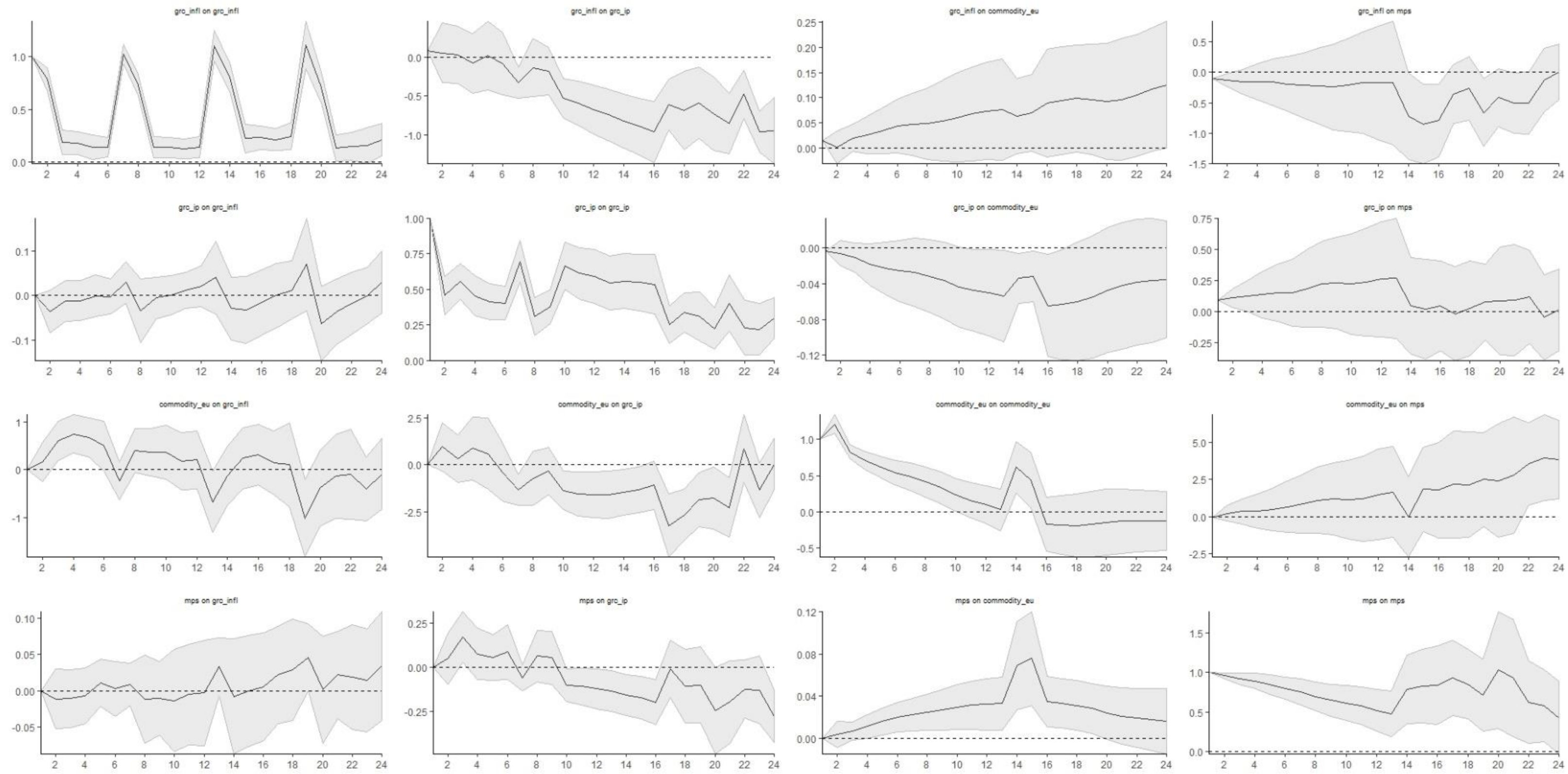
B.12 Local Projections – Eurozone Countries Specification – Italy

The figure presents the impulse responses for the local linear projection model, estimated following Jordà (2005) and presented in section 3.3.3, equation [3.5]. This specification specifically investigates the effects of the monetary shocks series on Italian inflation and industrial production. The variables included in this analysis are the inflation rate and industrial production index of Italy, the ECB commodity index and my monetary shocks series ordered last in the model. The impulse responses are estimated with 5 lags and plotted along with 95% confidence bands.



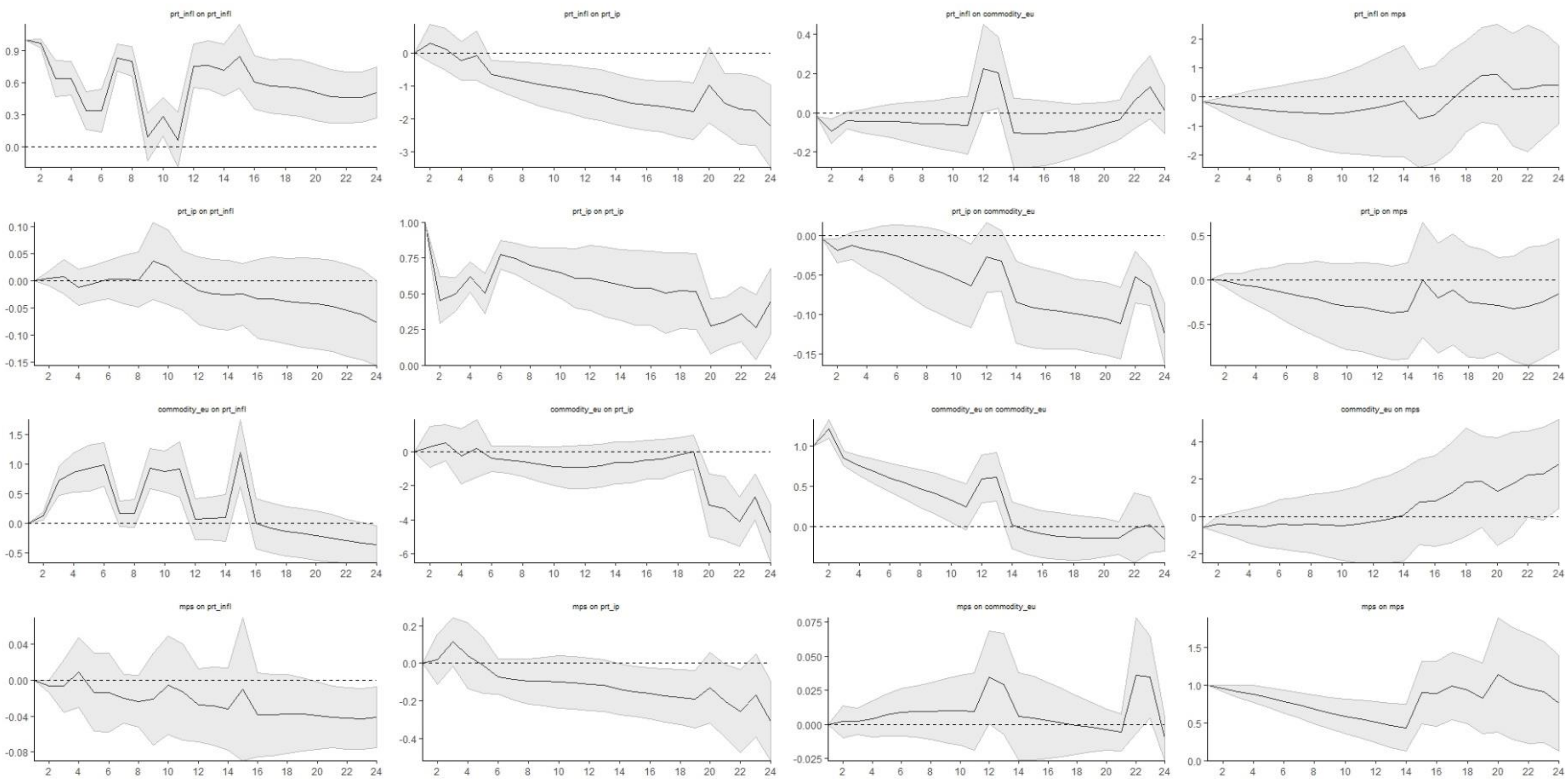
B.13 Local Projections – Eurozone Countries Specification – Greece

The figure presents the impulse responses for the local linear projection model, estimated following Jordà (2005) and presented in section 3.3.3, equation [3.5]. This specification specifically investigates the effects of the monetary shocks series on Greek inflation and industrial production. The variables included in this analysis are the inflation rate and industrial production index of Greece, the ECB commodity index and my monetary shocks series ordered last in the model. The impulse responses are estimated with 5 lags and plotted along with 95% confidence bands.



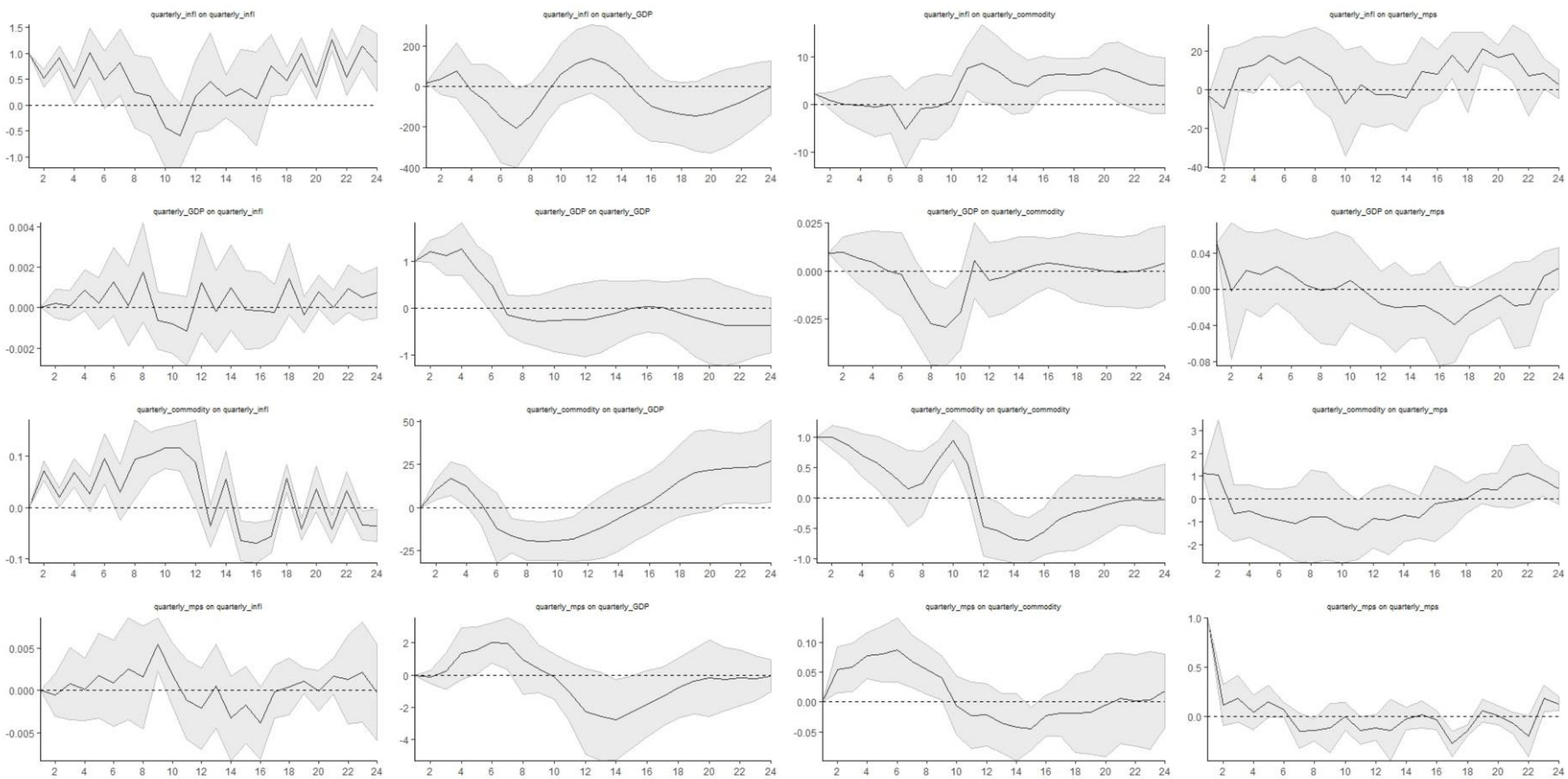
B.14 Local Projections – Eurozone Countries Specification – Portugal

The figure presents the impulse responses for the local linear projection model, estimated following Jordà (2005) and presented in section 3.3.3, equation [3.5]. This specification specifically investigates the effects of the monetary shocks series on the Portuguese inflation and industrial production. The variables included in this analysis are the inflation rate and industrial production index of Portugal, the ECB commodity index and my monetary shocks series ordered last in the model. The impulse responses are estimated with 5 lags and plotted along with 95% confidence bands.



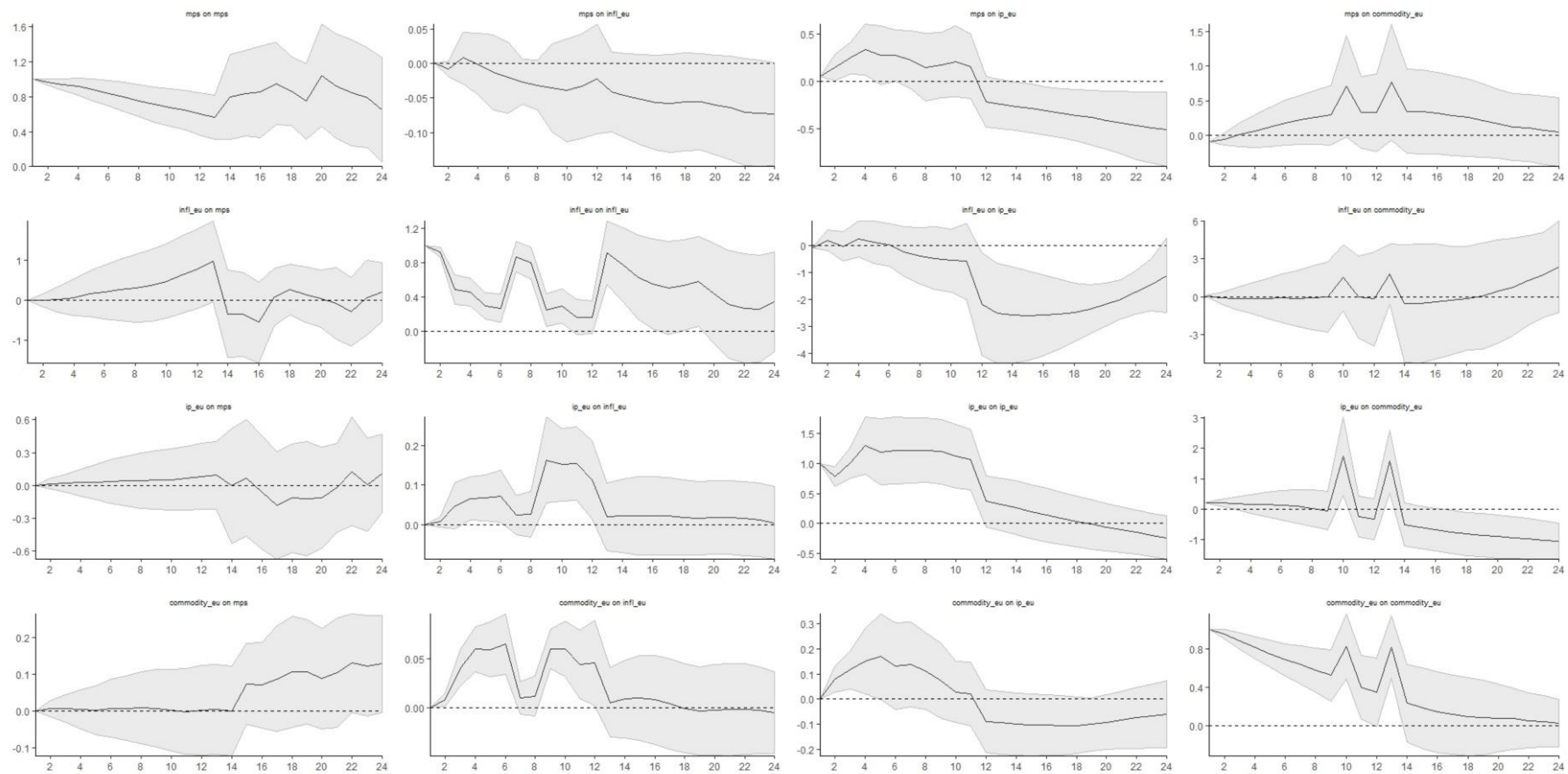
B.15 Local Projections – Quarterly GDP Analysis

The figure presents the impulse responses for the local linear projection model, estimated following Jordà (2005) and presented in section 3.3.3, equation [3.5], at a quarterly frequency. The variables included with the analysis are the inflation rate (HICP), the log of real GDP, the ECB commodity index and my monetary shocks series ordered last in the model. The impulse responses are estimated with 5 lags and plotted along with 95% confidence bands.



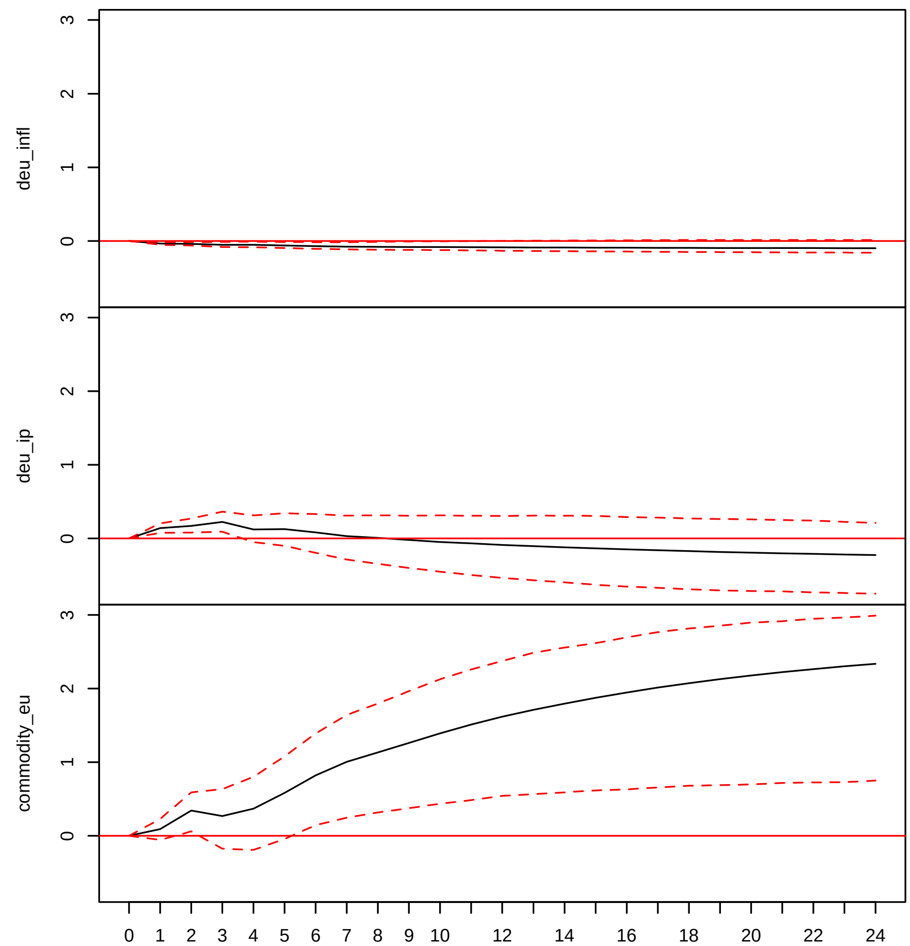
B.16 Local Projections – MPS Ordered First

The figure presents the impulse responses for the local linear projection model, estimated following Jordà (2005) and presented in section 3.3.3, equation [3.5] when the monetary policy shock series is ordered first in the model. The variables included with the analysis are the inflation rate, the industrial production index, the ECB commodity index and my monetary shocks series ordered last in the model. This test is a robustness check to additionally ensure the orthogonality of the shocks series. The impulse responses are estimated with 5 lags and plotted along with 95% confidence bands.



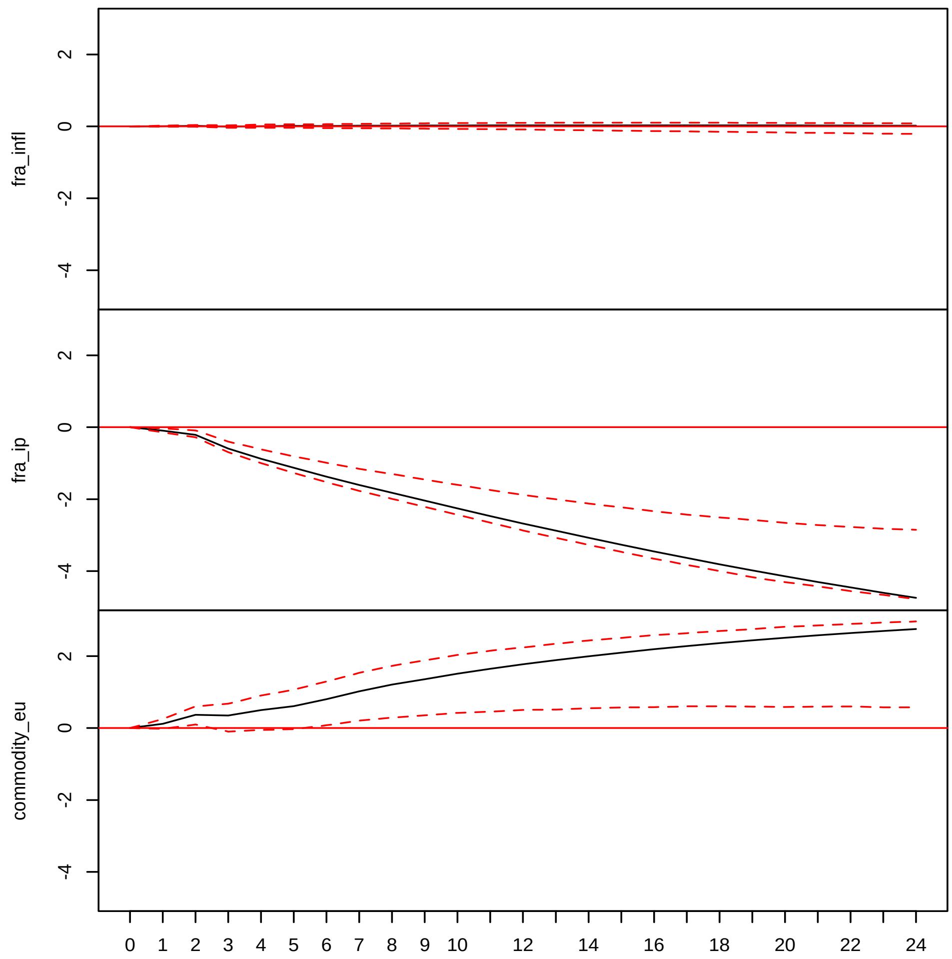
B.17 VAR – Eurozone Countries Specification – Germany

The figure shows the impulse response functions of the endogenous variables retrieved from the VAR presented in section 3.3.3, equation [3.4], conducted on data from Germany. The paths correspond to the impulse response of output to a 100 bps contractionary monetary policy shock, plotted along with 95% confidence bands. The VAR includes 5 lags and the impulse responses are computed with 2000 repetitions. Sample: 2000–2016.



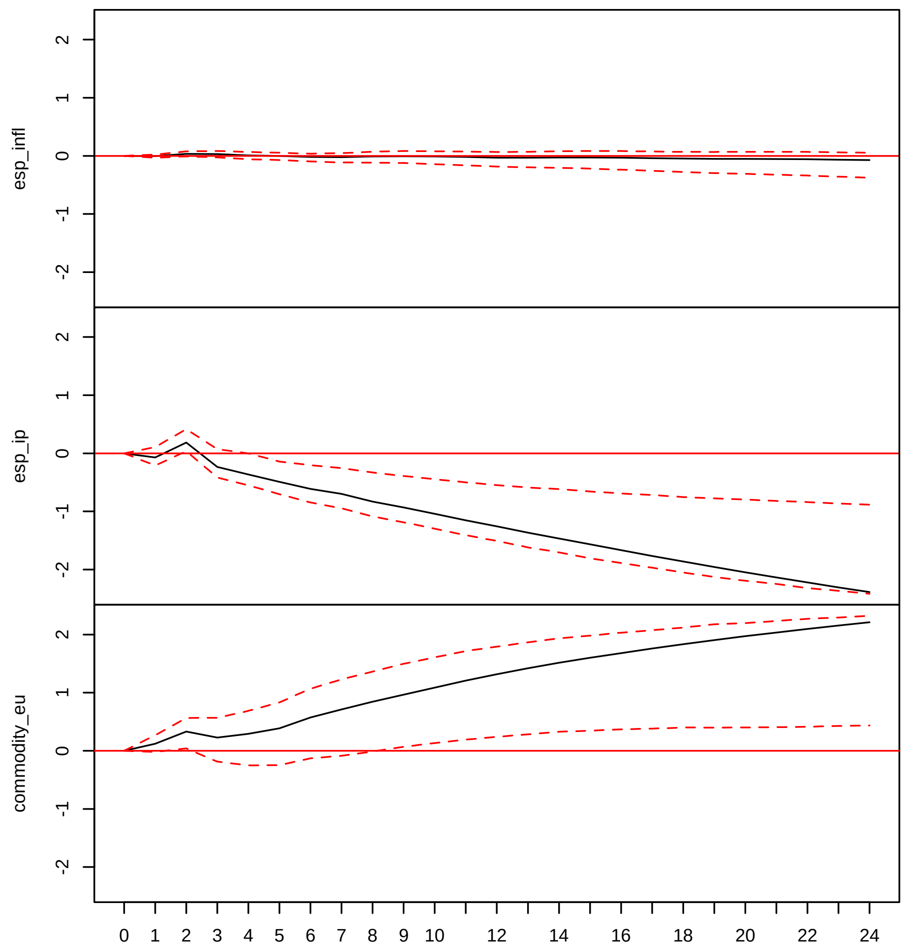
B.18 VAR – Eurozone Countries Specification – France

The figure shows the impulse response functions of the endogenous variables retrieved from the VAR presented in section 3.3.3, equation [3.4] conducted on data from France. The paths correspond to the impulse response of output to a 100 bps contractionary monetary policy shock, plotted along with 95% bootstrapped confidence bands. The VAR includes 5 lags and the impulse responses are computed with 2000 repetitions. Sample: 2000–2016.



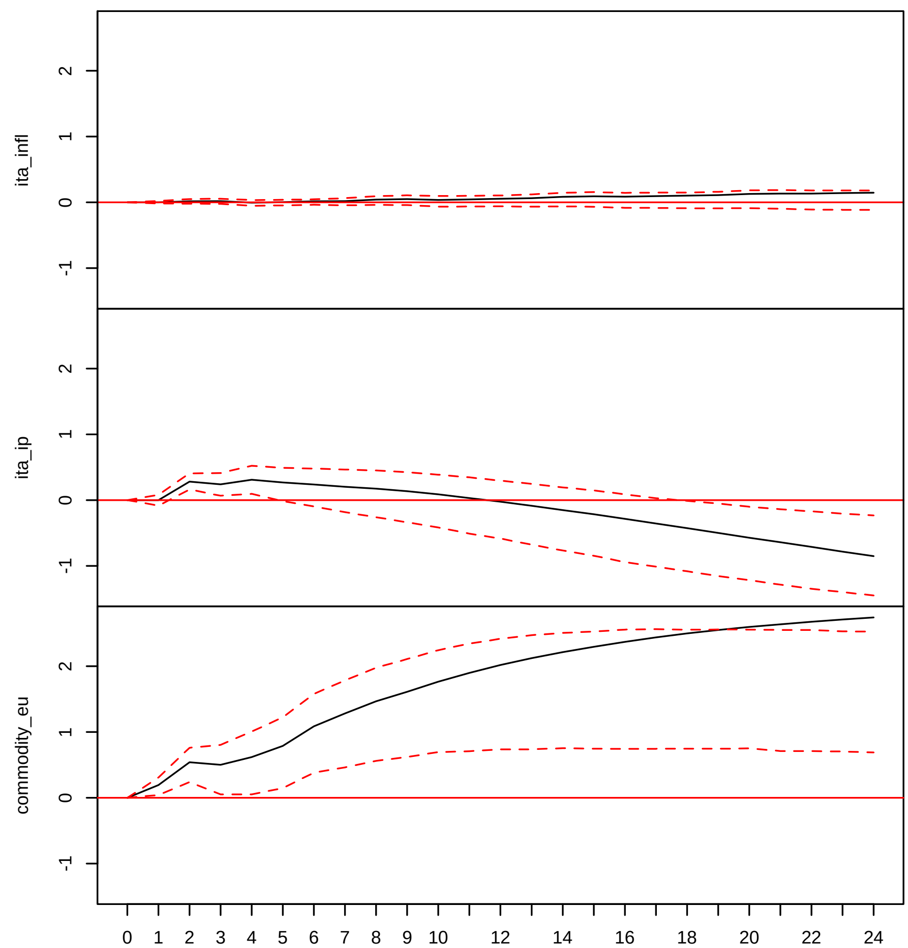
B.19 VAR – Eurozone Countries Specification – Spain

The figure shows the impulse response functions of the endogenous variables retrieved from the VAR presented in section 3.3.3, equation [3.4] conducted on data from Spain.
The paths correspond to the impulse response of output to a 100 bps contractionary monetary policy shock, plotted along with 95% bootstrapped confidence bands. The VAR includes 5 lags and the impulse responses are computed with 2000 repetitions. Sample: 2000–2016.



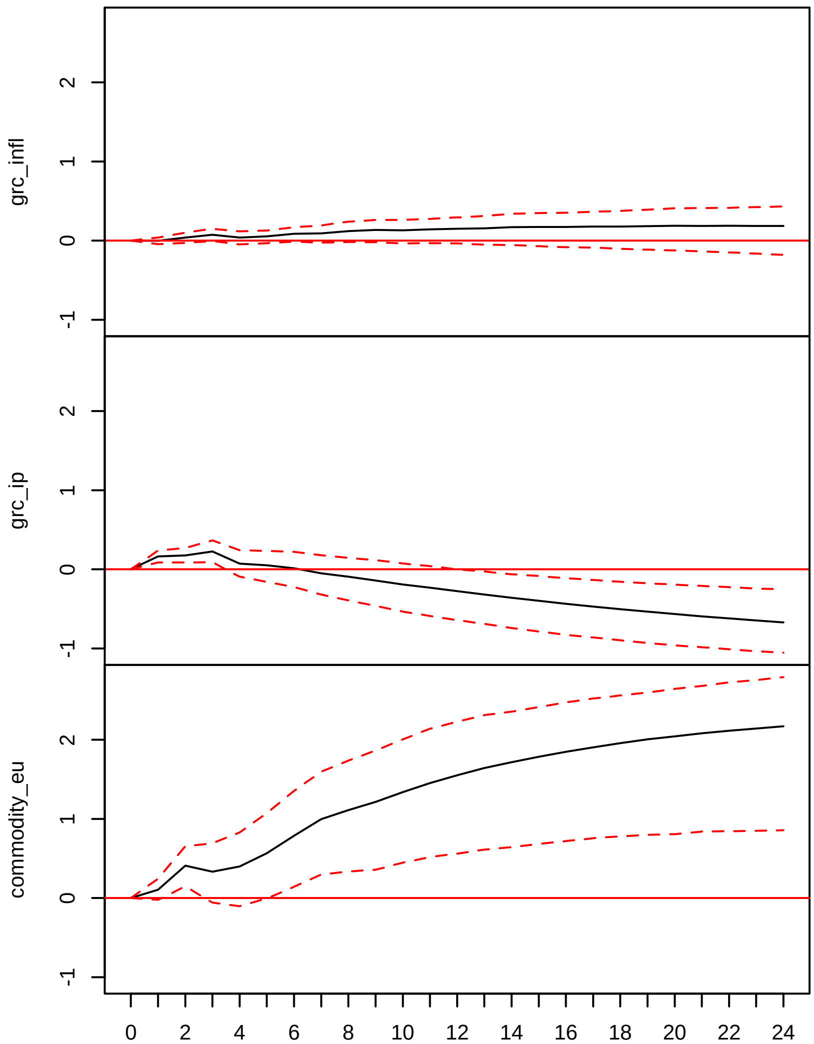
B.20 VAR – Eurozone Countries Specification – Italy

The figure shows the impulse response functions of the endogenous variables retrieved from the VAR presented in section 3.3.3, equation [3.4] conducted on data from Italy. The paths correspond to the impulse response of output to a 100 bps contractionary monetary policy shock, plotted along with 95% bootstrapped confidence bands. The VAR includes 5 lags and the impulse responses are computed with 2000 repetitions. Sample: 2000–2016.



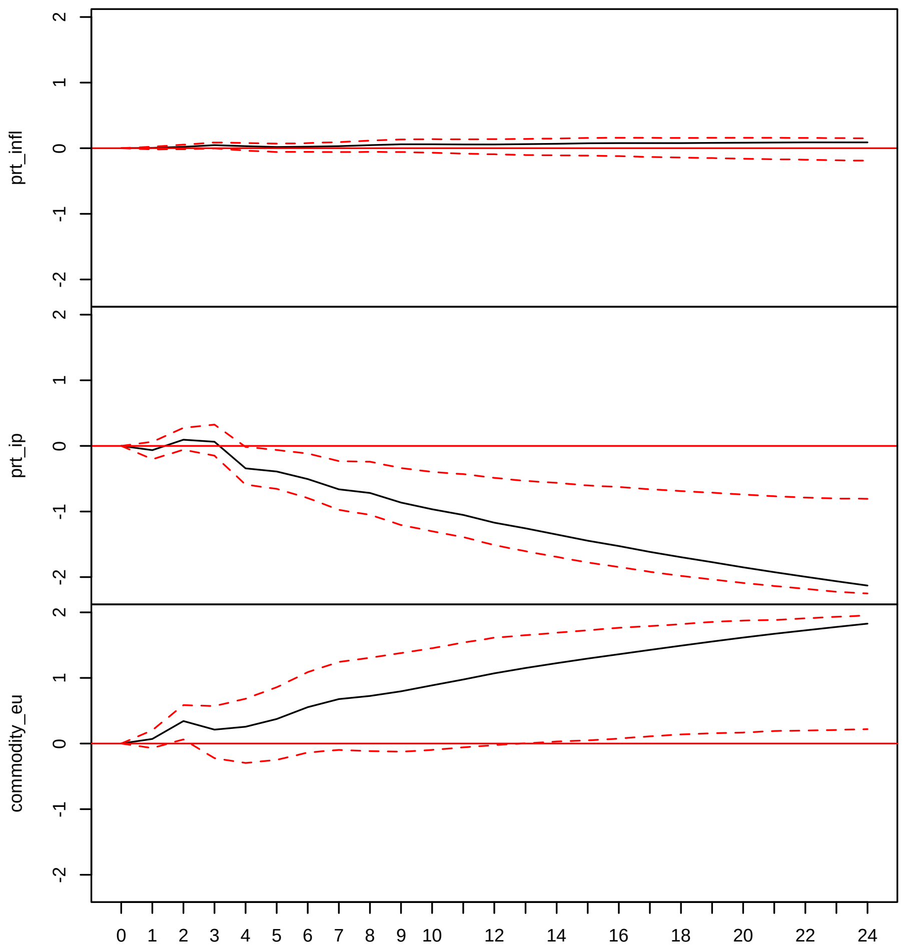
B.21 VAR – Eurozone Countries Specification – Greece

The figure shows the impulse response functions of the endogenous variables retrieved from the VAR presented in section 3.3.3, equation [3.4] conducted on data from Greece. The paths correspond to the impulse response of output to a 100 bps contractionary monetary policy shock, plotted along with 95% bootstrapped confidence bands. The VAR includes 5 lags and the impulse responses are computed with 2000 repetitions. Sample: 2000–2016.



B.22 VAR – Eurozone Countries Specification – Portugal

The figure shows the impulse response functions of the endogenous variables retrieved from the VAR presented in section 3.3.3, equation [3.4] conducted on data from Portugal. The paths correspond to the impulse response of output to a 100 bps contractionary monetary policy shock, plotted along with 95% bootstrapped confidence bands. The VAR includes 5 lags and the impulse responses are computed with 2000 repetitions. Sample: 2000–2016.



Appendix C – Chapter 4

Table C.1 – Data Sources

Table C.1. Data Sources			
Variable Name	**Geo***	**Source**	**Websites**
INTEREST RATES			
Nominal Interest Rate	EU	European Central Bank	www.ecb.europa.eu
	UK	Bank of England	www.bankofengland.co.uk
Overnight Interest Rate	EU	European Central Bank	www.ecb.europa.eu
	UK	Bank of England	www.bankofengland.co.uk
MACRO VARIABLES FORECASTS			
Inflation (1Y - 2Y)	EU	Quarterly Bulletin - Survey of Professional Forecasters	www.ecb.europa.eu
	UK	Inflation Report - Bank of England	www.bankofengland.co.uk
GDP Growth (1Y - 2Y)	EU	Quarterly Bulletin - Survey of Professional Forecasters	www.ecb.europa.eu
	UK	Inflation Report - Bank of England	www.bankofengland.co.uk
MACRO VARIABLES			
Unemployment Rate	EU	OECD	www.oecd.org
	UK	Office for National Statistics	www.ons.gov.uk
Inflation Rate	EU	ECB Statistical Data Warehouse	sdw.ecb.europa.eu
	UK	Office for National Statistics	www.ons.gov.uk
GDP Rate	EU	ECB Statistical Data Warehouse	sdw.ecb.europa.eu
	UK	Office for National Statistics	www.ons.gov.uk
FINANCIAL MARKETS VARIABLES			
Volatility			
VSTOXX	EU	Bloomberg	Bloomberg Terminal
VFTSE	UK	Bloomberg	Bloomberg Terminal
Currencies			
Euro Dollar	EU	Bloomberg	Bloomberg Terminal
British Pound Dollar	UK	Bloomberg	Bloomberg Terminal

* EU= Eurozone, UK = United Kingdom

Table C.2 – Descriptive Statistics

Table C.2: Descriptive Statistics – monthly data (192 obs) - Whole Sample (2003 - 2018) - %					
	AVG	*MED*	*MAX*	*MIN*	*STDEV*
Panel A : ECB					
Nominal Rate	1.378	1.000	4.250	0.000	1.314
Overnight Rate	1.376	0.895	5.277	-0.331	1.573
Inflation Rate	1.669	1.900	4.100	-0.600	0.988
Industrial Production (log)	1.202	1.819	3.780	-5.519	1.926
Unemployment Rate	9.640	9.345	12.090	7.270	1.352
Inflation Rate Forecast	1.632	1.600	2.600	1.000	0.338
GDP Growth Forecast	1.586	1.700	2.400	0.000	0.496
Unemployment Rate Forecast	9.130	9.050	12.000	6.600	1.440
Financial Market Volatility	22.857	20.950	60.677	11.986	8.512
EURUSD Ex Rate	1.270	1.274	1.579	1.049	0.123
Panel B: BOE					
Nominal Rate	2.026	0.500	5.750	0.250	2.036
Overnight Rate	2.267	0.820	6.693	0.277	2.136
Inflation Rate	2.130	2.250	4.800	0.200	0.922
Industrial Production (log)	1.668	1.960	4.809	-6.083	1.992
Unemployment Rate	5.954	5.400	8.500	4.000	1.380
Inflation Rate Forecast	2.028	2.000	2.500	1.500	0.197
GDP Growth Forecast	2.257	2.400	2.900	1.500	0.377
Unemployment Rate Forecast	5.913	5.400	8.600	3.900	1.339
Financial Market Volatility	18.220	16.429	54.149	9.549	7.449
GBPUSD Ex Rate	1.629	1.606	2.080	1.224	0.209

Note: Table C.2 presents descriptive statistics of variables included in the empirical analysis. Panel A presents statistics for the ECB and Panel B for BOE. Each variable is shown distribution simple average, median, maximum, minimum and standard deviation.
Data Source: ECB website (www.ecb.europa.eu), ECB statistical Data Warehouse (sdw.ecb.europa.eu), BOE website (www.bankofengland.co.uk), The Office for National Statistics Website (www.ons.gov.uk), the OECD Website (www.oecd.org) and Bloomberg Terminal.

Appendix C.1 – The Output Gap

Figure C.1 presents the output gap (Panel A the ECB and Panel B BOE) computed as the difference between the long-run normal unemployment rate (u*) and the current unemployment rate (u_t) as shown in equation [C.1]:

$$\mathbf{U}_t = u^* - u_t \qquad [C.1]$$

Clark (2012) and Oet & Lyytinen (2017) adopt the version of the Taylor (1999a) the employs as a measure of economic slack the deviation between the long-run unemployment rate and the current unemployment rate. The challenge is represented by the estimation of the long-run unemployment rate (u* in equation [C.1]). Clark (2012) set this value at 6%, whereas Oet & Lyytinen (2017) use the available estimate of the CBO. In my analysis I employ a rudimental measure of the long-run unemployment rate, based on the average unemployment rate in the pre-crisis period (2000-2007) for both the ECB and BOE. The long-run unemployment rate is estimated to be 8.7% for the ECB and 5.1% for BOE, respectively.

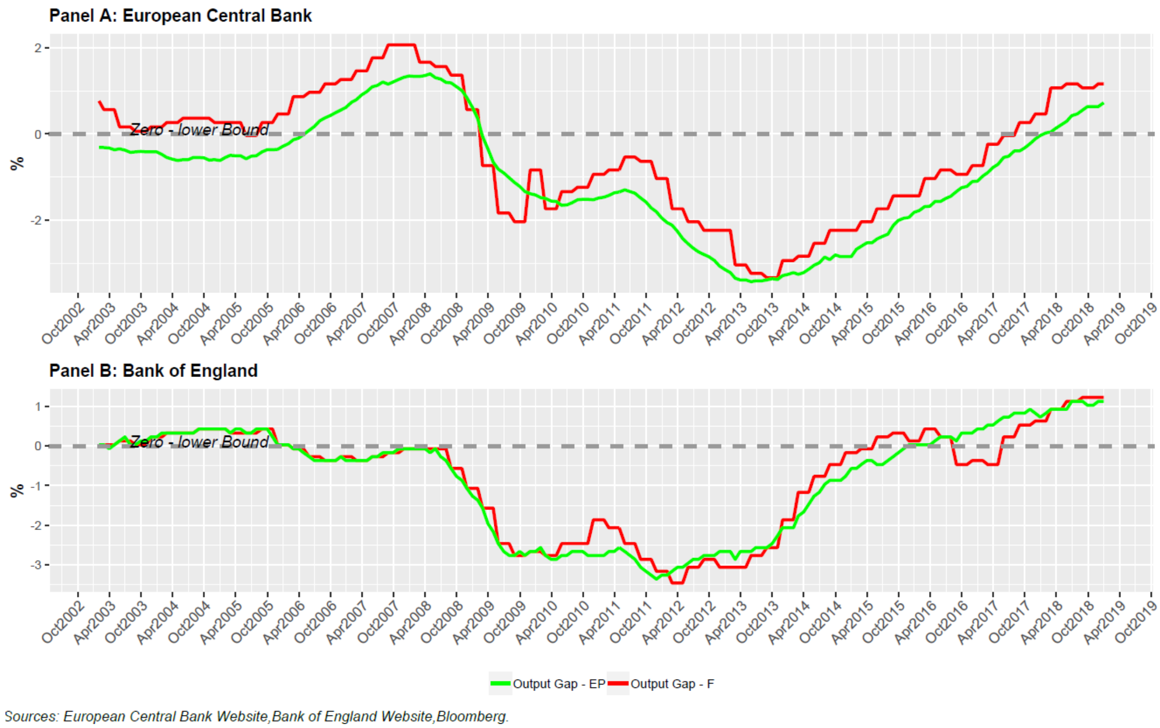


Figure C.1: Output Gap

The figure presents the time series for the output gap, in Panel A for the ECB and in Panel B for the BOE. The output gap is computed as in equation [C.1], and it is the difference between the ex-post (green line) or forecast (red line) of the long-run unemployment rate and the current unemployment rate. Sample period is (2003–2018) and includes192 monthly observations.

Appendix C.2 – The Overnight Interest Rate

When estimating the Taylor (1993, 1999a) Rules for the FED, Oet & Lyytinen (2017) recognized the importance of addressing the zero-lower bound and what happens when the rule suggests negative rates. For this reason they suggest they used of using alternative shadow rates in their framework following Wu & Xia (2016). In section 4.4.4 the Taylor Rules, estimated for both the ECB and BOE, were computed with the Nominal Interest rates, which represent an appropriate tool for the BOE. However, the zero-lower bound needs to be addressed for the ECB and therefore, I have conducted the analysis, presented in section 4.4.4., with Overnight Interest rates. The Overnight Interest rates employed for the institutions are the Euribor for the ECB and the Libor for the BOE, respectively. This additional analysis confirms the conclusions of section 4.4.4, improving the estimates of the Taylor (1993) Rule with forecasts data and the Augmented Taylor Rule for the ECB. The descriptive analysis for the BOE remains very close to the analysis performed in section 4.4.4.

Figure C.2 shows the Taylor Rules computed with ex-post data for both the ECB (Panel A) and the BOE (Panel B). The paths are very similar to the one shown in Figure 4.5, however, during the last regime of the ECB the Taylor (1993) Rule suggests for a brief period a negative interest rate, whereas in Figure 4.5 the Taylor (1993) Rule has always remained above the zero-lower bound. The difference between the Taylor (1993) Rule and the Taylor (1999a) Rule remains analogous to analysis shown in section 4.4.4. The Taylor (1999a) Rule largely overestimates the interest rate paths (Nominal Interest rate) from the third regime for both institutions. In the case of the BOE the analysis remains virtually similar to the one shown in section 4.4.4.

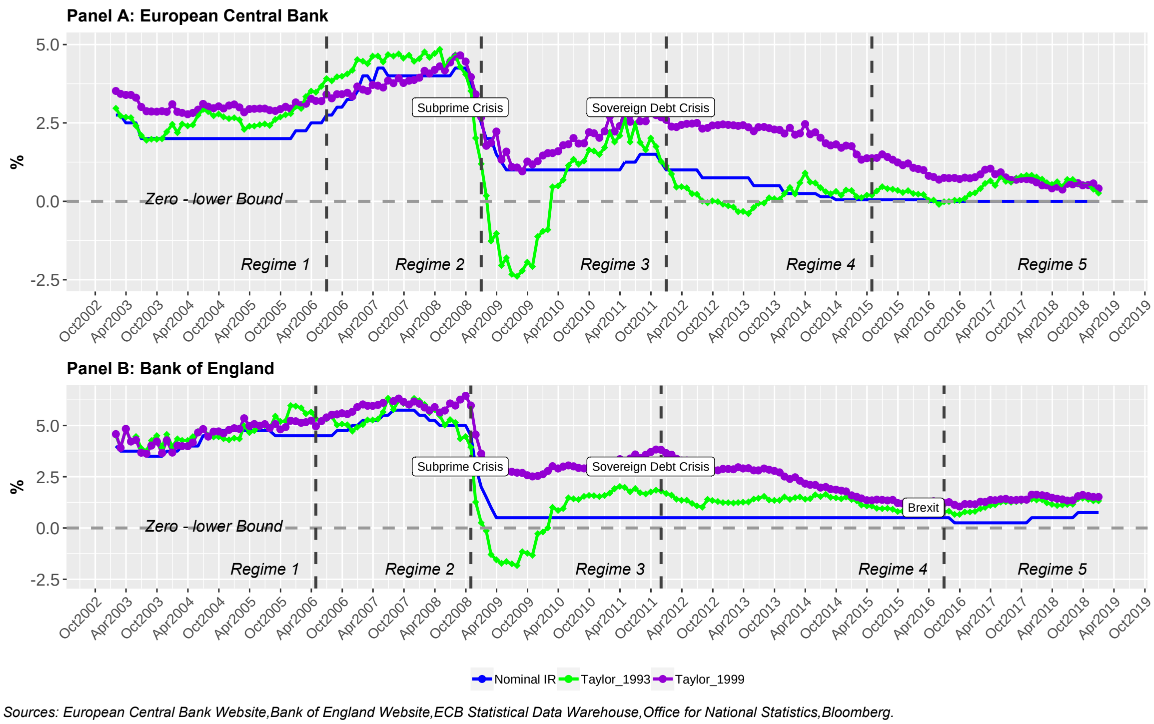
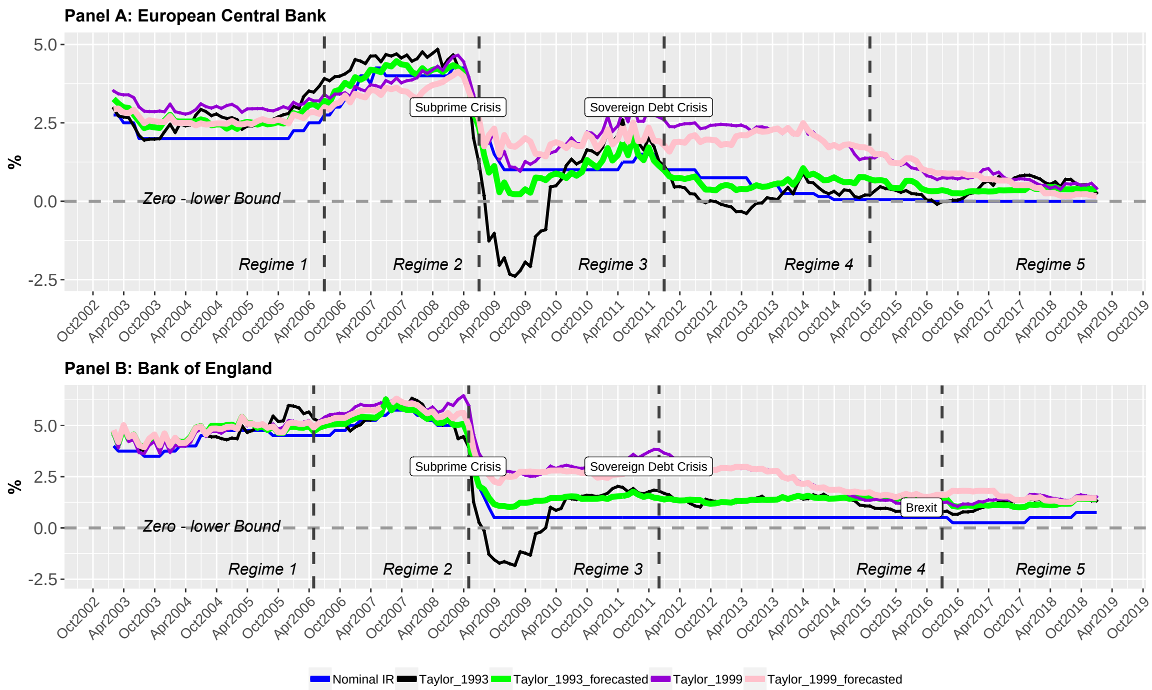


Figure C.2: Ex-Post Data Taylor Rule
The figure presents the Taylor Rule for the ECB (Panel A) and BOE (Panel B) computed using ex-post data. The estimation of the Taylor (1993, 1999a) Rules, following Oet and Lyytinen (2017), is conducted as Taylor-type Rule, as suggested by Clarke (2012) and as described by equation [4.5]. The Taylor rule are computed with Overnight Interest rate: the Euribor for the ECB and Libor for the BOE, respectively. The Nominal Interest rates are plotted along to the ex-post data Taylor (1993, 1999a) Rules. The regime samples computed with Bai-Perron (1998) are also plotted for both institutions. Sample period is (2003–2018) and includes 192 monthly observations.

Figure C.3. shows two interesting results in the case of the ECB: first, it confirms the descriptive analysis of section 4.4.4, in which the Taylor (1993) Rule computed with forecasts “beats” the Taylor (1993) Rule computed with ex-post. Second, the Taylor (1993) Rule with forecasts offers an even more precise estimates of the interest rates path in the 4th and 5th regime. The two Taylor (1993, 1999a) Rules with forecasts tend to actually converge in the latest periods of the 5th regime, showing perhaps that by employing forecasts data the forecasted output gap, computed either with the output growth or with the unemployment rate, might have become both two analogously important elements of the conduct of monetary policy of the ECB. In the case of the BOE the Taylor (1993) Rule with forecasted data remains closer to the Nominal Interest rate, compared to the Taylor (1999a) Rule confirming the analysis of section 4.4.4.

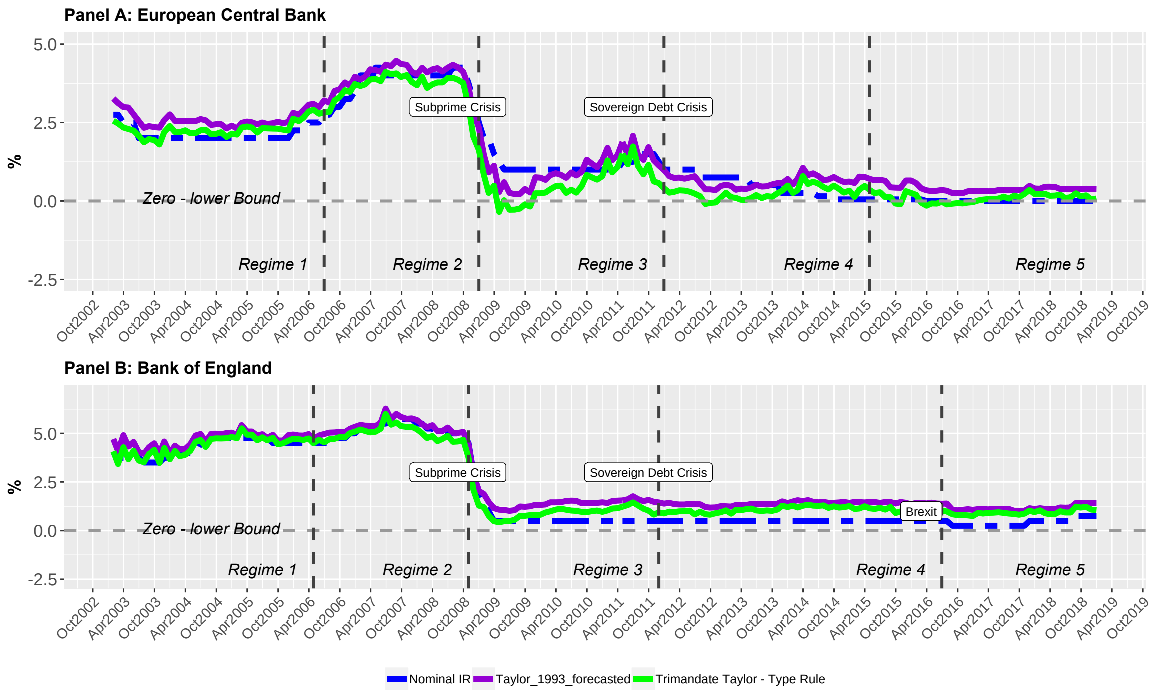


Sources: European Central Bank Website,Bank of England Website,ECB Statistical Data Warehouse,Office for National Statistics,Bloomberg.

Figure C.3: Forecasted Data Taylor Rule
The figure presents the Taylor Rule for the ECB (Panel A) and BOE (Panel B) computed using forecasts. The estimation of the Taylor (1993, 1999a) Rules, following Oet and Lyytinen (2017), is conducted as Taylor-type Rule, as suggested by Clarke (2012) and as described in equation [4.5].]. The Taylor rule are computed with Overnight Interest rate: the Euribor for the ECB and Libor for the BOE, respectively. The Nominal Interest Rate series is plotted along both for the ECB and BOE. The regime samples computed with Bai-Perron (1998) are also displayed for both institutions. Sample period is (2003–2018) and includes 192 monthly observations.

Lastly, Figure C.4 shows the Augmented Taylor Rules for the ECB (Panel A) and the BOE (Panel B), respectively. The Augmented Taylor Rule for the ECB shows interestingly that the implied interest rate is below the zero-lower bound from the beginning of the 4th regime (October, 2012). The path “recovers” at the end of the regime to fell back further under the zero-lower bound in the 5th regime. Compared to the analysis shown in section 4.4.4, the

ECB Augmented Taylor Rule fells beyond the zero-lower bound also at the beginning of the 3rd regime (April, 2009).



Sources: European Central Bank Website,Bank of England Website,ECB Statistical Data Warehouse,Office for National Statistics,Bloomberg.

Figure C.4: The Augmented Taylor Rule

The figure presents the Augmented Taylor Rule for the ECB (Panel A) and BOE (Panel B) computed using forecasts. The Augmented Taylor Rule is computed following the Taylor (1993) Rule and adding the FMSS variable (computed as shown in equation [4.4]). The Augmented Taylor Rule is computed with a Taylor-type Rule, as suggested by Clarke (2012) and as shown in equation [4.5]. The coefficient for the FMSS variables is equal to the coefficient of the output gap. The Augmented Taylor Rules are computed with forecasts. The Nominal Interest Rates is plotted along both for the ECB and BOE. The regime samples computed with Bai-Perron (1998) are also displayed for both institutions. Sample period is (2003–2018) and includes192 monthly observations.

This additional analysis points out the importance of addressing the zero-lower bound (Wu & Xia, 2016) in the case of the ECB. An additional important aspect that hasn't yet been discussed and perhaps not entirely reflected in the Overnight Interest rate is the set of unconventional monetary policy tools used by the ECB and how they have affected the path of the interest rate. A further version of this research will tackle this aspect and aim to include the unconventional monetary policy tools within the Taylor Rule framework

Bibliography

Abel, A. B. (1989). Asset Prices under Heterogenous Beliefs: Implications for the Equity Premium. Philadelphia, PA: University of Pennsylvania.

Ai, H., & Bansal, R. (2018). Risk Preferences and the Macroeconomic Announcement Premium. *Econometrica*, 86(4), 1383-1430.

Altavilla, C., Brugnolini, L., Gürkaynak, R. S., Motto, R., & Ragusa, G. (2019). Measuring euro area monetary policy. *Journal of Monetary Economics*, 108(1), 162-179.

Bai, J., & Perron, P. (1998). Estimating and Testing Linear Models with Multiple Structural Changes. *Econometrica*, 66(1), 47-78.

Bai, J., & Perron, P. (2003). Critical values of multiple structural change test. *Econometrics Journal*, 6(1), 72-78.

Ball, L. (1999). Policy Rules for Open Economies. In J. B. Taylor, Monetary Policy Rules (pp. 127-156). University of Chicago Press.

Barakchian, M. S., & Crowe, C. (2013). Monetary policy matters: Evidence from new shocks data. *Journal of Monetary Economics,* 60(8), 950-966.

Barsistha, A., & Kurov, A. (2008). Macroeconomic cycles and the stock market's reaction to monetary policy. *Journal of Banking & Finance*, 32(12), 2606-2616.

Bekaert, G., Hoerova, M., & Lo Duca, M. (2013). Risk, uncertainty and monetary policy. *Journal of Monetary Economics*, 60(1), 771-788.

Bernanke, B. S. (2004). The Logic of Monetary Policy, December 2. Washington DC: Speech at the National Economists Club.

Bernanke, B. S. (2011). The Effects of the Great Recession on Central Bank Doctrine and Practice, October 18. Boston, MA: Speech at the 56th Economic Conference.

Bernanke, B. S. (2015). Should monetary policy take into account risks to financial stability? May 25, from: https://www.brookings.edu/blog/ben .

Bernanke, B. S. (2017). Monetary policy in a new era. Conference: Rethinking Macroeconomic Policy, Washington DC.

Bernanke, B. S., & Blinder, A. S. (1992). The Federal Funds Rate and the Channels of Monetary Transmission. *American Economic Review*, 82(4), 901-921.

Bernanke, B. S., & Gertler, M. (1995). Inside the Black Box: The Credit Channel of Monetary Policy Transmission. *Journal of Economic Perspectives*, 9(4), 27-48.

Bernanke, B. S., & Gertler, M. L. (1999). Monetary policy and asset price volatility. Economic Review, Federal Reserve Bank of Kansas City, 4(1), 17-51.

Bernanke, B. S., & Kuttner, K. N. (2005). What Explains the Stocks Market's Reaction to Federal Reserve Policy? *Journal of Finance*, 60(3), 1221-1257.

Bernanke, B. S., & Mihov, I. (1998). Measuring Monetary Policy. *Quarterly Journal of Economics*, 113(3), 869-902.

Black, F. (1972). Capital Market Equilibrium with Restricted Borrowing. *Journal of Business*, 45(3), 444-455.

Black, F. (1993). Beta and Return. *Journal of Portfolio Management*, 20(1), 8-18.

Black, F., Jensen, M. C., & Scholes, M. (1972). The Capital Asset Pricing Model: Some Empirical Tests. Studies in the Theory of Capital Markets, Michael C. Jensen, ed., Praeger Publishers Inc., 1-52.

Blinder, A. S., Ehrmann, M., Fratzscher, M., De Haan, J., & Jansen, D.-J. (2008). Central Bank Communication and Monetary Policy: A Survey of Theory and Evidence. *Journal of Economic Literature*, 46(4), 910-945.

Blinder, A., Goodhart, C., Hildebrand, P., Lipton, D., & Wyplosz, C. (2001). How Do Central Banks Talk? Centre for Economic Policy Research, London: Geneva Reports on the World Economy.

Botzen, W. W., & Marey, P. S. (2010). Did the ECB respond to the stock market? *Journal of Policy Modeling*, 32(1), 303-322.

Boyd, J. H., Hu, J., & Jagannathan, R. (2005). The Stock Market's Reaction to Unemployment News: Why Bad News is usually good for Stocks. *Journal of Finance*, 60(2), 649-672.

Burriel, P., & Galesi , A. (2018). Uncovering the heterogeneous effects of ECB unconventional monetary policies across euro area countries. *European Economic Review*, 101(1), 210 -229.

Caputo, R., & Herrera, L. O. (2017). Following the leader? The relevance of the Fed funds rate for inflation targeting countries. *Journal of International Money and Finance*, 71(1), 25-52.

Carlin, B. I., Longstaff, F. A., & Matoba, K. (2014). Disagreement and asset prices. *Journal of Financial Economics*, 114(2), 226-238.

Carlson, J. B., Melick, W. R., & Sahinoz, E. Y. (2003). An option for anticipating Fed Action. *Federal Reserve Bank of Cleveland: Economic Commentary*.

Carvalho, C., Nechio, F., & Tristao, T. (2018). Taylor Rule Estimation by OLS. Federal Reserve Bank of San Francisco - Working Paper 11, 1-39.

Champagne, J., & Sekkel, R. (2018). Changes in monetary regimes and the identification of monetary policy shocks: Narrative evidence from Canada. *Journal of Monetary Economics*, 99 (1), 72-87.

Chava , S., & Xsu, A. (2015). Financial Constraints, Monetary Policy Shocks, and the Cross-Section of Equity Returns. Working Paper - Georgia Institute of Technology, 1-32.

Chen, H., Joslin, S., & Tran, N.-K. (2010). Affine Disagreement and Asset Pricing. *American Economic Review*, 100(2), 522-526.

Chen, N.-F., Roll, R., & Ross, S. A. (1986, Jul). Economic Forces and the Stock Market. *Journal of Business*, 59(3), 383-403.

Christiano, L. J., Eichenbaum, M., & Evans, C. (1996). The Effects of Monetary Policy Shocks: Evidence from the Flows of Funds. *Review of Economics and Statistics*, 78(1), 16-34.

Christiano, L. J., Eichenbaum, M., & Evans, C. L. (1999). Monetary Policy Shocks:What have we learned and to what end? In J. B. Taylor, & M. Woodford, Handbook of Macroeconomics (Vol. 1, pp. 65-148).

Clarida, R., Gali, J., & Gertler, M. (1998). Monetary policy rules in practice. Some international evidence. *European Economic Review*, 42(6), 1033-1067.

Clarida, R., Gali, J., & Gertler, M. (2000). Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory. *Quarterly Journal of Economics*, 115(1), 147-180.

Clark, T. E. (2012). Policy Rules in Macroeconomic Forecasting Models. *Economic Commentary*, 1-5.

Cloyne, J., & Hurtgen, P. (2016). The Macroeconomic Effects of Monetary Policy: A New Measure for the United Kingdom. *American Economic Journal: Macroeconomics*, 8(4), 75-102.

Cochrane, J. H., & Piazzesi, M. (2002). The Fed and Interest Rates - A High - Frequency Identification. *American Economic Review*, 92(2), 90-95.

Coibion, O. (2012). Are the Effects of Monetary Policy Shocks Big or Small? *American Economic Journal: Macroeconomics*, 4(2), 1-32.

Cooper, I., & Priestley, R. (2009). Time-Varying Risk Premiums and the Output Gap. *Review of Financial Studies*, 22(7), 2801-2833.

Crowe, C., & Meade, E. E. (2008). Central bank independence and transparency: Evolution and effectiveness. *European Journal of Political Economy*, 24(4), 763-777.

Diether, K. B., Mallow, C. J., & Scherbina, A. (2002). Differences of Opinion and the Cross Section of Stock Returns. *Journal of Finance*, 57(5), 2113-2141.

Du, B., Fung, S., & Loveland, R. (2018). The informational role of options markets: Evidence from FOMC announcements. *Journal of Banking & Finance*, 92(1), 237-256.

Ehrmann, M., & Fratzscher, M. (2004). Taking Stock: Monetary Policy Transmission to Equity Markets. *Journal of Money, Credit & Banking*, 36(4), 719-737.

Ehrmann, M., & Fratzscher, M. (2007). Transparency, Disclosure and the Federal Reserve. *International Journal of Central Banking*, 1(8), 179-224.

Eichenbaum, M., & Evans, C. (1995). Some Empirical Evidence on the Effects of Shocks to Monetary Policy on Exchange Rates. *Quarterly Journal of Economics*, 110(4), 975-1009.

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, 33(1), 3-56.

Fama, E. F., & French, K. R. (2007). Disagreement, tastes, and asset prices. *Journal of Financial Economics*, 83(3), 667-689.

Fausch, J., & Sigonius, M. (2018). The impact of the ECB monetary policy surprises on the German stock market. *Journal of Macroeconomics*, 55(1), 46-63.

Faust, J., & Rogers, J. H. (2003). Monetary policy's role in exchange rate behavior. *Journal of Monetary Economics*, 50(7), 1403-1424.

Faust, J., & Svensson, L. E. (2001, May). Transparency and Credibility: Monetary Policy with Unobservable Goals. *International Economic Review*, 42(2), 369-397.

Faust, J., Swanson, E. T., & Wright, J. H. (2004). Do Federal Reserve Policy Surprises Reveal Superior Information about the Economy? *The B.E. Journals in Macroeconomics*, 4(1), 1-31.

Fieldhouse, A. J., Martens, K., & Ravn, M. (2018). The Macroeconomic Effects of Government Asset Purchases: Evidence from Postwar U.S. Housing Credit Policy. *Quarterly Journal of Economics*, 133(3), 1503-1560.

Fischer, S., & Merton, R. (1984). Macroeconomics and finance: The role of the stock market. Carnegie - Rochester Conference Series on Public Policies, 21, 57-108.

Flannery, M. J., & Protopapadakis, A. A. (2015). Macroeconomic Factors Do Influence Aggregate Stock Return. *Review of Financial Studies*, 15(3), 751-782.

French, K. R., & Roll, R. (1986). Stock return variances: The arrival of information and the reaction of traders. *Journal of Financial Economics*, 17(1), 5-26.

Friedman, B. M., & Kuttner, K. N. (2010). Implementation of Monetary Policy: How do Central Banks Set Interest Rates? In B. M. Friedman, & M. Woodford (Eds.), Handbook of Monetary Economics (Vol. 3B, pp. 1345-1438). Elsevier.

Garcia, D. (2013). Sentiment during Recessions. *Journal of Finance*, 68(3), 1267-1300.

Gerlach, S. (2007). Interest Rate Setting by the ECB, 1999:2006. *International Journal of Central Banking*, 3(1), 1-45.

Gerlach, S., & Schnabel, G. (2000). The Taylor rule and interest rates in the EMU area. *Economics Letters*, 67(2), 165-171.

Gerlach, S., & Stuart, R. (2019). Plotting interest rates: The FOMC's projections and the economy. *Journal of Macroeconomics*, 60(1), 198-211.

Gertler, M., & Karadi, P. (2015). Monetary Policy Surprises, Credit Costs and Economic Activity. *American Economic Journal: Macroeconomics*, 7(1), 44-76.

Gorter, J., Jacobs, J., & De Haan, J. (2008). Taylor Rules for the ECB using Expectations Data. *Scandinavian Journal of Economics*, 110(3), 473-488.

Grossman, S. J., & Stiglitz, J. E. (1980). On the Impossibility of Informationally Efficient Markets. *American Economic Review*, 70(3), 393-408.

Gürkaynak, R. S. (2005). Using federal funds futures contracts for monetary policy analysis. Finance and Economics Discussion Series 2005-29, Board of Governors of the Federal Reserve System (US).

Gürkaynak, R. S., Sack, B., & Swanson, E. (2005a). Do Actions Speak Louder than Words? The Response of Asset Prices to Monetary Policy Actions and Statements. *International Journal of Central Banking*, 1(1).

Gürkaynak, R. S., Sack, B., & Swanson, E. (2005b). The Sensitivity of Long-Term Interest Rates to Economic News: Evidence and Implications for Macroeconomic Models. *American Economic Review*, 95(1), 425-436.

Gürkaynak, R. S., Sack, B. P., & Swanson, E. T. (2006). Market-Based Measures of Monetary Policy Expectations. *Journal of Business & Economic Statistics*, 25(2), 201-212.

Hardouvelis, G. A. (1987, May). Macroeconomic Information and Stock Prices. *Journal of Economics and Business*, 49(2), 131-140.

Jensen , G. R., & Mercer, J. M. (2002). Monetary Policy and the Cross-Section of Expected Stock Returns. *Journal of Financial Research*, 25(1), 125-139.

Jarocinski, M., & Karadi, P. (2020). Deconstructing monetary policy surprises: The role of information shocks. American Economic Journal: Macroeconomics, 12(2), 1-43

Jordà, O. (2005). Estimation and Inference of Impulse Responses by Local Projections. *American Economic Review*, 95(1), 161-182.

Kontonikas, A., & Kostakis, A. (2013). On Monetary Policy and Stock Market Anomalis. *Journal of Business Finance and Accounting*, 40(7), 1009-1042.

Kontonikas, A., MacDonald, R., & Saggu, A. (2013). Stock market reaction to fed funds rate surprises: State dependence and the financial crisis. *Journal of Banking & Finance*, 37(11), 4025–4037.

Krueger, J. T., & Kuttner, K. N. (1996). The Fed Funds futures rate as a predictor of Federal Reserve Policy. *Journal of Futures Markets*, 16(8), 865-879.

Kurov, A. (2010). Investor Sentiment and the stock market's reaction to monetary policy. *Journal of Banking & Finance,* 34(1), 139-149.

Kurov, A. (2012). What determines the stock market's reaction to monetary policy statements? *Review of Financial Economics*, 21(4), 175-187.

Kurov, A., Gilbert, T., & Wolfe, M. H. (2020). The Disappearing Pre-FOMC Announcement Drift. *Working Paper*, 1-15.

Kuttner, K. N. (2001). Monetary policy surprises and interest rates: Evidence from the Fed Funds futures market. *Journal of Monetary Economics*, 47(3), 523-544.

Kuttner, K. N. (2011). Monetary Policy and Asset Price Volatility. Should We Refill the Bernanke-Gertler Prescription? In D. D. Evanoff, G. G. Kaufman, & A. g. Malliaris, New Perspectives on Asset Price Bubbles: Theory, Evidence, and Policy. (pp. 1-37). Oxford University Press.

Lansing , K. J., & Pyle, B. (2015). Persistent Overoptimism about Economic Growth. *FRBSF Economic Letter*, 3(1), 1-5.

Lubik, T. A., & Schorfheide, F. (2007). Do central banks respond to exchange rate movements? A structural investigation. *Journal of Monetary Economics*, 54(1), 1069-1087.

Lucca, D. O., & Moench, E. (2015). The Pre- FOMC Announcement Drift. *Journal of Finance*, 70(1), 329-371.

McQueen, G., & Roley, V. V. (1993). Stock Prices, News, and Business Conditions. *Review of Financial Studies*, 6(3), 683-707.

Milgrom, P., & Stokey, N. (1982). Information, Trade and Common Knowledge. *Journal of Economic Theory*, 26(1), 17-27.

Miller, E. M. (1977). Risk, Uncertainty, and Divergence of Opinion. *Journal of Finance*, 32(4), 1151-1168.

Milton, H., & Raviv, A. (1993). Differences of Opinion Make a Horse Race. *Review of Financial Studies*, 6(3), 473-506.

Mishkin, F. (1995). Symposium on the Monetary Transmission Mechanism. J*ournal of Economic Perspectives*, 9(4), 3-10.

Mishkin, F. (1996). The Channels of Monetary Transmission: Lessons for Monetary Policy. *NBER Working Paper*, N. 27, 33-44.

Mishkin, f. S., & Eakins, S. G. (2018). Financial Markets and Institutions (9th Edition ed.). Pearson.

Mishkin, F. S., & White, E. N. (2002). U.S. Stock Market Crashes and Their Aftermath: Implications for Monetary Policy. NBER Working Paper, 8992.

Mueller, P., Tahbaz-Salehi, A., & Vedolin, A. (2017). Exchange Rates and Monetary Policy Uncertainty. *Journal of Finance*, 72(3), 1213-1252.

Neuenkirch, M. (2012, March). Managing financial market expectations: The role of central bank transparency and central bank communication. *European Journal of Political Economy* (28), 1-13.

Oet, M. V., & Lyytinen, K. (2017). Does Financial stability Matter to the Fed in Setting US Monetary Policy? *Review of Finance*, 21(1), 389-432.

Orphanides, A. (2001). Monetary Policy Rules Based on Real-Time Data. *American Economic Review*, 91(4), 964-985.

Owens, R. E., & Webb, R. H. (2001). Using the Federal Funds Futures Market to Predict Monetary Policy Actions. *Business Economics*, 36(2), 44-48.

Plagborg-Møller , M., & Wolf, C. K. (2019). Local Projections and VARs estimate the same impulse responses. *Working Paper*, Princeton University, 1-36.

Rigobon, R., & Sack, B. (2003). Measuring the reaction of monetary policy to the stock market. *Quarterly Journal of Economics*, 118(2), 639-669.

Rigobon, R., & Sack, B. (2004). The impact of monetary policy on asset prices. *Journal of Monetary Economics*, 51(8), 1553-1575.

Rogers, J. H., Scotti, C., & Wright, J. H. (2018). Unconventional Monetary Policy and International Risk Premia. *Journal of Money, Credit & Banking*, 50(8), 1827-1850.

Romer, C. D., & Romer, D. H. (1989). Does Monetary Policy Matter? A New Test in the Spirit of Friedman and Schwartz. *NBER Macroeconomics Annual 1989*, 4(1), 121-184.

Romer, C. D., & Romer, D. H. (2004). A New Measure of Monetary Shocks: Derivation and Implications. *American Economic Review*, 94(4), 1055-1084.

Rozeff, M. S. (1974). Money and Stock Prices. *Journal of Financial Economics*, 1(3), 245-302.

Rudebusch, G. (2006). Monetary Policy Inertia: Fact or Fiction? *International Journal of Central Banking*, 2(4), 85-135.

Savor, P., & Wilson, M. (2013). How Much Do Investors Care About Macroeconomic Risk? Evidence from Scheduled Economic Announcement. *Journal of Financial and Quantitative Analysis*, 48(1), 343 - 375.

Savor, P., & Wilson, M. (2014). Asset Pricing: A tale of two days. *Journal of Financial Economics*, 113(1), 171-201.

Scholl, A., & Uhlig, H. (2008). New evidence on the puzzles: Results from agnostic identification on monetary policy and exchange rates. *Journal of International Economics*, 76(1), 1-13.

Sims, C. A. (1972). Money, Income, and Causality. *American Economic Review*, 62(4), 540-552.

Sims, C. A. (1980). Macroeconomics and Reality. *Econometrica*, 48(1), 1-48.

Sims, C. A. (1986). Are forecasting models usable for policy analysis? *Quarterly Review, Federal Reserve Bank of Minneapolis*, issue Win 1-16.

Sims, C. A. (1992). Interpreting the macroeconomic time series facts. The effects of monetary policy. *European Economic Review*, 36(5), 975-1011.

Sinha, A. (2015). FOMC Forward Guidance and Investor Beliefs. *American Economic Review: Papers & Proceedings, 105*(5), 656-661.

Svensson, L. E. (2003). What is Wrong with the Taylor Rules? Using Judgment in Monetary Policy through Targeting Rules. *Journal of Economic Literature*, 41(2), 426-477.

Svensson, L. E. (2010). Inflation Targeting. In B. M. Friedman, & M. Woodford (Eds.), *Handbook of Monetary Economics* (Vol. 3, pp. 1237-1302).

Svensson, L. E. (2012). Evaluating Monetary Policy. In E. F. Koening, R. Leeson, & G. A. Kahn, *The Taylor Rule and the Transformation of Monetary Policy* (pp. 245-274). Hoover Institution Press.

Svensson, L. E. (2019). What rule for the Federal Reserve? Forecast Targeting. Forthcoming *International Journal of Central Banking*, 1-42.

Svensson, L. E., & Tetlow, R. J. (2005). Optimal Policy Projections. *International Journal of Central Banking*, 1(3), 177-207.

Taylor, J. B. (1993). Discretion versus policy rules in practice. Carnegie - Rochester Conference Series on Public Policy, (pp. 195-214). North - Holland.

Taylor, J. B. (1999a). A Historical Analysis of Monetary Policy rules. In J. B. Taylor, Monetary Policy Rules (pp. 319-348). University of Chicago Press.

Taylor, J. B. (1999b). The robustness and efficiency of monetary policy rules as guidelines for interest rate setting by the European Central Bank. *Journal of Monetary Economics*, 43(1), 655-679.

Taylor, J. B. (2001). The Role of the Exchange Rate in Monetary-Policy Rules. *American Economic Review*, 91(2), 263-267.

Tetlock, P. C. (2007). Giving content to investor sentiment: The role of media in the stock market. *Journal of Finance*, 62(3), 1139-1168.

Tetlock, P. C. (2011). All the News That's Fit to Reprint: Do Investors React to Stale Information? *Review of Financial Studies*, 24(5), 1481-1512.

Tetlock, P. C. (2014). Information Transmission in Finance. *Annual Review of Financial Economics*, 6(1), 365-3684.

Thorbecke, W. (1997). On Stock Market Returns and Monetary Policy. *Journal of Finance*, 52(2), 635-654.

Tobin, J. (1969). A General Equilibrium Approach To Monetary Theory. *Journal of Money Credit & Banking*, 1(1), 15-29.

Uhlig, H. (2005). What are the effects of monetary policy on output? Results from an agnostic identification procedure. *Journal of Monetary Economics*, 52, 381-419.

Varian, H. R. (1985). Divergence of Opinion in Complete Markets: A note. *Journal of Finance*, 40(1), 309-317.

Varian, H. R. (1989). Differences of Opinion in Financial Markets. In C. C. Stone, Financial Risk: Theory, Evidence and Implications (pp. 3-37). Springer, Dordrecht.

Wachter, J. A., & Zhu, Y. (2018). The Macroeconomic Announcement Premium. *NBER Working Paper*, 24432,1-50.

Whaley, R. E. (2000). The Investor Fear Gauge. *Journal of Portfolio Management*, 26(3), 12-17.

Wingender, A. M. (2011). Monetary Policy Shocks and Risk Premia in the Interbank Market. *B.E. Journal of Macroeconomics*, 11(1), 1-21.

Woodford, M. (2001). Monetary Policy in the Information Economy. Proceedings - Economic Policy Symposium - Jackson Hole, Federal Reserve Bank of Kansas City, p297-370.

Wu, J. C., & Xia, F. D. (2016). Measuring the Macroeconomic Impact of Monetary Policy at the Zero Lower Bound. *Journal of Money, Credit & Banking*, 48(2-3), 253-291.