Central bank communication: A quantitative assessment

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Acknowledgements

Abstract

In this paper we propose a new set of indicators of central bank's communication to estimate speech intensity in five different fields: monetary conditions, financial stability, external competitiveness, labour and social conditions and economic activity. We develop an automated text-mining routine using the Bank of International Settlements (BIS) collection of speeches given by central bank senior executives. We use this set of indicators to compare goals and strategies across several central banks (the Federal Reserve, the European Central Bank, the Bank of England and the Reserve Bank of Australia) from the late 1990s up to 2016. We then assess whether communication intensity is mirrored in central banks' policy decisions. Our empirical results suggest that communication can be a complement or a substitute for monetary policy. In those periods in which communication is more efficient in managing expectations, central banks may have less need for reliance on the traditional policy rate.

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1. Introduction

In the last decades, many central banks have become remarkably more transparent[1] for two main reasons. First, central bank independence has to be balanced by accountability. Second, central banks may more easily foster economic stability when economic agents have a clear understanding of central banks' goals. Having this in mind, central banks have started using communication as a key instrument to manage agents' expectations (e.g. Cosimano and van Huyck, 1993). Since the outbreak of the crisis, central banks have resorted to forward guidance and unconventional policies, they have intensified communication in order to publicly define the scope and implementation of their unconventional policies.[2]

Most of the literature so far has focused on central banks' communication on interest rates and its short-run effects. In particular, using high-frequency data a first strand of the literature has investigated whether central bank communication on interest rates may move financial markets in the intended direction, flatten the yield curve and limit financial volatility. These studies indicate that central bank communication exert a significant influence on financial markets and long-term interest rates in the euro area (Brand et al., 2006; Ehrmann and Fratzscher, 2007 and 2009; Musard-Gies, 2006; Hussian, 2011; Bernoth and von Hagen, 2004) and in the United States (Gürkaynak et al., 2005; Luik and Wesselbaum, 2016; Kohn and Sack, 2004). For the United Kingdom, Reeves and Sawinski (2007) find that the publication of Minutes of Monetary Policy Committee meetings and the Inflation Report significantly affect near-term interest rates expectations, while for Korea Lee et al. (2016) find that central bank communication has reduced liquidity impairment in 2001-2012. According to some studies, the effects of central bank communication have been more relevant during the crisis (see Hayo et al., 2012 for an analysis on the United States, and Nautz and Schmidt, 2009 for the euro area).

Following the argument pursued by Woodford (2001) that communication is a tool used by central banks to manage expectations, a second strand of the empirical literature has investigated the effect that announcements of an inflation target may have on inflation expectations and inflation outcomes. Overall, there is a general agreement on the beneficial effects of transparency on the variability of inflation and private sector's expectations (Kuttner and Poser, 1999; Czogała et al., 2005; Connolly and Kohler, 20014; van der Cruijsen and Demertzis, 2007; Ullrich, 200. Conversely, surprises in monetary policy actions increase uncertainty about the path the rate of inflation is going to take (Kliesen and Schmid, 2004). Finally, a third strand of the literature has analysed whether higher transparency and communication may improve forecasting accuracy[3] (Di Giorgio and Traficante, 2010; Sturm and De Haan, 2011; Lustenberger and Rossi, 2017) or modify the effects of monetary shocks (Hubert, 2017).

In contrast, so far only limited research has been conducted regarding the effects of communication on macroeconomic variables different from monetary policy interest rates. In particular, not much attention

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[1] Dincer and Eichengreen (2009) propose a measure of transparency and independence for more than 100 central banks.

[2] For a discussion on how central bank communication has changed since the global financial crisis, see Coenen et al. (2018).

[3] While there is more consensus in the literature on the impact of communication on financial markets and expectations, on the beneficial effect of communication and transparency on forecasting accuracy the aforementioned studies point to different conclusions. On the one hand, Di Giorgio and Traficante (2010) and Sturm and De Haan (2011) find that communication helps predict policy decisions. On the other hand, Lustenberger and Rossi (2017) find that more communication even increases forecast errors and dispersion.

has been paid as to how central banks disclose their goals and strategies and whether communication reflects central banks' mandates.

Our paper fills this gap by taking a broader perspective and analysing how central banks disclose information not only concerning interest rates, but also about other macroeconomic issues. To the best of our knowledge, our communication index represents the first attempt in the literature to quantify central banks' communication on a broader set of macroeconomic issues. Moreover, in the existing literature the analysis is often based on communication indicators which are "manually" computed, while herewith we develop an automated routine which can be easily updated, applied to other central banks or adapted to other areas of research.

Central banks communicate in a number of ways, namely though qualitative communication instruments (e.g. public speeches, official publications, statements and minutes), as well as quantitative communication instruments, such as inflation (and other macro variables) forecasts. In this paper we focus only on central banks' qualitative communication, more precisely public speeches. To build our communication indexes, we propose an automated routine using the Bank of International Settlements (BIS) collection of speeches given by central bank senior executives of four central banks, namely the Reserve Bank of Australia (RBA), the European Central Bank (ECB), the Bank of England (BoE) and the Federal Reserve (Fed).[4] For each central bank, we select a list of keywords to estimate speech intensity in five different fields: monetary conditions, financial stability, external competitiveness, labour and social conditions and economic activity. Our sample covers the period from the first quarter of 1997 to the first quarter of 2016, for all central banks except the BoE and the ECB. For the euro area, the sample starts in the first quarter of 1999, as the ECB started exercising its full powers only with the introduction of the euro on 1 January 1999. For the United Kingdom, the sample is shorter due to data availability and starts in 2006. By covering a long sample up to 2016, our indexes potentially provide insights on changes in communication strategy during and in the aftermath of the recent global crisis.

Our set of communication indexes can be useful to address a large number of policy questions. To illustrate the potential use of this set of indexes, in this paper we present a comparative assessment of central banks' communication strategies. The paper empirically compares the monetary policy stance and the intensity of central banks' communication about a broad set of macroeconomic variables.

Our analysis consists of three steps. First, we develop an automated text-mining routine to compute communication indicators in different fields. Second, for each central bank we estimate a period-specific Taylor rule and we assess to what extent central banks alternate between stable prices, output stabilization, financial and external stability in order to achieve the goals stated in their mandates. Third, we assess whether announcements made by senior executives are reflected in the policy decisions adopted by their respective central banks.

We find that overall communication on inflation and economic activity is in line with policy measures undertaken by central banks. With the exception of the RBA, we observe less consistency between words and policy actions for what concerns financial stability. These empirical results help deriving some insightful considerations about the relation between the conduct of monetary policy and central bank communication. While in some periods and in some macroeconomic fields the communication goes along with the policy-making, in some others our analysis points out some inconsistency between

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4   For an analysis on the effects of both quantitative and qualitative communication, see Hubert (2017).

communication and the conduct of monetary policy. This does not mean that the central bank does not do what it says. Our findings rather suggest that communication can be a complement or a substitute for monetary policy. In those periods in which communication is more efficient in managing expectations, central banks may have less need for reliance on the traditional policy rate (Friedman, 2008). Furthermore, central banks may resort more to communication as a policy tool in those periods in which the interest rate is at the zero lower bound (ZLB) and hence monetary policy is ineffective.

The paper is structured as follows. Section 2 describes the content analysis used to build our communication indexes and presents the methodology we adopt for our analysis. Section 3 discusses the results and section 4 summarises the main conclusions. Appendix A provides more details on data, while Appendix B provides further information on the mandates of the central banks in our sample.

2. Data and methodology

We estimate a standard linear period-specific Taylor rule responding to output gap, inflation, changes in the exchange rate and credit growth:[5]

$$r_t = c_t + (1 - \rho_t)\left[\alpha_{1t} E_t \pi_{t+4} + \alpha_{2t} ygap_t + \alpha_{3t}(s_t - s_{t-1}) + \alpha_{4t}(l_t - l_{t-1})\right] + \rho_t r_{t-1} + \varepsilon_t \qquad (1)$$

The specification in Eq. (1) allows for interest-smoothing of order one, captured by the time-varying parameter ρ_t, and assumes that in setting the policy interest rate, the central bank reacts to 1-year ahead inflation forecasts (π_{t+4}), the output gap ($ygap_t$), fluctuations in the exchange rate ($s_t - s_{t-1}$) and private credit-to-GDP expansion/contraction ($l_t - l_{t-1}$). The time-varying constant term, which depends on the steady-state level of the interest rate ($\bar{r}_t$), the level of trend inflation ($\bar{\pi}_t$) and the target level of the output gap ($\overline{ygap}_t$), is defined as:

$$c_t = (1 - \rho_t)(1 - \alpha_{1t})\bar{\pi}_t + \bar{r}_t + \alpha_{2t}\overline{ygap}_t \qquad (2)$$

We estimate the time-varying coefficient Taylor rules described in Eq. (1) for four countries: Australia, the euro area (15 countries), the United Kingdom and the United States.

For the estimation of the period-specific Taylor rule, we follow Coibion and Gorodnichenko (2011). To estimate the parameters of the Taylor rule we follow Boivin (2006) and assume that each of the parameters follows a random walk process. Using a Kalman filter and the corresponding smoother, we construct time series of the response coefficients of the Taylor rule and of the time-varying constant. To extract a measure of trend inflation from the time-varying constant, we make additional assumptions about the equilibrium real interest rate and the central bank's targets for the output gap. We follow Kozicki and Tinsley (2009) and we use the Hodrick-Prescott filter over each time period to approximate the equilibrium real interest rate and the target output gap. We extract a trend measure of each series,

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[5] For the sake of tractability, in the specification of the reaction function we neglect the presence of asymmetries and non-linearities. However, we acknowledge that in some periods the central bank' reaction function may be non-linear. Some authors have provided empirical evidence on the Fed's reaction function. Kim et al. (2005) find relatively strong evidence of non-linearity in the US monetary policy during the pre-Volcker era. Their results are consistent with recession aversion, in which policy-makers care more about decreases than increases in output. For the Volcker-Greenspan era, there is no evidence of non-linearities. Bec et al. (2002) test for the presence of asymmetries in the US monetary policy and explore the possibility that the Fed reaction function may depend on the state of the business cycle. They find that during expansions the Fed has responded to inflation more aggressively than during recessions.

which we then feed into the Taylor rule along with estimates of time-varying parameters, to extract our measure of trend inflation.

For the estimation, we use the following quarterly data over the period from the first quarter of 1997 to the first quarter of 2016 (the sample starts in 1999 for the euro area and in 2006 for the United Kingdom): the forecasts for the inflation rate, the output gap, the change in the real effective exchange rate, the growth of private credit (as GDP ratio) and communication intensity indices for four categories, namely monetary conditions, financial stability, external competitiveness and economic activity. Data sources and coverage for each country are summarized in Table A in Appendix A.

For each central bank, we select a list of keywords to quantify speech intensity on five different topics: monetary conditions, financial stability, external competitiveness, labour and social conditions[6] and economic activity. To compute communication indicators on each topic we propose an automated technique based on content analysis of the speeches collected by the BIS Central Bank hub. We build communication indices by programming two software routines in R: a web crawler and a text miner. These two routines enable us to create a large quarterly panel data set based on 3218 speeches: 321 for the RBA, 1434 for the ECB, 434 for the BoE and 1029 for the Fed.

As a first step, the web crawler, extracts detailed information of all speeches available at the BIS Central Bank hub, such as the speaker, the corresponding central bank, the date, etc. The extraction is achieved by analysing the HTML content of the BIS homepage and extracting texts stored under several HTML tags. The tabular presentation of the speeches on the BIS homepage is crucial to generate a complete table containing the above-mentioned information and the URLs of each speech's PDF file. After extracting this information, the web crawler automatically downloads and stores the speeches available at the BIS Central Bank hub.

As a second step, the text miner analyses the content of the speeches. The text miner prepares a corpus from the downloaded speeches that allows the text mining package to analyse the speeches. Prior to the analysis, the speeches stored in the corpus undergo several adjustments, such as conversion of capital letters to lower case letters, combining expressions into single words, etc., to simplify the output and allow for more comprehensive results. Subsequently, it text-mines the speeches, searching for a user-defined list of keywords which is reported in Table 1.

The relative intensity index on topic j in quarter t ($C_{j,t}$) is calculated as the number of words counted in the category j in quarter t ($N_{j,t}$) divided by the total number of words counted in quarter t (N_t): $C_{j,t} = \frac{N_{j,t}}{N_t}$.

Our automated routine to build the communication indices combines both the intensity and the topic of communication. In this respect, it represents a step forward compared to both techniques using only the number of speeches to measure the intensity of central bank communication (Lustenberger and Rossi, 2017), those relying on dummy variables to quantify communication (Ehrmann and Fratzscher, 2009; Ferrero and Secchi, 2009), as well as those non-automated techniques employing a manual counting of keywords (Allard et al., 2013).

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[6] For the time being, we do not use the communication index on labour and social conditions when we compare communication indicators and the Taylor rule coefficients.

The main advantage of using an automated technique is that it allows the researcher to extend the sample to include more recent data, other sources of communication or to extend it to other central banks. However, we acknowledge that an automated technique as ours is not able to capture the tone of central bank communication. Distinguishing between optimistic and pessimistic statements would improve the analysis, as it would allow us to assess whether communication have asymmetric effects.[7] A narrative approach would permit to pick up some nuances of statements, but at cost of less automation and more difficulties in the updating of the index.

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[7] In this vein, some papers analyse the tone (optimist or pessimistic) of central banks' statements. Among these studies, Hayo and Neuenkirch (2012) distinguish between news that point towards monetary policy tightening and monetary policy easing. Hansen and McHanon (2016) measure the tone of Fed communication with dictionary methods. Rosa (2011a) creates a three value scale where -1 refers to statements indicating monetary policy easing and +1 refers to monetary policy tightening. This approach is also used in Rosa (2011b) and Rosa (2011c). Balke and Petersen (2002) use a -2 to +2 scale to convert statements in the Fed's Beige Book to numerical values. According to their study, the Beige Book contains additional information about future economic activity. Finally, Tobback et al. (2017) propose a Hawkish-Dovish indicator that measures the degree of "hawkishness" or "dovishness" of the media's perception of the ECB's tone at each press conference. They compare two methods to calculate the indicator: semantic orientation and Support Vector Machines text classification. They show that the latter method tends to provide more stable and accurate measurements of perception on a labelled test set.

Table 1: Keywords used to build up communication indices

Communication index	List of relative keywords
Monetary conditions	"price stability, "inflation", "monetary aggregate", "monetary aggregates", "monetary base", "money base", "quantitative easing", "refinancing rate", "refinancing rates","m0", "m1", "m2", "m3", "interest rate", "interest rates", "policy rate", "policy rates", "asset price", "asset prices", "housing", "house price", "house prices", "commodities", "commodity", "commodity price", "commodity prices", "oil", "lending facility", "lending facilities", "deposit facility", "deposit facilities"
Financial stability	"financial cycle, "bank rate", "bank rates", "financial stability", "asset price", "asset prices", "housing", "house price", "house prices", "shadow bank", "shadow banks", "capital rule", "capital rules", "bank regulation", "bank regulations", "bailout", "bailouts", "bank bailout", "bank bailouts", "capital buffer", "Basel II", "Basel III", "regulatory spread", "credit risk", "credit risks", "bank risk", "bank risks", "default", "defaults", "lending", "lendings", "loans", "loan", "deposits", "deposit", "counter-cyclical", "feedback loop", "financial accelerator", "financial accelerators", "non-performing loans", "non-performing loan", "credit", "credits"
External competitiveness	"import, "export", "trade", "exchange rate", "exchange rates", "financial account", "financial accounts", "current account", "current accounts", "capital account", "capital accounts", "capital inflows", "capital inflow", "capital outflows", "capital outflow", "external debt", "external debts", "external deficit", "external deficits", "external surplus", "oil", "commodities", "commodity", "gold"
Economic growth	"national development plan", "national development plans", "output", "productivity", "output gap", "GDP", "investment", "investments", "priority sector", "priority sectors" ,"competitiveness"
Labour and social issues	"unemployment", "employed", "unemployed", "inactive", "participation", "labour force", "labor force", "labour market", "labor market", "labour markets", "labor markets", "labour demand", "labor demand", "labour supply", "labor supply", "labour cost", "labor cost", "workers", "worker", "wage", "wages", "payroll", "skill", "skills", "skilled", "training", "education", "apprenticeship", "active policies", "active policy", "almp", "safety net", "safety nets", "hiring", "hirings", "recruitment", "social security", "tax wedge", "shadow economy", "informal sector", "informality", "vacancies", "vacancy", "dismissal cost", "dismissal costs", "bargaining power", "labour union", "labor union", "labour unions", "labor unions", "temporary contracts", "temporary contract", "part-time", "vulnerable employment", "vacancy rates", "poverty", "inequality", "inequalities", "income distribution", "segregation", "health", "education", "social security", "pension", "pensions", "automatic stabilizer", "automatic stabilizers", "safety net", "safety nets", "financial inclusion", "financial literacy", "development", "developments", "school", "schools", "female", "females", "youth", "young", "women", "elder", "vulnerable", "vulnerables"

Figure 1 shows the relative intensity indexes, rescaled from 0 to 100, for each central bank. A cross-country comparisons provides some interesting insights. Overall, a common observation across the four central banks is that they have always communicated quite intensively on monetary policy and that they have increased communication on financial stability in the run-up of the financial crisis. However, some cross-country differences emerge, which may reflect central banks' policy priorities. The RBA has communicated on external development and growth more intensively than the other central banks. Conversely, the ECB has not given large emphasis to growth and external developments in official speeches. Since late 2007, the BoE has given more relevance to financial stability than other central banks, while the Fed has communicated on labour and social issues more intensively than other central banks.

Figure 1: Relative intensity communication indexes – cross-country comparison
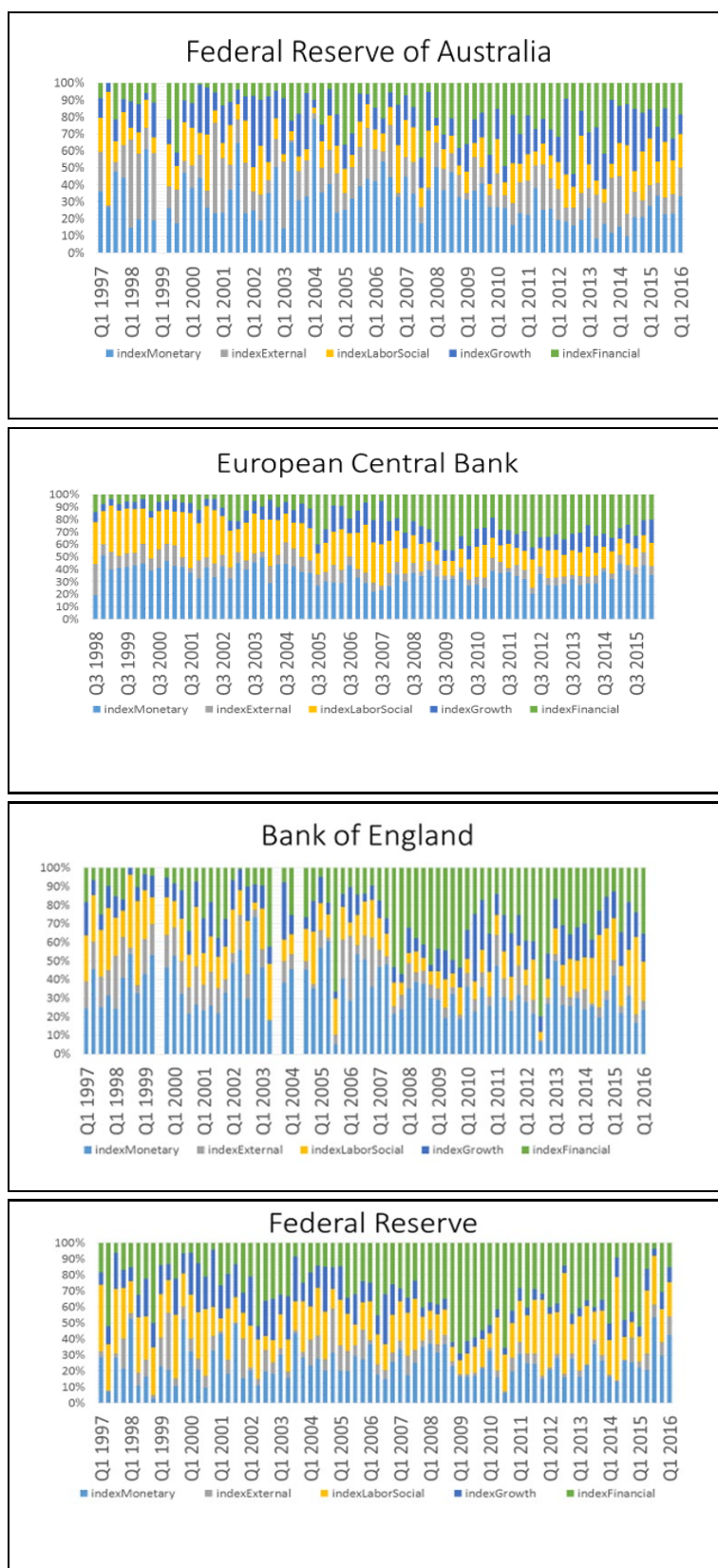
Source: BIS Central Bank hub and authors' calculations. The indexes are computed from 3218 speeches: 321 for the RBA, 1434 for the ECB, 434 for the BoE and 1029 for the Fed.

3. Results

We start estimating the period-specific Taylor rule described in Eq. (1). We compare each time-varying coefficient with the relative communication intensity index. More precisely, we compare the response to expected inflation with the monetary intensity communication index, the response to the output gap with the economic activity intensity communication index, the response to the exchange rate with the external development intensity communication index and the response to credit growth with the intensity communication financial stability index. The results for the estimated parameters, including the time-varying constant, are presented in in Figure 2-Figure 5 along with one standard deviation confidence intervals.

The Reserve Bank of Australia

Since 2004, the RBA's communication on monetary conditions and economic activity and policy reactions to respectively inflation and output gap have gone hand in hand. Between 2004 and the outbreak of the crisis, communication intensity has shifted from economic activity to monetary conditions. On the one hand, communication on monetary conditions has gradually intensified between 2004 and 2009 before stabilizing afterwards. On the other hand, RBA senior executives have communicated less intensively on economic activity between 2004 and 2009, but then – in the aftermath of the crisis – concerns on economic activity have regained attention. This is perfectly mirrored in the RBA's response to inflation and output gap.

The RBA's communication on financial stability has become more intense in the aftermath of the financial crisis, while it has been limited before the financial crisis except in the third quarter of 1999 and in early 2005. The increasing focus on financial stability during the global crisis is reflected in the stronger reaction to financial variables (i.e. credit growth) between 2007 and 2009. The greater emphasis on financial conditions is consistent with the RBA mandate stated in the *Reserve Bank Act 1959*. The RBA has had a longstanding responsibility for financial stability and the Act has long been interpreted to imply a mandate to pursue financial stability. This responsibility was reconfirmed in the context of the 1998 reforms to financial sector regulation in Australia and more recently was outlined in the September 2010 Statement on the Conduct of Monetary Policy.

Communication on external competitiveness has been very intense from early 1998 to early 2002, following the Asian crisis, which caused a significant drop in Australian exports, and the strong depreciation of the Australian Dollar from early 1997 to late 2001. It has slightly intensified after the first quarter of 2011, following the appreciation of Australian Dollar. The intensity of communication on external developments in periods of currency distress is in line with the RBA's mandate. However, overall the response to exchange rate fluctuations has been very mild.

The European Central Bank

Communication on monetary conditions has been very intense until mid-2005 but then scaled down during the financial crisis. Starting from mid-2014, communication on monetary conditions has regained intensity especially following the Quantitative Easing (QE) program announced in January 2015. The emphasis on monetary conditions and price stability is perfectly mirrored in its response to inflation forecasts.

Communication on economic activity has intensified between 1999 and 2007, whereas the policy reaction of the ECB to the output gap has remained constant since 2002. Despite the ECB not pursing a dual mandate, overall the reaction to output gap has never been negligible.[8]

As observed for other central banks, communication on financial conditions has become more intense during and in the aftermath of the crisis. Despite the more intense communication on financial stability, the ECB has not reacted to financial variables though its traditional policy tool. This "inconsistency" suggests that the ECB may have preferred to resort to policy tools other than the interest rate, such as macro-prudential tools or unconventional monetary policies, to address financial imbalances at their source.

Although the ECB has been less concerned about external competitiveness than about price stability, economic growth and financial stability, the intensity of the ECB's communication on external developments has been not negligible especially before the crisis. However, the reaction to exchange rate fluctuations has been negligible.

The Bank of England

The Bank of England's communication on financial stability has intensified and peaked during the financial crisis and in the third quarter of 2012 following the launching of the Funding for Lending Scheme in July 2012 and the Financial Services Act. In practice, however, and despite the intense communication, the policy rate of the Bank of England has not reacted to credit growth.

Communication on economic activity has been slightly less pronounced during the crisis. It has then increased in the aftermath of the crisis, in line with the announced support to real variable targets as long as price and financial stability holds (see Bank of England, 2013).

Interestingly, the Bank of England, in setting its policy rate, is highly concerned about output stabilisation, although it does not explicitly has a dual mandate. However, the reaction to output gap fluctuations has been stronger in 2006-2009 when communication on economic activity has not been particularly intense. This result suggests that communication and monetary policy may be substitutes. Central banks may rely less on the traditional policy rate when communication is efficient in managing expectations and /or when the policy rate hits the ZLB.

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[8] Some concerns have been risen on the ECB's practice of pretending that inflation is the only objective, while taking account of output variability in practice, as it would only "make for less-transparent policy and ensure that the central bank will have difficulty communicating the rationale for its policy actions." (See Remarks by Mr. Laurence H. Meyer, Member of the Board of Governors of the US Federal Reserve System, to the University of California at San Diego Economics Roundtable, San Diego, California, 17 July 2001).

Communication on monetary conditions has remained quite constant and hence it has become slightly less intense from 2012 onwards. This is reflected in the Bank of England's monetary policy reaction, which was very tight in 2006-2007 when energy prices led to high inflation pressures and then has been extremely mild since 2012.

Similarly, the policy reaction to exchange rate fluctuations has been strong between 2006 and 2007 and very mild afterwards. Since 2009, the Bank of England has preferred not to respond to exchange rate fluctuations, considering most of them as temporary shocks. The strong reaction to exchange rate fluctuations in 2006-2007 can be interpreted as an attempt to maintain competitiveness on external markets in a period characterized by high input costs, due to increasing oil prices, and the appreciation of the pound sterling against the US dollar.

The Federal Reserve

The Federal Reserve has a dual mandate of promoting stable inflation and maximum employment. Having control over only one instrument, the federal funds rate, the Fed's priorities continuously alternate between inflation and economic activity.

Communication on monetary conditions shows a stable trend, with peaks in the second quarter of 2000 (Dotcom bubble) and the third quarter of 2001 (September 11 attacks and policy rate drop) and since the third quarter of 2015 (policy rate reversal/increase).

The Fed, pursuing a dual mandate, has been concerned about economic growth. Between 1998 and 2007, the intensity of communication on economic activity has been as intense as communication on monetary conditions, with peaks in the last quarter of 2000 as a reaction to the dotcom bubble and job destructions between 2000 and 2004. More recently, communication on economic activity has showed a significant and persistent reduction since the first quarter of 2007. These concerns on economic activity are reflected in the Fed's reaction function. The response to the output gap has been relatively stronger between 1998 and 2001 before stabilizing between 2001 and 2007 and then slightly declining since early 2007. Our results point out a re-prioritisation from inflation stabilization to economic growth during the period 1998-2007, which is reflected both in a more intense communication and in a stronger policy response to output gap. This finding is consistent with some empirical works which estimate the Fed's reaction function. Among these studies, Lalonde and Parent (2006) find that the Fed's focus was mainly on inflation over the first 10 years of Greenspan's term as Fed chairman. Then, around 1998, having built up credibility over the first 10 years of the Greenspan era, the Fed has started focusing more on economic activity. In the same vein, Belongia and Ireland (2016) argue that between 2000 and 2007 the Fed has gradually shifted the emphasis away from stabilizing inflation and towards stabilizing output. They also argue that over this period the Fed has departed from rule-like behaviour and set the conditions for monetary disturbances.

The Fed's communication on financial conditions has intensified following some international events which had been perceived as sources of financial distress: in mid-1997 and end of 1998 following the Russian debt default in August 1998 (exacerbated by travails of the hedge fund Long Term Capital Management), in mid-2002 following the Argentinian Peso-crisis and between end of 2008 and end of 2010 following the Lehman default and the Eurozone crisis. However, these concerns on financial distress during the recent global crisis have not been reflected in the Fed's reaction to credit conditions, which has remained mild. As observed for the ECB, the Fed is likely to have preferred other instruments

than the interest rate to address financial imbalances. In addition, during the crisis, with interest rate at the ZLB, the Fed might not be in a position of using the policy rate to stabilize financial markets.[9]

Communication on external developments shows a downward trend, especially since 2005. Overall, except a mild reaction between 1997 and 2000, the Fed has never responded very strongly to exchange rate fluctuations.

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[9]   We have estimated the Taylor rule for the Fed using the shadow rate (see data computed by Leo Krippner https://www.rbnz.govt.nz/research-and-publications/research-programme/additional-research/measures-of-the-stance-of-united-states-monetary-policy/comparison-of-international-monetary-policy-measures)   to quantify the effects of Quantitative Easing (QE) and forward guidance. We observe a positive response of the shadow rate to credit conditions during the financial crisis, which point out that the Fed may have preferred to use QE and policy measures other than the federal funds to stabilize financial markets. Results are available upon request.

Figure 2: Time-varying Taylor rule coefficients and communication indexes - Australia
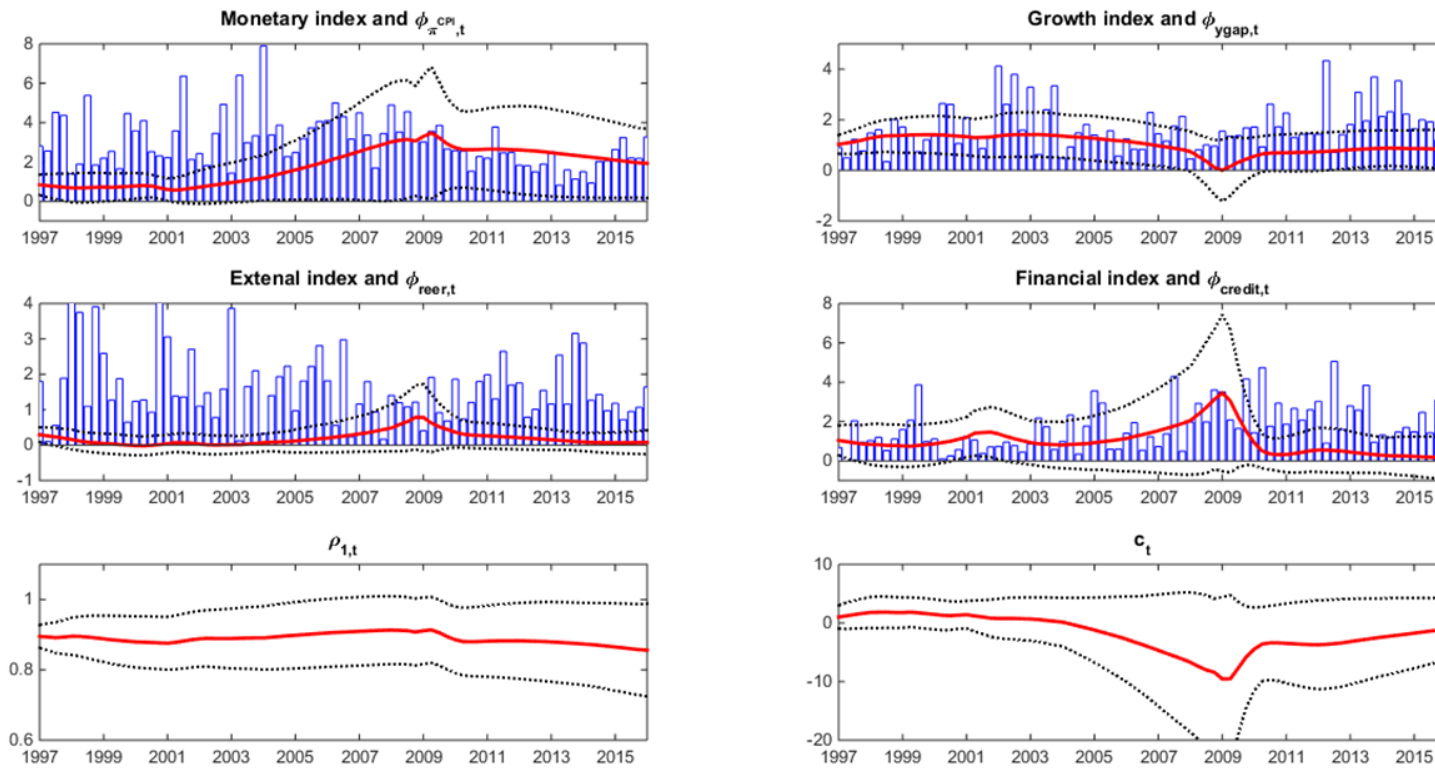
Note: The red lines represent the time-varying coefficients in the Taylor rule, estimated using the methodology proposed by Coibion and Gorodnichenko (2011), with confidence bands (dotted lines). The bars represent the communication indexes.

Figure 3: Time-varying Taylor rule coefficients and communication indexes - Euro area
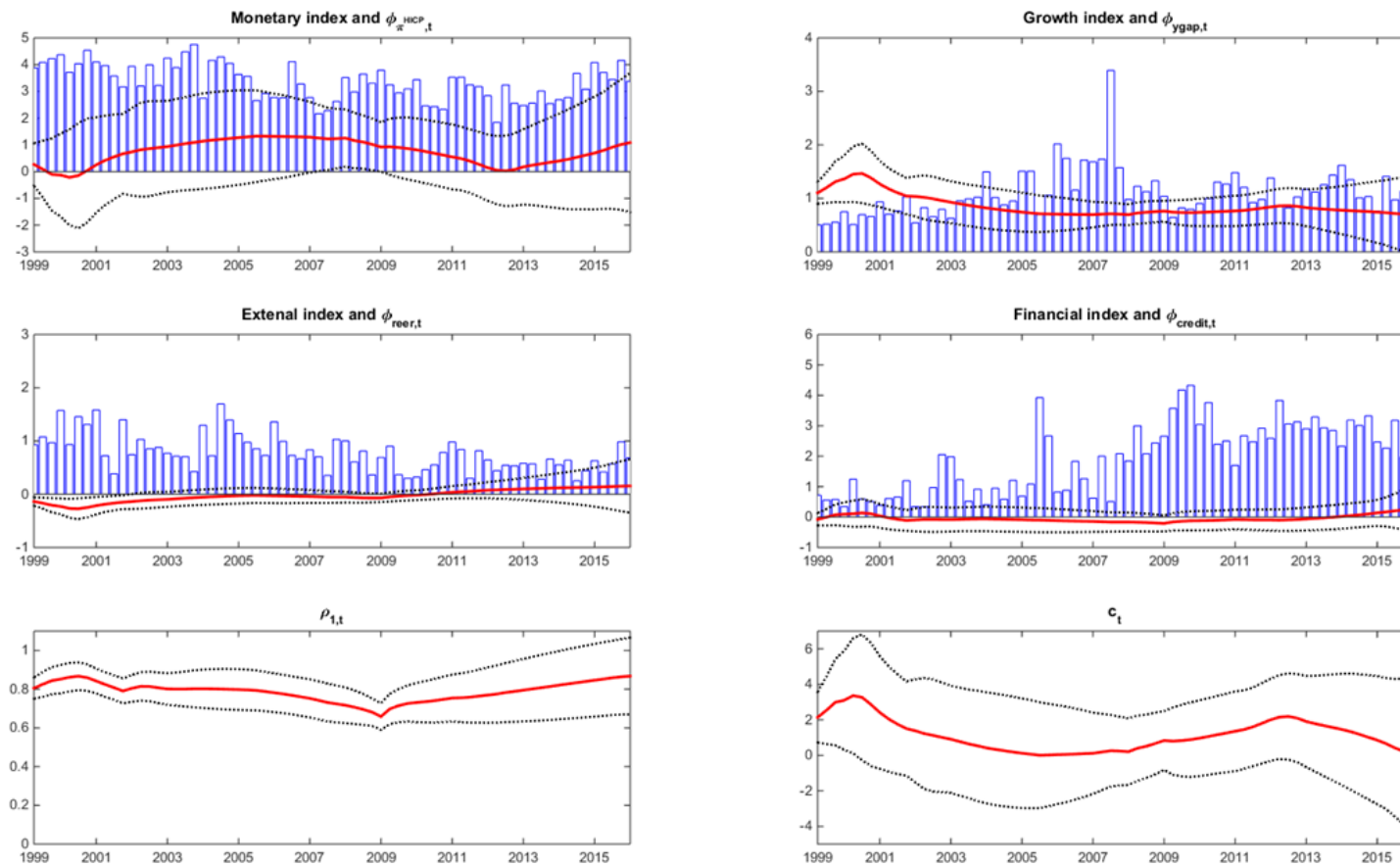
Note: The red lines represent the time-varying coefficients in the Taylor rule, estimated using the methodology proposed by Coibion and Gorodnichenko (2011), with confidence bands (dotted lines). The bars represent the communication indexes.

Figure 4: Time-varying Taylor rule coefficients and communication indexes - United Kingdom
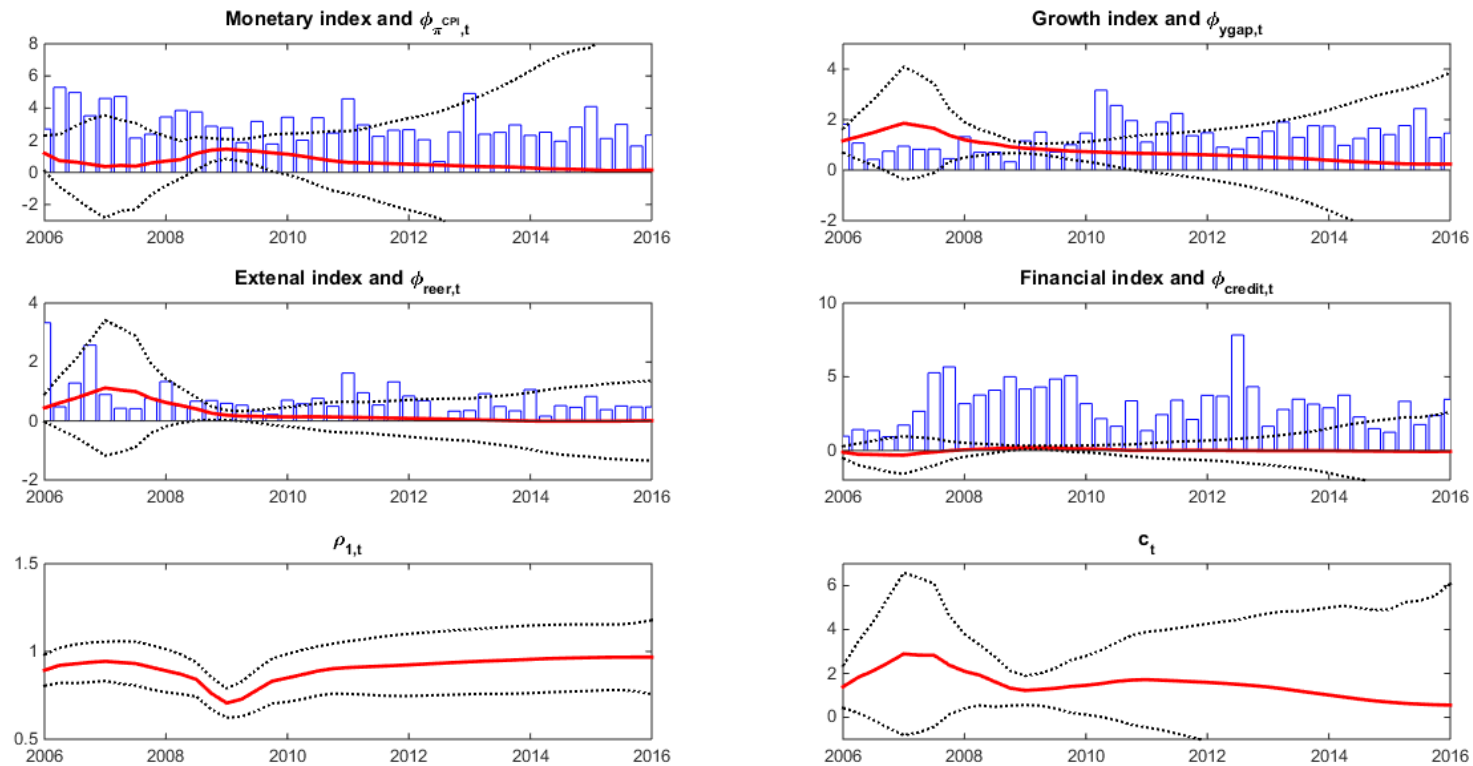

Note: The red lines represent the time-varying coefficients in the Taylor rule, estimated using the methodology proposed by Coibion and Gorodnichenko (2011), with confidence bands (dotted lines). The bars represent the communication indexes.

Figure 5: Time-varying Taylor rule coefficients and communication indexes - United States
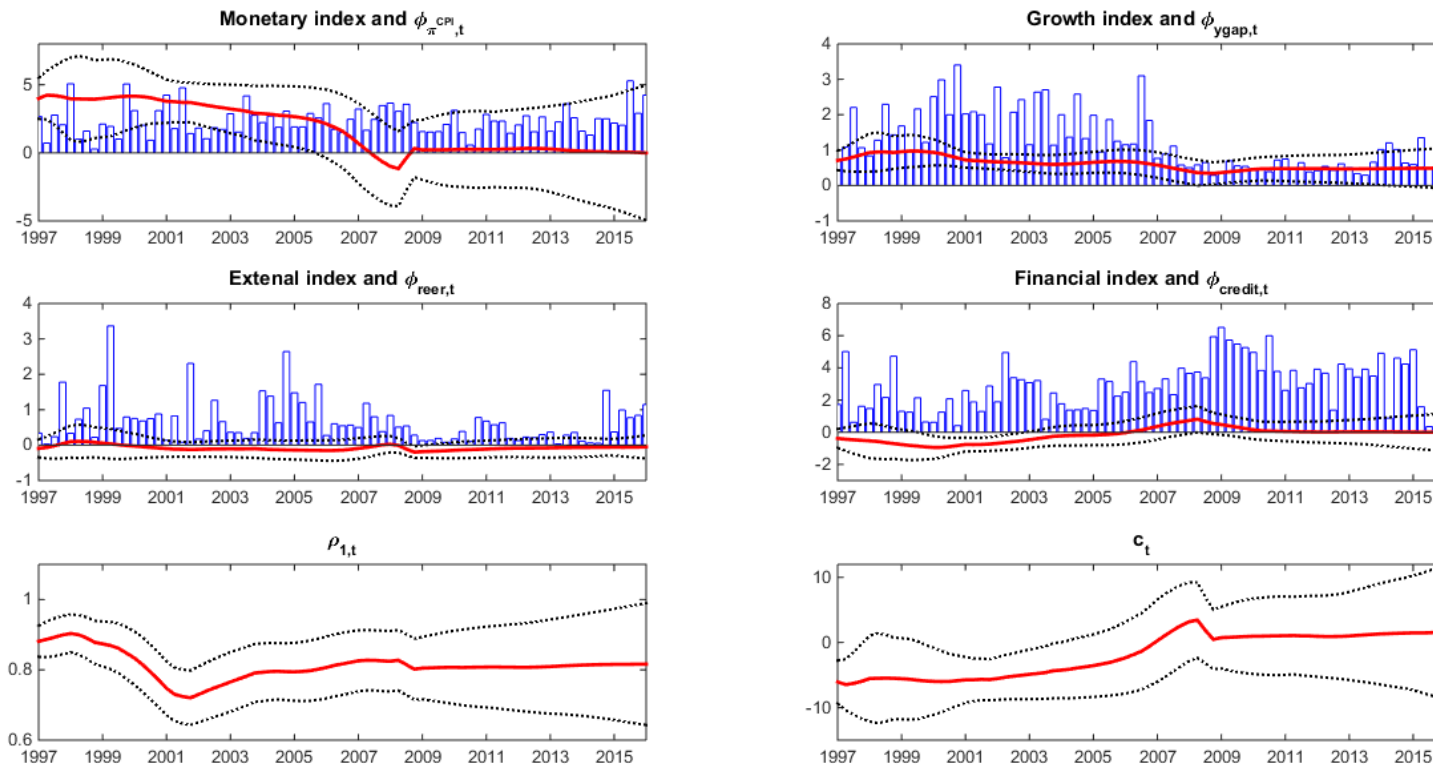

Note: The red lines represent the time-varying coefficients in the Taylor rule, estimated using the methodology proposed by Coibion and Gorodnichenko (2011), with confidence bands (dotted lines). The bars represent the communication indexes.

4. Conclusions and further extensions

The comparison across the selected central banks highlights some differences in the adopted strategies. Overall, some common trends emerge across the central banks in our sample.

On the one side, for the Fed, the ECB and the RBA we observe consistency between words and action concerning inflation and economic activity. A surprising result is that overall not only the Fed, having explicitly a dual mandate, has reacted to output gap fluctuations, but also the RBA, the BoE and the ECB.

This result seems to suggest that even those central banks that conduct monetary policy according to an inflation targeting regime, or whose public charge places clear primacy on maintaining a low inflation rate, nonetheless seek to achieve that objective at the least possible cost in terms of foregone output.

Regarding financial stability, all central banks have increased their communication on financial conditions during and in the aftermath of the financial crisis. However, only the RBA has translated words into action and reacted to credit expansion/restriction. There are several factors behind this result, which draw insightful considerations on the interactions between central banks' communication and mandates and the conduct of monetary policy. First, financial stability is somehow implicitly included in the RBA's mandate, but not in the other central banks' mandate. Second, the ECB, the Bank of England and the Fed may have preferred to resort to instruments other than the interest rate, such as macro-prudential tools or unconventional monetary policies, to address fiscal imbalances at their source.

Overall, the lack of consistency between the intensity of central banks' communication and the strength of monetary policy observed in some periods or in some fields can be interpreted as the attempt to use communication as a policy tool to affect market expectations. Central banks may use communication to substitute monetary policy interventions though the traditional policy tool, especially when the interest rate is at the ZLB or when communication is highly effective and hence less policy action is needed.

Although our analysis already provides insights on central bank communication strategy, there is still room for further extensions and applications. A further step forward would be distinguishing between optimist and pessimist statements to assess whether communication may have asymmetric effects and analysing the impact of communication on forecasting performance. In addition, as forecasting of labour market variables has so far received limited attention in the literature, focusing labour market forecasts would represent an insightful contribution to the literature. In this respect, our index of central bank communication on labour and social issues represent a useful step forward in this direction.

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Appendix A: Data Description

Table A: Data source and coverage

Variable	Source	Coverage
Inflation	Australia: Survey measure of union officials' inflation expectations; Median inflation for 1 year ahead; Year-ended (Source: Reserve Bank of Australia).	1997Q1-2016Q1
	Euro area: HICP inflation forecasts (1 year ahead). European Central Bank	1999Q1-2016Q1
	United Kingdom: Average of other forecasters' projections of CPI inflation (2 years ahead). Bank of England inflation report.	1997Q1-2016Q1
	United States: CPI inflation forecast (1 year ahead). Federal Reserve Bank of Philadelphia. Survey of professional forecasters.	1997Q1-2016Q1
Output gap	Australia: OECD Economic Outlook No 99 - June 2016	1997Q1-2016Q1
	Euro area: OECD Economic Outlook No 99- June 2016	1999Q1-2016Q1
	United Kingdom: OECD Economic Outlook No 99- June 2016	1998Q1-2016Q1
	United States: OECD Economic Outlook No 99- June 2016	1997Q1-2016Q1
Real effective exchange rate	Australia: OECD Economic Outlook No 99- June 2016	1997Q1-2016Q1
	Euro area: BIS	1997Q1-2016Q1
	United Kingdom: OECD Economic Outlook No 99- June 2016	1998Q1-2016Q1
	United States: OECD Economic Outlook No 99- June 2016	1997Q1-2016Q1
Private credit-to-GDP	Australia: BIS Total credit statistics	1997Q1-2016Q1
	Euro area: BIS Total credit statistics	1999Q1-2016Q1
	United Kingdom: BIS Total credit statistics	1998Q1-2016Q1
	United States: BIS Total credit statistics	1997Q1-2016Q1
Policy rate	Australia: Interbank Overnight Cash Rate. Reserve Bank of Australia	1997Q1-2016Q1
	Euro area: Euribor. European Central Bank	1999Q1-2016Q1
	United Kingdom: Official Bank Rate. Bank of England	1998Q1-2016Q1
	United States: Federal Funds Rate. FRED Economic Data, Federal Reserve Bank of St Louis.	1997Q1-2016Q1

Appendix B: Central Banks' mandates

A typical central bank's mandate can be classified in terms of two sets of alternatives: between a hierarchical or a dual mandate, on the one hand, and an implicit or explicit inflation objective, on the other hand. During the 1990s, a number of central banks adopted a framework that is called inflation targeting, combining a hierarchical mandate and an explicit inflation objective. The inflation target is sometimes set as a point and sometimes as a range. New Zealand in 1990 became the first country to establish a formal inflation-targeting regime. Canada followed in 1991, the United Kingdom in 1992, and Australia and Sweden in 1993. Subsequently, Finland and Spain adopted inflation targeting (before becoming members of the European Monetary Union) and in the last few years several developing countries have adopted this approach. Although the European Central Bank does not identify itself as an inflation-targeting regime, the Maastricht Treaty sets price stability as the ECB's primary objective and the ECB has set an explicit numerical target for inflation. The United States, in contrast, combines a dual mandate and an implicit inflation objective. Australia is a case of a dual mandate with an explicit inflation target.

The Reserve Bank of Australia

The specifics of the Reserve Bank of Australia's mandate rest on the provisions in section 10 of the *Reserve Bank Act 1959* requiring the Bank to "ensure that the monetary and banking policy of the Bank is directed to the greatest advantage of the people of Australia" and that its powers are "exercised in such a manner as, in the opinion of the Reserve Bank Board, will best contribute to: (a) the stability of the currency of Australia; (b) the maintenance of full employment in Australia; and (c) the economic prosperity and welfare of the people of Australia". To achieve these statutory objectives, the Bank has an inflation target and seeks to keep consumer price inflation in the economy to 2-3%, "on average, over the cycle". This definition of inflation targeting allows for the natural short-run variations in inflation and hence introduces a certain degree of flexibility.

The *Corporations Act 2001* includes as an objective "the reduction of systemic risk and the provision of fair and effective services by clearing and settlement facilities". To support this objective, the Act sets various obligations for providers of clearing and settlement facilities, and gives the Reserve Bank of Australia the power to set financial stability standards, and gives both the Reserve Bank of Australia and the Australian Securities & Investments Commission (ASIC) various powers relating to licensing, standard-setting and direction over a provider of such facilities.

Source: http://www.rba.gov.au/fin-stability/resources/2012-09-map-aus-fsf/mandates.html

European Central Bank

To maintain price stability is the primary objective of the Eurosystem in the context of a hierarchical mandate. This is laid down in the Treaty on the Functioning of the European Union, Article 127 (1). "Without prejudice to the objective of price stability", the Eurosystem shall also "support the general economic policies in the Union with a view to contributing to the achievement of the objectives of the Union". These include inter alia "full employment" and "balanced economic growth". The Treaty establishes a clear hierarchy of objectives for the Eurosystem. It assigns overriding importance to price stability. The Treaty makes clear that ensuring price stability is the most important contribution that monetary policy can make to achieve a favourable economic environment and a high level of employment.

The ECB's Governing Council sets the explicit numerical inflation target. This is currently set with an explicit ceiling of 2 % and an implicit lower bound of 0%. This is the case of a range rather than a point, with no preference stated for the midpoint.

Source: https://www.ecb.europa.eu/mopo/intro/objective/html/index.en.html

The Bank of England

Article 11 of the Bank of England Act sets the objectives for monetary policy as "to maintain price stability" and "subject to that, to support the economic policy of Her Majesty's Government, including its objectives for growth and employment." The explicit target, set by the Chancellor of the Exchequer (the equivalent of the Minister of Finance in many countries or the Secretary of the Treasury in the United States), is currently 2.5% and the target is for retail prices excluding mortgage interest payments.

The Bank's monetary policy objective, stated in Article 11 of the Bank of England Act, is to deliver price stability – low inflation – and, subject to that, to support the Government's economic objectives including those for growth and employment. Price stability is defined by the Government's inflation target of 2%. The remit recognises the role of price stability in achieving economic stability more generally, and in providing the right conditions for sustainable growth in output and employment. The Government's inflation target is announced each year by the Chancellor of the Exchequer in the annual Budget statement.

The 1998 Bank of England Act made the Bank independent to set interest rates. The Bank is accountable to parliament and the wider public. The legislation provides that if, in extreme circumstances, the national interest demands it, and Government has the power to give instructions to the Bank on interest rates for a limited period.

If the target is missed by more than 1 percentage point on either side – i.e. if the annual rate of CPI inflation is more than 3% or less than 1% – the Governor of the Bank must write an open letter to the Chancellor explaining the reasons why inflation has increased or fallen to such an extent and what the Bank proposes to do to ensure inflation comes back to the target.

A target of 2% does not mean that inflation will be held at this rate constantly. That would be neither possible nor desirable. Interest rates would be changing all the time, and by large amounts, causing unnecessary uncertainty and volatility in the economy. Even then it would not be possible to keep inflation at 2% in each and every month. Instead, the Monetary Policy Committee's aim is to set interest rates so that inflation can be brought back to target within a reasonable time period without creating undue instability in the economy.

Source: http://www.bankofengland.co.uk/monetarypolicy/Pages/framework/framework.aspx

The Fed

In 1977, Congress amended The Federal Reserve Act, stating the monetary policy objectives of the Federal Reserve as: "The Board of Governors of the Federal Reserve System and the Federal Open Market Committee shall maintain long-run growth of the monetary and credit aggregates commensurate with the economy's long run potential to increase production, so as to promote effectively the goals of maximum employment, stable prices and moderate long-term interest rates."

Source: https://www.chicagofed.org/publications/speeches/our-dual-mandate-background