Speaking in Tongues? Diagnosing the consistency of central banks' official communication

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Abstract

This paper first develops a theoretical framework allowing to examine the challenges for central banks' communication policies when confronted to international markets and to the cultural heterogeneity of agents receiving the signals they send. While the former is linked to the international use of the currency, the latter dimension can notably cover linguistic heterogeneity, different degrees of financial literacy of the receptors of the banks' communicated messages, or some distance from the bank's emitting position. The framework also embeds the cases of inflation targeting or non-inflation targeting central banks. The model is then confronted to the empirical diversity of the communication by major central banks, assessed through a textual analysis of central banks' official discourses. It is shown that central banks tend to adapt the consistency of their communication with regard to the context they face. The dimensions we highlight are thus important to forecast central bank's policy decisions.

Keywords: Central banks ; Communication ; Inflation Targeting ; Wordscores
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1 Introduction

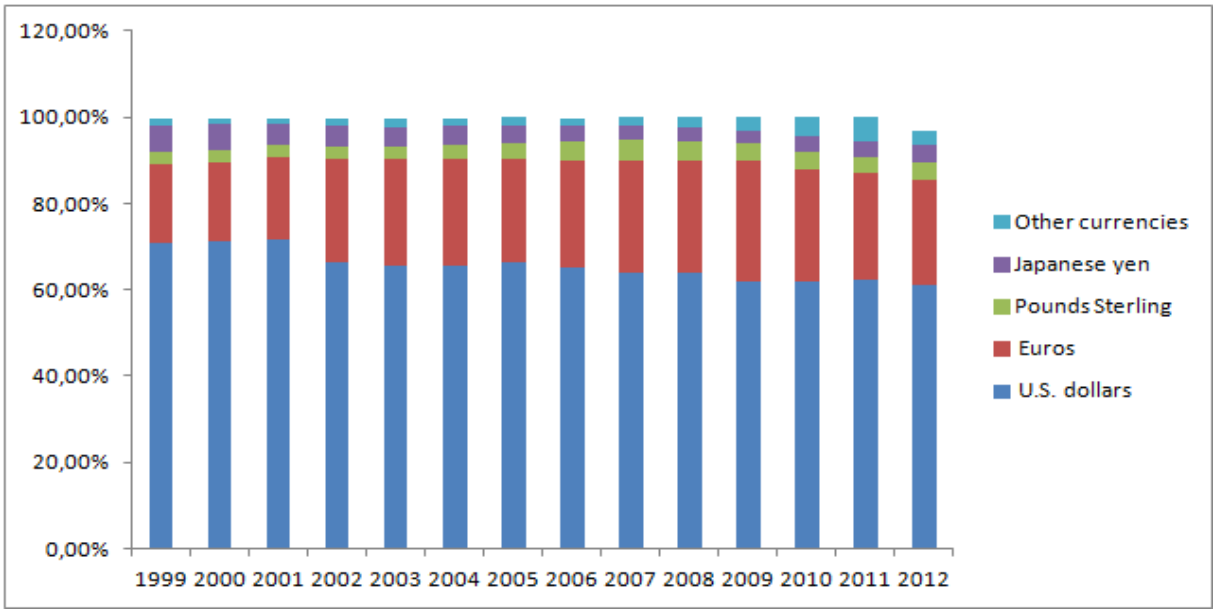
Over the last decades, central banks have introduced large changes in the conduct of their monetary policy. The move towards more central bank independence was followed by a request for greater transparency, and therefore, increased accountability. Communication policy has, thus, become an important instrument in the central banks' toolbox. An effective communication policy is more and more seen as a mean to enhance the consistency (i.e., clarity and, thus, the predictability) of monetary policy decisions, improve monetary policy's effectiveness and, in the end, meet the objective of price stability (see, e.g., Issing, 1999, Woodford, 2001 or Mishkin, 2004).

Clearly, the choice of a communication strategy by a central bank, and of the tools used to implement it, does not only depend on the framework adopted (among which, inflation targeting). It should also be adapted to the audiences that receive the signals sent by the central bank. However, these audiences can differ in several dimensions. The ones on which this paper focuses are, (i), the use of the domestic currency in the international markets (or, the relative importance of the international audience, compared to the national one) and, (ii), the cultural heterogeneity of the public (a feature which can be related, e.g., to the linguistic diversity, the degree of financial literacy of the audience, or a measure of the distance of an agent from the central bank's position - say, its headquarters).

The first dimension - that domestic currencies traded in other countries (i.e., "xenocurrencies") are more numerous and more traded today - has been described by, e.g., Thimann (2008), and is illustrated by the American dollar. The latter is a paragon of the situation, as at least half of the U.S. currency circulates abroad (Judson, 2012). But the dollar is not alone: since its inception, the euro has also internationalized, and rapidly so, reaching an important position in international financial flows (see, e.g., Gourinchas et al., 2012). Figures 1 and 2 illustrate the increasing importance of the euro, and the non-negligible share of other currencies, in the conduct of international trade and finance. As shown in Figure 1, in the 1999-2012 period, 80%-90% of official foreign exchange reserves were held in U.S. dollars or euros. The U.S. dollar and the euro are also heavily used as means of effecting payments in international trade. An indication of this is that dollars

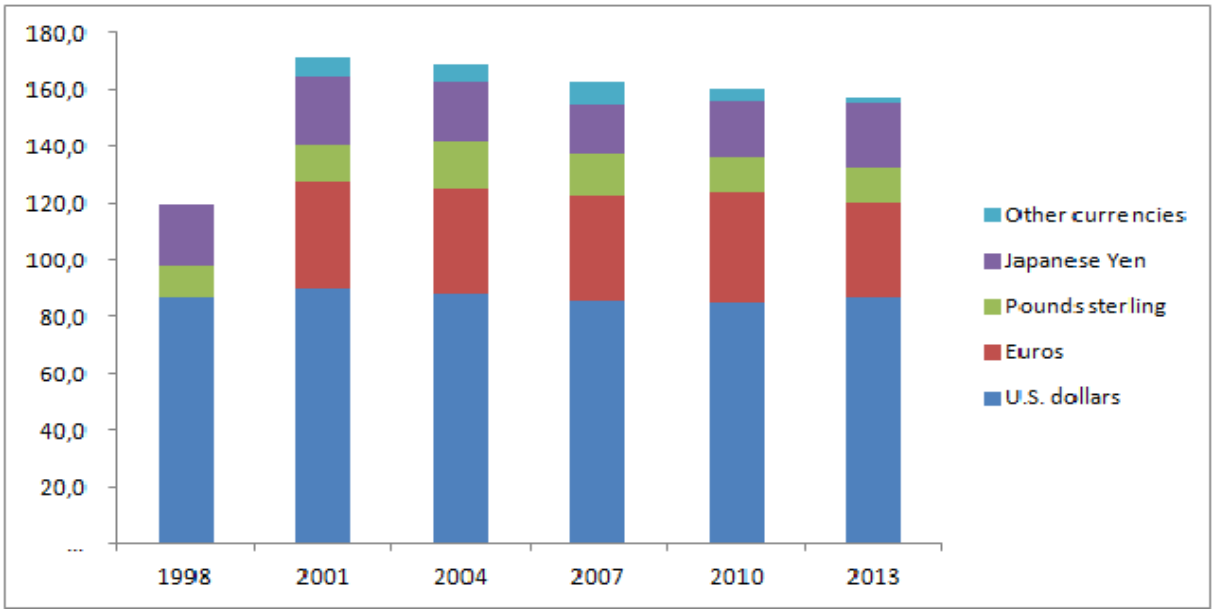
and euros passed hands in 60% to 70% of all transactions in foreign-exchange markets (Figure 2). The figures also reveal that, even though two currencies strongly dominate, the importance of international audiences is also a concern for other central banks, whose currency is also internationally exposed. In a word, central banks now have to expect their communications to impact not only their own residents, but also international actors (themselves potentially of different kinds: fund managers, insurers, exporters, tourists, etc.).

Figure 1: Currency Composition of Official Foreign Exchange Reserves



Source: IMF (2015)

Figure 2: Currency distribution of global foreign exchange market turnover



Note: As two currencies are involved in each transaction, the percentage shares of individual currencies sums to 200%.

Source : BIS (2013)

On the second dimension, the heterogeneity of the central banks' audiences, the literature has been relatively divided. On the theoretical side, the stress has been put on the reception of the messages sent by the central bank, and the implied degree of transparency of the central bank. In particular, Morris and Shin (2002), Cornand and Heinemann (2008), Demertzis and Viegi (2008), Hellwig and Veldkamp (2008), and Gizatulina (2013) have analyzed the optimal communication of central banks confronted with agents that receive noisy information and conflicting signals. The assumption of this strand of the literature, which we share, is that central banks are not able to affect similarly the expectations of all private-sector members at all times. Empirically, the focus, up to now, has essentially been on the degree(s) of financial literacy of the general public and the understanding (and, in the end, endorsement) of monetary policy (see, e.g., van der Cruijsen et al., 2011, or Carvalho and Nechio, 2014). But the heterogeneity also

characterizes professional policy forecasters, if only because of their distance to the central bank as an "informational hub" (Berger et al., 2009), or because of different priors (Berger et al., 2011).

Here, we develop a framework that allows to consider the two dimensions simultaneously, and analyze the implications of the heterogeneity of the "receivers" of the messages or signals sent by the central banks, both theoretically and empirically. We consider the two dimensions in the same model because the internationalization of the currencies itself brings a new twist to the issue, as the language agents speak in their everyday life may not be the same as the one used by the central bank that manages the currency they use or trade in. This may typically be the case in countries with a large population of immigrants (Canada, for example) or when the currency is used by agents with different cultural backgrounds and belongings (as in the euro area or in the US). One can thus expect that the communication policies of central banks that act in such a context have to be different than for the ones that interact with a more homogeneous population (as the Bank of Japan, for example).

However, to our knowledge, if the communication by central banks has been studied, the presence of an international audience in parallel to the national one, and the interaction with heterogeneous backgrounds (cultural and/or linguistic) have not been fully investigated. The case we make in this paper is that both dimensions have to be considered, as they do not systematically overlap or are not present to the same degree. More precisely, if, in some cases, the two dimensions are related, they are clearly distinct in other ones. For example, the international use of the dollar means that, in many parts of the world, the Federal Reserve communicates with agents that do not belong to her national audience, nor share her language. In this case, the two dimensions overlap. The euro area is a different case in point, as the euro "national" market does not coincidate with a - culturally and linguistically - homogeneous audience while, in parallel, the European Central Bank has to deal with the international role of the euro. Hence, the euro area is a case where the two dimensions are not superposed on each other. These two central banks thus provide two cases in a spectrum that can host the other central banks.

Our assumption is that a larger degree of internationalization and / or of heterogeneity

of the audience should induce the central bank to communicate in a more consistent way[1], to allow agents to "learn" her language, so that they can make similar expectations on the future stance of the policy rate. In other words, our argument is that the more diverse the audience, the more consistent (and thus, predictable) should the central bank's communication be.

The model we build on is Morris and Shin's (2002), which has become the workhorse model to study communication policies. We modify it to embed explicitly the different dimensions outlined above, to check how it should impact the consistency of central banks' communication policies. The model also includes, more standardly, the monetary policy framework chosen. As the adoption of an inflation target by many central banks in developed countries has contributed to dug the institutional differences between monetary institutions, it is now usual to compare the targeting institutions with the non-targeting ones. This dimension has been the most studied and, although a consensus still has to be established on the relative benefits of inflation targeting (see, e.g., Capistran and Ramos-Francia, 2009, Blattner et al., 2008, Mishkin and Schmidt-Hebbel, 2007), it has been shown that inflation targeters have a reinforced duty to anchor agents' expectations (Johnson, 2002; Levin et al., 2004; Vega and Winkelried, 2005; Gurkaynak et al., 2010). Communicating consistently is certainly crucial here, and the evidence that some non-targeting central banks appear to be more predictable than targeting ones (Willhelmsen and Zaghini, 2011) may be due to the fact that these central banks (among which no less than the European Central Bank and the Federal Reserve) have had to overcome the absence of an inflation target in their strategy by a better (i.e., more consistent) communication policy.

In our view, the existence and relative importance of the dimensions exposed here probably explain that Ehrmann and Fratzscher (2007) find a large variation in communication strategies across central banks and, more generally, that a consensus about an optimal communication strategy has not yet emerged, as Blinder et al. (2008) expose. This is probably only a revelator of the fact that central banks try to manage expectations in different ways because they have to, due to the different frameworks they have

[1]By being consistent, we mean that a central bank's communication policy uses a similar vocabulary through time.

adopted and to the relative importance of the different types of audiences they have to communicate to. In Table 1, we synthesize the dimensions that the communication policies of central banks have to take into account. As one can see, diversity rules, as no central bank is confronted with a comparable situation.

Table 1. Central banks' characterization

Central Bank	Currency internationalization	Inflation Target	Heterogeneity	
			Ethnic fractionalization	Linguistic fractionalization
European Central Bank	24%	NO	0.23	0.27
Federal Reserve	62%	NO	0.49	0.25
Bank of England	4%	YES	0.12	0.05
Bank of Japan	4%	NO	0.01	0.01
Bank of Canada	n/a	YES	0.71	0.57
Riksbank	n/a	YES	0.06	0.19
Norgesbank	n/a	YES	0.05	0.06

Source : authors, based on IMF (2015) and Alesina et al. (2003).

Of course, this has not forbidden the literature to test the effectiveness of central banks' transparency and, thus, their different means of communicating their policy stances. For instance, Carlson et al. (2006) show that the communication apparatus built by the FOMC has improved the public's ability to predict interest rate decisions. Hayo and Neuenkirch (2010) find that FOMC communications help predict target rate decisions, while Apel and Grimaldi (2012) observe that the sentiment and tone of Swedish central bank's minutes is useful in predicting future policy decisions. For the Norges Bank, Holmsen et al. (2008) show that the publication of its interest rate forecasts improves the financial markets participants' understanding of central bank's reaction. Transparency being a component of what may constitute an optimal communication strategy, the literature has also brought some results. For example, Walsh (2007) stresses that more-accurate central bank forecasts of demand shocks reduce the optimal degree of transparency, while more-accurate forecasts of cost shocks increase it. Also, van der Cruijsen et al. (2010) show that, beyond the optimal level of transparency, the accuracy of private sector expectations starts to worsen.

Our argument thus builds on these established facts and results. We contend that each central bank has to adapt and design the consistency of its communication policy

depending on the underlying environment it is confronted with: the presence of a multicultural factor, the pressures that it may undergo due to the internationalization of its currency, and the adoption (or not) of an inflation target. Each of these dimensions may induce the monetary authority to send more consistent messages to the audiences with which she has to communicate, to increase the influence of her communication by allowing her audience(s) to learn her own language. We thus confront the intuitions from the theoretical model to the actual communication of 7 central banks (representative of the different possible cases, as summarized in Table 1), using the official statements to assess the consistency of the guidance delivered by central banks. In other words, we examine whether these central banks' communication has remained consistent over time, in order to reduce the various discrepancies that may exist between different types of agents' expectations, and if the more exposed central banks (to the dimensions outlined above) have managed to be more consistent than their less exposed peers. We thus offer a diagnosis, comparing the theoretical optimal policy with the one actually used by these central banks.

The remainder of the paper is thus organized as follows: Section 2 introduces the theoretical model. Section 3 tests the empirical accuracy of the model with regard to central banks' communication consistency and presents the results, while section 4 concludes.

2 The Model

2.1 The central banks' objectives

We start with a standard framework, fundamentally based on Morris and Shin's (2002) referential model, so as to facilitate comparisons with previous works and to avoid relying on debatable assumptions. As such, we look at the discretionary case and consider that a central bank that does not adopt an inflation targeting framework receives the following instantaneous loss function:

$$L_t^{NT} = \frac{1}{2} E_t \left[(1+\lambda) y_t^2 + (\delta - \lambda) (\pi_t - \pi^*)^2 \right] \tag{1}$$

where π_t denotes the inflation rate at time t, π^* the inflation objective, E_t the ex-

pectations operator, y_t the output gap, and where uncertainty about the central bank's preferences is represented by the random variable λ. It is assumed that $\lambda \in [-1, \delta]$ and that $E(\lambda) = 0$; $E(\lambda^2) = \sigma_\lambda^2$. In other words, there is an informational asymmetry between the central bank and the general public about the weight of the arguments in the monetary authority's objective function, as in, e.g., Chortareas and Miller (2003) or Ciccarone and Marchetti (2012).

An inflation targeting central bank is assigned the following standard loss function:

$$L_t^{IT} = \frac{1}{2} E_t \left[(1+\lambda) y_t^2 + (\delta - \lambda) (\pi_t - \pi^*)^2 + h \left(\pi_t - \pi^T \right)^2 \right] \tag{2}$$

where π^T is the central bank's inflation target. The central bank, whatever the regime it has adopted, acts under the constraint of a standard Lucas-type supply function[2] and of a demand function:

$$y_t^s = \omega (\pi_t - \pi_t^e) - \varepsilon_t \tag{3}$$

$$y_t^d = -t (i_t - \pi_t) + \varsigma_t \tag{4}$$

where ω and t are two parameters.π_t^e denotes private sector expectations about the relevant state of inflation, i_t is the interest rate, and ε and ς designate, respectively, the supply and demand shocks, with zero mean and constant variance, σ_ε^2 and σ_ς^2. The model is thus, in this part, very canonical (see, e.g., Walsh, 2010).

Standard resolution by minimizing the loss function with regard to inflation delivers the average inflation rate under each policy framework:

$$\pi_t^{NT} = \frac{(\delta - \lambda)^2 \pi^* - \omega^2 (1+\lambda)^2 \varepsilon_t}{\omega^2 (1+\lambda)^2 + (\delta - \lambda)^2} + \frac{\omega^2 (1+\lambda)^2}{\zeta^{NT}} \pi_t^e \tag{5}$$

$$\pi_t^{IT} = \frac{(\delta - \lambda)^2 \pi^* - \omega^2 (1+\lambda)^2 \varepsilon_t + h^2 \pi^T}{\omega^2 (1+\lambda)^2 + (\delta - \lambda)^2 + h^2} + \frac{\omega^2 (1+\lambda)^2}{\zeta^{IT}} \pi_t^e \tag{6}$$

where $\zeta^{NT} = \omega^2 (1+\lambda)^2 + (\delta - \lambda)^2$ and $\zeta^{IT} = \omega^2 (1+\lambda)^2 + (\delta - \lambda)^2 + h^2$.

[2]Fendel and Rülke (2012) and Abott and Martinez (2008) provide empirical evidence on the Lucas supply function for developed economies, showing in particular that the inflation surprise positively correlates with the output gap.

It can be seen easily from the comparison of the two expressions that an inflation targeting regime reduces the risk of a drift of the inflation process the central bank has to control (as can be seen by comparing the coefficients associated with the expectation term in the two equations, and noting that $\frac{\omega^2(1+\lambda)^2}{\omega^2(1+\lambda)^2+(\delta-\lambda)^2+h^2} < \frac{\omega^2(1+\lambda)^2}{\omega^2(1+\lambda)^2+(\delta-\lambda)^2}$). This result, now standard (see Walsh, 2010), can however be mediated (and even reversed) by the uncertainty surrounding the central banks' preferences (δ). Inflation targeting is thus not necessarily a winning strategy in presence of uncertainty.

From what precedes, we can derive the associated expressions for the interest rate under each regime:

$$i_t^{NT} = t\pi_t^{NT} + t.i.p. = t\left\{\frac{(\delta-\lambda)^2\pi^* - \omega^2(1+\lambda)^2\varepsilon_t}{\omega^2(1+\lambda)^2+(\delta-\lambda)^2} + \frac{\omega^2(1+\lambda)^2}{\zeta^{NT}}\pi_t^e\right\} + t.i.p. \quad (7)$$

$$i_t^{T} = t\pi_t^{T} + t.i.p. = t\left\{\frac{(\delta-\lambda)^2\pi^* - \omega^2(1+\lambda)^2\varepsilon_t + h^2\pi^T}{\omega^2(1+\lambda)^2+(\delta-\lambda)^2+h^2} + \frac{\omega^2(1+\lambda)^2}{\zeta^{IT}}\pi_t^e\right\} + t.i.p. \quad (8)$$

where $t.i.p.$ indicates terms independent of policy. The above conclusion is of course unaffected.

2.2 Private agents' expectations

Adopting the point of view of any agent i, member of a continuum of agents spread over the unit interval [0,1], the agent has to chose an expectation of inflation, $\pi_{i,t}^e$, to maximize a Morris and Shin's (2002) type of utility function given by:

$$u_i\left(\pi_{i,t}^e, \pi_t\right) = -(1-r)\left(\pi_{i,t}^e - \pi_t\right)^2 - r\left(L_i - \bar{L}\right) \quad (9)$$

where π_t is the "fundamental" rate of inflation the agent has to expect and r is a constant, such that $0 < r < 1$ and

$$L_i \equiv \int_0^1 \left(\pi_{j,t}^e - \pi_{i,t}^e\right)^2 dj \;\; and \;\; \bar{L} \equiv \int_0^1 L_j dj$$

The first part of the utility function is a standard quadratic loss in the distance between the agent's expectation and the actual inflation rate, π_t. The second part is the beauty

contest element of the framework, which increases in the distance between each agent's action and the average action. The parameter r is the weight given to the beauty contest part (thus, a larger r corresponds to a greater consideration given to the externality related to the coordination motive of the population of agents). It has to be noted that, even though the (socially inefficient) externality disappears when one considers the aggregate population, there exists a conflict between individual decisions and the socially optimal solution.

The optimal expectations process for any agent is the first order condition:[3]

$$\pi^{e}_{i,t} = (1 - r)\, E_i(\pi_t) + r E_i(\bar{\pi^{e}_{t}}) \tag{10}$$

where π_t is the period inflation rate, and $\bar{\pi^{e}_{t}}$ the average expectations of the whole set of private agents living in the economy.

To inform their expectations, agents observe a public signal, p, related to inflation:

$$p_t = \pi_t + \eta_t \tag{11}$$

where η is normally distributed, with mean zero and variance σ^2_η. Given that the public signal is common knowledge, the best any agent can do is to second-guess what the others, the j agents, will anticipate. Hence, the expectation process can be rewritten as:

$$\pi^{e}_{i,t}(p) = (1 - r)\, E_i(\pi_t \mid p_t) + r \int_0^1 E(\bar{\pi^{e}_{j,t}} \mid p_t) d_j = p_t \tag{12}$$

In addition to the public signal, the agents will take into account a private signal, $s_{i,t}$. However, as stated in the introduction, given the evidence that agents differ in their degree of financial literacy, as well as the fact that some domestic users of a currency do not necessarily share the language used by the central bank, the information given by the central bank may not be interpreted in the same way by all agents. Thus, we consider that some agents have more precise private signals than others. Berger et al. (2009, 2011) make the case for the eurozone and the U.S. respectively while, e.g., Farvaque et al. (2013)

[3]This expression is the same as the one used in Morris and Shin (2002).

have shown that the European Central Bank (ECB) is confronted with differing degrees of trust depending on the country of residence. However, these observations can easily be generalized, as all the central banks that have to communicate with people of different origins[4], languages[5], backgrounds[6] or degree of financial literacy[7]. Hence, the audience of the central bank can be divided into two categories. On the one hand, a category of people that does not necessarily understand perfectly the language used by the central bank, as it generally makes use of another one in its everyday life, or is further from the central bank's information hub (Berger et al., 2009). This category is referred to by an o subscript, and represents a fraction ρ of the population. And, on the other hand, the "vernacular", regrouping the people that use (that is, understand perfectly) the idiom of the central bank, referred to by a v subscript, representing a fraction $(1-\rho)$ of the total population. Hence, a proportion $(1-\rho)$ of the population has a better handling of the information delivered by the central bank (i.e., the public signal), which translates in a smaller variance of the private signal processed by this share of the population. Formally, for the private signal, we have:

$$s_{o,t} = \pi_t + \kappa_{i,t}$$

$$s_{v,t} = \pi_t + \kappa'_{i,t}$$

with $\kappa_{i,t} \sim N(0; \sigma_\kappa^2)$ and $\kappa'_{i,t} \sim N(0; \frac{\sigma_\kappa^2}{\gamma})$.[8]

Considering agent i as a member of continuum of agents, the aggregate private signal is thus a weighted average of the private signals received by the two fractions of the central bank's audience and can then be written as follows:

$$s_{i,t} = \rho s_{o,t} + (1-\rho)\, s_{v,t} = \pi_t + \rho\kappa_{i,t} + (1-\rho)\,\kappa'_{i,t} \tag{13}$$

[4]Thinking of immigrants for example, one can consider the situation of Canada, where 20% of the population has a birthplace located out of the country.

[5]The European situation may come to one's mind, but the Fed has also to consider, for example, the situation of Puerto Rico.

[6]Backgrounds can be related to one's history (having known a situation of hyperinflation, for example), field of study, professional experience, etc. See Farvaque et al. (2013) for a discussion of these factors.

[7]On this dimension, see, e.g., Bucher-Koenen and Ziegelmeyer (2014) or Carvalho and Nechio (2014).

[8]See Cornand and Heinemann (2008) for a similar treatment of heterogeneity in a Morris and Shin (2002) framework.

The weight of the error term $\kappa_{i,t}$ in the aggregate private signal depends on ρ, the share of the audience that does not use a similar language as the central bank, and the weight of the error term $\kappa'_{i,t}$ depends on the share of the population that has a good understanding of the central bank's communication policy $(1-\rho)$. Hence, the more an audience is heterogeneous, the larger the weight of $\kappa_{i,t}$ in the expectation process, the less precise the agent's private signal.

Moreover, given the fact that some central banks have a wider scope in their communication process, if only because the currency they manage is more often used on international markets (see above and BIS, 2013), we include the possibility that central banks have to communicate to two types of agents. The first type is their "natural" destination, that is the people living in the currency area they manage, whose expectations process has been derived right up to here. The second type are the agents who use the currency they manage, if only for professional reasons (importers, exporters, fund managers, etc.), but do not live in the currency area (and for whom, as a consequence, their currency is not a "natural habitat").[9] This second type is considered here to rely more on information cascades or mimetic behavior (see Akerlof and Shiller, 2009) and, as a consequence, to discount further (or process worse, see Berger et al., 2009, 2011) the central bank's communication. This is introduced to take into account, for instance, that investors tend to fly back towards their "natural habitat" in times of crisis, or to herd, as has been seen regularly (see, for a recent illustration, Mobarek et al., 2014). Hence, in the continuum of agents in the economy, a fraction $(1-P)$ of them discounts the central banks' communication. We thus assume that agents $i \in [P, 1]$ will de facto rely more on their private signals than the others.

As in Morris and Shin (2002) or Cornand and Heinemann (2008), we know, from the first order condition (10), that the expected inflation by an agent that receives both types of signal is given by:

$$E\left(\pi_t \mid p_t, s_{i,t}\right) = \frac{\alpha p_t + \beta s_{i,t}}{\alpha + \beta}$$

where $\alpha = 1/\sigma_\eta^2$ and $\beta = \gamma/\left(\rho\gamma + (1-\rho)\right)\sigma_\kappa^2$ are the precision of the two information

[9] An immediate analogy is with the "domestic bias" often observed in international finance (see, e.g., Karlsson and Nordén, 2007).

sources, while the others' expectation, as the agent can guess them, is:

$$E\left(s_{j,t} \mid p_t, s_{i,t}\right) = E\left(\pi_t \mid p_t, s_{i,t}\right) = \frac{\alpha p_t + \beta s_{i,t}}{\alpha + \beta}$$

Thereby, as demonstrated by Cornand and Heinemann (2008), the optimal strategy of any agent is a linear strategy of the form:

$$\pi^e_{i,t} = \varphi s_{i,t} + (1 - \varphi)\, p_t \tag{14}$$

The optimal weight given to the private (versus the public) signal, φ, depends on an agent's expectations about the behaviour of the other agents. As the best response of any agent is unique, in equilibrium, all of them will select the same value for this parameter.

Given our assumption about the distribution of the agents along the continuum (i.e., the distinction of a part of the population that discounts more the central bank's communication), the conditional estimate of the average action across all agents is then given by the following:

$$E\left(\bar{\pi}^e_t\right) = P\left[\varphi E\left(s_{j,t} \mid p_t, s_{i,t}\right) + (1 - \varphi)\, E\left(p_t \mid p_t, s_{i,t}\right)\right]$$

$$+ (1 - P)\left[\tau E\left(s_{j,t} \mid p_t, s_{i,t}\right) + (1 - \tau)\, E\left(p_t \mid p_t, s_{i,t}\right)\right] \tag{15}$$

where we assume that $\tau \equiv \varphi + \epsilon > \varphi$, to represent the higher discount of the public signal by the second part of the population, which is "further" (in terms of, e.g., language, distance, or background) from the central bank than the other part.[10] Substituting with the expressions given above delivers:

$$E\left(\bar{\pi}^e_t\right) = \left[P\left(1 - \varphi\right) + (1 - P)\left(1 - \tau\right)\right] p_t + \left[P\varphi + (1 - P)\,\tau\right] \frac{\alpha p_t + \beta s_{i,t}}{\alpha + \beta}$$

As a consequence, for any resident agent i, the optimal expectation is of the form:

$$\pi^e_{i,t} = r E_i\left(\bar{\pi}^e_t \mid p_t, s_{i,t}\right) + (1 - r)\, E_i\left(\pi_t \mid p_t, s_{i,t}\right)$$

[10] As a consequence, ϵ is only a distance parameter and can not be considered as a control variable for the typical agent.

By successive simplifications, this delivers:

$$\begin{aligned}\pi_{i,t}^{e} &= p_t \frac{r\left[(2\alpha-1)+\beta\left[P\left(1-\varphi\right)+\left(1-P\right)\left(1-\tau\right)\right]\right]}{\alpha+\beta} \\ &+ s_{i,t}\frac{\beta\left(r\left[P\varphi+\left(1-P\right)\tau-1\right]+1\right)}{\alpha+\beta}\end{aligned} \tag{16}$$

Using $\tau = \varphi + \epsilon$, we get:

$$\begin{aligned}\pi_{i,t}^{e} &= p_t \frac{r\left[(2\alpha-1)+\beta\left[\left(1-\varphi\right)-\epsilon\left(1-P\right)\right]\right]}{\alpha+\beta} \\ &+ s_{i,t}\frac{\beta\left(r\left[\varphi+\epsilon\left(1-P\right)-1\right]+1\right)}{\alpha+\beta}\end{aligned} \tag{17}$$

Then, comparing the value of the coefficients in (14) and (17) and solving for φ, we get the equilibrium value of this parameter:[11]

$$\varphi^{*} = \frac{\beta\left(r\left[\left(1-P\right)\epsilon-1\right]+1\right)}{\alpha+\beta\left(1-r\right)}$$

Hence, an optimal expectation process by any agent i is equal to:

$$\begin{aligned}\pi_{i,t}^{e} = p_t \frac{r}{\alpha+\beta}\left\{(2\alpha-1)+\frac{\beta\left(\alpha-\left(\alpha+\beta\right)\epsilon\left(1-P\right)\right)}{\alpha+\beta\left(1-r\right)}\right\} \\ + s_{i,t}\frac{\beta}{\alpha+\beta}\left[\frac{r}{\alpha+\beta\left(1-r\right)}\left[\epsilon\left(1-P\right)\left(\alpha+\beta\right)-\alpha\right]+1\right]\end{aligned} \tag{18}$$

and the average optimal expectation, (15), can thus be obtained - by successive substitutions - and be written as:

$$\bar{\pi_t^e} = s_{i,t}\left(\varphi+\epsilon\left(1-P\right)\right)+p_t\left(\left(1-\varphi\right)-\epsilon\left(1-P\right)\right)$$

or:

$$\begin{aligned}\bar{\pi_t^e} &= s_{i,t}\beta\left\{\frac{\epsilon\left(1-P\right)\left(1+r\right)+\left(1-r\right)}{\alpha+\beta\left(1-r\right)}\right\} \\ &+ p_t\left\{\frac{\alpha-\left(\alpha+\beta\right)\epsilon\left(1-P\right)}{\alpha+\beta\left(1-r\right)}\right\}\end{aligned} \tag{19}$$

[11] And thus: $1-\varphi = \frac{\alpha+\beta[1+r(2+3P-\epsilon(1-P))]}{\alpha+\beta(1-r(1-2P))}$.

2.3 Central banks' communication impact on expectations

Inserting this expectation process in the central bank's control variable allows to analyze the impact of its communication, according to the chosen framework (π_t^{NT} and π_t^{IT}) and to the importance of the other factors we consider. Formally, combining equations (7), (8) and (19), we can write the interest rate the central bank has to manage as:

$$E_t\left(i_t^{NT}\right) = \frac{t\left(\delta-\lambda\right)^2\pi^*}{\omega^2\left(1+\lambda\right)^2+\left(\delta-\lambda\right)^2} + \frac{t\omega^2\left(1+\lambda\right)^2}{\zeta^{NT}}\bar{\pi_t^e} \tag{20}$$

$$E_t\left(i_t^{IT}\right) = \frac{t\left(\delta-\lambda\right)^2\pi^*+h^2\pi^T}{\omega^2\left(1+\lambda\right)^2+\left(\delta-\lambda\right)^2+h^2} + \frac{t\omega^2\left(1+\lambda\right)^2}{\zeta^{IT}}\bar{\pi_t^e} \tag{21}$$

These equations can be analyzed (through comparative statics) by differentiating with regard to our variables of interest. Doing so delivers the following results :

- First, as an inspection of ζ^{NT} and ζ^{IT} reveals, the impact of the expectation process ($\pi_{i,t}^e\left(p,s_i\right)$) on the interest rate is reduced in case of an inflation-targeting central bank. The adoption of an inflation target thus benefits the central bank by reducing any potential drift the expectation process could induce on the interest rate. As a consequence, inflation-targeting central banks could be allowed to communicate less consistently, relying instead on the anchor provided by the inflation target. However, the impact of the other features of the contexts in which central banks operate could offset this benefit, as the other results show.

- Second, with regard to the proportion of people that are not belonging to the currency area managed by the central bank, P, we have:

$$\frac{\partial E\left(i^f\right)}{\partial P} = (.)\left[s_{i,t}\frac{\beta\left(-\epsilon\left(1+r\right)\right)}{\alpha+\beta\left(1-r\right)} + p_t\frac{\left(\alpha+\beta\epsilon\right)}{\alpha+\beta\left(1-r\right)}\right]$$

  where $(.)$ is the coefficient attached to the expectation process in equations (20) and (21), conditionally on the framework adopted by the central bank (i.e., $f = IT, NT$). The first term of this expression is negative, while the second is positive. This reveals a positive influence of the proportion of "outsiders" (remember that non-residents agents represent a proportion $1-P$ of the population) on the average private signal and, by way of consequence, on the control the central bank has on

this part of the expectation process. However, this is offset, at least in part, by the influence of the parameter on the importance of the public signal, p_t. This combination should thus induce a central bank whose currency is internationally traded to have a more consistent communication policy, to reinforce the weight of the public signal with regard to the private one. This is confirmed by the influence of the distance parameter, ϵ, as we have: $\frac{\partial^2 E\left(i^f\right)}{\partial P \partial \epsilon} = (.)\left[s_{i,t}\frac{-\beta(1+r)}{\alpha+\beta(1-r)} + p_t\frac{\beta}{\alpha+\beta(1-r)}\right]$. The first term of this expression is negative, while the second is positive. However, it clearly appears that the (absolute value of the) first coefficient is larger than the second. In other words, the larger the distance with regard to the central bank's informational hub - to use Berger et al.'s (2009) expression -, the harder it will be for the central bank to avoid any drift in the private signal part of the interest rate process in presence of an heterogeneous audience. As a consequence, it is even more important that the communication of the central bank is consistent if it is confronted with a more internationalized use of its currency. Typically, as shown in Table 1, this case applies to the Fed and the ECB, and much less to the other central banks in the sample we study below. The latter two central banks should thus communicate more consistently, or try to communicate even more effectively than their peers, a result that will be tested empirically in the next section.

- Third, we look at the impact of the precision of the public signal, α. Here, we get:

$$\begin{aligned}\frac{\partial E\left(i^f\right)}{\partial \alpha} &= (.)\left[s_{i,t}\left(-\beta\frac{[(1-r)+(1+r)\,\epsilon\,(1-P)]}{\left[\alpha+\beta\,(1-r)\right]^2}\right)\right. \\ &+ \left. p_t\frac{(\beta\,(1-r)+r\epsilon\,(1-P))}{\left[\alpha+\beta\,(1-r)\right]^2}\right]\end{aligned}$$

The first term between brackets is negative, while the second one is positive. Hence, the higher the precision of the public signal, the larger the impact on the public signal itself (p_t), with the opposite effect on the private signal ($s_{i,t}$). This result is basically reminiscent of the ones obtained in the literature on the topic (e.g., Morris and Shin, 2002, Cornand and Heinemann, 2008, or, in an even closer set-up, Demertzis and Viegi, 2008) and, as such, acts as a check of the conformity and coherence of the model with regard to the literature on the topic. It also confirms that a more consistent communication may help private agents to coordinate, and

avoid the destabilizing effects of the specularity induced by the beauty contest part of the expectation process.[12]

- This is confirmed by the impact of the precision of the private signal, β. We have:

$$\begin{aligned}\frac{\partial E\left(i^f\right)}{\partial \beta} &= (.)\left[s_{i,t}\frac{\alpha\left[(1-r)+(1+r)\,\epsilon\,(1-P)\right]}{\left[\alpha+\beta\,(1-r)\right]^2}\right.\\ &+ \left.\frac{-\left(1-P\right)\epsilon\alpha r-\alpha\left(1-r\right)}{\left[\alpha+\beta\left(1-r\right)\right]^2}p_t\right]\end{aligned}$$

  where the signs of the terms between brackets are the opposite of the ones with regard to α, revealing symmetric impacts of the precision of the private signal. Better coordination could thus be favored by, for example, the use of a recurrent lexicon by the central bank, which the agents would get to learn, to build better forecasts of the policy moves.

- Completing this analysis with regard to the parameter measuring the heterogeneity of the currency circulating area, we get :

$$\frac{\partial E\left(i^f\right)}{\partial \rho}=\frac{\partial i}{\partial \beta}\frac{\partial \beta}{\partial \rho}=\frac{\partial i}{\partial \beta}\cdot\left[\frac{-\gamma\left(\gamma-1\right)\sigma_\kappa^2}{\left[\left(\rho\gamma+\left(1-\rho\right)\right)\sigma_\kappa^2\right]^2}\right]$$

  The last term of this expression is negative. As a consequence, the relative degree of cultural heterogeneity (and / or of financial illiteracy) has a negative impact on the influence the private signal ($s_{i,t}$) has on the expectation process, and a positive one on the impact of the public signal by being more predictable. This shows that, if this type of heterogeneity can threaten the efficacy of the central bank's policy, it can be fought by increasing the consistency of the communication, to improve the impact of the public signal. As a consequence, consistency in their communication will be all the more important for central banks confronted with more heterogeneous

[12] Looking at the interaction between the precision of the public signal and the heterogeneity of the central bank's audience, we get: $\frac{\partial^2 E\left(i^f\right)}{\partial\alpha\partial P}=(.)\left[s_{i,t}\frac{\beta\epsilon(1+r)}{\alpha[+\beta(1-r)]^2}+p_t\frac{\epsilon\left[\alpha\beta+\beta^2(1-r)-\alpha-\beta\right]}{[\alpha+\beta(1-r)]^2}\right]$. If the first term is obviously positive, the second will be only if the following condition is met: $(1-r)>\frac{\alpha(1-\beta)+\beta}{\beta^2}$. If this condition is fulfilled, then the impact of the precision of the public signal and of a larger part of residents will be positive.

contexts, be they linked to the spread of a currency over a large territory (as in the European monetary union) or to differences in financial literacy.[13]

- Finally, we compute the second derivative of the impact of the precision of the public signal ($\frac{\partial E\left(i^f\right)}{\partial \alpha}$), with regard to ρ, the share of the audience that does not use a similar language as the central bank, $\frac{\partial^2 E\left(i^f\right)}{\partial \alpha \partial \rho}$.[14] Knowing that $\frac{\partial \beta}{\partial \rho} = \frac{\gamma}{\sigma_\kappa^2} \cdot \frac{1-\gamma}{(\rho\gamma+(1-\rho))^2} > 0$, we have:

$$\begin{aligned}\frac{\partial^2 E\left(i^f\right)}{\partial \alpha \partial \rho} &= (.)\left[s_{i,t}\left(-1\right)\left[\left(1-r\right)+\left(1+r\right)\epsilon\left(1-P\right)\right]\cdot\frac{\left[\left[\alpha+\beta\left(1-r\right)\right]^2-2\left(\alpha+\beta\left(1-r\right)\right)\left(1-r\right)\right]}{\left(\alpha+\beta\left(1-r\right)\right)^4}\cdot\frac{\partial\beta}{\partial\rho}\right.\\ &+ \left. p_t\cdot\frac{\partial\beta}{\partial\rho}\cdot\frac{\left[\left(1-r\right)\left[\alpha+\beta\left(1-r\right)\right]^2-2\left(\alpha+\beta\left(1-r\right)\right)\left(1-r\right)\left(\beta\left(1-r\right)+r\left(1-P\right)\epsilon\right)\right]}{\left(\alpha+\beta\left(1-r\right)\right)^4}\right]\end{aligned}$$

This expression is negative, if the following condition is verified: $\frac{r}{1-r} > \frac{1-\beta}{\epsilon(1-P)}$. Under this condition, the share of agents that do not use the same language positively impacts the precision of the public signal. If the condition is not met, that is, for example, if the value of the beauty contest is quite large, the contention that more heterogenous currency areas should induce their central banks to communicate more is even truer.

To sum up, more internationalized currencies should induce central banks to communicate more. This is also the case for central banks facing more heterogenous (or less literate) audiences. At least, they should try to communicate more effectively than their peers who are less confronted with these features. Importantly too, our framework reveals that inflation targeting does not systematically act as a one-stop shopping solution, as its potential benefits may be offset (at least, partially) by the other dimensions we consider here. We now turn to check if the evidence does confirm the theoretical results.

[13] A side result of our framework is thus that in countries with lower degrees of education, as a proxy to financial literacy, the central bank should increase and sharpen their communication. The framework has thus also some relevance for emerging and developing countries, although our empirical analysis below does not include central banks from these categories of countries.

[14] Remember that P is the proportion of residents, which does not necesarily imply the use of the same language, as stated above.

3 Assessing the consistency of central banks' communication

As revealed by the theoretical framework, the internationalization of a currency and the presence of a cultural/linguistic heterogeneity in a monetary union require a consistent communication policy by central banks, whether they have adopted an inflation targeting regime or no. Therefore, though all central banks have to disseminate public information in a consistent way, the pressure is even stronger if they manage a "xeno-currency", or work in a multi-cultural environment. Hence, our aim now is to examine whether central banks' communication has remained consistent over time, in order to reduce the various discrepancies that may exist between agents' expectations, and if the more exposed central banks have managed to be even more consistent than their less exposed peers. The main assumption underlying this procedure is that central banks with a consistent communication policy can be considered as being more predictable than their peers with a less consistent communication policy, given that they use a similar lexicon through time to describe their policy decisions, the evolution of economic aggregates, and the future stance of their policy rates.

3.1 The method and the data

In order to test for central banks' communication consistency, and thus predictability, we focus on a central instrument that they use to communicate, their "Monthly Bulletin" (or its equivalent) and apply the Wordscores methodology to these texts. Introduced by Laver et al. (2003), this technique, which relies on computerized content analysis, compares the patterns of words used in a set of "reference texts" (i.e., with known policy positions) with words contained in a series of "virgin texts", to estimate their respective policy positions. Words are then treated as data (Krippendorff, 2004)[15] and the assumption is that the relative frequencies of the use of specific words provide information on future monetary decisions. However, the meaning of a specific word often depends on

[15]According to Laver et al. (2003): ¨this method treats the texts not as discourses to be read, understood and interpreted for meaning, but as collections of word data containing information about the position of the texts' authors on predefined policy statements¨.

the context in which it is used. For instance, while the word "growth" appears to be a positive signal, the phrase "slow growth" does not. Therefore, we here rely on two-word combinations of a noun and an adjective in this analysis, such as "lower inflation" or "higher unemployment".

The reliability of the Wordscores approach is enhanced by removing the human factor from the coding process[16]. Empirical studies have mainly used a hand-coding approach to code central banks' communication (from hawkish to dovish for instance), such as Musard-Gies (2006), Gerlach (2007), Heinemann and Ullrich (2007), Rosa and Verga (2008), and Jansen and de Haan (2009). However, a drawback of this approach is its subjectivity, i.e., researchers base their coding on different communication devices or may interpret the same information differently, thereby rendering their results inaccurate in the context of our study. The Wordscores approach differs notably from these (otherwise comparable) methods in that it does not use predefined coding dictionaries as in Bligh and Hess (2010), nor subjective judgments by human coders as in Bulir et al. (2010). Therefore, it is the most adequate textual-analysis approach that allows to check if agents from different locations, and/or with a different cultural and linguistic background, will be able to engineer a similar expectational process about the future stance of the monetary policy, relying on the same public signal.

The method we use requires estimates of the positions of the references texts by using a tightening/easing classification. Given that we are interested in the consistency (predictability) of central banks' statements, we rely on central banks' next policy decision following the public signal to code the reference texts on the policy dimension. For instance, as the ECB increased its main refinancing rate to 0.25 basis point in December 2005, the statement (public signal) of the ECB on November 2005 is then coded +0.25. Wordscores then provides estimates of the "score" of a two-word combination, based on its relative frequency in the set of reference texts where the combination was followed by a tightening/easing monetary policy. These estimates will then serve as the basis (reference) for estimating policy stances in the set of virgin texts.

[16]Practically, Wordscores can be implemented using a command line version for Stata. See http://www.tcd.ie/Political_Science/wordscores/ for more details on the method.

More precisely, the Wordscores methodology is defined as follows (Laver et al., 2003):

$$Probability_{w,r} = \frac{Frequency_{w,r}}{\sum_r Frequency_{w,r}} \tag{22}$$

$$Wordscore_w = \sum_r Probability_{w,r}.Value_r \tag{23}$$

where w denotes a two-word combination in the set of reference texts, denoted by r, and $Value_r$ denotes the assigned value of the reference text. For instance, assume that the two-word combination "high vigilance" appears 10 times in the set of reference texts as followed by a tightening policy[17] and twice in by an easing policy[18]. Then, the probability of "high vigilance" followed by tightening in the set of reference texts (i.e., $Probability_{(w:high\ vigilance, r:tightening)}$) will be 0.84 ($= \frac{10}{10+2}$), while the probability of "high vigilance" followed by easing (i.e., $Probability_{(w:high\ vigilance, r:easing)}$) will be 0.16 ($= \frac{2}{10+2}$). Using these probabilities, the wordscore of "high vigilance" is:

$$\begin{aligned} Wordscore_{(w:high\ vigilance)} &= Probability_{(w:high\ vigilance, r:easing)}.Value_{(r:easing)} \\ &+ Probability_{(w:high\ vigilance, r:tightening)}.Value_{(r:tightening)} \\ &= 0.16.(-0.25) + 0.84.(0.5) = 0.38 \end{aligned}$$

Therefore, if a virgin text contains the combination "high vigilance", Wordscores assumes that it contributes 0.38 to the virgin text's estimation policy. Point estimates on the policy dimension are generated for virgin texts, being computed as the mean of the scores of the combinations, weighted by their relative frequencies within these texts. This procedure also computes confidence intervals, delivering a measure of the uncertainty associated with each position score. In a nutshell, this technique matches virgin texts probabilistically, given their patterns of words usage, to reference texts with known policy positions. Hence, we analyze the central bank's communication consistency by measuring the ability of different agents to predict the future direction of the policy rate at time *t+1,* following the words contained in the statement at time t[19]. The procedure thus

[17] denoted with a hypothetical value of +0.5.

[18] denoted with a hypothetical value of -0.25.

[19] As an illustration, Wordscores computes the policy decision of the ECB in February 2006 by analyzing the words contained in the ECB's statement of January 2006.

provides a measure of the consistency (predictability) of central banks' communication policy.

Finally, it is crucial for the validity of this approach to select the appropriate reference texts. They should provide enough information on the different policies dimensions for which one would like to evaluate where the virgin texts lie. Therefore, the reference texts should be used in the same context as the virgin ones, i.e., Wordscores requires similarity between the set of reference texts and the set of virgin texts. Central banks' communication from the 1999-2005 period are considered here as the reference texts, given that there has been enough variations in terms of the number of policy (and notably, policy rates) changes, the direction of changes, and changes in the central banks' vocabulary as well. This allows to acknowledge the flexibility (or adaptation) central banks use in the way they communicate their policy decisions, given that their constraints, objectives and priorities may evolve over time. Two cases in point are the clarification by the ECB, in May 2003, of its monetary policy strategy, discussing the importance of the role of money in its policy (Berger et al., 2011), and the discussion of the quarterly macroeconomic projections made by the Eurosystem staff since June 2004. These have led the ECB to use new words to describe its monetary policy decisions (Jansen and de Haan, 2013). Therefore, central banks' communication from 1999 until 2005 contain enough information about policies dimensions, and are used to estimate the policy positions of the virgin texts from 2006 onwards.

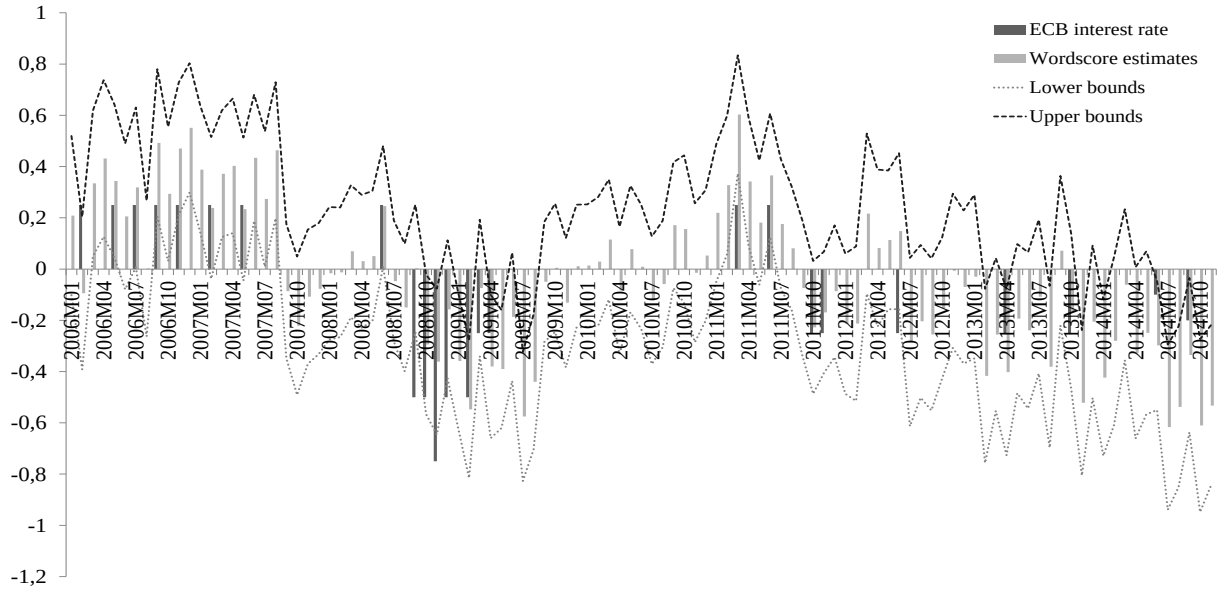
3.2 The ECB as an illustrative case

Given that the ECB faces an heterogeneous audience and manages a currency that is relatively internationalized, we consider it as a typical case for exposing the Wordscores methodology.

The ECB uses various instruments to communicate with different target groups. We here consider that the editorial of the *Monthly Bulletin* is a relevant source of information for central bank watchers if not a one-stop-shopping piece of information, if only for the easy access agents can have to it (Gerlach, 2007). The editorials contain an explanation of why interest rates were changed (or not), plus a summary statement of the Governing

Council's view of the economy, hence, self-containing the information released by the President's introductory statements. The editorials of the *Monthly Bulletin* of the ECB from the period 1999 to 2005 form the set of reference texts, while the posterior ones form the set of virgin texts. Figure 3 provides a comparison between the estimated policy positions of virgin texts obtained through the Wordscores methodology with the actual policy decisions of the ECB.

Figure 3. Results of the Wordscores approach for the period 2006-2014, ECB



The dark bars show the Wordscores simulation results for the virgin texts, i.e., the policy dimension of the introductory statements between January 2006 to October 2014[20] and the grey bars show the change of the main refinancing rate of the ECB. The figure also shows the 95% confidence interval around the scores. The bars indicate the timing and direction of changes of both the ECB's rate and the Wordscores simulation. The ECB's key interest rate and the Wordscores simulation have remarkably similar evolutions. There has been a persistent increase of the ECB's rate from the beginning of 2006

[20]It is worth reminding that the estimated policy position for October 2014 is obtained by analyzing the words of the editorial of September 2014.

until mid 2007, followed by a downward trend from mid 2008 until the beginning of 2009. The Wordscores simulated rate accurately reproduces these movements, only relying on the words contained in the editorials of the *Monthly Bulletin*. After this period, and until mid 2011, the rate did not vary and the Wordscores policy estimation is also lying around 0. Finally, the increase and decrease of the ECB's rate in the beginning and the end of 2011, respectively, are properly predicted as well.

Therefore, the analysis reveals that the ECB's communication has remained quite consistent, using a constant vocabulary to send signals related to its policy decisions. Given that the ECB acts in a context marked by the strong internationalization of the euro and by a relatively large degree of cultural/linguistic heterogeneity (cf. Table 1), such a constancy can only help different agents to predict more accurately, and similarly the direction of the future path of its policy rate, as was expected from our theoretical framework.

Interestingly, as can be seen in Figure 3, the Wordscores methodology does not preclude forecasts of relatively strong variations, nor of negative policy rates. This lies in contrast to the need for central banks to smooth interest rates changes, if only to to prevent troubles in financial markets (Woodford, 2003) and to their consideration of a Zero Lower Bound for their policy rate. The relative discrepancy between these features and the forecasts obtained from Wordscores does not mean that the latter is "wrong" but, on the contrary, reveals that the messages conveyed by the ECB can sometimes be hard to interpret and / or that they are not always followed by the appropriate (i.e., expectable) deeds[21,22]. This is all the more troubling given that this bank is confronted with a multicultural audience, and should be all the more attentive to communicate clearly, as the above framework has revealed.

Figure 4 delivers another view of the results, displaying the cumulative Wordscores value (i.e., the sum of all previous values of the Wordscores estimations and of the current value.), the behavior of the ECB's policy rate, and the moves of the long-term interest rate

[21]Given that agents are aware of the policy constraints faced by the central banks, the Wordscores methodology remains a relevant approach to predict the directions of future changes in the policy rate.

[22]Interestingly, this observation occurs for the KOF monetary policy communicator as well, which predicts larger variations of the key interest rate, but is still broadly in line with the qualitative evolution of the MRR. See http://www.kof.ethz.ch/en/indicators/monetary-policy-communicator/.

from 2008 to 2014. The latter is introduced because the ECB and other central banks have been confronted to the Zero Lower Bound of interest rates in the last part of the period we cover, and it has been shown that long-term rates are more informative in such a context (Wu and Xia, 2014). Clearly, the time courses of the Wordscores estimates and the ECB's policy rate are closely related from 2006 to the end of 2007 while, from 2008 on, it is the long term interest rate that moves closer with the Wordscores estimates, showing the qualitatively good forecasts obtained with the Wordscores methodology and the reliance of the ECB on unconventional measures to reduce longer maturities. Interestingly, the correlation grows over time, revealing the increased consistency of ECB's communication through its editorials.

The approach used in this paper is thus relevant to assess the consistency (predictability) of the ECB's communication policy, and it delivers interesting insights. We now turn to other central banks, to assess if it can still be relevant for other central banks working in different contexts.

Figure 4. ECB main refinancing rate and cumulative Wordscores estimates

3.3 Are other central banks as consistent as the ECB?

We replicate the Wordscores approach for a set of inflation targeting and non targeting central banks in developed countries, facing different contexts in terms of currency internationalization, and of cultural (and language) heterogeneity. As shown in Table 1, the sample includes Canada, Norway, Sweden, and the United Kingdom for the inflation targeting central banks[23], and Japan and the United States for the non targeting ones[24]. Compared with the ECB, each of these central banks acts in a different environment, all of them coinciding with different values of the model's parameters (as shown in Table 1).

We here rely on communication tools that are considered as relevant for central banks watchers and that have an impact on financial markets, hence, the latters may be different across central banks. One might then argue that we compare "apples and pears" when considering different communication tools, but for most of the central banks, the structure of communication instruments, such as press releases or post-meeting statements, have evolved through time (e.g., for the Riksbank and the Bank of Japan), thereby rendering the Wordscores analysis irrelevant if used (cf. Section 3.1). We then only consider communication tools that have had a consistent structure throughout the period (1999-2014).

For the Bank of Canada, we use the "Fixed Announcements Dates" press releases, which were introduced in November 2000, whereby it announces decisions on its target for the overnight policy rate on eight pre-specified dates each year. Each release includes the reasons underlying the policy decision, a forward-looking policy guidance, and the Council's view of the economic outlook (Fay and Gravelle, 2010; Hendry and Madeley, 2010; Hayo and Neuenkirch, 2011) . For the Bank of England, we use the Monetary Policy Committee minutes, which deliver an assessment of the economic conditions in the national and international markets, and reflect the policy actions conditional upon future developments of macroeconomic variables (Gerlach-Kristen, 2004; Reeves and Sawicki, 2007; Dow et al., 2009). For the Fed, we rely on the Federal Open Market Committee post-meeting statement, as it contains the Committee's view about future economic de-

[23]Canada adopted a target on February 1991, the United Kingdom on October 1992, Sweden on January 1993 and Norway on March 2001.

[24]The evolution in Japan is too recent to influence our sample and analysis.

velopment and an outlook on the future federal funds target rate (Pakko, 2005; Hayo and Neuenkirch, 2010). We use the summary of the Monthly Report of Recent Economic and Financial Developments for the Bank of Japan, which contains a summary of economic and financial developments, and which forms the basis of the decision for money market operations (Fujiwara, 2005). Concerning the Norges Bank, the Press releases of the Executive Board's monetary policy decision are used. Each Press release contains forecasts of inflation, the output gap and other variables, along with an assessment of the general economic situation (Holmsen et al., 2008). Finally, for the Riksbank, we use the Minutes of the Executive Board's monetary policy meeting, as they report the views of all MPC members about the economic outlook and the future path of key variables (Apel and Grimaldi, 2012).

As for the ECB, for the Wordscores simulation, we consider the releases from 1999 until 2005 as the set of reference texts, and the releases published afterward as virgin texts. Figures 5 to 10 below show the results of the Wordscores approach for these central banks.

Figure 5. BoC interest rate and cumulative Wordscores estimates

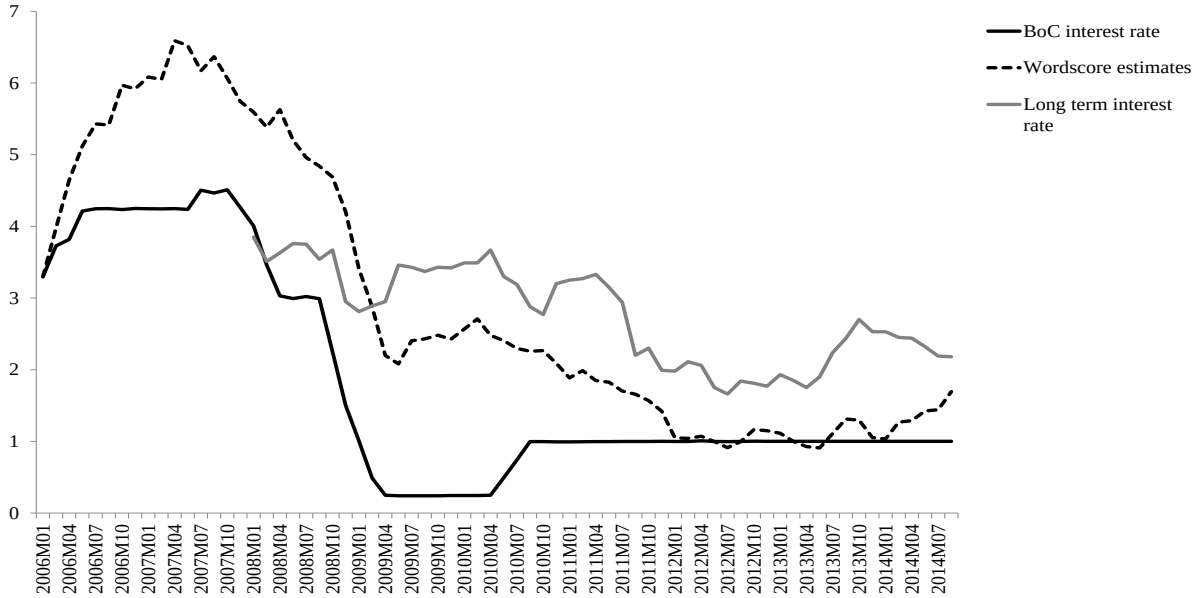


Figure 6. BoE interest rate and cumulative Wordscores estimates

Figure 7. FED interest rate and cumulative Wordscores estimates

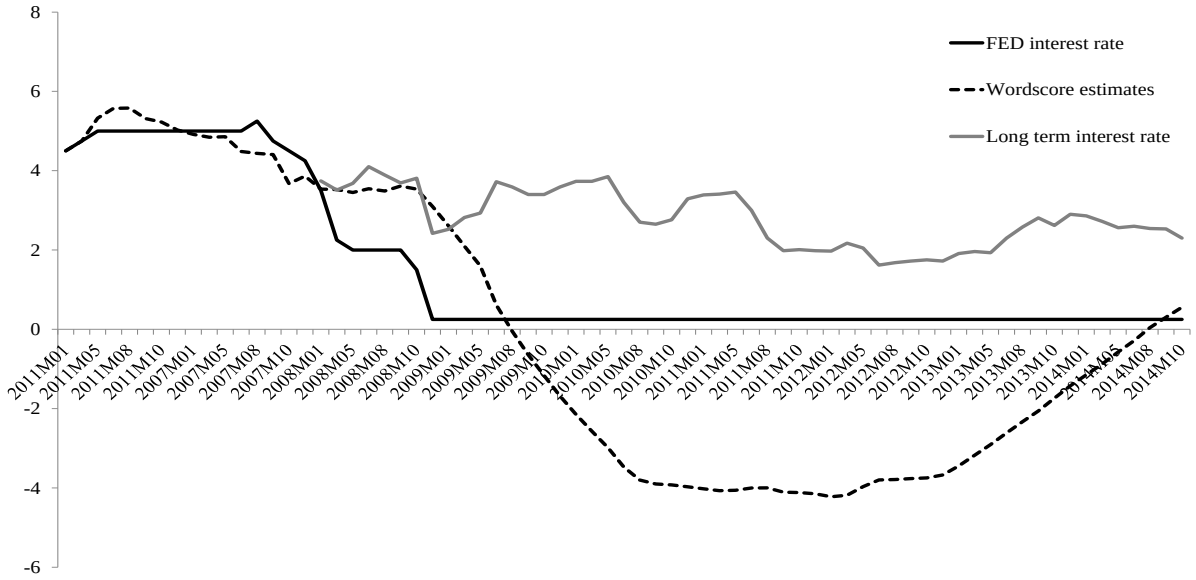


Figure 8. BoJ interest rate and cumulative Wordscores estimates

Figure 9. Norges Bank interest rate and cumulative Wordscores estimates

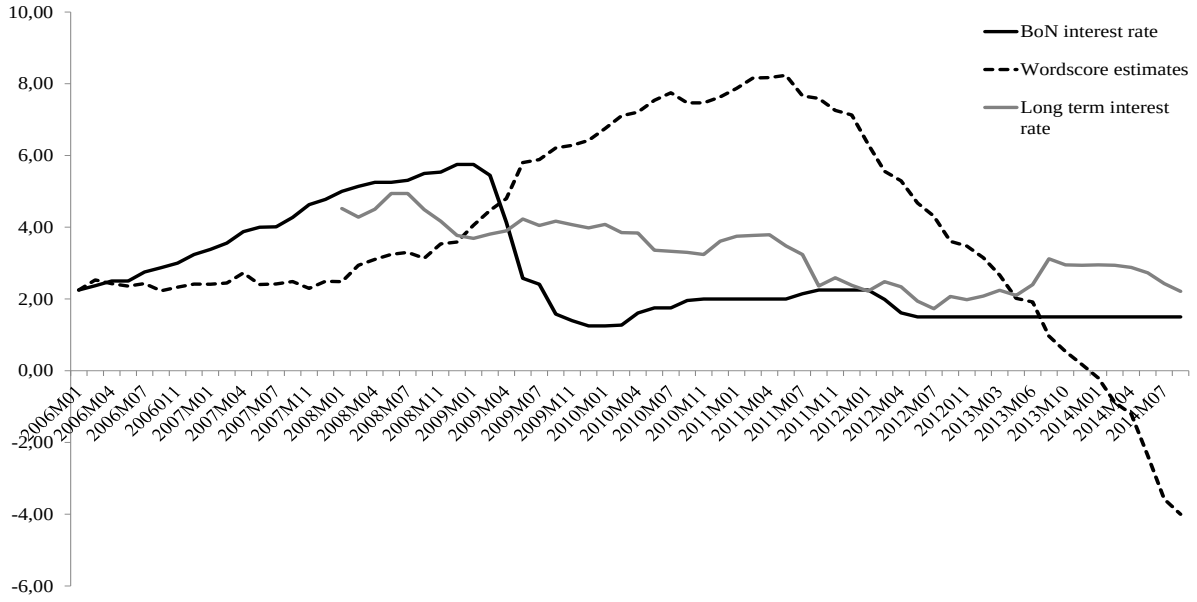
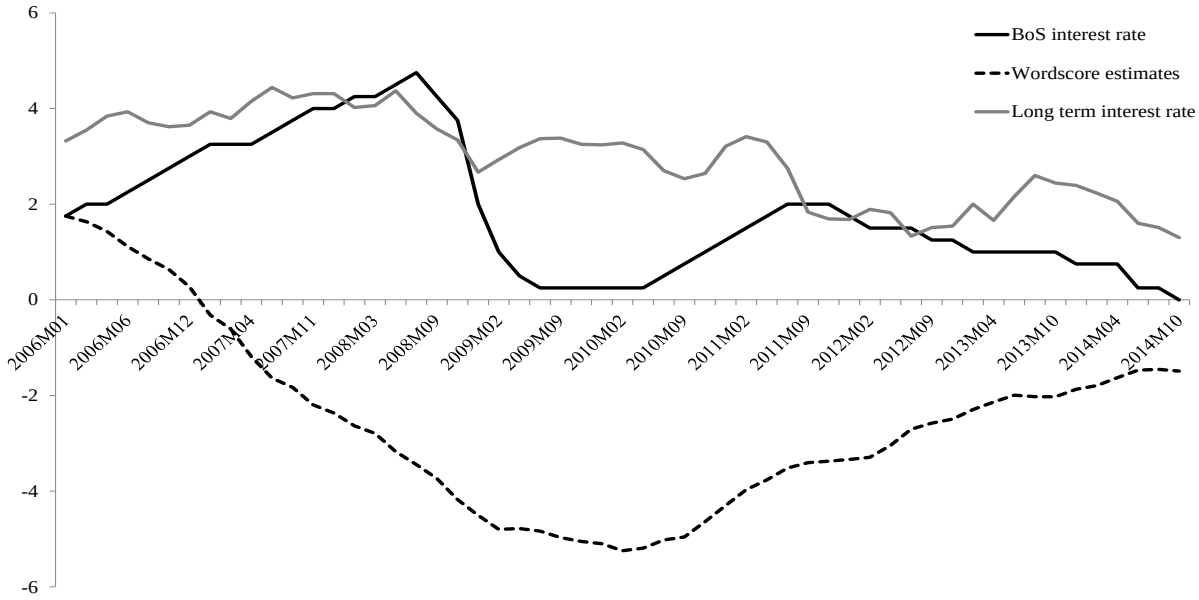


Figure 10. Riksbank interest rate and cumulative Wordscores estimates



On the one hand, it appears that the cumulative Wordscores estimates for the Bank of Canada, the Bank of England, and to a lesser extent for the Fed, replicate accurately the moves and directional changes of the short-term interest rates from 2006 to 2007,

and of the long-term interest rates from 2008 on. This means that central banks which receive important scrutiny from international markets (i.e., for which agents from financial markets in different countries pay a particular attention to the policy guidances they provide) and which have relatively strong ties with foreign exchange markets, need to have their messages understood uniformly by heterogeneous agents (a situation quite similar to the ECB's), to make agents' expectational processes similar, and thus, to achieve their objectives of price stability. This explains the consistency trait of their communication policies.

On the other hand, the result for the Bank of Japan and for FED is interesting in the sense that it illustrates one specificity of the methodology emphasized before: given that the BoJ and the FED decreased their interest rates at the end of 2008 to 0.1 basis point, they were confronted to the Zero Lower Bound, as they could not decrease further their interest rates, even though their communication policies had an accommodative stance. Therefore, the Wordscores cumulative value for the BoJ and the Fed decreases and remains negative from 2008 onwards, while the value of their interest rates did not change throughout this period. Nevertheless, for the Federal Reserve, the long-term rates provide better guidance, and the Wordscores proves reliable, correctly reflecting the direction of the changes from the end of 2011 to 2014.

Finally, the results for the Riksbank and the Norges bank reveal that the consistency of their press releases and statements can hardly be helpful for predicting the future path of their respective policy rates. These results do not mean that these central banks are not predictable, as many empirical studies find that other forms of their communication policies help predict their future policy decision(s) (e.g., speeches, interviews, interest rate forecast..., see Holmsen et al., 2008 or Apel and Grimaldi, 2012). However, given that these central banks do not have the constraints the ECB and other major central banks have[25], i.e., the presence of agents from different countries and with different languages which are attentive to the messages they provide, they may not need to be as consistent in the way they communicate their policy decisions. This explains the fact that the Wordscores approach can in particular replicate with accuracy the moves of the ECB's

[25]The FED, the BoE, the BoC.

rate and the Fed's FFR, but fails to reproduce the changes of the policy rate of the other central banks. In other words, it seems that the constraints faced by the different central banks in our sample are relatively well understood, and that their communication has a degree of consistency (and, thus, of predictability) that lies in conformity with the audience(s) they target[26].

This is verified by the comparative statistics displayed in Table 2 and 3, which reveal the effectiveness of the Wordscores approach for the various central banks' rates and for the long term interest rates, as Jansen and de Haan (2013) did for the first years of the ECB. As shown in Table 2 and 3, the central banks which have to deal with an heterogeneous audience and a strongly internationalized currency are more likely to have a consistent communication policy than the ones which are less subject to these pressures. It clearly emerges that the Wordscores approach allows the most accurate predictions (either for an easing or a tightening monetary policy) for the ECB, the Bank of Canada, the Bank of England and the Federal Reserve[27] rates and the long term interest rates of the currency areas they manage, whereas the estimated previsions for the Riksbank and the Norgesbank are of poor quality, thereby confirming the previous observations about the communication strategies of these central banks. Although it is important to remind that the Wordscores approach is more likely to complement rather than to substitute itself to other predictive methods based on macroeconomic projections for instance, it still gives important insights about the specificity of the communication policy of these central banks, even when the Zero Lower Bound strikes, as long-term rates may then contain more relevant information than the short-term ones.

Hence, different agents located in different areas or with a different culture/language can better predict the futur path of the policy rates of the ECB, the BoE, the BoC, and the Fed using the same public signals. Therefore, it seems that these institutions take into account the constraints they face and their potential impact on the volatility of the inflation rate when setting their communication policy, as could be expected from

[26]It is worth noting that, to take into account the possibly more important of the forward guidance by inflation targeting central banks, we have considered the predictions made at $t+2$ or $t+3$ with central banks' public statements at time t, obtaining similar results (available upon request).

[27]Given that the Bank of Japan has rarely moved its policy rate during that period, such statistics (% correct ease or % correct tight) would be meaningless.

our theoretical framework. The results thus confirm that there is no such thing as a "one-size-fits-all" communication framework that is optimal for all central banks, given the different environments in which they have to define and implement their monetary policies.

Table 2. Effectiveness of the Worsdcore approach for central banks' interest rates

Currency area	Correlation	% correct prediction	% correct ease	% correct tight	% correct no change
Euro area	0.83	60	90	43	42
Canada	0.89	61	35	88	60
England	0.88	73	80	88	52
United States	0.84	50	66	38	45
Japan	0.55	N/A	N/A	N/A	97
Sweden	0.32	35	32	36	40
Norway	-0.21	24	16	30	27

Table 3. Effectiveness of the Worsdcore approach for long term interest rates

Currency area	Correlation	% correct prediction	% correct ease	% correct tight	% correct no change
Euro area	0.60	57	70	30	60
Canada	0.74	60	61	40	70
England	0.84	55	48	44	55
United States	0.51	52	46	46	60
Japan	N/A	N/A	N/A	N/A	N/A
Sweden	0.19	40	40	42	40
Norway	0.24	57	61	60	50

3.4 Robustness check

A full-fledged econometric test of the theoretical predictions of the framework is unfortunately out of reach, given the nature of the data involved. For instance, currency

internationalization data are only available for 4 currencies out of the 7 considered in this present study, precluding to quantify the effect of the evolution of currency internationalization on the consistency of central banks' communication policy.

Therefore, we test the consistency, and thus, the predictability of central banks' communication by regressing the accuracy of the Wordscores estimated value (i.e., accuracy = Wordscores estimate - central bank's policy rate) on the degree of ethnic diversity of the currency areas managed by the central banks considered in this paper[28]. We also add a dummy variable that takes the value 1 if the central bank has an inflation target, and 0 otherwise. We run the following estimation:

$$WS_t = c + \alpha.EF + \beta.IT + \varepsilon_t$$

where WS_t is the difference between the Wordscores estimated value and the actual policy rate at time t. WS_t measures then the degree of the predictability of the central bank's communication policy. EF represents the ethnic fractionalization index, IT is the dummy variable, and ε_t is the error term with constant variance and normal distribution. There are 527 observations. The estimation delivers a value of α negative and equal to -0.61 (significant at the 1% level, with a S.D. equal to 0.22), and a β positive and equal to 0.79 (significant at the 1% level, with a S.D. equal to 0.12), which tend to show that the non targeting central banks and the central banks that have a high degree of ethnic diversity in their currency areas (such as the ECB) are, on average, more predictible through their communication policies than the inflation targeting central banks and those with a low degree of ethnic diversity, i.e., forecasters make less forecast errors of the policy rate at time $t + 1$ of non targeting central banks and in currency areas where there is a high degree of ethnic diversity, when relying on central banks' public information at time t (and we obtain similar results when considering the previsions made at time $t+2$). As such, this result is a rejoinder to some previous empirical studies (Willhelmsen and Zaghini, 2011). All in all, this set of results lends support to our theoretical framework, as well as to the relevance of the Wordscores approach.

[28]We do not include the language fractionalization index given that it has a high degree of correlation with the ethnic index.

4 Conclusion

Given that the ECB, the FED and other major central banks are implementing a monetary policy that has an international impact, it is a challenge for these institutions to be understood uniformly when explaining their monetary policy decisions. In this paper, we highlight the negative effects induced by the presence of a multi-cultural factor, and the internationalization of a currency, when central banks communicate about their monetary policies. In a second step, we use the Wordscores methodology to assess if these central banks' communication policies remained consistent through time to tackle these negative effects. Our results show that these central banks have used a somewhat similar lexicon to explain their policy decisions, and that they have adapted their policies to the constraints raised by the heterogeneity of the agents they have to convince of the credibility of the message they convey.

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