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WHO ARE THE FORERUNNERS,  
ECONOMISTS OR CENTRAL BANKERS?

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# Who are the forerunners, economists or central bankers?

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## Abstract

Is it possible to tell whether central banks' choices are grounded on monetary theories or whether the theories derive from what central bankers have already experimented? This study delves into this issue by adopting an approach that is novel for at least two reasons. First, it involves a lexical comparison between the textual content used by central banks and in economic articles. Second, this comparison is drawn using quantitative tools. In short, the variables measured here are words and segments of text that were submitted to a statistical analysis to identify trends and behaviors in central bankers and economists that would otherwise not be immediately apparent.

## Keywords

Monetary forerunners; Central bankers' speeches; Monetary approaches; Quantitative history of economic thought.

## JEL Classification

B22, B59, E58

## 1. Introduction

This paper deals with the making of monetary policies, focusing particularly on the relationships between policies and theories. The question prompting our analysis was: to what extent are the central banks' choices grounded on monetary theory? Nothing new there. This is an old topic, but further investigated here from a different, possibly new, approach, i.e. a lexical comparison between the textual output of central banks and economic articles. The tools used to

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pursue this purpose are uncommon for the history of economic thought because they are mainly quantitative.

The use of such quantitative methods in economics is still in an embryonal stage, confined to studies on the citations of various authors or works over time, or series of journals and publications. The notion of “quantitative” takes on a different meaning here because the results and conclusions are drawn exclusively from the measurement of certain variables. In a sense, this is an article regarding the *quantitative history of economic thought*.

The particularity of this analysis concerns the variables, because what we measure are words and segments of text (combinations of words),<sup>1</sup> not traditional economic magnitudes. In short, we broke texts down into words and segments of sentences that we statistically analyzed to identify trends and behaviors that would otherwise not be immediately apparent. This method involves the use of large sets of data and a particular method for retracing features, frequencies and sequences in the use of words that can shed light on questions such as the one in the title of this paper.

To conduct this research, we first confined the area of analysis to two dimensions of central banking: scientific articles containing monetary models (ART from now onwards) and central bankers’ speeches (CBS). We considered 614 articles and 5,157 speeches written and given respectively between 1999 and 2014. We treated the words/segments they contained as our data, associating them with certain *active variables* from the spatial and temporal perspectives. In our analysis, the active variables are represented by: 1) schools of thought or theoretical approaches in which articles are categorized; 2) central banks; and 3) years covered by the analysis.

We chose *correspondence analysis* as the most appropriate analytical method that would enable us to place words/segments contained in articles/speeches in relation to the above active variables. This is an exploratory data processing technique belonging to multivariate statistics and designed to analyze simple two-way and multi-way tables in which there is some measure of correspondence between the rows and columns. Correspondence analysis was well suited to our purposes because our study lacked an *a priori* hypothesis to verify; it enabled us to identify systematic relationships between variables, without any prior expectations regarding the nature of these relationships. The words/segments considered appeared as rows in a matrix, while central banks, schools of thought and years were presented as columns hypothetically containing these words. From this matrix we extracted some output in terms of the spatial distribution of the words/segments used by central

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<sup>1</sup> “Financial crisis” and “central bank independence” are examples of segments, i.e. concepts expressed by two or more words identifiable as a single variable.

bankers and economists, which provided the foundations for some hypotheses on the mutual influence between the strategies central bankers sketch in their speeches and the theory on central banking forming the object of scientific articles, as discussed in the first part of this paper (Sections 2-4).

In the second part (Section 5-6), we looked at how the use of the words/segments evolved over 15 years (keeping the speeches separate from the articles) to gain an idea of any changes over time in the use of certain crucial words/segments. These first findings on the associations between words/segments used by central banks and schools of thought were tested by means of a *cross-correlation analysis*. The use of *cross-correlograms* generated some information regarding the temporal order of the selected crucial words/segments used by central banks and economists. Thus, while correspondence analysis told us something about the relative frequency (meaningfulness) of certain words in economic models and speeches, cross-correlograms added information about the sequentiality (chronology) of such word/segment usage in these models and speeches. It would be wrong to conclude that the temporal order identified expresses any causality between the two actors (central bankers and economists), but it does tell us something about the use over time of certain words/segments that evoke concepts, strategies and policies.

Reconstructing these sequentialities can shed light on the relationship connecting policy to theory, and particularly elucidate whether theory generally precedes policies, as common sense leads us to suppose.

The work ends with some final comments on the outcome of the two parts of the research.

## **2. Dataset and method**

We extracted theory-related words from 614 scientific articles in highly-indexed international scientific journals (the Journal of International Financial Markets, Institutions and Money, the Journal of Monetary Economics, the Journal of Money, Credit and Banking, and the International Journal of Central Banking) and in series of well-known working papers (including those of the Centre for Economic Policy Research, the National Bureau of Economic Research, the Bank for International Settlements [BIS], the International Monetary Fund) published between 1999 and 2014. Extracting words and segments meant ignoring mathematical and symbolic reasoning, but this is part of the method. It is a shortcoming that is (partially) offset by the fact that, in a primarily formal article, economic reasoning involves translating mathematical concepts or outcomes into descriptive language, and therefore into words. We analyzed the corpus by year of publication and theoretical imprint of each article, distinguishing between new Keynesian macroeconomics (NKM),

new classical macroeconomics (NCM), new institutional macroeconomics (NIM), behavioral economics (BEH), and the dynamic stochastic general equilibrium (DSGE) models. We applied this classification (which obviously represents only one among several possible classifications of central banking models) by considering the keywords included in each article, the stated purposes of the author(s), the analytical method employed, and the references. Each article was read and classified as belonging to one of the above schools of thought, indexing it by its year of submission instead of the year of publication in order to ignore the time elapsing between the writing of a paper and its appearance in print.

We regarded CBS as proxies of policies, and retrieved the final dataset concerning them from the BIS website, which includes 5,157 speeches made by central bankers from the Bank of Canada (BoC), the Bank of England (BoE), the Bank of Japan (BoJ), the Central Bank of Chile (CBoC), the European Central Bank (ECB), the US Federal Reserve System (FED), the Reserve Bank of Australia (RBA), the Reserve Bank of India (RBI), the Reserve Bank of New Zealand (RBNZ), the South African Reserve Bank (SARB), the Swiss National Bank (SNB), and the Sveriges Riksbank (SR).

All figures – scatterplots, trends and correlograms – showing the outcomes are grounded on relative frequencies. This makes any differences in the number of articles and speeches within and between the groups irrelevant.

A further preliminary analysis of the central bankers' speeches was restricted to the those given by presidents and governors of central banks in order to remove the potential distortion deriving from statements made by central bank board members, and containing personal instead of official opinions. We decided to maintain the original, larger dataset, however, because the outcomes of the analysis focusing on the governors alone generated less meaningful differences than those considered here.

We examined the policy-makers' speeches and the economists' articles first separately and then jointly, with the primary aim of drawing some hypotheses regarding how they were related. We deconstructed the speeches and articles, and merged them into a single corpus of 5,771 texts, which formed our dataset. Then we distributed the dataset of CBS and ART data in rows, excluding the mathematical symbols. Each *word/segment* occupied a row, and the columns were shaped by the chosen *active variables*: year, central banks, and schools of thought (theoretical approaches). The first step thus involved building a data matrix that enabled us to interpret the interrelations between row profiles and column profiles. Interrelating means “measuring” the distance between the words/segments and the active variables (see Greenacre, 2007; Beh E.J. and R. Lombardo, 2014).

Once the matrix had been established, it could be represented on Cartesian quadrants in which the horizontal and vertical axes are determined by the chosen active variables: year, CBS, and ART. Axes were selected according to the level of inertia, i.e. the variance exhibited by the active variables. In other words, the active variables were arranged according to the variance characterizing their own lexicon. The two pairs of active variables with the greatest distance in their lexicon identified the horizontal and vertical axes.

Then we could also work with illustrative or *case variables*, i.e. words belonging to rows that can be pinpointed on the scatter plot showing the distribution of the dataset, and then associated with the active variables. This step helps to clarify the characteristics of the lexicon used by central bankers and economists.

The multiplicity of the active variables generates the multidimensionality of the data matrix. Exploratory factorial analysis enables this multidimensionality to be reduced by transforming data into non-correlated variables and building factorial or semantic axes that constitute “points of view” on the phenomenon observed (Bolasco, 2013: 62). These points of view are contextual in that they display relationships across a broad corpus of texts by reducing the amount of information. Specific software is needed to analyze such a large dataset, so we used Automatic Lexical and Textual Processing for the Analysis of Content (TALTAC) to manage the corpus, and SPAD to extract the figures relating to our study.

We used Stata to obtain cross-correlograms that could tell us something about the time primacy in the use of specific words and segments. We built correlograms to consider each word/segment separately in the two domains, CBS and ART, and we calculated the relative frequency of use of each word/segment of interest in both domains, for the years under study. A correlogram compares the trend of these frequencies, identifying correlations and the temporal order. The most meaningful results, in terms of the correlations between the CBS and the ART, are set out in the second part of the paper. Disaggregated information regarding the relationships between each theoretical approach (ART) and the speeches (CBS) as a whole is provided when it is meaningful for data interpretation purposes.

Our final goal was to combine our spatial (correspondence) and temporal (correlograms) analyses to reach a conclusion regarding the paired CBS/ART word use, and thus attempt to answer our previously-posed question: who are the forerunners, economists or central bankers?

### **3. Treating speeches and articles separately**

#### *3.1 Speeches and articles: a first snapshot*

The presentation of our outcomes starts from a snapshot of the vocabulary characteristically used by central banks. This vocabulary is represented in a scatterplot that “can be regarded as a map, because the position of each [central bank] can be regarded as a two-dimensional position, almost like a geographical location in a region defined by latitude and longitude. We say that the scatterplot [...] simply expresses the [words/segments] in a visual format that communicates [...] information” (Greenacre 2007: 5). Correspondence analysis provides “ways for describing data, interpreting data and generating hypotheses” without a theoretical model or preconceived hypothesis. How can the following scatterplots be read? A word/segment close to an active variable – central bank, model, or year – means that the word/segment in question connotes texts/speeches concerning said active variable. In the center (centroid) of the figure, we naturally find the words/segments that are common to the active variables we are considering, without characterizing one or few in particular.

We find the “inertia” or “variance” of the figure on the two axes: the higher the inertia, the greater the variability of the lexicon concerning the active variables in question; and the lower the inertia, the more homogeneous the lexicon.

Figure 3.1 shows words and segments grouped around the 12 central banks.

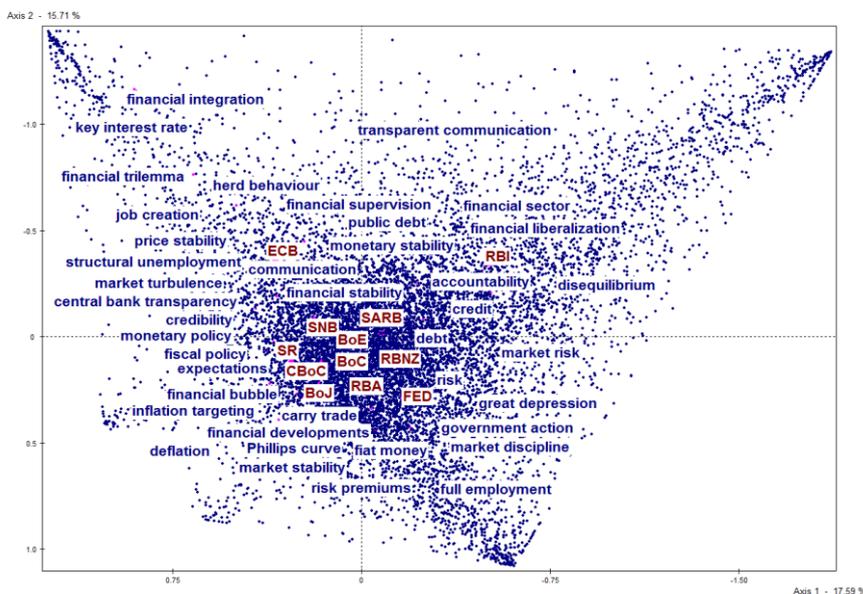


Figure 3.1. Speeches (Inertia: Axis 1: 17.59%, Axis 2: 15.71 %)

As mentioned above, a useful criterion for understanding scatter plots generated by correspondence analysis is to bear in mind that the relative frequencies of word/segment use associated with the active variables (CBS in Figure 3.1) are represented as follows: each active variable is surrounded by the words it uses most often in relative terms. This does not mean that

“price stability,” which lies far from FED, does not appear in FED’s speeches, it is just found relatively less frequently than in the ECB’s speeches.

Three polarities are apparent in the scatter plot in Figure 3.1. The lexicon used by the ECB, RBI, and FED spread in three distinct directions, though the horizontal (17.59%) and vertical (15.71%) inertia (roughly speaking, the generalized variance or variability of the words over the set of 12 central banks) demonstrate that none of the central banks stands apart from the others. The horizontal axis is determined by the ECB (25.9%) and RBI (45.3%), the vertical axis by the ECB (37.1%) and the FED (22.4%). The relatively low levels of inertia show that the central banks we considered used a rather homogeneous glossary, with a limited variance that related primarily to the ECB, RBI, and FED.

The distribution of the highlighted words and their proximity to the active variables (CBS) shows that the ECB focused particularly on “stability,” during the period considered, while the RBI concentrated on “finance” and “financial topics”, which can also be found in the FED, but under the label of “risk” together with “government action” and “full employment”. Finally, “inflation”, “expectations”, and “fiscal policy” are peculiar to the SR and the banks interested in inflation-targeting strategies. The use of such a large lexicon and the relatively low inertia (variance) prevent us from drawing any conclusions concerning differences in the central banks’ theoretical approaches, however. We can only say that the central banks’ lexicon is fairly homogeneous, with some characteristic features.

The same procedure on the economic models generates the following scatterplot.

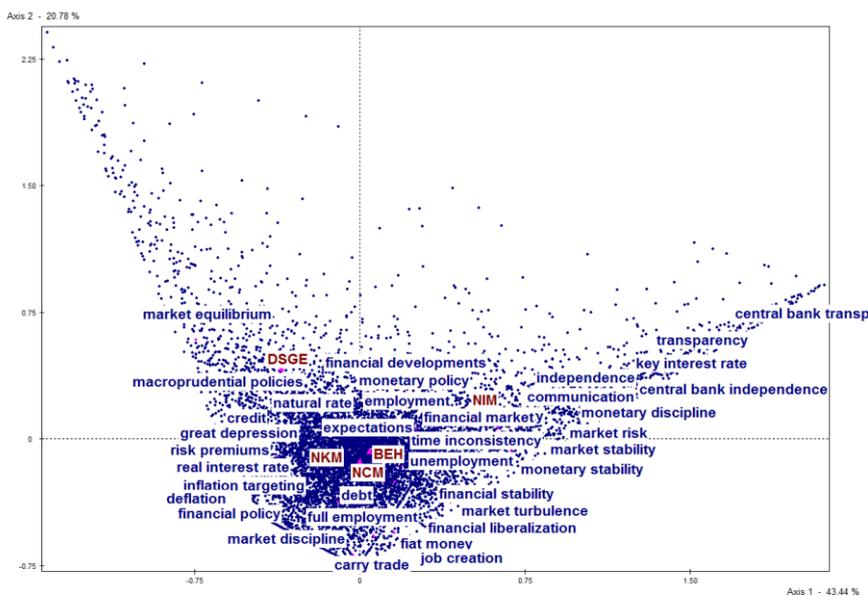


Figure 3.2. Models (Inertia: Axis 1: 43.44%, Axis 2: 20.78 %)

As shown in Figure 3.2, although NKM, NCM and BEH are located in the *barycenter* or *centroid* (the darkest area of the scatterplot corresponding to the vector of the averages), which forms the core overall vocabulary, some originality comes from the NIM and DSGE models. The horizontal axis is defined by NIM (65.5%) and DSGE (25.1%), and the vertical axis by DSGE (47.9%) and NCM (22.3%). The high horizontal (43.44%) and vertical inertia (20.78%) mean that the various macroeconomic approaches show a high level of differentiation as regards word use, and it is worth exploring this differentiation in more depth. In particular, the NIM lexicon appears to differ from that of the other approaches (given its strong contribution to the inertia).

We said the horizontal variance is marked by DSGE and NIM. On reading the words/segments located along these two directions, it is plain that DSGE primarily signposts monetary policy and its evolution, including the recent macroprudential strategies, while the other direction marked by NIM highlights institutional concerns relating to the functioning of central banks: independence, transparency, credibility, and accountability.

## 4. Combining speeches and models

### 4.1 Models and central banks: a single dataset

Some further insight emerged when we combined the CBS and ART data to obtain a single dataset composed of the 5,157 speeches and 614 scientific articles. Figure 4.1 shows the distribution of the resulting lexicon.

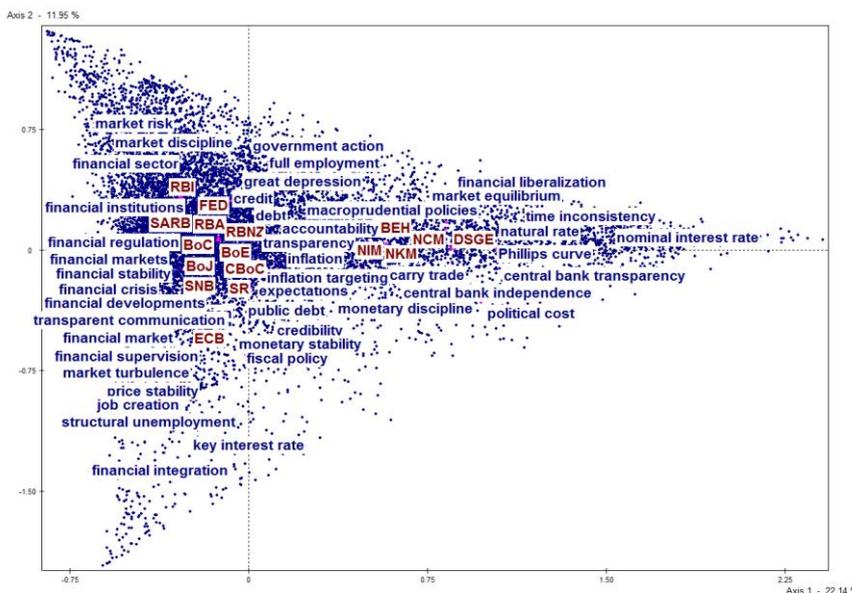


Figure 4.1. Landscape of theories and speeches combined (Inertia: Axis 1: 22.14%, Axis 2: 11.95%)

At a glance, we can see that the CBS and ART are grouped in two distinct areas, or lexical clusters. The distances between the theoretical approaches are narrower, or even disappear; the central banks form a cluster too, but spread over a wider area. How can this figure be interpreted?

We can see that all the words/segments relevant to the practice of monetary policy and financial phenomena are closer to the CBS, while topics concerning the characteristics of central banks and evoking the theory of monetary policy encircle the ART. The words typical of modeling, such as “equilibrium”, “integer”, “stochastic”, etc., are not highlighted; being exclusive to ART, such terms cannot be an object of comparison with the CBS. It is in the words/segments shared by the two actors (central banks and economists) that our interest lies.

Generally speaking, Figure 4.1 shows that the number of words/segments surrounding the CBS is higher than the corresponding number distinguishing the ART. This means for a start that the CBS make use of a richer corpus of words than the ART. Regarding the two axes, we can see that the horizontal axis is built around the contribution of two theoretical approaches, NKM (28.4%) and NCM (19.07%), while the vertical axis is anchored to the RBI (20.5%) and the ECB (50.8%). These variables generate a specific glossary that is useful in building the cloud in Figure 4.1. The two models employ a specific technical language used in modeling that is pinpointed along the horizontal axis, while the language of the two central banks is polarized vertically around certain keywords, among which “stability” stands out for the ECB, and “financial” for the RBI.

Figure 4.1 could lead us to the conclusion that NIM comes closer to the vocabulary of the CBS than DSGE, but this is only partially true. NIM has an overlap with the CBS that is not shared by the other theoretical approaches, while it uses certain words/segments often enough to keep NIM separate from CBS.

#### *4.2 The overlap between models and central banks: reducing the dataset*

At this point, we cannot say whether the clear polarization of the central banks on the one hand, and of the schools of thought on the other, is due to the words/segments of interest or to other words used by central bankers and economists that are not pertinent to central banking. To understand the weight of the “central banking” words alone, we move to a more stylized diagram built on a lexicon cleansed of the words that are irrelevant for our purposes. Figure 4.2 is obtained by placing the CBS and ART in relation to a list of words/segments commonly used in central banking debates (basically, those appearing in Fig. 4.1) to reveal contiguities between central banks and theoretical approaches after reducing their lexical diversity.

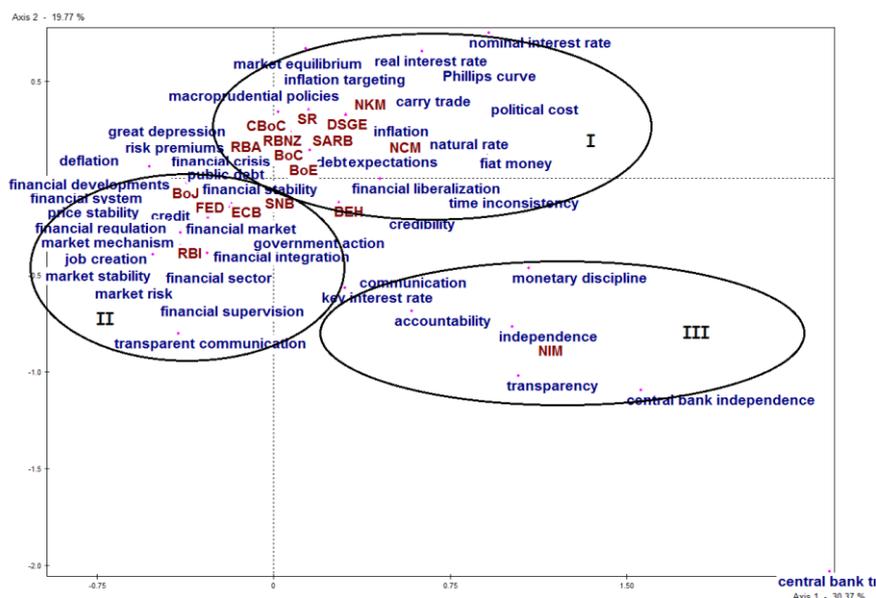


Figure 4.2 CBS and ART: reduced dataset (Inertia: Axis 1: 30.37%, Axis 2: 19.77%)

Even with this broad simplification, the distribution of the variables confirms the previous results: first, the area of contiguity between central banks and models is extremely limited; second, among the words/segments chosen, those connoting the CBS are much more numerous than those distinguishing the ART.

Three quasi-homogeneous areas can be seen in the above scatter plot. Area I touches four theoretical approaches, NKM, NCM, DSGE and BEH – but BEH lies in between areas I and III – and seven central banks: RBA, SR, BoC, BoE, CBoC, SARS, RBNZ. The words/segments in this space are typical of the debate focusing on inflation and how to control it: “monetary policy”, “inflation”, “expectations”, and “disinflation”, as well as “inflation targeting”. Over the years analyzed, some of these banks were concerned with inflation-targeting strategies.

Area II is the only one to include all central banks: BoJ, FED, SNB, ECB, and RBI. On closer examination, we can certainly say that this group of central banks is surrounded by all aspects of finance. With the exception of “financial liberalization”, we find here all the topics linked to the central banks’ engagement in the financial sphere. It is worth noting that also all the words/segments referring to the real economy are included in this area occupied by the central banks.

Area III is reserved for a particular theoretical approach, NIM, which lies very far away from the heart of the scatter plot, but it is worth emphasizing the contiguity of BEH with this area. Although NIM seemed closer to the CBS than to the ART in Figure 4.1, it is clear from the previous Figure 4.2 that NIM detaches itself from both the CBS and NKM, NCM, DSGE and BEH.

This tells us something about the relationships between the two groups of variables, but it does not account for the fact that the lexicon evolved over time. More importantly, it says little about the influence of the ART on the CBS, which needs to be examined in order to move towards a more dynamic analysis.

### 5. Speeches and models: evolution over time

Does central banking theory and practice evolve over time? The following figures provide some answers to this question.

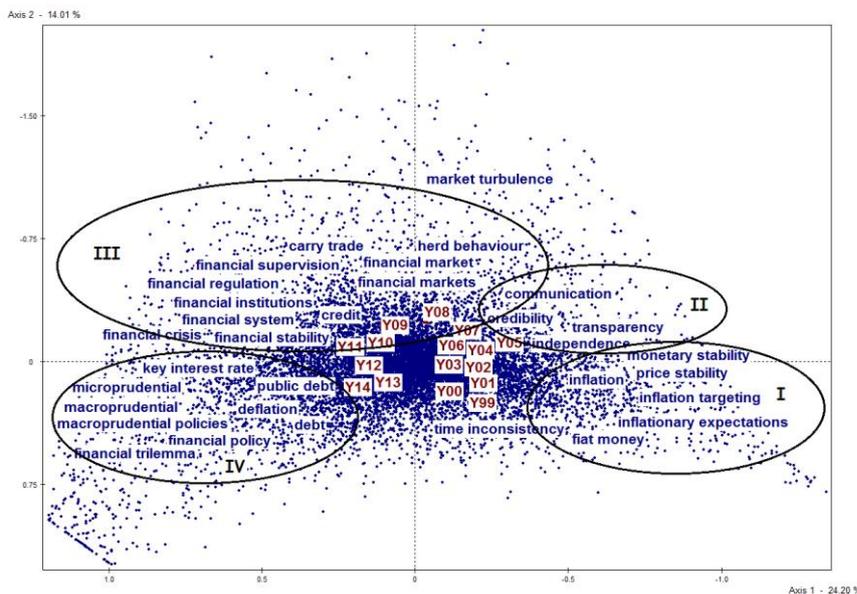


Figure 5.1. Speeches over years (Inertia: Axis 1: 24.2%, Axis 2: 14.01%)

Figure 5.1 shows how central bankers' vocabulary evolved. We used the year as the active variable to compute the principal axes. Moving anticlockwise, the words reveal a remarkable evolution in the trajectory that connects quadrant IV with quadrant III, via quadrants I and II; a change to which the relatively high horizontal and vertical inertia testify (24.2% and 14.01%, respectively). In particular, the horizontal axis is established by the differences between the years 2012 (10.2%) and 2013 (14.7%), and the vertical axis by the differences between 2008 (25.6%) and 2009 (25.2%).

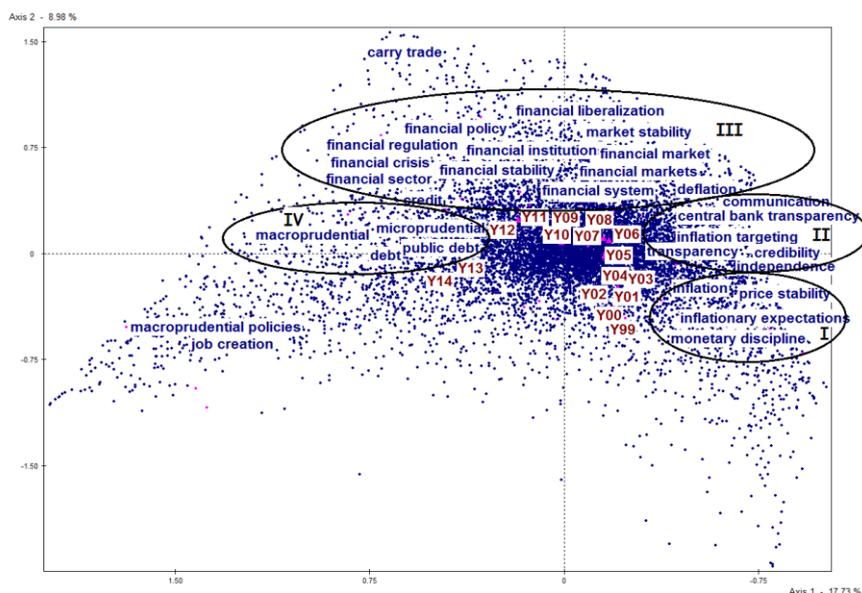


Figure 5.2 Articles over the years (Inertia: Axis 1: 17.73%, Axis 2: 8.98%)

Figure 5.2 illustrates the distribution of the words used in the selection of scientific articles on central banking from 1999 to 2014. This figure shows a similar “evolution” in the ART lexicon to the one seen in the figure relating to the CBS. There is some discontinuity, but the movement over the years is sufficiently clear. This means that, although the variance is not particularly high (see the inertia on the two axes), the economists’ word usage shows a well-defined change that is represented by data arranged along the diagonal in the matrix. The horizontal axis is determined by 2014 (44.8%), and even more by 2013 (16.07%): these were the years in which the economists’ lexicon exhibited the greatest change (distance). The years 2009 (17.1%) and 2014 (16.6%) define the vertical axis.

We must stress that the variance is higher for the CBS than for the ART, meaning that the terms used by the economists in building their models over the years changed less than the language employed by central bankers. But, what matters is the parallel movement of the words in their two worlds. At first sight, this observation suggests that most of the language is shared by the two worlds and evolves in much the same way. The above scatter plots show that words such as “inflation”, “independence”, “transparency”, “credibility”, and “finance” occupy the same place in the figures depicting the evolution of the economists’ models and of the central bankers’ speeches.

The comparison between Figures 5.1 and 5.2 highlights the same position of the sub-areas I-IV, telling us that the lexical change in the two ‘groups’ (CBS and ART) is probably determined by the same factors, i.e. a cultural change of attitude to specific aspects or events mainly characterizing the economic and financial arena, the 2007 crisis.

Following the same order, we can start from the monetary topics included in sub-area I, which characterized the debate among central bankers and economists in the years from 1999 to 2004. “Inflation”, “price stability” and also “inflation targeting” marked those years in the central banks alone. Then, the same new topics involved both the groups, enriching the debate on “transparency”, “credibility”, and “communication” with “independence” to ferry the scholars and policy-makers towards the new issues. The two figures do not really show differences in the time sequence: from 2005 to 2007 included, what we have called the institutional topics attracted everybody’s attention.

Financial topics “arrived on the scene” in 2008, occupying center stage until 2012. It is worth emphasizing that “credit” comes to the fore together with the financial topics, for both central bankers and economists. Just as “price stability” is pivotal among the monetary topics, the financial arena is dominated by “financial stability”, although the latter is not a topic that belongs to the 2007 crisis.

Finally, the last IV sub-area includes “macroprudential”, “microprudential” (clearly belonging to the later, or post-crisis debate), and “debt”, the new mantra attracting the interest of central bankers and economists alike.

However, although Figures 5.1 and 5.2 show a similar evolution of the debate in central banks and articles, expressed here by the words/segments the evolution of the debate over the years, they tell us nothing about the temporal precedence in dealing with specific topics. These figures do not say who leads or influences whom. This is the question developed in the next section.

## **6. Interrelationships between economists’ articles and central bankers’ speeches: who influences whom?**

We now attempt to investigate the relationship between central banks and economists to establish when the content of scientific articles is subsequently taken up by central bankers and, vice versa, when central bankers adopt words/segments before they are used in scientific articles. In this manner, we aim to provide a first glimpse of the interrelationship between policies and theories.

The aim of the following analysis, built on the sub-areas emerging from Figures 5.1 and 5.2, taking the polarization emerging from the scatterplot in Figure 4.1 into account, is to classify the relationship between the use of the same word/segment by the CBS and ART as one of the following four possible cases: a) a correlation showing that one group precedes the other; b) a correlation that is the result of autocorrelation, i.e. each group speaks according to its previous lexicon; c) a correlation determined by third-party factors, i.e. both groups are influenced by the

same exogenous factors; or d) a random walk prevails in one or both processes despite some degree of correlation.

We calculated the relative frequency of each word/segment chosen by the CBS and ART and obtained *cross-correlograms* of the same topic in the two time series referring to the CBS and ART, respectively. The most meaningful figures are included here. We have also mentioned (but not shown) the variables lacking any apparent relationship, and we have grouped the various topics into four homogeneous areas on the basis of the scatterplots in Figures 5.1 and 5.2, i.e. monetary, governance, financial, and ‘most recent’.

To explain the cross-correlograms, we can refer to Figure 6.1, concerning “inflation”: this cross-correlogram should be interpreted on the basis of the distribution of the vertical segments (spikes) and according to their height. The distance between two spikes corresponds to one year and, assuming that ART is the independent variable and CBS is the dependent variable, on the horizontal axis we find the point where the two variables are considered at the same time (lag 0). To the right of lag 0, the lag is positive, i.e. ART precede CBS. To the left, the lag is negative, i.e. CBS precede ART. Basically, when the spikes on the right are higher than the spikes on the left, ART precede CBS; and the opposite applies when the spikes on the left are higher than those on the right.

On the vertical axis that refers to the height of the spikes, when the spike ( $\rho$ ) is positive, there is a cross-correlation between the two variables, and the height of the vertical segment is a measure of this correlation.<sup>2</sup>

When the spike is negative, there is a negative correlation, i.e. the variables of the two sets move in opposite directions. For example, looking at Figure 6.2 on ‘price stability’, while CBS are paying more attention to ‘price stability’, ART are paying less. When the spike is nil, there is no correlation. In short, the higher the spike ( $\rho$ ), the more robust the correlation, be it positive or negative. Finally, as mentioned earlier, each period (the distance between two contiguous spikes) corresponded to 1 year (95% confidence interval).<sup>3</sup>

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<sup>2</sup> Correlation can be interpreted as the degree of association between two random variables - in our case, between the same word in ART and CBS. Correlation satisfies  $-1 \leq corr(X_{MODS}, X_{CBS}) \leq 1$  with larger positive/negative values indicating stronger positive/negative relationships between  $X_{MODS}$  and  $X_{CBS}$ . If  $X_{MODS}$  and  $X_{CBS}$  are independent, then  $corr(X_{MODS}, X_{CBS}) = 0$  (see Koop, p. 324).

<sup>3</sup> The cross-correlation ( $\rho$ ) between the two time series ART and CBS can be described by the following normalized cross-covariance function:

$$\rho_{CBMOD}(h) = E[(MOD_t - \mu_{MOD})(CB_{t+h} - \mu_{CB})] / \sigma_{MOD}\sigma_{CB}$$

where:

### 6.1 Monetary topics

The monetary topic opens with a classic central banking issue, “inflation”, the trends of which clearly show that the use of this word rapidly declined in the ART, moving from a relatively high frequency (approximately 12‰ in 1999) to almost nil in 2014. In other words, inflation has virtually disappeared from the economists’ horizon. The CBS exhibited a similar decline in the use of “inflation,” but the change was decidedly more gradual.

The results of our computation are given in Figure 6.1.

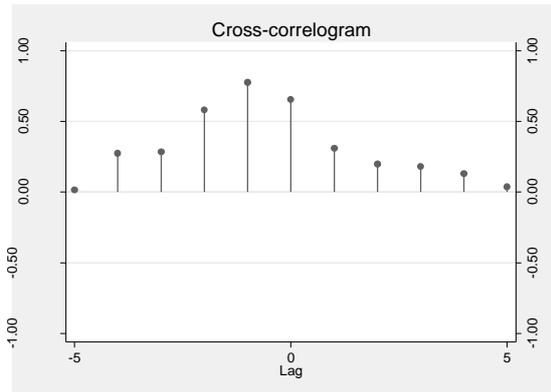


Figure 6.1 Inflation

The cross-correlogram regarding “inflation” in the ART and CBS shows that the term appears first in the CBS, then in ART. The figure clearly shows that the use of the word “inflation” by central bankers came before its analogous use by economists (in one period at least), with a strong correlation (0.777); and this correlation is still noticeable after two years (0.5803).

If we consider each school of thought individually, however, we can see a close correlation between the CBS and NCM (0.6477), NKM (0.8562), and NIM (0.5200), with the CBS preceding the ART in one period, while the correlation is weak for DSGE, and absent for BEH.

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$\rho$  = cross-correlation

$h$  = lag

$E$  = expected value

$\mu$  = means of the ART or CBS process

$\sigma$  = standard deviation of the ART or CBS process

In the case of inflation, it is worth emphasizing that the autocorrelation existing on the side of the CBS is very limited, with the first spike just outside Bartlett's 95% confidence bands.<sup>4</sup> If we accept that the CBS preceded or led the ART, this is tantamount to saying that central bankers began to pay less attention to inflation, and economists then followed in their footsteps.

Continuing with monetary topics, the notion of "price stability" is very common in the central bankers' vocabulary during the study period.

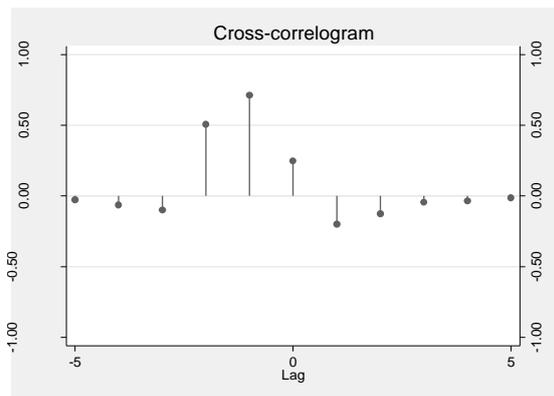
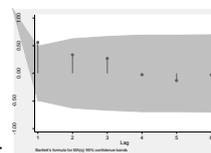


Figure 6.2 Price stability

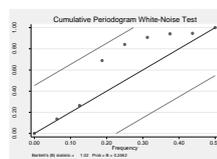
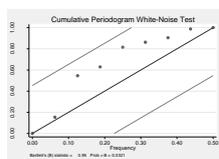
Figure 6.2 concerning "price stability" shows that the influence was limited to a few periods when the CBS preceded the ART. Although the correlation between the two variables in the period before lag 0 is strong (0.7115), the CBS did not influence the ART for long afterwards. The economists were clearly not very interested in "price stability". Given that 'white noise' dominates these distributions,<sup>5</sup> and that there is no autocorrelation, while there is a correlation, but it is very low at lag 0, we can conclude that random relationships characterize the use of "price stability" in the two groups.

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<sup>4</sup> Autocorrelation of "inflation" is very limited in CBS: . Autocorrelation exists when the spikes exceed the Bartlett's band highlighted in grey.

<sup>5</sup> Bartlett's test referring to "price stability" shows in both cases, CBS and ART, that the process is no different



from white noise. CBS: and ART:

As for other strictly monetary topics, we should mention the negative correlation between the ART and CBS as concerns “deflation”: their interest in this topic appeared to go in opposite directions, raising some questions in this respect.

Outcomes similar to those concerning “price stability” are obtained when we analyze “inflation targeting.”

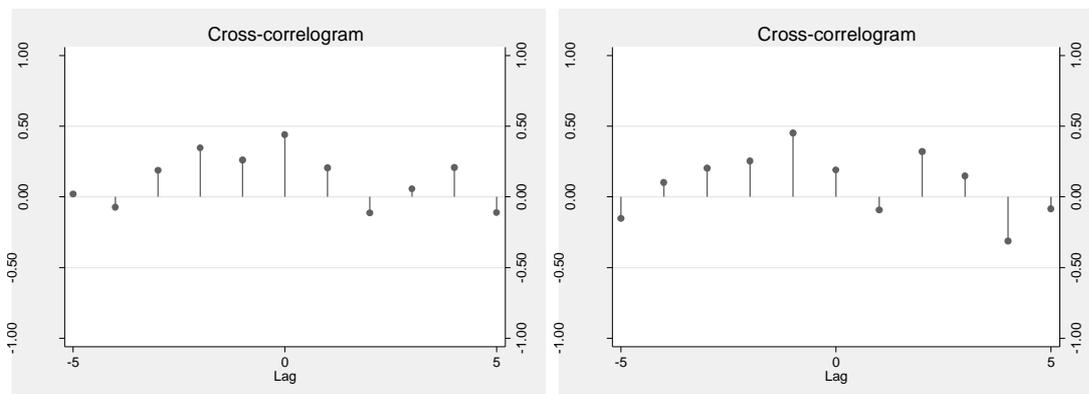


Figure 6.3 a) Inflation targeting

b) Expectations

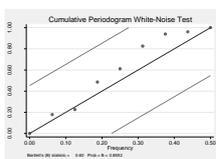
Looking at “inflation targeting” (Figure 6.3.a), a typical central bank strategy, but widely questioned in economic theory, a substantial symmetry becomes prominent, with no clear sequential relationship, although the CBS comes before the ART over at least two periods. Here again, autocorrelation leaves room for ‘white noise’, emphasizing the difficulty of establishing and interpreting the relationship.<sup>6</sup>

Since monetary policy is the art of managing expectations, we decided to include “expectations” (Figure 6.3.b) among the monetary topics, but no meaningful outcomes emerged. “Expectations” correlated weakly between the CBS and the ART, with the BEH, NIM, and NCM models showing this weak correlation, while symmetry dominates in DSGE. The CBS preceded the ART because the NKM models lagged behind the central banks. The combination of these relationships explains Figure 6.4, showing the CBS with a slight lead that prompts a sort of reaction effect with a negative correlation lagging two years behind.

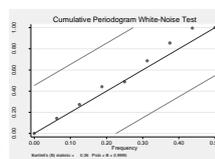
“Expectations” follows the same trend in the two spheres, and so do “inflation targeting” and “inflation”. It seems interesting that, although “inflation” is connoted by autocorrelation, while

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<sup>6</sup> White noise characterizes both CBS



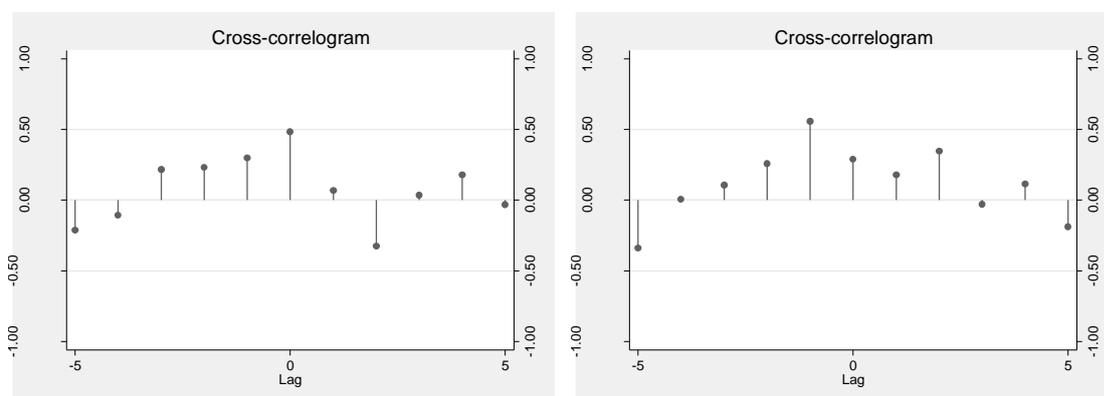
and ART



“inflation targeting”.

“expectations and “inflation targeting” are completely stochastic, they all follow a coupled trend, giving the impression that a third party guides the lexical movements.

Looking at Figure 4.2, we can restrict the analysis to ART (NKM, NCM, DSGE, BEH) and CBS (CBoC, RBA, RBNZ, BoC, BoE, SR, SARB) included in the same sub-area I. The resulting scatter plots, shown in Figure 6.4, reveal no significant differences with respect to Figure 6.3, confirming that the CBS play a leading role even when the actors, CBS and ART, make use of a similar vocabulary.



a)

Figure 6.4 Inflation targeting (a) and expectations (b) in sub-area I of fig. 4.2

Before going on with the governance topics, we can already see that the central banks precede the models in all cases where autocorrelation exists, however limited. This may be due to the different characteristics of speeches vis-à-vis models. Because of its discursive nature, a speech frequently mentions previously-treated topics, giving rise to a certain continuity in the central bankers’ discourse that is not encountered in scientific articles. ‘White noise’, i.e. a “random walk” effect, seems to prevail, however.

#### *b) Features of central bank governance*

In recent decades, “inflation” has frequently been associated with “independence” to identify a necessary condition for improving the action of central banks.

“Independence” appears to be a topic common to the CBS and ART, but – rather surprisingly – no autocorrelation was found here. As shown in Figure 6.5.a, the influence is mutual in the period preceding and following the lag 0, with the ART slightly ahead of the CBS. The quasi-symmetry here is the result of the NIM anticipating the CBS, balanced by the lack of correlation with the

NCM and the delay of the NKM models. Considering NIM vs. CBS alone, we find a high correlation during one period. Note that, in analyzing institutional features, the behavior of the various ART should be considered separately because of the different and even contrasting trends they exhibit.

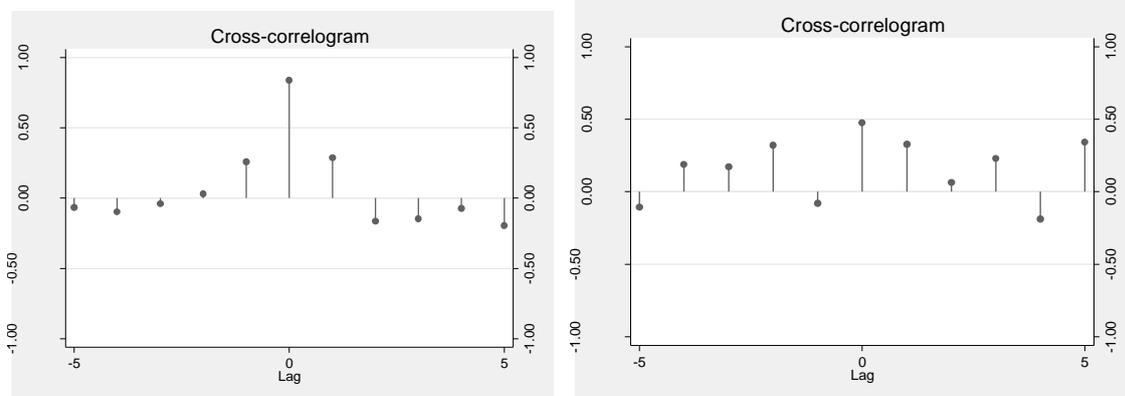


Figure 6.5. a) Independence

b) Credibility

“Independence” involves “credibility”, which shows the same trend (see Figure 6.5.b), but with a weaker correlation and no autocorrelation. “Credibility” was first debated by the economists, particularly those favoring the NIM and NKM approaches, while a correlation is lacking for all other schools of thought.

“Credibility” leads to “communication”, a topic that is increasingly at the center of central banks’ concerns.

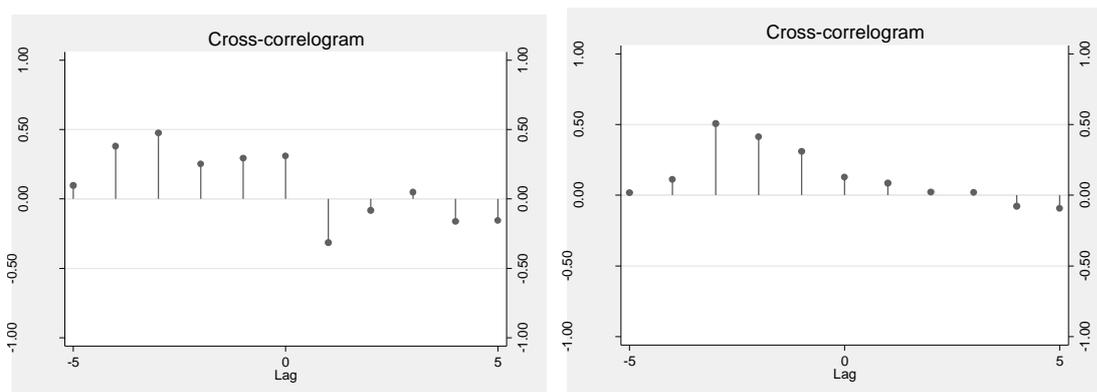


Figure 6.6. a) Communication

b) Transparency

Figure 6.6.a suggests that the relationship between the CBS and ART is rather weak. The NIM and NKM are the only models in which “communication” is positively correlated with the CBS, albeit with a lag. “Communication” is in the NIM area in Figure 4.2, and midway between the CBS and ART in Figure 4.1, showing a small correlation in Figure 6.6.a. The term stands out here for its increasing use in both the CBS and the ART. Looking at Figure 6.6.a, it is impossible to say who

leads whom, although the correlogram indicates that the ART lag behind the CBS, although “communication” remains a word mainly connoting NIM – but only NIM, not all the ART, as mentioned above. The conclusion that can be drawn about “communication” is that it is autonomously treated by the two groups, while some relationships may exist if we consider single theoretical approaches. NIM disproves the possibility of the two processes being completely random.

“Communication” is frequently accompanied by “transparency”, another matter of concern for central banks years before it became relevant to economists.

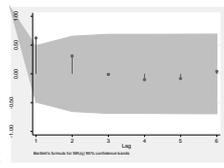
While central banks do not talk of “independence” from governments and political power, they discuss their own “transparency” more than economists do. Figure 6.6.b shows three periods when the CBS took the lead, reaching the highest correlation (more than 0.500) in the third period. This trend suggests that the CBS are characterized by autocorrelation too, and this is confirmed by the test.<sup>7</sup> Exploring the theoretical approaches in depth, we find that the BEH models considered “transparency” before the CBS, there was symmetry for NIM, and no correlation or a negative one for the remaining three approaches, DSGE, NCM, and NKM, which led to the above results. Therefore, considering CBS and NIM alone, we can say that they proceed parallel to each other, both interested in “transparency” but with a weak correlation.

*c) Financial topics*

“Finance” is certainly a new area of interest for central banks, which are gradually introducing it in their constitutions, primarily under the label of “financial stability”, which appears as follows:

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<sup>7</sup> CBS autocorrelation for “transparency” is limited, however:



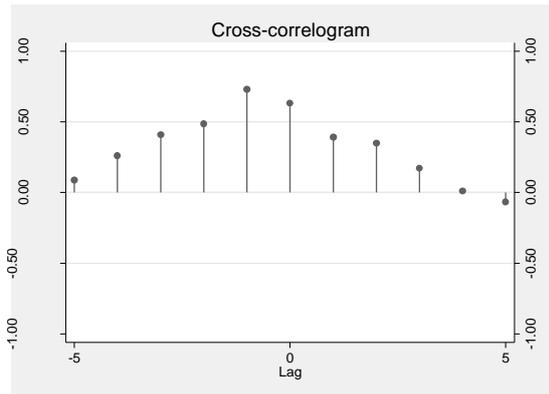


Figure 6.7. Financial stability

We can see that the correlation of the first period to the left of lag 0 is high (0.735), and therefore robust. Central banks clearly consider “financial stability” an important goal, and so do economists, after a while. This is initial evidence of the more *normative* nature of the CBS as opposed to the *positive* character of economic models. For goals like financial stability, central banks are ahead of the economists. For more abstract notions, such as financial markets or financial systems (see below), the economists and their models guide the debate. The weight of autocorrelation cannot be ignored, however. It affects both the trends, and the CBS in particular, showing that finance is a new crucial area on which central banks are converging.

As for “inflation”, the autocorrelation connoting the CBS but not the ART contributes to explaining why the figure shows a high correlation and the CBS ahead of the ART.

When addressing a “financial crisis” (a concrete phenomenon), there can be only one result.

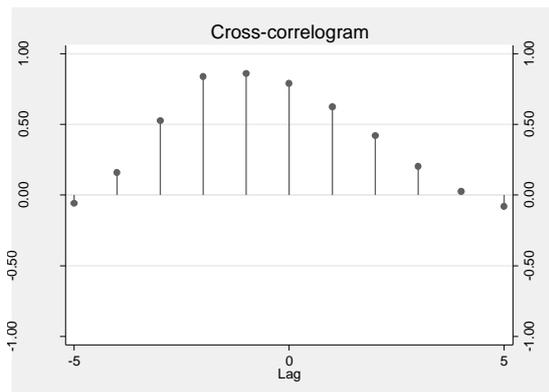


Figure 6.8. Financial crisis

In Figure 6.8, the correlation (0.8591) refers to the CBS preceding the ART in one period, and there is no room for doubt. All of the theoretical approaches lag behind the central bankers, who

undoubtedly started speaking about ‘financial crisis’ before the economists. The autocorrelation is high and involves five periods for the CBS and four for the ART.<sup>8</sup> Although the CBS precedes the ART, we cannot say there is a temporal precedence in favor of the ART. “Crisis” (without a qualifying adjective) showed much the same trend as “financial crisis”, strengthened by a high correlation (0.8871) over two periods, whereas “shock” is a typical ART term. Where topics such as crisis are involved, we surmise that a third factor guides the debate for both CBS and ART.

A financial debate demands other views. None of the following topics show any autocorrelation, while some form of correlation can be seen.

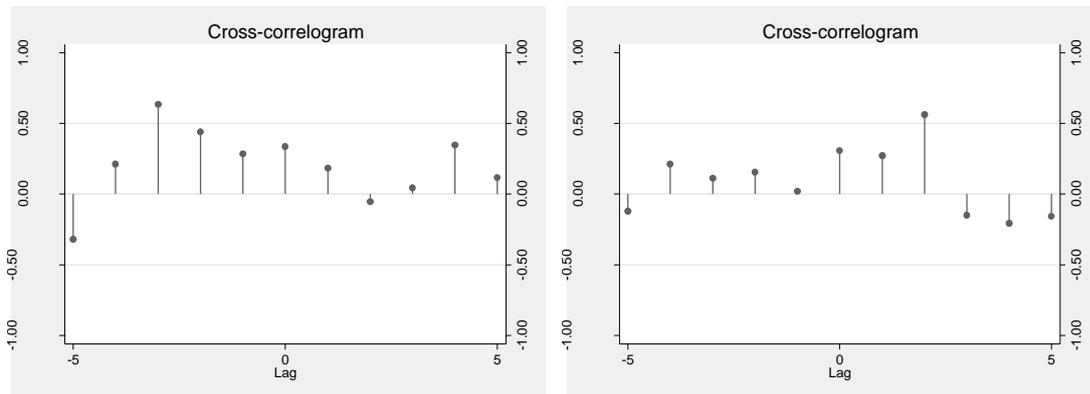
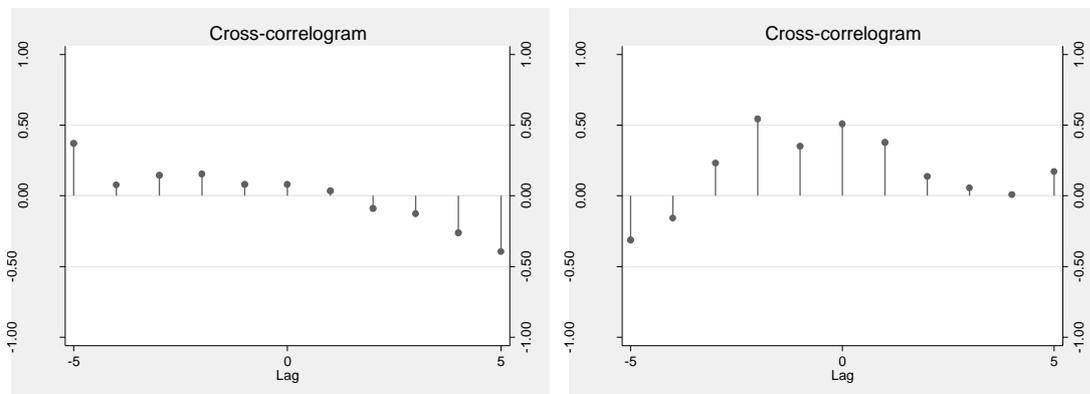


Figure 6.9. a) Financial institutions

b) Financial market

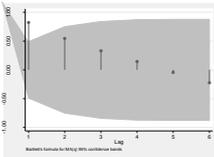
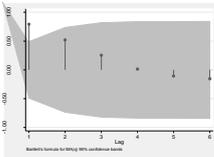


e) Financial markets

f) Financial system

Two trends are represented in the series of graphs in Figure 6.9. Starting from the top left, the term “financial institutions” shows a low correlation that is not clearly determined by either the

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<sup>8</sup> Autocorrelation in CBS  and in ART  for “financial crisis”.

CBS or the ART. The ART clearly shows a slight autocorrelation (with one value outside Bartlett’s confidence band), which partially explains the symmetry if we consider one year before and after the lag 0. The high value of the third spike on the left is uninfluential in determining the lag 0.

In the diagram at top right (“financial market”) the ART precede the CBS. No autocorrelation on either side leaves room for any white noise. The bottom left-hand diagram is devoted to “financial markets”, in the plural, with a slight autocorrelation in both the CBS and the ART. It is worth noting that while central banks speak of “financial markets”, economists write about the “financial market”: the former is a more concrete concept, the latter more abstract. For “financial institutions”, the CBS lead the ART in all the diagrams where the term makes an appearance. Finally, at bottom right, “financial system” reveals a symmetry with a partial autocorrelation on the CBS side.

“Financial” is an adjective widely used together with other nouns, and we can obtain some information on its uses by disaggregating the theoretical approach: what stands out is that NIM models preceded the CBS in several periods, reaching a meaningful correlation (0.5101) in the fourth period, whereas an almost perfect symmetry emerges between the CBS and the BEH models. The NCM models clearly lagged behind the CBS, although the correlation was almost as high (0.6052) as two periods previously. The same applies to NKM, which is characterized by the same two-period delay and a weaker correlation (0.4817). The DSGE models also followed behind the CBS, with an even greater delay (at least three periods).

The above analysis induces us to conclude that there is no dialogue between the CBS and ART on “financial” topics. Each follows its own patterns, largely ignoring the debate in the other group,

The next figure concerns a “monetary” topic that has recently been receiving much attention, namely “credit”. Figure 6.10 shows that the temporal trend from CBS to ART clearly points downwards for this term.

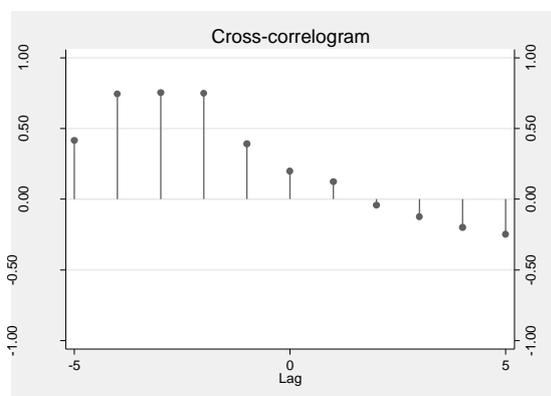


Figure 6.10 Credit.

A correlation exists and is robust (0.7546), though the ART lag approximately 3 years behind the CBS. In other words, the influence of the central bankers' speeches on the economists' models takes three periods to appear. The correlogram confirms that central banks were discussing "credit" long before the economists. We should note, however, that both BEH and NIM showed symmetry between the CBS and the ART, i.e. they moved together. Finally, NKM displayed a clear negative correlation.

Autocorrelation partially affects the CBS, but not the ART.<sup>9</sup> This can contribute to explaining the nature of Figure 6.10, which shows the CBS ahead of the ART. The height of the spikes on the left is due mainly to autocorrelation, meaning that credit represents a constant in the debate among central banks.

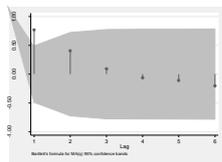
Being a typical issue for central banks, "credit" not only shows autocorrelation, but is also placed immediately at the center of the central banks' reaction to the events of 2007-09, i.e. the financial crisis (or credit crunch). Far from being the object of theorization, it is used by central banks as a readily-available tool. The models can only follow, as shown by their peak in 2010-2011 (two years later) when "credit" became the object of theoretical debate as the persistence of the crisis. Interest in credit then declined for both the CBS and the ART.

Summarizing, the word "financial" (though "finance", incidentally, showed no correlation) is a concern of the central banks when applied to objectives, strategies, and targets, while it is matter of theory when it refers to a type of market or system that can be more or less liberalized. This is a simple observation that explains the existing correlation (largely due to autocorrelation) to some degree, but fails to account for its cause.

*d) More recent topics*

This final part concerns the topics that have been attracting the attention of both central bankers and economists in recent years.

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<sup>9</sup> Autocorrelation in CBS for "credit":

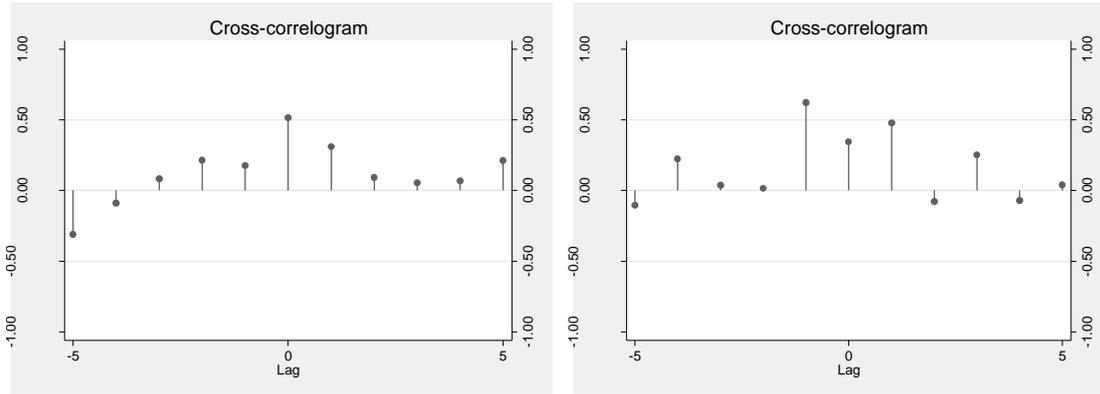


Figure 6.11. a) Debt

b) Public debt

“Debt” is a new, much-debated issue (Figure 6.11.a). Computing all the models, the correlation was not particularly high, but the trend was clear: the ART preceded the CBS. No autocorrelation is detectable.

The ART are ahead of the CBS when we individually analyze NKM, NCM, and DSGE, which showed a strong correlation (0.6924), and NIM, which instead showed a weak correlation. The only approach for which the ART followed the CBS was BEH.

Considering “public debt”, Figure 6.11.b, the CBS are slightly ahead of the ART, although the two groups are not far from symmetrically influencing each other.

The final correlograms, shown in Figure 6.12, focus on two words, “macroprudential” and “microprudential”, that have been increasingly used in recent years, now that the financial and economic crisis has obliged central banks to adopt new tools to sustain economic growth and fight deflation. The former denotes a new policy that is frequently anchored to stimuli that are more fiscal than monetary.

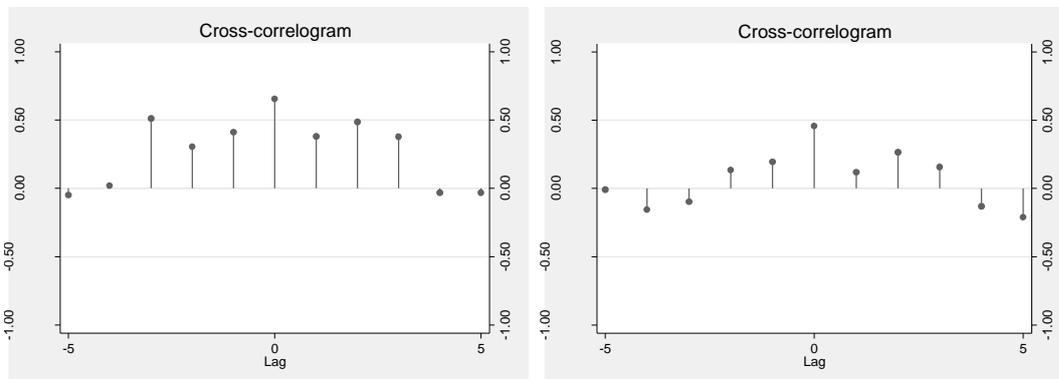


Figure. 6.12 a) Macroprudential

b) Microprudential

Figure 6.12.a shows a type of symmetry between the CBS and ART, since the word “macroprudential” has spread at the same rate across the two areas under study. The correlation is meaningful, while autocorrelation appears on the CBS side. A more detailed analysis shows that the NIM and NCM models slightly preceded the CBS, while the latter started using the term before the NKM and DSGE models. This figure also shows the trends of a word new to central banking, or an improved financial lexicon: microprudential (Figure 6.12.b). Both the relative frequencies are very low, and the correlation is very weak, but they suffice to indicate that the CBS slightly preceded the ART.

The scatterplots concerning these new topics show similar tendencies in both CBS and ART, that can be interpreted as a common reaction to the same stimuli. In other words, rather than either one influencing the other, it is plausible to suppose that both have reacted to some message coming from outside, or simply “in the air”.

Summing up, the above correlograms show that a correlation exists between the use of the same words/segments by the CBS and ART, but are unable to explain it. In general, it seems that the ART follow the CBS in the use of certain crucial words/segments. But this observation should be considered with the following issues (at least) in mind. When a new topic makes its appearance in both the CBS and the ART, it follows a similar trend. Once a topic has become established, it goes its separate way, which may be similar when autocorrelation or third factors play a part. Otherwise the two paths may become completely autonomous, following a random walk typology, even if some correlation makes its appearance. In this last, frequent case, we are induced to treat CBS and ART as two distinct groups evolving each according to its own rules. This point is further discussed in the concluding remarks.

## 7. Some first remarks

Correlation does not mean causation. This is a well-known statistical truth that is confirmed here, and the starting point for trying to answer the above-mentioned questions. Who influences whom? Who are the forerunners?

Concerning the first question, in many (but not all) cases, the CBS and ART seem to take turns in leading one another. It seems quite clear that the CBS precede the ART when there are goals to be reached. This evidently happened for “financial stability” and “inflation”, among others. When the debate touches on more abstract concepts like “financial system” and “financial market”, or conditions such as “credibility”, the ART lead the CBS. In short, central bankers seem more concerned with *normative* economics, while economists reaffirm their *positive* view.

This statement induces us to claim that the cross-correlation can only be explained by investigating knowledge generation in the two groups. Howitt (2006: 363) wrote that policy is knowledge of *what* works, while theory tries to explain *why*. Howitt's interpretation is not so different from the above distinction between normative and positive. The two knowledge processes use the same objects, exemplified here by words/segments, but they follow different paths and possibly also different time courses because they focus on different tasks (what and why). The fact that the objects used coincide explains the recurrent and ongoing cross-correlations, while the fact that the tasks differ accounts for the sequentiality.

Thus our initial questions about who leads whom, and whether the CBS and ART influence one another are inappropriate. The CBS and ART follow different paths, as Figure 4.1 seemed to anticipate.

It is true that, in the main, the CBS precede the ART, as in the case of "financial stability". It is plain that "financial stability" is an issue commonly addressed by both groups, but so far it seems to have been of more interest to bankers than to theoreticians. But "financial stability" is a typical goal that focuses more on *what* than on *why* – and this clearly explains the economists' delayed interest in this construct.

Sometimes the ART lead the way for the CBS, however, as in the case of "debt," which describes a state, or condition that needs to be explained. Sometimes there is symmetry. We can certainly conclude that monetary policy is only partially grounded on monetary theory; and that financial policy is only partially based on financial theory. This is a consequence of the different goals of the knowledge acquisition process of central bankers and economists. To conclude, rather than forerunners, we are dealing here with parties involved in different practices. Central bankers conduct monetary experiments, also on the grounds of past theories, while economists debate monetary experiments.

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