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From global diffusion to local semantics: unpacking the scientization of central banks

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Abstract

This article investigates the scientization of central banks and analyzes the evolving knowledge production. Existing literature suggests that scientized knowledge production either becomes globally more similar over time or is driven by local political economy considerations. However, research on the structure of central bank knowledge production is lacking. To address this, I conduct semantic network analysis on 75 000 central bank working papers and articles from top economics journals. Findings show global organizational forms of knowledge production have diffused, but semantics remain localized. The semantic structure becomes increasingly clustered over time, with a notable division between the Federal Reserve System (FED) and non-FED clusters. Only Federal Reserve produces knowledge aligned with top academic journals. Cluster differences are not solely due to mandates or political contexts but depend on specific policy environments. This research illuminates the evolution of knowledge production within central banks and underscores the influence of organizational and policy contexts.

Key words: social networks, transnational diffusion, organizations, economics

JEL classification: Z13: economic sociology; economic anthropology; language; social and economic stratification, B29: history of economic thought since 1925: other

1. Introduction

Scientization, the adoption of cultural beliefs by modern organization, that rational and scientific knowledge ought to drive organizational behavior has not only been a common feature of international organizations (Drori and Meyer, 2006; Quark, 2012; Kentikelenis and Seabrooke, 2017; Zapp, 2018), but has also spread within entire policy making fields (Marcussen, 2006; Lebaron, 2008; Marcussen, 2009; Claveau and Dion, 2018). Policy making fields are particularly interesting in this regard, because once scientization has taken hold, the scientized knowledge produced in these fields continues to be productive and

subject to internal politics (Ban, 2016; Ban et al., 2016; Kentikelenis and Seabrooke, 2017; Mudge and Vauchez, 2018; Ibrocevic, 2022; Thiemann, 2022). However, the literature on the scientization of policy makers focusses either on particular policy programs or on in-depth case studies of a policy making organization. Studies on the structure of knowledge production for an entire scientized policy field are still amiss. Studies on global diffusion mainly concentrate on the spread of organizational forms, rather than the knowledge produced within such forms, and thereby miss possible variation in the content of policy ideas. I take up central banks as an extreme case of a scientized field of knowledge production to fill this gap in our knowledge. In this article, I analyze the semantics produced in the field of central banking research as the scientization process progresses over time. Thereby, I provide first insights into the structure of knowledge production on the semantic level during and after the scientization process has fully established itself within a global policy making field.

In recent years, knowledge production within the field of central banking has become a focus for social scientists. Studies have shown that central banks have increasingly produced scientized knowledge (Marcussen, 2009; Claveau and Dion, 2018; Thiemann et al., 2018; Backhouse and Cherrier, 2019; Thiemann et al., 2020). This increased production has coincided with the adoption of organizational forms such as working papers as genre, research departments, an increase in PhD holders in central banks, and the emergence of coordination structures for central bank research such as the Central Bank Research Association or the International Banking Research Network. Furthermore, central bankers have built knowledge infrastructures in the form of training centers, which are used to diffuse scientized knowledge within their community (Broome and Seabrooke, 2015; Johnson, 2016). All of this research activity has bled over into academic economics, particularly macroeconomics and finance (Claveau and Dion, 2018). Lastly, several studies show that the research activity of central banks is not only for show, but can become productive in creating new organizational norms which transform the policy making field from within (Baker, 2013a; Ban et al., 2016; Thiemann et al., 2018; 2020; Thiemann, 2022).

While all of these insights have greatly contributed to our understanding of the scientization of central banking and the role of science in general for policy makers, a perspective which puts the organizational field and the semantic structure within this field at its core is still missing. Semantic structures in this article are understood to be relationships between closely related concepts produced by actors within an organizational field (Fuhse et al., 2020). Key questions on the dynamics of knowledge production within a scientized policy field are therefore left unanswered. For example, the literature on the diffusion of organizational norms in central banks would suggest that central bank research would become more similar over time. This is for three possible reasons: First, the type of knowledge produced in scientized organizations partially depends on organizational and institutional contexts. Central banks have over time become more similar to each other as research on the worldwide adoption of central bank independence (Polillo and Guillén, 2005), inflation targeting (McNamara, 2002; Wasserfallen, 2019) and central banks as organizations (Marcussen, 2005) have shown. Second, central banks orient themselves towards a singular, highly centralized academic field in economics located in elite US economics department (Fourcade, 2006). Therefore, everybody is considering the same form of knowledge as a legitimate form of science. Third, the Federal Reserve as the most important central bank in the world could function as a hegemon within the field of knowledge production and thereby become

the de facto arbiter of what is considered valid research within the central banking field. All of these factors would suggest that the semantic structure of central bank knowledge production would converge over time as scientized knowledge production becomes increasingly the norm within the organizational field.

This view, however, is contrasted by another literature which suggests that translating organizational norms like scientization into local context always subjects these organizational norms to local political struggles. Therefore, the knowledge produced by research departments would only to some extent adhere to global standards, but rather serve as resources in these struggles (Maman and Rosenhek, 2009; 2011; Ban, 2016; Mudge and Vauchez, 2018, 2022; Backhouse and Cherrier, 2019; Mandelkern, 2019; Ibrocevic, 2022). Hence, even though the organizational and institutional environment of central banks has become more similar over time, deviations and local varieties in semantics are considered legitimate forms of knowledge within the organizational field (Krampf, 2013; Braun and Downey, 2020; Wansleben, 2023). Therefore, by looking at the semantic structure of central bank knowledge production, we can evaluate whether and how much scientized knowledge production leads to a convergence amongst national central banks. Only by looking at this semantic structure beyond individual policies or specific central banks, we can understand the general patterns in central banks' scientization.

In this study, I take a first step in advancing our understanding of the emerging semantic structure of central bank knowledge production as scientization takes hold. To do so, I collected data on all 33 000 working papers written by the G20 and European Union central banks in addition to the International Monetary Fund and the Bank of International Settlement in the period 1991–2020. Understanding the semantic structure of central bank scientization requires a relational approach, because knowledge produced within working papers can only be evaluated in the larger context of the organizational field. To facilitate this relational approach, I rely on more recent advancements in quantitative text analysis called semantic network analysis (Rule et al., 2015; Bail, 2016). These approaches allow for a more direct analysis of the similarity in knowledge production in an organizational field. Beyond revealing the macro-structure of knowledge production within the organizational field at large, these methods also allow an in-depth analysis of semantic networks produced by individual central banks or groups of central banks.

My analysis reveals three key features of the semantic structure of scientized central bank knowledge production: First, while global organizational forms of knowledge production have diffused in the central banking field, the semantics, however, remain localized. This is to say that over time, the semantic structure becomes increasingly clustered roughly splitting into a cluster for the Federal Reserve System and a non-Federal Reserve System cluster. The non-FED cluster further splits into multiple smaller clusters over time. Second, a further analysis of the relationship between central banks and top journals in economics shows that only the FED system tightly aligns with the knowledge produced in academic circles. Third, differences emerging in-between clusters are not merely down to variation in mandates or political economic context, but rather depend on the direct policy environment of central banks. For example, the comparison between the FED cluster and the cluster including the European Central Bank (ECB) shows that individual policy fields are constituted differently on the semantic level. Beyond differences in how both clusters conceptualize policy fields, they also show differences in how these policy fields relate to each other.

The article continues as follows: the first section introduces central banking as a case of a policy field, which has undergone a scientization process over the past 30 years. The second section then conceptualizes this process in terms of dynamics within organizational fields and posits possible hypotheses on the emerging semantic structure within such a field. I then introduce my dataset and methods, followed by two analytical sections. The first analytical section presents the result of the semantic structure on the organizational field level, while the second section takes the cluster including the ECB and the FED cluster as examples to present differences on the semantic level itself. I conclude by discussing these results in the context of the current literature on the scientization of central banks and by providing possible explanations for the pattern observed in the analysis.

2. The scientization of central banks

The following section will shortly introduce the case of central banks as an organizational field, which has not only adopted new norms of what is considered authoritative knowledge, but also has adopted formal organizational structures to effectively diffuse norms within its field.

Central banks as an organizational form have spread in accordance to world-polity style diffusion processes in the early 20th century (Marcussen, 2005; Singleton, 2010; Martín-Aceña and Tortella, 2016). Since then, we have seen the spread of specific organizational norms on their institutional embedding within nation states (central bank independence) and policy framework (inflation targeting) (Polillo and Guillén, 2005; Wasserfallen, 2019). Norms on knowledge production have followed suit in the mid-90s when central banks underwent a rapid scientization process. While many central banks have engaged earlier with academia, the large-scale adoption of scientific knowledge production itself only became a norm in the 90s. This is to say that they began to coach their policy decisions in technocratic and seemingly scientific language rather than bureaucratic policy making (Marcussen, 2006, 2009).

This type of shift in knowledge production was made possible by mainly two factors: first, a general agreement by the stake holders of central banks, financial markets and the political system that inflation control was the primary task of central banks, inflation targeting was a legitimate way of conducting monetary policy and that central bank independence was the most efficient institutional setting for central banks (Braun and Downey, 2020). This agreement among the environment of central banks then allowed for the formalization of inflation targeting as an easily diffusible policy paradigm (McNamara, 2002; Walter, 2019), thereby providing the groundwork for its translation into common approaches within macroeconomics. Second, in response to the collapse of the Soviet Union, the central banking community at the same time built a large network of conferences, training sites and organizational training for the upcoming central banks in post-Soviet states. In the process of creating a training program for these new central banks, the global central banking community agreed upon cultural and organizational norms of central banking, thereby making them "diffusible" (Broome and Seabrooke, 2015; Johnson, 2016). The intellectual infrastructure still persists until this day and is one of the underlying reasons central bankers are often considered a global epistemic community. Since the move towards scientization, central banks have immensely increased their research capacity and often consider themselves as one of the foremost economics departments in their respective countries. Research

on this community of central bank researchers is relatively new, although previous research established that central bankers themselves either produce knowledge within their organizational field by themselves or entered into alliances with economists in academia to generate knowledge in an effort to transform their own organizational field (Baker, 2013b; Ban et al., 2016; McPhilemy, 2016; Claveau and Dion, 2018; Mudge and Vauchez, 2018; Thiemann et al., 2018; Backhouse and Cherrier, 2019; Thiemann et al., 2020; Thiemann, 2022).

Understanding the structure of knowledge production is therefore even more important in this organizational field, because the knowledge produced is not only for show, rather it can become instrumental in transforming the organizational field itself. However, the literature on the scientization of policy makers focus either on particular policy programs or on in-depth case studies of a policy making organization. Studies on the structure of knowledge production for an entire scientized policy field are still amiss. To gain further insights into how such a scientization process could be theorized the next section will examine central banking from an organizational field perspective and leverage this perspective to form expectations of the semantic structure underlying central bank scientization.

3. Organizational fields and central banks

First insights into the scientization process the central banking field is undergoing and its effect on the semantic structure of the field can be gained from a neo-institutional perspective on organizational fields. Organizational fields are defined as "those organizations that, in the aggregate, constitute a recognized area of institutional life" (DiMaggio and Powell, 1983, p. 148). In the case of central banking, the respective field is global and consists of all central banks in major economies. The world-polity literature suggests that in such a global organizational field, we can expect the emergence of a shared culture which diffuses globally (Strang and Meyer, 1993; Meyer et al., 1997). Scientization is one such cultural norm, which suggests to policy makers, that their policy making ought to be described in rationalized and scientific language. (Drori et al., 2006; Drori and Meyer, 2006). This coaching of policy decisions is used by policy makers to signal to their environment that policy problems are dealt with in a rational and scientific way. While scientization as a cultural norm also includes shared believes in the knowability of the social world, methodology and professional self-understanding, scientized knowledge "identifies patterns, organizes evidence, and maps and models relations" (Drori and Meyer, 2006, p. 64). The rationale for scientization is that decision making based on scientific knowledge purports to be universal, objective and outside of possible distributional conflicts. The invisibilization of distributional conflicts through the application of scientific knowledge is what makes it applicable without any concern over the local context the knowledge is used in. The universality of scientific knowledge is therefore the property of science, which makes it easily diffusible within organizational fields such as central banking (Fourcade, 2006). Crucially, such adoptions of cultural norms such as scientization serve to legitimize organizations in the eyes of its environment as members of the wider organizational field.

Indeed, a range of studies have shown that world-polity style diffusion of organizational forms has occurred in the central banking field. Marcussen (2005) has shown that central banks as organizations spread between nation states in the early 20th century (see Singleton, 2010 for a historical overview). Studies on the spread of central bank

independence, the now dominant institutional form of central banks, has shown similar patterns (McNamara, 2002; Polillo and Guillén, 2005). Beyond pure organizational forms, policy making practices have spread within the organizational field as well. Studies on the worldwide spread of inflation targeting have shown that even policy practices spread within the organizational field of central banks (Johnson, 2016; Wasserfallen, 2019).

Given the state of the literature on organizational fields and central banks, one would expect a close relationship between the knowledge production of central banks. This expectation is supported by studies showing the creation of an epistemic community of central banks (Haas, 1992; Kapstein, 1992; Verdun, 1999; Baker, 2013b; McPhilemy, 2016; Westermeier, 2018). Epistemic communities are considered actors who collectively hold similar world-views and organize in ways to implement those world-views. Johnson (2016), for example, shows how central banks in developed countries built training centers (this came in the form of specialized training centers, workshops, personal exchange to foreign central banks, training retreats and conferences) for upcoming central banks of post-soviet countries. As a side product of this training exercise, central bankers created cultural norms of what good monetary policy ought to be, while at the same time building the infrastructure to easily and rapidly diffuse policy knowledge within the organizational field. Given that central banks as an organizational field have built infrastructures of knowledge diffusion, adopted similar organizational forms for policy making and knowledge production itself, we would expect that over time the knowledge they produce would become more similar.

This expectation is, however, contradicted by a secondary literature on policy diffusion. In contrast to world-polity style diffusion, this literature assumes, that adoption of global norms requires translation efforts into local institutional contexts. Halliday and Carruthers (2007) show how changes made during the adoption of a global norm can recursively feed back into world polity, thereby effectively changing the norm itself. Chorev (2012) expanded on this and showed that nation states are more likely to adopt a global norm once nation states observe other seemingly similar nation states adopt the global norm with minor changes without losing legitimacy within world-polity.

The production of scientized knowledge during the scientization process therefore does not imply that all scientized knowledge produced by central banks has to be considered scientific within the hierarchy of economics for the generation of legitimacy. Within this hierarchy, only knowledge produced within the top of the profession, that is, the top US economics departments and journals, is perceived as objective enough to be recognized as science (Fourcade, 2006). Rather, scientized knowledge production by technocratic central banks merely signals to their environment that they deal with relevant policy problems in a rationalized way. For this signaling to produce legitimacy for central banks, it is often enough to adopt the language at the core of the economics profession without outright producing science as perceived in the field of economics (Fourcade, 2009; Reay, 2012; Schmidt-Wellenburg, 2018). This flexibility in possible forms of knowledge ranging from the perceived universality of science and the possible particularities of scientized knowledge production in central bank research departments suggests that economic knowledge is much more adoptable to context specific policy challenges of central banks without suffering legitimacy losses. This line of thinking would suggest that the underlying semantic structure of scientization is localized based on social, political and economic conditions, but not independent from each other.

This perspective is also supported by the literature on the adoption of organizational forms and knowledge by central banks. The literature has shown that the adoption of organizational norms requires a translation process, which in return makes the new organizational norm subject to political struggles within and outside the organization (Maman and Rosenhek, 2009, 2011; Ban, 2016; Mudge and Vauchez, 2018, 2022; Backhouse and Cherrier, 2019; Mandelkern, 2019; Ibrocevic, 2022; Yee, 2023). This notion is also reflected in studies on scientization in international organizations (Quark, 2012; Kentikelenis and Seabrooke, 2017; Zapp, 2018). Quark (2012) argues that actors adopt science as a standard for knowledge production; however, this in itself leads to scientized politics, that is, conflicts over what is considered the right science for policy problems. Mudge and Vauchez (2018), for example, show that the ECB might have taken up science as a form of knowledge production due to its embeddedness in a global field of central banking; however, the most important scientific export of the ECB, macroeconomic modelling techniques, was heavily influenced by the position of the ECB within the bureaucratic field of the EU, its position in global financial markets and the professional field of economics. The economic object created by these models, the European economy as a macroeconomic object separate from its constituent national economies, results in their analysis from the embeddedness of the central bank itself. Following this line of thinking and the literature of translation of global norms into local context, one would expect the semantic structure of scientized knowledge production to be fractured into central banks with similar positions within their global and national environments. This is to say that the resulting semantic structure should show a clustering of similar central banks, rather than a global increase in similarity.

To analyze the semantic structure in which knowledge is produced, I collected all available working paper written by all G20 and EU central banks in addition to all working papers by the International Monetary Fund (IMF) and the Bank of International Settlement (BIS). This dataset allows me to analyze the structural evolution within the organizational field of central banking within an ideal context for adoption: the production of abstract, scientized knowledge in the form of a well-standardized genre of economics working paper (Breslau and Yonay, 1999).

4. Data and method

The analysis of the semantic structure of an organizational field like central banking requires to gather all working papers by central banks. Working paper were collected via the RePEc database, the biggest database for economics articles available. Some central banks do not work with the RePEc database, and their working papers are therefore unavailable. For these central banks I used web-scrapping to collect their working paper in December 2020. I chose all central banks within the EU and G20 in addition to the IMF and BIS. This data collection process allowed me to gather 33780 working paper the period 1991–2020. Beyond the publication itself, the data collection yielded the abstract, keywords, title and authorship data for each publication. For the purposes of this study, only papers with abstracts were used. The Saudi Central Bank and the Reserve Bank of India are excluded from this analysis, as their working papers are only available in full-text PDFs.

Establishing the semantic structure of knowledge producing fields usually uses citation and co-citation analysis. Citation analysis, however, is problematic for the purposes of this

study, because these analytical tools require a reasonably complete citation record for all publication. This record is often provided by professional databases like Web of Science, which itself is provided the reference list by the publisher. This kind of data collection does not exist for working paper of central banks. While the RePEc database extract references from full-text PDFs automatically, the coverage ratio is too low to allow for reliable analysis via citation analysis.

Instead of citation analysis, I use quantitative text analysis to infer the relationship between the knowledge production within the organizational field of central banks. More specifically, I use semantic network analysis to extract the content and, more importantly, the structure of the intellectual field created by central banks. Semantic network analysis has important advantages compared to more common text analysis algorithms. While topic models work just as well to extract the content of a large corpus of documents, it requires extra steps to show the relationship between topics, documents, and the organizations they stem from. Semantic network analysis on the other hand performs just as well at extracting topics, while at the same time having the relational approach required for the analysis built in (Roth and Cointet, 2010; Lee and Martin, 2015; Rule et al., 2015; Bail, 2016; Hoffman, 2019; Fuhse et al., 2020).

The specific semantic networks calculated here are similarity networks between the abstracts of working papers written by central banks[1]. I use "textnets" an r-package, which implements the methodology of Bail (2016). I follow the bag-of-words approach, which assumes that texts can be represented by lists of words, rather than full sentences. Following this approach, I removed common stop words, numbers, and punctuations from the texts and lemmatized every token. Finally, I use a speech tagger which identifies nouns, proper nouns and compound nouns between adjectives and nouns. Previous studies have shown that it is mostly nouns which make up the important content of documents (Roth and Cointet, 2010; Bail, 2016). This approach produces a document-term-frequency (DTF) matrix. The DTF matrix represents all documents as a frequency distribution over all remaining words in the text corpus. To avoid over-estimating the significance of terms appearing too often or too rarely, I weight the DTF matrix using term-frequency-inverse document frequency scores. To infer a network between groupings of documents, the package then uses the bipartite DTF matrix to link organizations based on the co-presence of terms within their abstracts. A weight within the grouped network "is defined by the sum of the term-frequency-inverse document frequency for the overlapping terms" (Bail, 2016, p. 11828). The last step of the analysis is to cluster the resulting network using the Louvain clustering algorithm.

Beyond calculating relationships between central banks, I also use the method by Bail (2016) above to determine the periodization for my analysis. For this, I group all texts written in one year together and calculate the similarity between all years for the entire period. Three periods were found by this analysis. The first period ranges from 1991 to 1999—the period when central banks began adopting institutional norms from their scientific environment. It is in this period when the working paper as a new genre for the dissemination of knowledge became established. The next period is between 2000 and2010. During this period almost, all central banks have established working paper series. This also maps unto the time period which is commonly known as the Great Moderation in which the trifecta of inflation targeting, interest rate control and central bank independence as policy program, policy instrument and institutional arrangement of modern central banking came to

prominence (McNamara, 2002; Polillo and Guillén, 2005; Wasserfallen, 2019; Braun and Downey, 2020).

The disruption of the Great Financial Crisis on the organizational and institutional arrangement also shows in the periodization found by my analysis. The last period matches events in recent economic history. The immediate post-crisis period was marked with a reconfiguration of large parts of the economics profession and saw the emergence of new subfields within economics. More importantly, central banks swayed from their heavy use of macroeconomic models such as Dynamic Stochastic Equilibrium Models (DSGE), which were partially to blame for the crisis itself (Fligstein et al., 2014). It is also in this period, when large parts of the transnational regulatory framework were reworked and most central banks received mandates for financial stability (Baker, 2013b; McPhilemy, 2016; Lombardi and Moschella, 2017; Thiemann et al., 2020).

To analyze the network structure, I rely the description of network visualizations and modularity scores. The visualization of networks requires a sparsification algorithm, because similarity networks of large quantities of texts are too dense to identify patterns or find clusters. Following Bail (2016), I use a disparity filter, which removes ties below a threshold alpha. While the visual analysis provides insights into the relationship between different organizations to the professional field of economics, the calculation of modularity scores provides insights into the structure of the network. Modularity scores calculate the degree to which clusters form within a network. Clusters are defined as groups of nodes, which have dense connections within groups, but only sparse connections between groups. If the organizational field of central banks does become more similar over time, modularity should decrease over time. The results of the analysis are robust for different periodizations and alpha values (see Appendix A).

5. The semantic landscape of central bank knowledge production

This section shows how the organizational field of central banks has evolved over time. In the networks, an edge is produced if two organizations produce similar content in their abstract within one period. The thickness of the line indicates the level of similarity, while the color of the nodes indicates the results of the clustering algorithm.

Figure 1 shows the semantic structure of the central banking field for the entire period 1991–2020. Two large clusters form between the Federal Reserve System and the rest of the field. The only exception to this pattern is Mexico, which clusters with the Federal Reserve System. The non-FED cluster is itself split into three separate clusters. The most distant cluster from the Federal Reserve System is the cluster including Germany, Netherlands, Finland, the ECB and Luxembourg. The second cluster can roughly be described as consisting of Eastern European and Emerging Market economies. This cluster roughly surrounds the ECB cluster and is itself surrounded by a cluster including international organizations such as the IMF and the BIS, but also most non-European emerging economies and mid-sized European countries. This last cluster is also what connects the larger organizational field with the FED cluster.

Figure 1 already provides us with few indications of the semantic structure underlying central bank scientization. The large central banks at the top of the monetary hierarchy, the Federal Reserve, ECB or the Bank of England, are not at the center of the similarity network, which would indicate a role-model position within the organizational field. This role
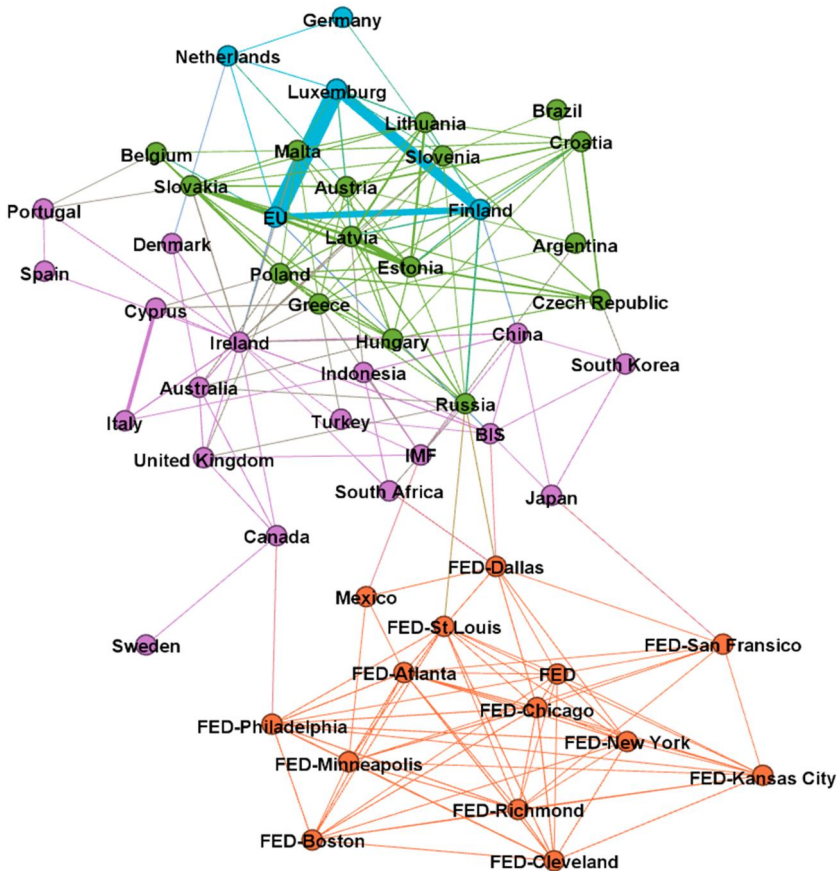
Figure 1. Similarity network of central banks between 1991 and 2020. Colors = clusters found by Louvain clustering. Alpha = 0.25.

is also not filled by organizations suggested by a world-polity approach, that is, the two international organizations BIS and IMF. Rather, the IMF and BIS at best could be considered facilitators between the two large clusters (Seitzer et al., 2023). Further, membership in the European Monitary Union (EMU) does not seem to be a factor for central bank knowledge production. Central European countries like Luxembourg, Germany and the Netherlands form a cluster with the ECB; however, other members of the European Monetary Union, independent of the size of their economies, do not seem to be closely aligned with this "core" cluster. Lastly, Eastern European central banks seem to cluster in their knowledge production, most likely due to their shared training experience in the 90ies, in spite of their vastly different political economies (Nölke and Vliegenthart, 2009).

While the analysis of the entire period already shows that the field of central bank knowledge production is not as homogeneous as the literature on diffusion of central banking norms would suggest, a closer look at the individual periods shows how the semantic structure becomes more modular over time. Further, the graph shows how late adopters of

central bank scientization embed themselves into the existing field of knowledge production.

Figure 2 shows the semantic network for the first period 1991–1999. At this point in time, only few central banks have adopted working papers as a genre of writing. Most of them only have very few working papers; it is mostly the members of the FED system (FEDs), which have established working paper series. Three aspects appear important in this first period: First, the FEDs do not all cluster together, but rather are more dispersed between other central banks. Second, except for the large FED cluster, there does not seem to be clear cut regional clustering, beyond the fact that with the exception of the Canadian central bank, only the Federal reserve and ECBs have joined into the scientized knowledge production of central banks at this point. Furthermore, the IMF and BIS have yet to take their position at the heart of the semantic network. The results of the first period should not be overestimated, because some central banks only established research departments during the period and have published too few working papers to make strong claims about their similarity to other central banks and presumably an understanding of what constitutes the genre of central bank working paper has not established itself yet.
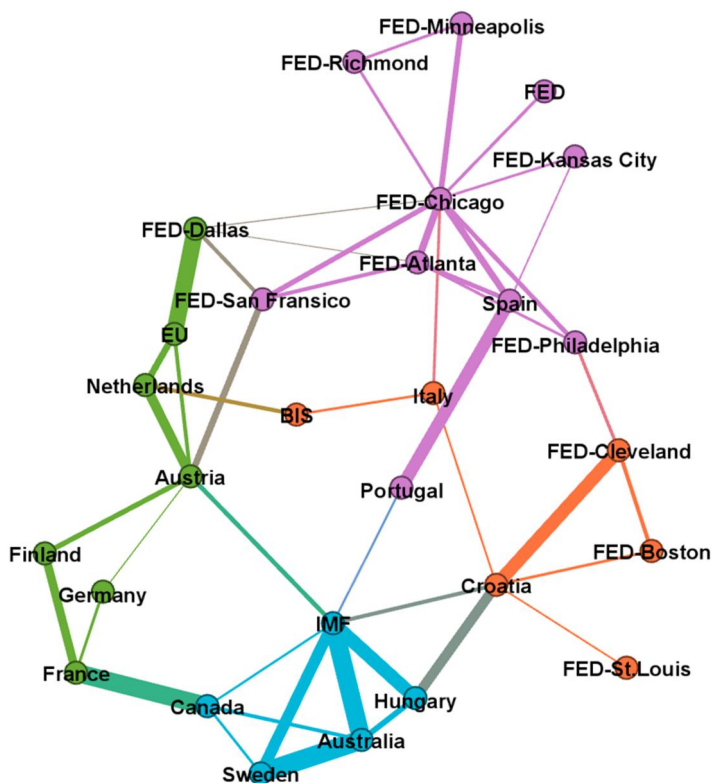

Figure 2. Similarity network between central banks in-between 1991–1999. Colors = clusters found by Louvain clustering. Alpha = 0.225. Alpha = 0.225. Modularity = 0.5.

Figure 3 shows the network for the period of 2000–2010. By this point in time, most central banks have adopted working papers as a genre of writing. In contrast to the previous period, the clustering of the network has progressed, that is, groups have higher in-group connections than out-group connections. The FEDs largely begin to cluster together; however, some exceptions remain. The non-FED part of the organizational field is barely connected to the Federal Reserve System, with the exception of the FED-Dallas and FED-San Francisco. Eastern European countries begin to cluster together; however, the cluster is surprisingly not as clear cut as in the network over the entire period or in the last period. The BIS during this period is closely connected to emerging economies in Japan, South Korea, Turkey, Mexico and South Africa, while the IMF shows greater similarity with ECBs.

The last period 2011–2020 continues the trend from previous periods (Fig. 4). The network has become even more clustered. Eastern European central banks form their own cluster, suggesting that the training activities of the central bank community had lasting effects on the scientized knowledge production by these central banks in spite of differences in the political economies of Eastern European countries (Nölke and Vliegenthart, 2009). Against
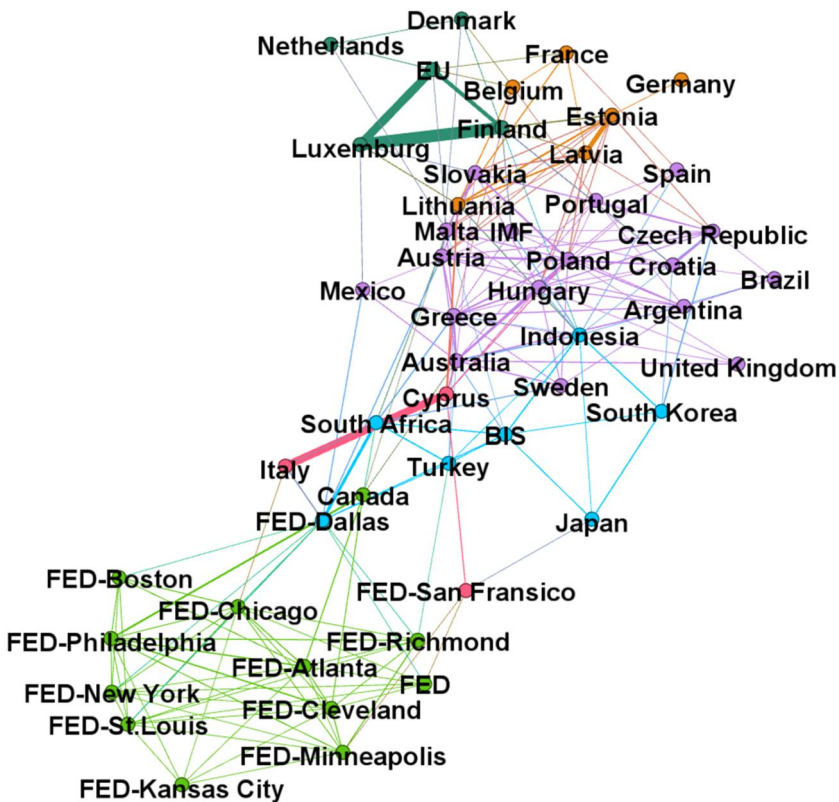

Figure 3. Similarity network between central banks in between 2000 and 2010. Colors = clusters found by Louvain clustering. Alpha = 0.27. Modularity = 0.488.

Figure 4. Similarity network between central banks in between 2011 and 2020. Colors = clusters found by Louvain clustering. Alpha = 0.25. Modularity = 0.53.

this backdrop, the inclusion of the Austrian central bank in the Eastern European cluster is plausible, as one of the primary training facilities for Eastern European central banks is the Joint Vienna Institute, which itself operates under the auspices of the Austrian central bank (Johnson, 2016). The ECB still remains their close relationship with the central bank of Luxembourg, Finland and Germany. Compared to previous periods, the IMF and BIS are now position close to each other and connect a number of non-European emerging economies with each other. Most strikingly, the FED system has now split of into their own cluster with the exception of Mexico. The last cluster, however, does not conform to a clear pattern. While the IMF and BIS are unsurprisingly positioned at the center of mostly emerging economies or countries which were engulfed in the European Sovereign Debt crisis, other countries such as Sweden, Belgium, Denmark, Canada and Australia show semantic similarity without a straight forward explanation.

So far, the analysis of the organizational field of central bank knowledge production has shown that the semantic structure of the organizational field has not become more homogeneous. Rather, the organizational field has clustered into two large clusters. The FED cluster as a distinct area of economic thinking from the rest of the organizational field. The non-FED field in return has clustered into three smaller groups based roughly on either regional similarity in the case of the Eastern European cluster or seemingly similar economic ideology in the case of the ECB cluster. The third cluster in part shows a similar pattern. The central banks surrounding the IMF and BIS are all either emerging economies or under conditionality of the IMF (Greece). While the rest of the clusters seem to be rather ambiguous in their relationship towards the rest of the network, none of these clusters are, however, entirely clear cut. The FED cluster includes Mexico, while the Eastern European Cluster contains Malta.

5.1 The exception to the rule: the Federal Reserve System's position in academic economics

Even though the above analysis of the semantic network suggests an increased clustering of central banks into relatively distinct groups of knowledge production, one question remains: How can the most prolific producer of central bank knowledge the Federal Reserve System, the guardian of the world currency, be separate from the rest of the organizational field it regularly serves as a role model for?

One plausible explanation lies in the development of the economics profession and its relationship with the US bureaucracies. As Fourcade (2009) argues, the lack of a traditional role for public servants and a general distrust of state intervention meant that US government officials derived their legitimacy as policy makers from their membership in a profession. The identification with professional standards set within elite US economics departments (Fourcade, 2006) allowed policy makers to supply seemingly non-partisan, technical expertise, which would banish political considerations from policy making. Both state bureaucracies and academic economists view the free market and market economies as the default reference category for an ideal relationship between the state and the economy.

Against the historical and institutional background of the US economics profession, one expectation could be that a scientized Federal Reserve System would align itself with the institution it partially derives its professional legitimacy from: academia. To test this explanation, I repeated the above analysis, but this time I included the most important journals in economics, macroeconomic and finance. Academic journals were chosen based on two factors: their prestige within economics and their topical relation to central banks (macroeconomics and finance). This resulted in the inclusion of the big five journals in economics (Rath and Wohlrabe, 2016; Wohlrabe, 2016). To determine the top journals in finance and macroeconomics, I compared rankings and accumulated a list of top journals. Most rankings of economic subfields come to comparable results on the importance of the top journals (Kodrzycki and Yu, 2006; Kohlscheen, 2011; Rath and Wohlrabe, 2016; Wohlrabe, 2016). 33 664 journal articles were collected.

Figure 5 shows the network for the period 1991–2020. The network does indeed split into two large clusters: The Federal Reserve System (and Mexico), which is tightly connected to the output of academic journals and the entire rest of the organizational field. The only smaller cluster left consists of finance journals, which are, however, still mostly connected to the FED/journal cluster.

The semantic network observed between the scientized central banking field and economic science and the analysis of the organizational field above indicates that indeed not all central banks produce knowledge similar to the most prestigious academic outlets in the economics profession. The Federal Reserves are much more aligned with the knowledge produced in the prestigious outlets of academic economics, whereas every other central bank (with the exception of Mexico) is either not willing or able to produce knowledge similar to the mainstream of academic economic thinking. One possible explanation relates to market economies as a reference category developed in the historical and institutional context of the US economics profession. The US economics profession is not faced with the same policy problems as economists outside the US, due to its position in the international political economy. Policy areas such as exchange rate regimes, capital flight during financial crisis, trade imbalances or exchange rate volatility play almost no role for the US, which
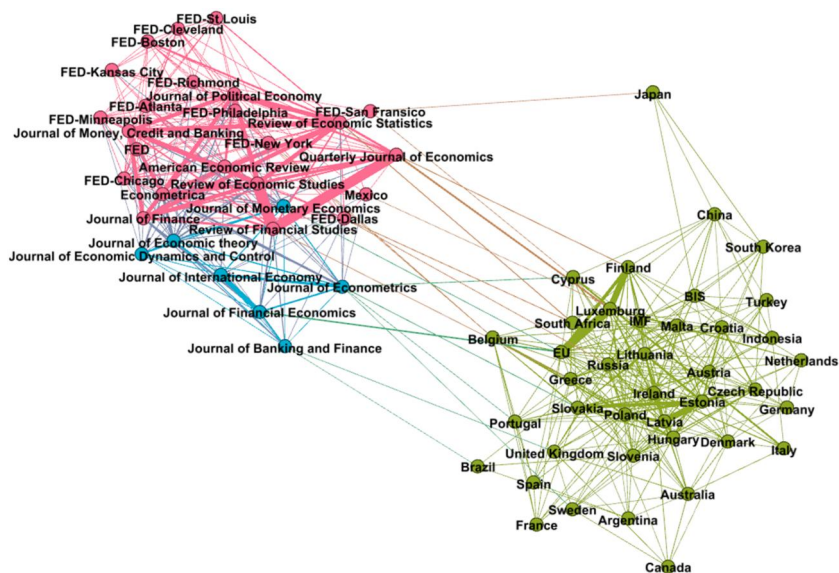
Figure 5. Similarity between central banks and top economics journals in the period in between 1991 and 2020.

controls the global reserve currency and is the biggest economy in the world (Schwartz, 2019; Pape, 2022). Put differently, policy problems faced by central banks outside the US that deviate from the ideal of a US market economy are seen as pathologies of their political economies, rather than legitimate ways of organizing the economy from the point of view of US economic thinking.

This result suggests that these central banks do not produce knowledge akin to what is perceived by the economics profession as the most scientific form of knowledge, that is, the most abstract and considered to be the most objective form of knowledge. More importantly, however, is that the increased modularity in the semantic network indicates not only that variation in knowledge production remains, but intensifies over time. A crucial question remains from the analysis above: if variation in economic thinking persist or even increases, what are possible explanations for the differences observed on the organizational level? The next section provides insights into how these differences come about by zooming into the semantic relationships created by the working papers of the two most distant clusters: the ECB and the FED cluster.

6. Spotting the difference: the meaning-structure within clusters

The above analysis has shown that the meaning-structure of an organizational field such as central banking does not become more homogeneous over time, but rather splits into mostly regionalized clusters. However, the analysis itself is rather abstract, since it is not clear where the difference in the meaning-structure lies. Is it, for example, differences in the large topics covered or the way similar policy areas are viewed differently in various parts of the organizational field? To gain insights into these questions, I have constructed word

co-occurrence networks following the methodology outlined by Rule et al (2015) for the two clusters furthest apart in the last period of analysis: The FED cluster and the ECB cluster.

Figure 6 shows the resulting ECB cluster network, while Fig. 7 shows the same network for the Federal Reserve cluster. Differences appear in almost all meaningful properties of the semantic network. The structure of the networks themselves differs. While the FED cluster has a number of tightly connected topics surrounding monetary policy (the light green topic), the ECB cluster is significantly more modular (topics are more distinct from each other). This suggests that for the ECB macroeconomic policy areas perceived to be semantically more distinct. While the topics themselves appear to be more distinct, the mere existence of a wider array of topics covered by the ECB cluster seems to indicate that more areas of macroeconomic policy making are perceived to be necessary by the ECB cluster to fulfill its role as a central bank than the FED cluster.

Differences do not only persist between topics covered or their relation to each other, but also in the way policy areas are constituted on the semantic level. Take for example the topic for monetary policy, the core policy area for central banks (Figs. 8 and 9). Again, the FED network includes significantly more words regarding formal modeling compared to the ECB. Further, the ECB cluster includes a different mix of policy considerations within their monetary policy topic. It includes words in regard to sovereign debt crisis, that is, fiscal policy, but also financial stability and quantitative easing. This indicates that monetary policy is institutionally inter-twined with other macroeconomic policy areas in spite the more modular structure of the entire semantic network compared to the FED. Contrast this with the FED cluster, which only includes fiscal policy as inputs for formal models, while largely ignoring financial markets and quantitative easing. The only exception to this is exchange rate regimes; however, these might appear in the FED cluster due to the inclusion of Mexico into the analysis of co-word occurrences.

7. Discussion and conclusion

The scientization of central banks has been considered one of the latest shifts in a long line of organizational transformation within central banking. I have examined scientization as a dynamic process where organizations adopt norms to signal to their environment a rationalized handling of policy problems. I go beyond mere adoption to explore the semantic structure of scientization processes. My findings indicate that while central bank scientization may have spread within the central banking field as suggested by world-polity scholars, the knowledge produced within the field does not align with the same pattern. The analysis showed that central bank knowledge production becomes more modular over time, that is, knowledge produced by central banks becomes increasingly distinct. More importantly, this clustering of central banks into distinct knowledge production clusters progresses even as other formal organizational variables point towards an increase in scientization. The semantic structure of scientized knowledge production therefore does not follow the same world-polity style adoption of what are legitimate problems to be researched by central banks. This is in spite of the wide-spread adoption of organizational norms on how and by whom scientized knowledge can be produced, the adoption of organizational norms by nation states on the institutional environment of central banks (central bank independence
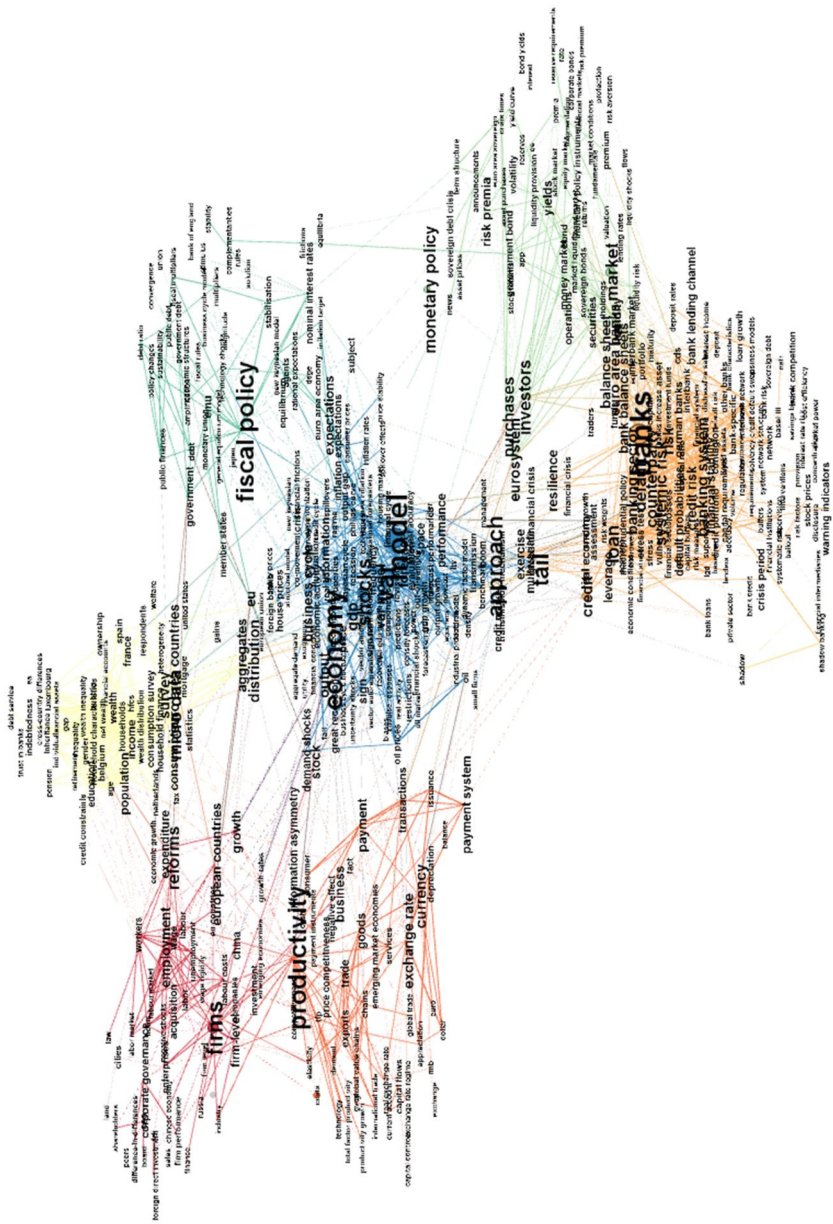
Figure 6. Co-Word network 2011–2020 ECB cluster (ECB, Germany, Luxembourg, Finland). Colors = topics, label size = inbetweenness centrality.
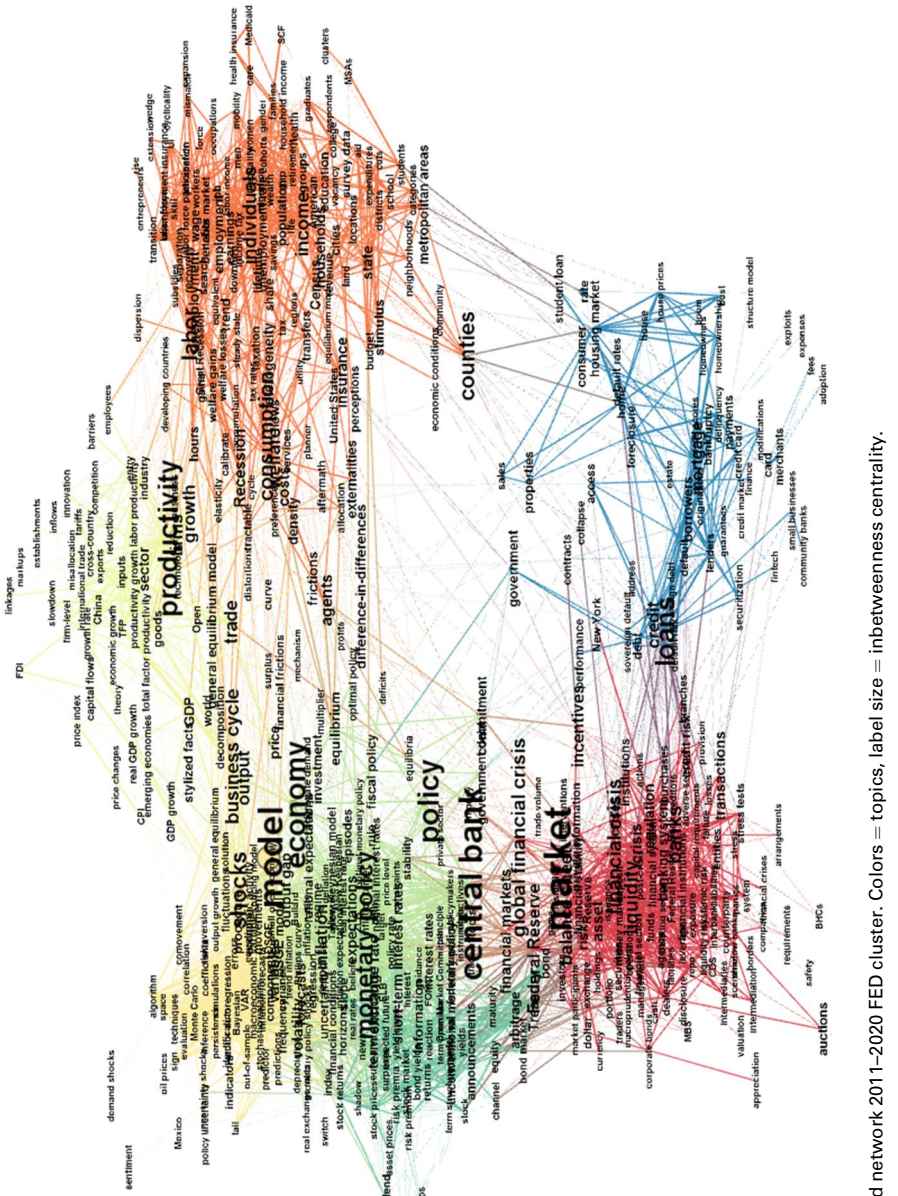
Figure 7. Co-Word network 2011–2020 FED cluster. Colors = topics, label size = inbetweenness centrality.

Figure 8. Monetary policy topic for the FED cluster.

Figure 9. Monetary policy topic for the ECB cluster.

and inflation targeting) and the emergence of an epistemic community of central bankers supported by an infrastructure specifically built to diffuse knowledge.

However, the alternative hypothesis of knowledge being determined by localized political struggles or the position of a central bank in a variety of overlapping global and local fields is

not entirely borne out either. The emerging cluster of Eastern European central banks persists and becomes more distinct from other central banks even though their political economies, position in monetary hierarchies and economic conditions diverge over time. This might be due to soviet economic thinking thoroughly being discredited by the fall of the iron curtain. Scientized knowledge production of central banks in post-Soviet states was therefore not contested by a local tradition of economics, which co-evolved with the state bureaucracies. Beyond the Eastern European cluster, central banks within currency areas do not clearly align either. Members in the European Monetary Union, or for that matter European Union, do not become more similar over time, nor does the ECB become the most central actor among these central banks. Rather, a small number surrounding the ECB become more similar over time, but remain distinct from the rest of the EMU or EU central banks. Among the clusters of central banks, the Federal Reserve cluster is most distinct from the rest of the field.

The addition of the most prestigious economics journal into the semantic network shows that the Federal Reserve System closely aligns their knowledge production with the institution scientized knowledge production mimics: academia. Taken together the analysis of the semantic networks of scientized knowledge production of central banks disprove a number of commonly assumed properties of scientization: First, central bank scientization does not lead to homogenization of scientized knowledge production within the central banking field. Second, the biggest central banks in the world (ECB, FED, Bank of England) are not the most central actors within the semantic network. Third, central banks are not homogeneous actors within the semantic network; rather, localized clusters of economic thinking emerge. Lastly, not all central banks produce knowledge, which is comparable to what is considered the most scientific knowledge produced in top US journals; this is only done by the Federal Reserve System and Mexico. These last two points become especially clear in the comparison of semantics within the ECB and FED clusters. The analysis shows that differences do not only emerge in the economic problems researched by central banks, but also how these economic problems relate to each other and are themselves constituted. While the ECB cluster produces knowledge on a wider array of more distinct policy problems, the FED cluster deals with fewer but fuzzier policy areas. However, while the FED cluster has less distinct topics, it does include a much higher degree of words relating to DSGE modelling and other formal models typically considered as "boundary objects" (Gieryn, 1983; Thiemann, 2022) within economic science. In contrast, the ECB cluster has more distinct topics, but these topics themselves include words relating to other macroeconomic policy areas. These macroeconomic policies are in contrast to the FED not coached in the language of formal mathematical models, but rather in real and local policy institutions within the European Union.

The presence of formal modeling, the purity of macroeconomic policy making and the position of these clusters in the larger semantic network provide some indication of what explains the pattern we find in the semantic network of scientized knowledge production. Macroeconomic policy making within the EMU is institutionally more complex compared to the USA, especially after the Great Financial Crisis monetary policy has become institutionally more complex. Unconventional monetary policy in the context of the European Sovereign Debt Crisis has led to a coalescence of previously distinct areas of macroeconomic policy making, which is exacerbated by concerns over financial stability (Gabor, 2016). Conducting "standard" monetary policy within the EMU is therefore much more "contaminated" by other policy areas. Compared to the US context, where some of these issues are also true, policy areas are much easier to be purified from each other. This is

despite the dense relationship between clusters. This purification of policy areas is also what sets the pre-conditions for the Federal Reserves to produce economic science proper, since purification of policy areas allows for much easier formalization of policy problems into economic boundary objects, that is, DSGE and other modelling techniques.

The analysis shows that scientized knowledge production in policy making fields does not entirely follow a strict policy making logic, nor does it adhere to the hierarchy of knowledge production of economics or the organizational field. Rather, it appears that knowledge production develops its own logic. Over time, organizations appear to undergo a differentiation process, in which scientized knowledge production develops its own institutional dynamics. This result is in line with previous research in the world-polity literature indicating a regionalization effect in the field of international organizations (Beckfield, 2010). Future research should treat these emerging dynamics as objects of inquiry in their own right, rather than seeing them as residues of either the scientific or local field constellations.

While this study was able to empirically show the dynamics of scientized knowledge production in a policy making field, it was unable to provide causal explanations of why these patterns emerge. Future research should investigate plausible explanations further. Similarity could emerge due to personal overlaps between organizations or fields. For example, one could expect that most FED researchers received their PhDs from top US economics departments. They therefore would have the tacit knowledge of what kind of research is expected for top journal publications and also co-author with their former colleagues in academia. Similarly, authors within the European Monetary Union are more likely to have been seconded or professionally worked with members of other central banks in transnational working groups, possibly leading to increased co-authorship between central banks or a common understanding of policy problems and therefore increased semantic similarity. Future research could for example analyze co-authorship data to establish overlap between professional networks or collect career histories of economists working in central banks to see if common educational background leads to increased semantic similarity.

Note

1. Non-English abstracts were translated to English via DeepL (De Vries et al., 2018; Proksch et al., 2019)

Acknowledgements

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Appendix A

While the graphical depiction of networks for each period provides descriptive insights into the structure of the organizational field of central banks and its relationship to the academic field, the depiction itself is the outcome of the sparsification algorithm or the periodization chosen. To test whether the clustering is a robust finding and not an artifact of either periodization or network sparsification, I calculate the modularity scores for networks in a 5-year moving time window for different values of the sparsification parameter alpha. As can be seen in Fig. 10, for reasonable values of alpha, the modularity increases over time. As expected, the slope of the trend decreases with increases in alpha, because higher values of alpha lower the threshold for inclusion of a similarity tie within the network. Lastly, modularity also decreases for higher alphas, because the inclusion of more similarity ties increases the ties between clusters and therefore reduces the total modularity score.
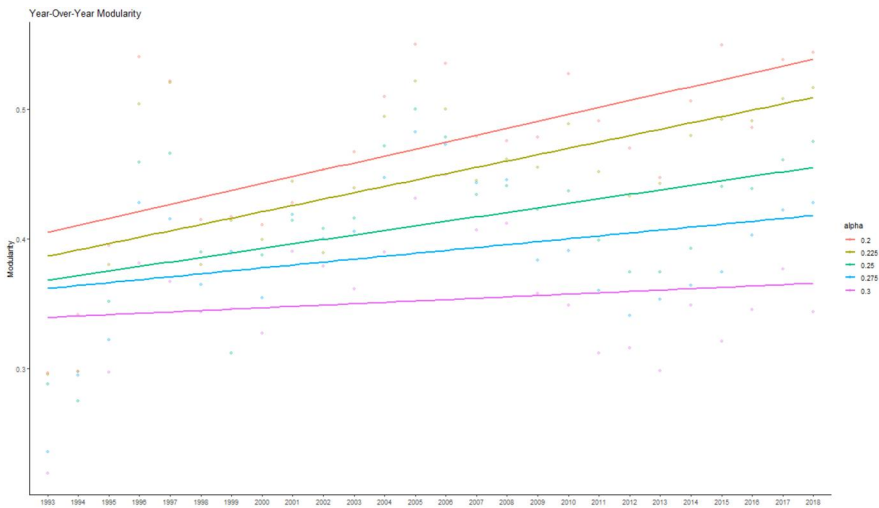

Figure 10. Modularity scores for moving 5-year time window over the entire period and linear trends for each value of alpha.