Towards Networked Varieties of Capitalism: Embracing Supply-side Complexity As a Post-pandemic Research Agenda

By Rashid C.J. Marcano Rivera*

Globalization suggests the convergence of national markets into a single capitalist system. Yet, evidence highlights the distinctiveness of different capitalisms based on firm, industry, and government-business relations. Do these varieties remain distinct or converge? I conceptually connect the rich descriptions of Varieties of Capitalism literature to social network analysis, proposing a new research agenda to explore contemporary economies' breadth and complexity, examining their structural transformations. An empirical section applies this approach to 76 shareholder networks at the country level from 2007 to 2019, using network density, finding conditional divergence and increased variance in behavioral outcomes beyond Western-centric categories.
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I. Introduction

In this article, I apply network analysis to enhance and further understanding of Varieties of Capitalism (VoC) in the twenty-first century.[1] VoC, one of the branches of Comparative Capitalism (CC) literature, considers the study of the political economy to be best understood by focusing on the firm from a relational standpoint (Hall and Soskice, 2001, 6). In this perspective, a firm navigates a series of challenges requiring a cohesive resolution across various sectors and levels of the economy: the financial system or corporate governance market, the firm's internal structure, labor/industrial relations, education and training systems, and inter-business relations. These coordinated decisions gradually shape an entrepreneurial culture and aggregate at the national level, forming patterns of complementary decisions, thus delineating different distinct types of capitalism.

While the role of firms is central to the VoC framework, it is essential to recognize the broader set of institutional structures that shape different VOCs. Factors such as the development and constitution of the skill-acquisition and education systems (Busemeyer and Trampusch, 2012; Busemeyer and Goerres, 2014), as well as the historical formation of dominant class fractions and alliances, and their associated ideologies, also play a crucial role in the development and sustenance of particular VOCs (Amable, 2003; Amable and Palombarini, 2009; Nölke et al., 2019; Schedelik et al., 2020). These elements interact with the firm-level organization of the economy, contributing to the national institutional fabric. However, this study focuses on corporate ownership and governance networks because firms act as pivotal nodes where various institutional forces converge. Understanding firm-level interactions, especially in the context of globalization and financialization, offers a specific lens through which the broader complexities of capitalism, such as observable patterns within ownership networks, can be analyzed.

This article aims to identify dynamic changes in VOCs and analyze countries' affiliations to certain categories of capitalism. By focusing on the period before and after the Global Financial Crisis (GFC) of 2007-2008, a time period marked by significant economic restructuring, I explore how capitalist systems adapt in times of systemic shocks. To accomplish this, I connect the VoC literature to techniques provided by network science, also known as social network analysis. By characterizing and examining shareholder networks of nineteen different countries, I assess the extent to which expectations of relational distinctiveness hold within these changing environments. While VOC posits a resilient and divergent typology for market economies against notions of a convergent or singular type of global capitalism (Hall

* Assistant Professor of Quantitative Sociology, University of Puerto Rico, Río Piedras Campus, rashid.marcano@upr.edu

[1] From this point on I use VoC referring to the background literature, and VOC referring to the typologies.

and Soskice, 2001, 56-60), authors have noted that financialization and globalization might perturb the stability of regulatory regimes and national institutions due to competitive pressures via developments in the sphere of the *market for corporate governance* (2001, 60-62). This raises the question: Are differences between VOC types in the sphere of the "financial system or market for corporate governance" distinct and stable, or have they been eroded towards convergence? (2001, 22-24) More crucially, how can we test whether this is happening?

I propose that we test and answer these questions using Social Network Analysis (SNA) I begin by reintroducing in Section II the foundational concepts of VoC and their subsequent theoretical extensions. Then, in Section III, I clarify what SNA can offer the VoC approach by mapping the latter's concepts onto SNA measures. Section IV examines the data generation process and operationalization, and details the methodology used for the empirical SNA analysis conducted in Section V. The article concludes with a summary and reviews potential paths for future research in Section VI.

II. VoC heretofore

VoC represents a key strand within the broader CC literature, building on earlier explorations of capitalist diversity. In response to simplified analyses of advanced market economies, VoC reclassified market economies into several distinct types: Liberal, Co-ordinated, Mediterranean or Mixed (Hall and Soskice, 2001; Hall and Gingerich, 2009), as well as Hierarchical and State Market Economies (Schneider, 2009, 2013; Molina and Rhodes, 2008) — LMEs, CMEs, MMEs, HMEs, and SMEs, respectively.[2] Each of these types represents a unique set of institutional complementarities across dimensions such as financial systems, labor relations, skill formation systems, corporate governance, and state intervention. By distinguishing among these types, VoC establishes a framework for understanding the variety within capitalist systems, framing itself as a critical tool for examining contemporary patterns of economic coordination.

The roots of VoC may be traced back to the earlier CC literature, which focused on institutional differences between the advanced countries of Western Europe. Andrew Shonfield's work in the 1960s outlined three archetypes of capitalism based on different coordination strategies involving the state, banks, and equity markets: a British "liberal" type, a German "corporatist" type, and a French "statist" type (Shonfield, 1965). This threefold approach to the typologies of capitalism continued into the 1970s and the 1980s in Katzenstein (1977), Katzenstein et al. (1978), and Zysman (1983). However, by the 1990s, as history seemed to end for some and the state retreated, corporatism and statism were dropped from the analysis of advanced capitalist societies, as the discourse shifted towards notions of convergence towards liberalism through privatization, deregulation, and market expansion (Schmidt, 2016; Strange et al., 1996; Waringo, 1999). This shift prompted a reevaluation of capitalist diversity, as globalization appeared to erode the distinctions between economic systems.

However, despite these convergence narratives, economic realities often still diverged. Globalization did not lead to the expected convergence of the world economic system (Abel and Bernanke, 2003; Gerschenkron, 1962; Samuelson and Nordhaus, 2005; Solow, 1956); in fact, the International Monetary Fund characterized the era as one of "divergence, big time" (Pritchett, 1995; IMF, 2000, 156), and political economists observed "no evidence of convergence ... over the postwar era" (Acemoglu, 2009, 17). The VoC framework emerged as a response to this continued divergence, challenging the convergence thesis by proposing that capitalism remains inherently pluralistic due to national institutional arrangements that resist homogenization. VoC posits that capitalist systems do not follow a single developmental trajectory, but are instead shaped by country-specific institutional complementarities. Consequently, VoC reasserted the relevance of classifying market economies into distinct categories, each shaped by a unique set of institutional relationships.

[2]Other responses have focused on explaining other factors that could explain differentiated paths of development of many countries, such as the literature on law, finance, institutions, and economic growth nexus, where some recent evidence would be partial to tying financial activities and financial sector development to conditional convergence (Aghion, Howitt and Mayer-Foulkes, 2005; Effiong, 2015; Fung, 2009). A more interesting demand-side approach, growth models, highlights the centrality of aggregate demand, income distributions, and social policies in economic development (Baccaro and Pontusson, 2016). The latter points at paths forward that merit serious consideration in the broader discourse of comparative and global political economy.

A. *Varieties of capitalism: convergence or divergence?*

In the VoC literature, *firms* are pivotal in the analysis of different economic systems. Firms navigate their institutional environments through strategic interactions that align with their needs, influencing decisions across various sectors and, in turn, shaping social, political, and economic spheres (Hall and Soskice, 2001). From this perspective, a rich body of literature has developed, one that explores how capitalism interacts with national institutions through institutional complementarities across dimensions such as financial systems, inter-firm relations, corporate ownership, and vocational training and education systems (Amable, 2003; Hall, 2015; Hall and Soskice, 2001; Hancké, Rhodes and Thatcher, 2007; Redding, 2005; Schneider, 2009; Whitley, 1999; Witt and Redding, 2013). These complementarities define ideal types of capitalism and offer a framework to explain how distinct varieties of capitalism exist and reproduce themselves.

Given the diversity of capitalist typologies in VoC – including LMEs, CMEs, MMEs, HMEs, or SMEs, among others – it becomes essential to examine whether these distinctions hold amidst the pressures of globalization and financialization. This leads to the core question: do the various types of capitalism converge or remain distinctive over time? This study addresses this question by focusing on the market for corporate governance as originally laid out by Hall and Soskice (2001) and employing network analysis to assess patterns within ownership networks. By linking VoC theory to empirical analysis, I aim to determine whether convergence is occurring or whether VoC typologies remain robust against global economic pressures.

The presence of market versus bank-based financial systems serves as a cornerstone of VoC's construing of political economies (Hardie et al., 2013). Market-based financial systems are typically associated with LMEs, while CMEs feature a prominent presence of bank-based systems and patient capital behavior (Vitols, 2004; Martinsson, 2009; Deeg, Hardie and Maxfield, 2016). This is because the mechanisms through which firms secure financing for their operations and investments have different sets of expectations depending on whether the financial architecture is geared more towards short-term returns vis-à-vis long-term, patient capital. This structurally influences the behavior of a firm to meet said expectations. This affects, for instance, whether firms retain skilled-labour in economic downturns, or how they conduct long-term planning, with various effects in production and for society as a whole (Roberts and Kwon, 2017). From the relational aspect, dense networks are formed by CME firms to solve for information needs in financing (Hall and Soskice, 2001, 22-23), leading to more consensual decision-making. This dichotomy between LME and CME countries has been criticized on various grounds, such as how it ignores other types of investors including venture capitalists (Klingler-Vidra, 2016), which may be characterized as a hybrid between these two types of systems. Others authors have focused on adding flexibility to the understanding of the manifestations of these archetypes, by noting the presence of both coordinated and uncoordinated institutions across established dimensions in both CME and LME countries (Witt and Jackson, 2016).

As hinted at earlier, VoC has expanded beyond Europe and the so-called "West", to include other VOCs such as HMEs, SMEs, East Asian capitalism, Dependent Market Economies, among others (Carney, Gedajlovic and Yang, 2009; Hall and Gingerich, 2009; Lane and Myant, 2007; Molina and Rhodes, 2008; Nölke et al., 2015; Nölke and Vliegenthart, 2009; Schneider, 2009).[3] Here, I quickly describe what the behaviors on inter-firm relations and corporate finance are in the VOCs other than the CMEs and LMEs represented in the dataset.

HMEs feature hierarchical relations, as "most firms are directly controlled and managed by their owners, either prominent families or foreign firms", such as multinational corporations (Schneider, 2009, 557). These firms exhibit high variance in their behaviors, ranging from healthy or elevated levels of competition to oligopolies or heavy state regulation, depending on the sector. Firms in HME countries tend to be directly controlled and managed in their corporate governance, while inter-firm coordination relations with other firms (e.g. suppliers, clients), access to technology, standard-setting, collaborative research and development, etc. — all these tend to focus on policy and politics rather than sectoral governance, unlike in CMEs (Schneider, 2009, 557-561). Multinational corporations and family-owned

[3]State Market Economies were originally described as State-permeated or State-led Market Economies, the more common term presently is simply State Market Economies. Dependent Market Economies are not incorporated yet into this analysis.

domestic groups largely govern economic coordination in these countries, often inhibiting market access in sectors like corporate governance and inter-firm relations by removing or *delisting* firms' securities and shares from the exchange or equity markets (2009, 565-566).[4] These actions can distort data on shareholding patterns, as multinationals may delist local subsidiaries, while local groups maintain voting control on listed companies, discouraging minority investors, self-governance, and hostile takeovers (38-41; 566).

MMEs, which were initially sketched in Hall and Soskice (2001), present an intermediate case between CME and LME characteristics (Molina and Rhodes, 2008, 224-228), with fragmented actor groups, and the State as a pervasive market regulator that compensates for market failures of coordination. This is illustrated in Figure 1 (below), where lower market capitalization in HMEs and MMEs contrast with the higher values seen in CMEs and LMEs. While closer to CMEs, the lack of clear cross-class or sectoral alliances and perceived incongruities between complementarities makes them more susceptible to liberalization in finance and other areas. Thus, MMEs should over time approach and even converge with LMEs in financial market behavior (Molina and Rhodes, 2008, 236), despite the underdevelopment of their financial markets (idid., 224).

Moving on to State Market Economies (SMEs), it is noted that capitalist actors in SMEs prioritize short-term financial investments over long-term development strategies (Nölke, 2018, 279). The States' role in the ownership of banks is clearly dominant, with India and China, the cases studied as SMEs, reportedly having control of 99% of bank assets during the 2000s via state-owned banks compared to vastly smaller numbers from most CME and LME countries (Bertay, Demirgüç-Kunt and Huizinga, 2015). SME strategies compensate for the short-term preferences of individuals and multinational corporations, as public banks are not likely to withdraw funding during an economic crisis to decrease exposure. With less reliance on equity markets, this VOC should display more community-like behaviors due to the different investment patterns of state banks, foreign, and local investors, as seen in Figure 1. This figure highlights the "underdevelopment" of financial networks attributed to SMEs (as well as MMEs and HMEs, for that matter), which are lower in comparison to LME and CME countries.

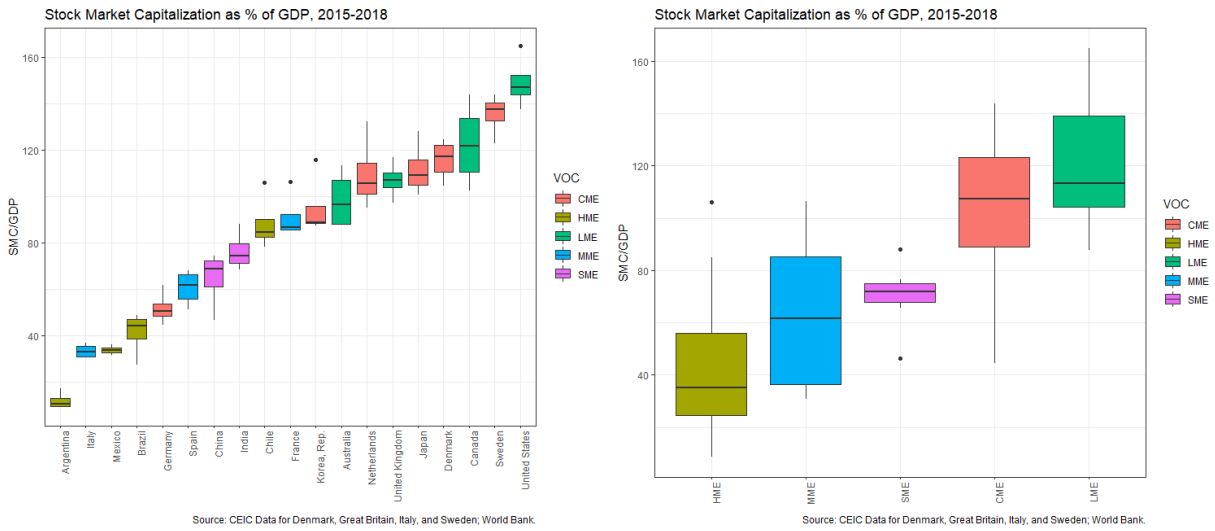

Figure 1. : Stock market capitalization of domestic firms as % of GDP by country and VOC type

[4]Coordination here refers to the "issues of coordination" firms must resolve, central to their competencies across the five areas described in Hall and Soskice (2001).

B. Critiques: lack of dynamism and direct measurements

In response to critics who have focused on the lack of dynamics in VoC analysis, its reductive and functionalist firm-centrism, and its allegedly superficial understanding of the variance exhibited between cases, there has been a further expansion in VoC analysis (Amable, 2003; Ebenau, 2012; Hancké, Rhodes and Thatcher, 2007; Lane and Myant, 2007; Schneider, 2009). Nevertheless, the qualitatively constructed VoC literature is, to some extent, still built upon ad hoc assumption-based archetypes lacking tractability, according to Hall (2015, 5-6) and Witt and Redding (2013, 269-270). Central concepts in VoC theory are nearly impossible to measure reliably across different Western developed nations, raising questions about construct validity when using quantitative data for these measures.

Beramendi et al. (2015, Ch.1) suggest that the combined modern pressures from globalization, technological and demographic shifts, and the presence of misaligned and "constrained" political priorities harm and weaken the complementarities shaping VOCs, thus hindering the identification or selection of optimal politico-economic strategies for comparative advantage (2015, 60-62). As globalization continuously recomposes economic actors, firms, markets, and States (Herrigel and Zeitlin, 2010), neoliberal globalization[5] introduces new tensions within national economies and reduces local control, creating tensions in the international liberal order (Babić, 2020; Ergen, Kohl and Braun, 2023). While some scholars expected domestic capital to retain influence to access favorable outcomes Lindblom (1982); Hacker and Pierson (2002), thereby keeping national capitalisms distinct, Figure 1 indicates that such accounts and reality may diverge, particularly as LMEs and CMEs display significant within-group variance and not much between-group distance in financialization and market capitalization, lending some credence to the points raised by Witt and Jackson (2016) regarding a need for flexibility about the behavior of archetypes.

As national economies have financialized, removing barriers for investment and capital flows, and the high technology service sector has increased and internationalized, the earlier industrializers, (CMEs and LMEs) have kept some distance from late industrializers (MMEs) and emerging markets (SMEs and HMEs) but have no clear distinction between themselves. Could it be that VoC as an approach has been overfitted in its main branch of thought by focusing on a narrower view of European, wealthier Western, and East Asian countries? Is it the case that, when we expand the view and application of the same logic to other countries, the distinctions between these advanced economies pale in comparison to the differences between other types?

The VoC approach highlights how states define economic strategies based on institutional advantages, yet the pace and impact of liberalization varies across economies (Hall and Soskice, 2001; Korotayev et al., 2011), perhaps due to "cross-class coalitions support[ing] existing regulatory regimes" (Hall and Gingerich, 2009, 477-480). Conflicting findings on convergence suggest a need for fresh approaches to capture these nuances empirically. While some have proposed an in-depth examination of educational and occupational training systems, inter-firm relations, or issues in generating valid measurable items (Schneider and Paunescu, 2012; Hall and Gingerich, 2009; Witt and Jackson, 2016), while others point to demand-side economics (Baccaro and Pontusson, 2016), a concept I agree with, I posit that an area where VoC could be expanded and flexibilized is the financial system or market for corporate governance. Some have begun to address this for CC from the supply-side (Ban and Helgadóttir, 2022), but I think an analysis centered on the firm, focusing on shareholder or stakeholder networks might be a better place to start. Shareholder ownership is a good measure for coordination in this sector, as opposed to non-equity debt structures, since it reflects firms' institutional environments and directly taps into the language and indicators used in previous studies (Hall and Gingerich, 2009; Witt and Jackson, 2016).

C. What SNA can offer

Since the VoC framework deals with relational information at the firm level (how firms interact with each other, secure capital, deal with governments and regulations), SNA is an ideal method to

[5]As defined by Babić Babić (2023), this is a process focused on the liberalization and deregulation of financial, labor, services, and goods markets based on the Washington Consensus (Williamson, 1990; Broad, 2004), the rollback and introduction of market-based efficiency logic to the welfare state and public services (Streeck and Thelen, 2005; Schram, 2019), and a race to the bottom of corporate tax rates to increase competitiveness and attractiveness to foreign capital (Heimberger, 2021).

further our understanding of the inner workings of market economies from the supply-side. SNA uses the notion that actors may be embedded in networks of social relations and interactions. From the observation of the presence and type of relations, we can then establish the position of actors within the structure of a network, their environment, and their surroundings, which affect various outcomes (Granovetter, 1973). As a tool, SNA can help us to bridge gaps in our understanding of domestic and international phenomena that are interrelated and thus better understood by examining multiple strata simultaneously. This approach has enriched, for instance, our understanding of how modern boom and bust cycles operate in contemporary global finance (Bauerle Danzman, Winecoff and Oatley, 2017).

Efforts to make the VoC approach more statistically grounded have not been not well-developed, as Hall and Gingerich state. These efforts lacked "good measures for the character of co-ordination" (Hall and Gingerich, 2009, 450), conceptually deemed to be at the heart of the analysis. In translating VoC's core ideas into measurable terms a series of indices and proxies have been used. While these may display construct validity – that is, they appear to measure what they're supposed to – they fail to account for the dynamic and interconnected relationships shaping these behaviors. For instance, while stock market capitalization may be associated with how reliant firms are on market-driven coordination, it is not free of distortions introduced by elements of concentration, direct or indirect government interventions, and inequalities that may mask our understanding of how the coordination in a given market economy works.

When delving into the central measure, Hall and Gingerich explain that coordination varies on a spectrum between market coordination and strategic interaction. From the financial and corporate governance perspective in LMEs, firms have access to larger equity markets, accompanied by rules for transparency, and "dispersed shareholding" (2009, 452-454) or ownership (Witt and Jackson, 2016, 790). In contrast, CME firms secure finance through long-term and strategic relations with "dense networks of shareholding" (Hall and Gingerich, 2009, 453). This language of density and dispersion is highly suggestive for SNA, and I believe that SNA offers techniques that would allow for the examination of such relationships between firms and other actors, as the language of relations and connections is inherent in the framework. Applying SNA to VoC analysis would provide us with a more thorough and dynamic understanding of different capitalist systems.

III. Recasting VoC through network analysis

VoC employs terminology that enables us to map its core concepts onto the framework of SNA, providing a natural starting point to bridge the gap towards network analysis. CME businesses are described as "powerfully co-ordinated," allowing them to operate from a "position of strength" vis-à-vis labor in general -– although the system leads to more aggregated, coordinated bargaining schemes, which solve collective action problems and make for more formidable, centralized actors (Schneider and Soskice, 2009). CMEs are described as "dense networks", and from this density of connections, support is found for "collaborative systems of vocational training" (Hall and Soskice, 2001, 18), with firms' participation and strategies being contingent in cross-shareholding mechanisms (like in Japanese keiretsu or Korean chaebols) and networks that "discourage hostile mergers and acquisitions" (2001, 23-24).[6] These firms solve a financing coordination problem with "dense networks linking managers and technical personnel inside a company to their counterparts in other firms, allowing for the sharing of reliable information" (2001, 22-23). However, there are reasons to think that globalization and financialization have weakened the rules facilitating such strategies (2001, 61).

Meanwhile, LMEs bear the opposite organizing scheme: with "uncoordinated" businesses, these firms have "less political influence... [except] in the US, as a result of its unusually decentralized political system" (Schneider and Soskice, 2009, 30). These companies secure finance and depend on their valuation in equity markets, where dispersed investors depend on publicly available information (Hall and Soskice, 2001, 27-28). This talk about dense networks ties directly to a measure that will be explored in the SNA methodology and the results section: network density. Density is the connectedness of a network, defined more strictly as the number of edges over the number of vertices times the possible connections of the vertices (Rodrigo-Alarcón et al., 2017). While connectedness does not explicitly imply the overlapping

[6]The network analogy is not lost on others such as Babić, Dixon, and Fichtner (2022, 3), who describe both CME and MME to be "[n]etwork-based coordination" systems.

and encompassing coordination mechanisms emphasized in the VoC literature, it comes close as a proxy measure.

Numerous measures developed in network science, increasingly applied in political economy studies (Cao, 2009; Winecoff, 2015; Young et al., 2021) offer insights into complex interdependent systems. A network conceptualization of VoC would help us make measurable direct key features of coordination empirically, increasing our precision vis-à-vis proxy variables employed by other studies. Aiming for brevity, in this study I only focus on network density. While other measures merit attention, they are best left for brevity to subsequent work. I can conduct a basic visualization to help bridge through some concepts between VoC and SNA. For now, I restrict these to CMEs and LMEs, to illustrate how some characteristics from VOCs could translate to network density.

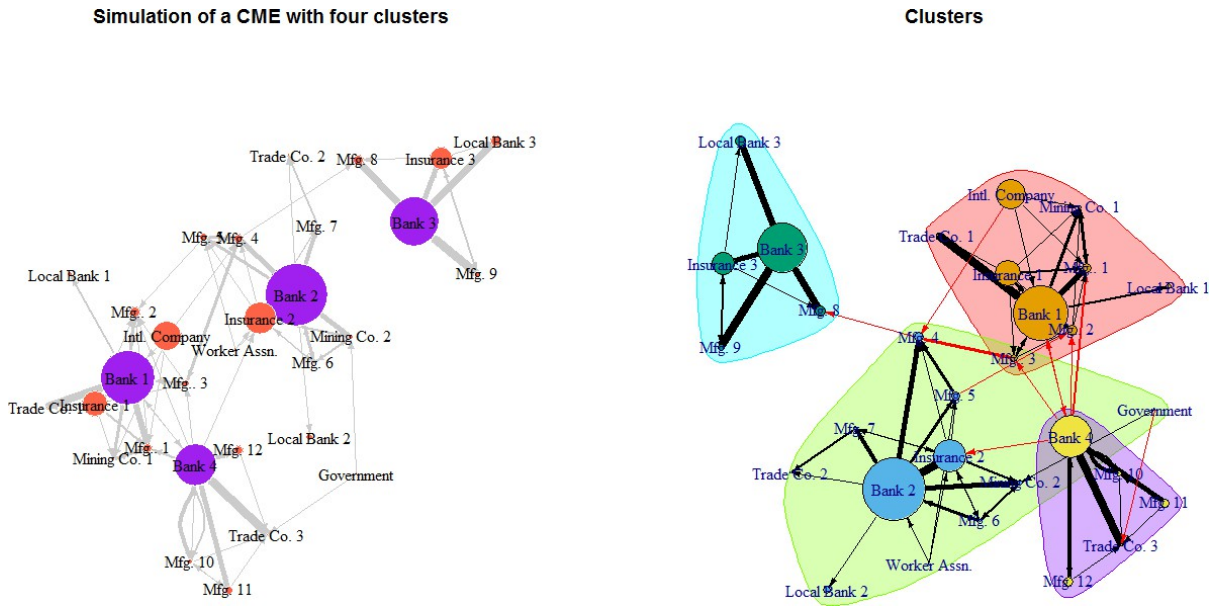

Figure 2. : Network representation for an idealized CME, given descriptions from Hall and Soskice (2001), density is at 9.2%. Ties represent shareholding ownership, that is, the proportion of shares an agent owns of the share capital of a firm. Source: Author's interpretation from descriptions.

A visual interpretation of these typologies can be seen in Figures 2 and 3, where a subset of some thirty companies and their interactions are either manually generated or simulated to approximate the descriptions of denser networks that discourage hostile mergers and acquisitions in CMEs, or the more 'dispersed' relations of firms dependent on equity markets in LMEs. Figure 2 portrays the network as having a series of pivotal commercial and central banks at the center of each of the modules (colored in purple to distinguish them easily from other nodes), as is the case of the Japanese keiretsu. These banks (and insurance companies) are central in coordinating and allowing access to capital for the companies within their group. Clusters are identified with a community identification algorithm and portrayed clearly.[7] In Figure 3 we observe more atomized, disconnected and disaggregated relations, as firms depend on less patient capital, and must release public information to entice investors to acquire stock in their firms to raise capital for projects. The result is a less dense and interconnected network.

Existing literature struggles to observe and quantify coordination across macroeconomic sectors – a key concept of the VoC framework. Traditional approaches have resorted to proxy variables and principal component analysis drawn from firm-level data to measure coordination to bridge this gap. However, this seems to be too indirect as a measurement approach, missing the complex relational dynamics

[7]Specifically, the cluster walktrap, an implementation of the walk-trap community finding algorithm in large networks (Pons and Latapy, 2005).

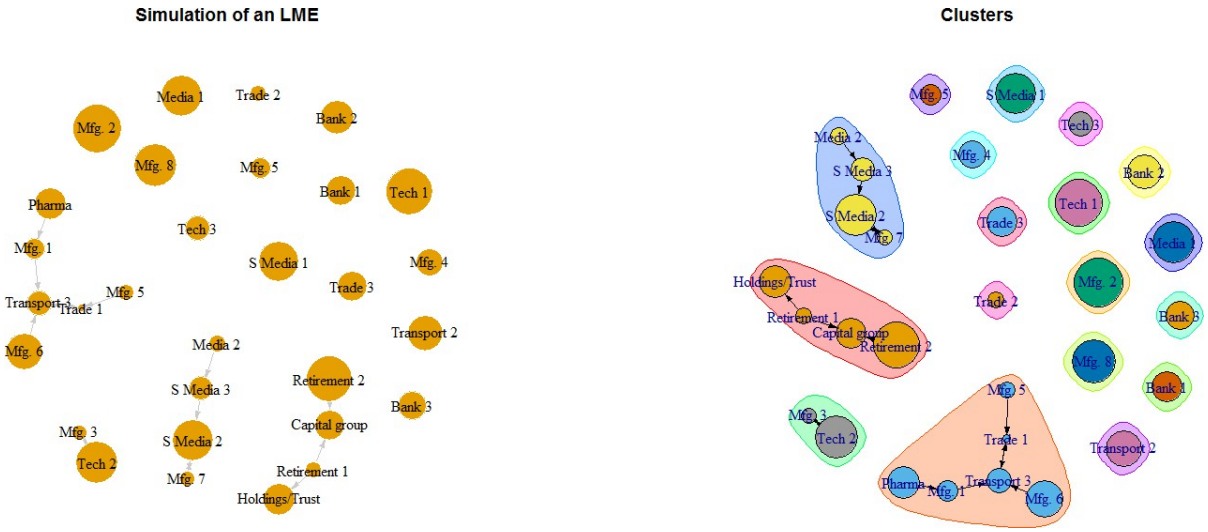

Figure 3. : Representation of LMEs, given descriptions from Hall and Soskice (2001), density is at 1.95%. Ties represent shareholding ownership, that is, the proportion of shares an agent owns of the share capital of a firm. Source: Author's interpretation from descriptions.

of coordination. In contrast, SNA directly maps the interactions of actors in shareholder networks, offering an accurate measure of coordination in practice. This method complements earlier studies that have examined shareholder behavior as part of corporate governance and finance analysis in VoC via ownership concentration (Witt and Jackson, 2016), the size of the stock market, and shareholders' legal protections and power (Hall and Gingerich, 2009).

What I propose is the direct examination of ties and relations within the shareholder ownership sector (or edges, links), and how they aggregate into measurable structures. With that, we gain a deeper comparative understanding of the financial sector. While this methodology is extensible to other spheres of the economy, the current focus on the density of the financial sector serves demonstrative purposes, acknowledging finance's critical position in the economy (Hall and Gingerich, 2009, 460). With this approach, we can dynamically track economic shifts and achieve an early detection of inconsistencies that might disrupt systemic complementarities.

By directly examining changes to the political economy observed in a crucial sector, this research offers a window into whether and how shifts in key sectors are unfolding and relate them to institutional changes and external factors. Colin Crouch's focus on institutional entrepreneurship and transformations (Crouch, 2005), along with Mark Blyth's and Kathleen Thelen's observations of institutional drift towards liberalization in CMEs (Blyth, 2003; Thelen, 2012), highlights a more flexible view of change that SNA can quantitatively assess, capturing how structural alterations impact society. Moreover, SNA allows, via inferential network analysis, as well as more standard qualitative and quantitative approaches, the study of how external factors impact these supply-sided relational structures. This offers a comprehensive view of the behaviors of sectors of the economy, institutional changes, and societal ramifications.

A. Density

Density is defined as the number of edges over the number of vertices times the possible connections of the vertices, that is:

$$D = \frac{E}{N(N-1)} \tag{1}$$

where $\boldsymbol{D}$ is density, $\boldsymbol{E}$ edges, $\boldsymbol{N}$ represents the nodes or node count. Density has been found to generally affect how firms react to technological and market dynamism (Rodrigo-Alarcón et al., 2017) in ways that align with VoC theory, where LMEs have faster and more dynamic technological development and growth as opposed to CMEs. According to Rodrigo-Alarcón et al. (2017), firms in high density situations see moderating effects in their responsiveness to technological innovation. Given the language used in VoC (Hall and Soskice, 2001; Hall and Gingerich, 2009; Schneider, 2009; Nölke et al., 2019), the expectation should be to see lower network densities in LMEs in contrast to the other varieties. Moreover, even if densities decline across the board, differential rates of change should keep CMEs as distinct and separate systems.

The VoC literature argues that CMEs, and other non-LME VOCs, will have higher density scores than LME networks in the static case. I expect density to serve to determine, among other things, as a measure of coordination, given the literature's description of shareholder conduct. Density would then be expected to fall for all networks over time as new firms enter, and we would expect to see this across all varieties of capitalism. However, the relative levels of density between LMEs and CMEs imply an expected differential rate of decreasing density: CMEs are expected to lose density at a slower pace than LMEs, preventing full convergence (as theorized in Hall and Gingerich, 2009). From what was discussed earlier, MMEs are expected to decrease their density at a similar or even faster rate, and even converge towards LMEs. In HMEs, given "distortions" of shareholding data stemming from the behavior of MNCs and family groups, the expectation is for higher density levels to remain in those countries. As for SMEs, the expectation should be similar to HMEs due to the larger role that state banks play guaranteeing corporate finance and system stability.

B. Expectations and hypotheses

I identify density to be a key attribute stemming from explicit descriptions of coordination across dimensionalities in the literature. Although other measures are available, for the sake of brevity, in this article I focus on density to help capture some aspects of coordination, and the presence or absence of well-connected, cohesive, tight, and dense systems. Following from the description of Section III. A:

H_1: Denser networks are expected to be present in countries where CME, HME, SME, or MME, rather than LME characteristics, are present.

If denser networks are expected to match CMEs and less dense networks to correspond to LMEs, then logically from Hall and Gingerich (2009, 477):

H_2: While network density tends to decrease over time, as networks expand, the rate at which density falls is lower in CMEs than in LMEs. Other VOC types are expected to follow this trend.

Now that we have made clear to the reader what network density is conceptually, and what to expect of this measure both in static and dynamic ways, I explain with more detail the data provenance, and how these measures are collected.

IV. Data and methodology

This study utilizes comprehensive shareholder data acquired from Bureau van Dijk's (BvD) Orbis database (van Dijk, 2019)(BvD Orbis is renowned for its broad global coverage, providing information on public and private companies, financial institutions, and other types of entities worldwide. Although BvD Orbis is renowned for its extensive coverage, it is also known to have limitations, especially regarding data quality, completeness, and representativeness across different regions and types of firms. Issues such as incomplete ownership data, potential duplication, and discrepancies in financial and entity-level information are documented concerns that researchers should be aware of when using ORBIS data (Arndt, 2023). These limitations require careful data cleaning and validation steps to enhance reliability and ensure accurate network representations, which I detail below.

I extracted shareholder network data, limited to the top twenty shareholders of each firm, with firm selection focusing on the target participating or incorporated legally in a country. Regarding case selection, I focused on nineteen countries: United States, United Kingdom, France, Germany, Japan, Spain, the Netherlands, China, Sweden, Italy, Canada, South Korea, Australia, Denmark, Brazil, Mexico, Argentina, India, and Chile. The choice of cases was purposefully guided by the list of major stock exchanges by market capitalization in 2018 (which is what was available when I started collecting the data for the purposes of my doctoral dissertation in 2019) provided by the World Federation of Exchanges members, affiliates, correspondents, and non-members.[8] Given the countries for which detailed network data were collected, I employ the two original categories, CMEs and LMEs, and incorporate Schneider's (2009) Latin American Hierarchical Market Economies (HMEs), the MMEs as described by several authors (Hall and Gingerich, 2009; Molina and Rhodes, 2008; Beramendi et al., 2015) and the SMEs described in Nölke et al. (2015); Nölke (2018); Schedelik et al. (2020). Although some country-markets selected were not always the largest, following this selection strategy led to a group that represented a combined total value of over 82% of all global equity capitalization for 2018.

While this focus on major economies provides a robust basis for comparing established VOCs, it also reflects a data availability bias towards large "Global North" markets. This limitation may influence generalizability to emerging and smaller economies, a trade-off that I address by concentrating on established capitalist typologies and my purposive (and non-probabilistic) approach, seeking to highlight meaningful intercompany relations where an abundance of such information exists. Future expansions of this analysis could benefit from broader datasets that more fully capture variations in emerging markets and more economies from the Global South.

The data contained in this set included twelve variables identifying, among others, the company name (transliterated to Latin alphabet), its BvD identification number, the economic sector for said entity, the country ISO code, and the operating revenue and number of employees. The shareholder side included similar information such as: shareholder name, BvD ID number, type of shareholder, country ISO code and two columns on the shares held, either direct or total, at the 6th month of the year for 2007, 2010, 2015, or 2019. The data on shares was re-expressed into a new "Sharehold" column, that took either the total value, or in case that was not available, the direct value. From there, an initial construction of node and edge-lists followed, assigning another numbering scheme internal to each country and year. Nodes refer to either the receiving entity (firm) or the sending entity (shareholder). Given that some companies also act as shareholders, this would not be a bipartite graph. The links (edges) are defined by the connections (share flow) between sender and receivers, and they could be linked in many cases bidirectionally, being directed graphs.

To address ORBIS's data limitations, as noted by Arndt (2023), I implemented data processing steps aimed at improving data quality. This included removing duplicates where identifiable, though some entities may remain distinct due to potential overlap or complexity in ownership structures, or omission. Given the challenges of fully consolidating all entities within corporate groups, this approach retains granularity for direct relationships where pertinent, while also acknowledging a residual risk of duplicate entities. By focusing on the top twenty shareholders for each firm, I additionally aimed to reduce the influence of minor connections and noise, emphasizing the most significant network actors for each country.

From the aforementioned numbering scheme, the edge-list followed, reflecting the directed nature of the data with senders and receivers weighted by the "Sharehold" data. These transformations enabled data processing with the igraph package in R. With these steps, I proceeded to the next phase of collecting variables detailing topological or structural aspects of the network. *Density* was obtained using the igraph package in R with the following code: ecount(G)/(vcount(G)*(vcount(G)-1))*100, where G is the graph or network for a given country-year, *ecount* counts the edges, and *vcount* the nodes or vertices of the graph.

Coordination refers to the strategic interaction firms engage with other economic actors, interacting with their institutional environment. It exists in a continuum between market coordination and strategic interaction among these actors (Hall and Gingerich, 2009). Dispersed shareholding is expected in

[8] Defined by the World Federation of Exchanges as "the total number of issued shares of Domestic Companies, including their several classes, multiplied by their respective prices at a given time"(2019, 8).

systems that operate predominantly with market coordination (like LMEs), whereas dense shareholding is anticipated in systems that engage more in strategic interactions (like CMEs). Given the conceptual proximity, I show the connection between network density to these patterns expected in the literature, while recognizing that it does not fully capture other community aspects that other network measures offer.

V. Characterizing the networks

As I delve into the discussion of network density, it is pertinent to recall both $\mathbf{H}_1$ and $\mathbf{H}_2$, which predicted denser networks in CMEs, HMEs, SMEs and MMEs with regard to LMEs in the former case, and non-convergence between CMEs and LMEs.

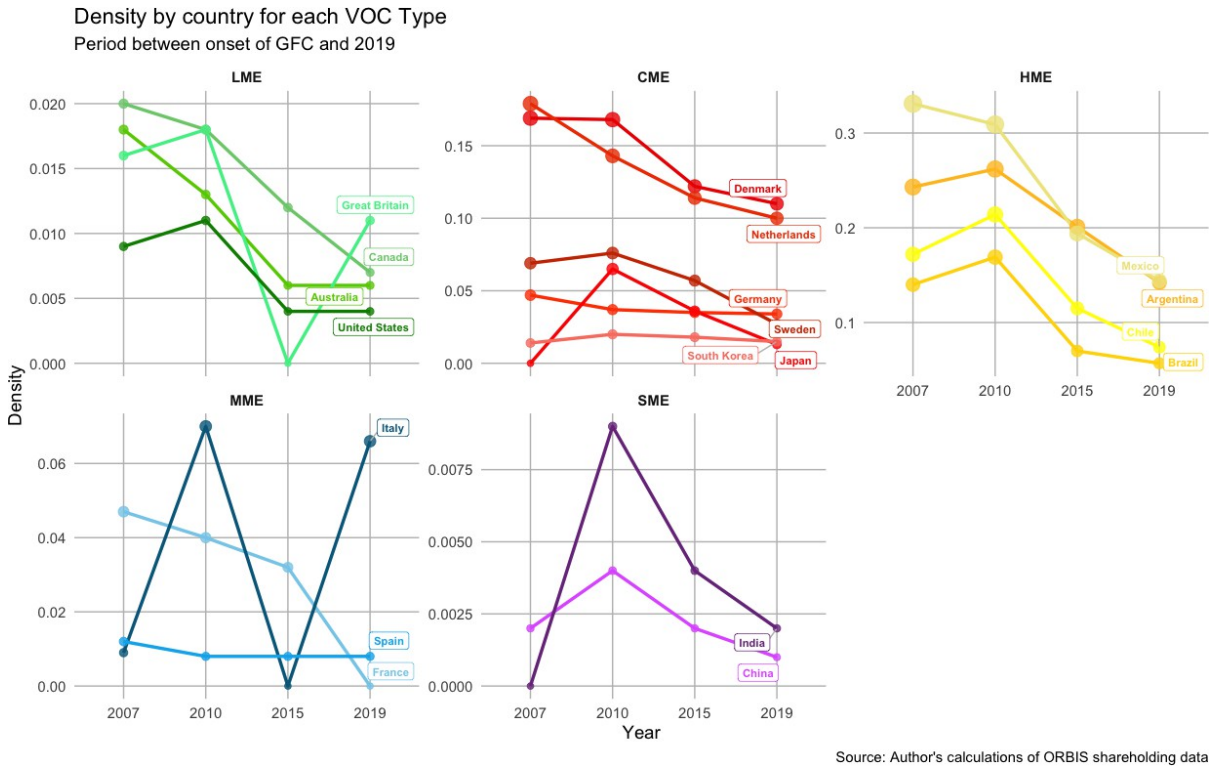

Figure 4. : Density trends over time, grouped by VOC type. Each panel represents a specific VOC, with varying y-axis scales to reflect differences in density levels. CMEs and HMEs exhibit notably higher densities, while LMEs, MMEs, and SMEs display much lower densities, requiring adjusted scales. This visualization highlights the distinct patterns and trajectories of density within each VOC category over the period from 2007 to 2019.

Regarding density, in 2007, right before the GFC began, HMEs appeared to have higher density than any other VOC, with CMEs following close by with a big spread of their density values. Much lower, and tightly packed, follow the LMEs, MMEs, and finally at almost 0, the SMEs. As we move over time, we notice that, as expected, density generally declines, with the relative exception of the MMEs which switch places with the LMEs from fourth place to third in the aftermath of the GFC of the late 2000s.

The analysis of Table 1 reveals that CMEs and LMEs are evolving as theorized in a similar downwards direction, at differing rates. Consistent with the initial expectations, HMEs—which began with higher densities overall—have maintained a gap relative to LMEs rather than converging by 2010. In

contrast, MMEs and SMEs behaved different and distinctively by starting at very low density levels and experienced *upward* trends, with SMEs notably doubling their baseline figures.

Variety of Capitalism (VOC)	**Avg. % Change 2007-2019**
Liberal Market Economies (LMEs)	-55.6326%
Hierarchical Market Economies (HMEs)	-53.0287%
Co-ordinated Market Economies (CMEs)	-37.5961%
Mixed Market Economies (MMEs)	+10.0514%
State Market Economies (SMEs)	+97.7357%

Table 1—: Average percentage change in network density from 2007 to 2019 by VOC type

The data can be examined succinctly with the fixed effects from mixed-effects models in Table 2. In that table, the baseline to which the VOCs and years are being compared to is LMEs and 2007. Noting the t-values and estimates, one observes that in general density was significantly reduced overall from 2007 to 2019, with the most substantial decrease by 2019 (t-value -3.89). In terms of VOCs, CMEs and HMEs displayed significantly higher density than the LME baseline in density, with MMEs and SMEs being closer to the baseline.

Several key points emerge. First, some expectations on density derived from the VoC and network literatures, summarized and re-expressed in Table 3, do not fully match what is revealed from the data as seen in Tables 1 or 2. However, some aspects clearly correspond: density shows, as expected from H_2, convergent behavior in terms of direction. All VOC types (and almost all countries) ended by 2019 with lower values from 2007, as seen in Figure 4. The comparison against the baseline of LMEs in 2007 on Table 2 yields a consistent finding with H_2 as well.

Estimates	**Density**	**Std. Error**	**t value**
(Intercept)	0.02	0.02	1.22
CMEs	0.06	0.02	2.41
HMEs	0.17	0.03	6.24
MMEs	0.01	0.03	0.50
SMEs	-0.01	0.03	-0.24
2010	0.01	0.01	0.90
2015	-0.02	0.01	-2.68
2019	-0.04	0.01	-3.89

Table 2—: Fixed effects of models on density, baseline is LMEs in 2007.

However, in terms of the levels they start and end at, the story is a bit more complicated: while LMEs, MMEs, and SMEs all share a small and tight area near zero throughout the entire period, CMEs have moved towards LMEs but at a slower rate, keeping a distance, with network density values five times larger than LME median levels by 2019. However, this pales in comparison to that of HMEs which stand magnitudes above all other VOCs: HMEs towered with values twelve and fifteen times higher than LMEs in 2007 and 2010, respectively, and over four times CMEs in 2007, and thrice over them in 2010. Diminished by 2019, they stood at eighteen-fold LME median values, while keeping a distance with shrinking CME numbers of 3.6 times their observed density levels.

This points at partial convergence: CMEs and HMEs are moving downwards in density metrics, but at rates that *keep them apart* from the cluster of LME, MME, and SME at the bottom of the distribution, which is what was expected as seen in Table 3. The mix of convergent and non-convergent behavior mostly confirms expectations and literature examined in Sections III. A and III. B above,

while at times offering unexpected variations. This mixed behavior aligns with Blyth (2003) and Thelen (2012)'s arguments on institutional drift, where systems evolve in response to external pressures, yet retain distinctive characteristics that prevent full convergence. The fact that CMEs and HMEs maintain significantly higher densities compared to LMEs suggests that the coordination mechanisms embedded in these economies persist despite the liberalizing pressures that tend to align systems toward a common model. The structural persistence of higher network densities in CMEs supports the notion that firm-level strategic interactions are not easily undone by market forces, suggesting a path-dependent resistance to full convergence via liberalization (Hall and Soskice, 2001). However, the decline in HME densities points to a vulnerability in maintaining coordination when faced with intensified global pressures, supporting perhaps arguments made by Beramendi and others on the disruptive effects of globalization and constrained political priorities (Beramendi et al., 2015, Ch. 1).

VOC	Key description	Network expectations	Findings
Co-ordinated	Powerfully Co-ordinated economies and firms, centralized actors, long-term commitments and investments. Cross-class/sectoral alliances. Embeddedness of associations in sectors. (Hall and Soskice, 2001)	Denser networks, slower decreases in density w.r.t. LMEs due to inter-firm relations and co-ordination mechanisms.	**Density was higher in CMEs than LMEs, descending at slower rates, keeping them apart.**
Liberal	Uncoordinated businesses, which depend on equity markets for capital access and valuation, investors interested in short-term profits, firms try to maximize shareholder value. (Hall and Soskice, 2001)	Lower densities, faster decreases on it due to reliance on market-based, arms-length distance.	**Density was lower in LMEs vs. CMEs, descending at faster rates.**
Mixed	Blend market-based and strategic interactions. Autonomous sectoral co-ordination and market co-ordination. State as a key actor regulating market, fragmented actor groups, financialization through banks instead of stock market.	Higher densities, closer to CMEs. Converging faster towards LMEs in financial market behavior over time.	**Density in MME was similar to CME in static terms, but fell faster dynamically, converging towards LME.**
Hierarchical	Influenced by the presence of multinational corporations and family conglomerates, less self-governance in corporations within groups, or those acquired by MNCs. States may try to intervene and regulate and coordinate some, but this varies by country and administration.	Higher densities due to delisting local acquisitions and family groups co-ordination.	**HMEs had the highest, albeit fastest-falling densities**, surpassing all VOC types.
State	State ownership of banks, tendency for short-run profitability in investments from non-institutional and government actors. Instability and volatility tempered by SOEs and banks. This aspect leads to several expectations of partial or fuller co-ordination (although the contradictions between actor preferences may weaken this). Low reliance on equity markets vis-a`-vis bank-financing.	Higher densities due to the active presence of state banks tempering market behaviour.	SMEs displayed the lowest densities, increasing but still lowest by the end of the examined period.

Table 3—: Summary of VOCs, descriptions of interest, and expectations from density, given the VOCs. In **bold**, findings consistent with expectations.

The discussion of HMEs and SMEs provides a valuable contrast to the largely Eurocentric and North American focus of the traditional VoC literature. Figure 4 illustrates that while SMEs and HMEs started with lower or higher initial densities, respectively, their trajectories diverge in notable ways. The rapid decline in HME densities aligns with critiques of HMEs being less institutionally embedded, as argued by Schneider regarding the fragility and lack of fit of coordination in these systems (Schneider, 2009). The increase in SME densities, albeit from a very low base, may reflect state interventions that create conditions for partial coordination, aligning with the discussed stabilizing role of SOEs and the State in these market economies.

These findings indicate that the Eurocentric dichotomy of LMEs and CMEs oversimplifies the realities of different capitalist systems, particularly those outside the Global North. The observed density trends underscore the importance of considering non-Western economies, as their coordination patterns do not fit neatly into existing VoC categories. This supports the argument made by Schneider and Soskice that expanding VoC analysis to include a wider range of economies reveals deeper insights into the varied impacts of globalization (Schneider and Soskice, 2009).

VI. Summary and Conclusion

The period from 2007 to 2019 was marked by significant crises, including the GFC, the subsequent Great Recession, and the Eurozone crisis. These disruptions catalyzed a clear restructuring within the global economy, making them an ideal case for applying network approaches to VoC. This study

leverages this turbulent era to examine changes in coordination structures, contributing a novel empirical perspective to VoC scholarship by utilizing SNA.

The analysis reveals both anticipated and unexpected patterns in the evolution of network density across VOCs during this period. As hypothesized, LMEs exhibited lower densities, reflecting their market-oriented, decentralized governance systems that rely on equity markets and arms-length relationships. The rapid decline in density among LMEs highlights the fragility of these systems during periods of economic instability. In contrast, CMEs display significantly higher initial densities, consistent with their reliance on strategic coordination and embedded inter-firm relationships. However, the slower rate of decline preserves a structural distinction, reaffirming Hall and Soskice's argument regarding the resilience of coordinated systems.

The unexpected behavior of HMEs provides an intriguing deviation from theoretical expectations. Starting with densities that were magnitudes above other VOCs, HMEs experienced the steepest declines, yet they remained the densest category by 2019. This finding suggests that hierarchical systems, characterized by concentrated ownership and state intervention, are uniquely vulnerable to global economic shocks, leading to rapid de-coordination. These dynamics highlight the limitations of extending traditional VoC frameworks to emerging or non-Western economies without accounting for their structural peculiarities.

MMEs and SMEs, initially positioned near LMEs, exhibited modest increases in density. SMEs showed the most dramatic relative growth, doubling their density from a low baseline. This shift perhaps reflects the stabilizing role of state-owned enterprises and government intervention in mitigating market volatility. Overall, these findings extend the VoC framework by incorporating dynamic structural changes, using SNA to quantify relational co-ordination across capitalist systems. The patterns observed suggest that while globalization fosters directional convergence in financial systems, the rates, and degrees of change vary significantly, preserving core distinctions. The mix of partial convergence and enduring divergence calls for a refinement of VoC typologies to better capture the complexities of evolving global capitalism.

My proposed approach of networked VoC engages directly with the structure of coordination of firms and markets by novelly applying SNA literature and concepts to VoC. While my approach does not substitute for an in-depth qualitative evaluation of the different cases, it complements that method by providing a clearer view of the macrostructure of network relations defining the economy, as well as measuring at the macro-level aspects of local and community variables, here limited to density. This, and other measures, can provide thorough perspectives on the state of the economy that current literature could easily ignore. This is an improvement to the VoC literature and, more generally, to CC. Overall, while globalization appears to drive a general trend toward convergence across capitalist systems, the differing rates and magnitudes of change across VOCs indicate that full structural convergence remains elusive. In other words, although some systems evolve in the same direction, significant differences in their evolution preserve distinct market configurations.

These results contribute to ongoing debates in the VoC literature regarding the impact of globalization and financialization on capitalist systems. The divergence between HMEs and CMEs and the clustering of LMEs, MMEs, and SMEs corroborate arguments about institutional resilience and path dependency in the face of global pressures (Hall and Soskice, 2001; Witt and Jackson, 2016). However, the sharp decline in density among HMEs and the unexpected rise in SMEs highlight the need to incorporate regional and historical specificities into VoC analyses.

Moreover, these findings underscore the utility of SNA as a tool for advancing the study of comparative capitalism. By quantifying relational structures, SNA enables a more granular understanding of coordination mechanisms, complementing traditional qualitative approaches. Future research should explore additional network measures, such as modularity and assortativity, to deepen insights into the resilience or fragility of capitalist systems. These would deepen our understanding of the resilience or fragility of VoC systems and their relationship to socio-economic outcomes, including inequality, growth, and regulatory effectiveness. By contextualizing these dynamics within times of economic upheaval, this analysis complements qualitative approaches by offering a macro-level perspective on how capitalist systems adapt to shocks.

The findings presented here not only deepen our understanding of the structural dynamics underpinning cordination in capitalist systems but also offer pathways to link these dynamics to broader

macroeconomic outcomes central to Growth Models. By incorporating relational data and structural network metrics, future research can explore how shifts in corporate governance influence aggregate demand, income distribution, and socio-economic policies across varieties of capitalism. Such efforts would advance the integration of VoC and Growth Models, providing a richer framework for analyzing via CC how capitalist systems evolve under contemporary economic pressures.

Although this study focuses on large economies, predominantly but not exclusively appertaining to the Global North, this selection is shaped by data availability and the methodological necessity of purposive sampling. While this limits generalizability to smaller economies, the findings offer a robust foundation for analyzing corporate governance structures across major VOCs. Future research should aim to extend these methodologies to underrepresented regions to evaluate how well VoC frameworks apply beyond their traditional geographic focus.

Expanding data coverage to include the period before 2007 (a challenging task due to limitations noted by Bureau van Dijk) and extending it beyond 2019 to capture the effects of the COVID-19 crisis would provide a broader understanding of systemic changes. Future research should also examine socio-economic and political outcomes—such as inequality, capital flows, electoral shifts, and regulatory changes—to further strengthen the connection between networked VoC and other critical dimensions shaping the political economy. The role of the structural power of capital, elites and their ideological preferences in an era of mass politics, alongside the pressures of globalization and the increasing concentration of markets in shaping economic policies and interactions, warrants further attention. By integrating descriptive and inferential network models into VoC analysis, scholars can develop a more comprehensive understanding of how institutional arrangements and corporate governance respond to global pressures.

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APPENDIX

A. Model Diagnostics

To ensure the robustness and quality of the mixed-effects model of Table 2, estimated with the `lmer()` function from the `lme4` package, a series of diagnostic checks were conducted using the `performance` package in R. The results are presented below.

A.1. Multicollinearity Check

Multicollinearity was assessed using `check_collinearity()`. Both the VOC and Year predictors showed low correlation, with Variance Inflation Factors (VIF) indicating no significant multicollinearity issues.

Table A1—: Multicollinearity diagnostics for model predictors

Term	VIF	Confidence Interval (CI)	Increased SE	Tolerance
VOC	1.00	[1.00, 1.00]	1.00	1.00
Year	1.00	[1.00, 1.00]	1.00	1.00

A.2. Convergence Check

Model convergence was verified using the `check_convergence()` function from the `performance` package. In the context of mixed-effects models estimated with `lmer()`, convergence refers to the optimization algorithm successfully finding parameter estimates that minimize the difference between the observed data and the model's predictions.

A key indicator of convergence is the gradient of the likelihood function at the estimated parameters. The gradient represents the rate of change of the likelihood function with respect to the model parameters. When the gradient is close to zero, it suggests that the algorithm has found a set of parameter values where the likelihood function is at a maximum (or, equivalently, where the negative log-likelihood is at a minimum), indicating stable parameter estimates.

In the model of Table 2, no convergence issues were detected. The model converged successfully, with a maximum absolute gradient of 1.02×10^{-7}. This minuscule gradient value confirms that the optimisation algorithm has effectively identified the optimal parameter values, providing confidence in the reliability and stability of the estimated coefficients.

Ensuring model convergence is crucial because non-convergence can indicate problems such as model misspecification, insufficient data, or numerical estimation difficulties. Thus, one may be assured that the model's results are trustworthy and that the inference drawn from the model is valid.

A.3. R-squared Values

The R-squared values for the mixed-effects model were calculated using Nakagawa's R2 method, which is specifically designed for models with both fixed and random effects, as implemented in the `performance` package. Nakagawa's R2 provides two distinct measures:

- **Marginal R-squared (Fixed Effects)**: This value represents the proportion of variance explained solely by the fixed effects, which in this model are 'VOC' and 'Year'.
- **Conditional R-squared (Fixed and Random Effects)**: This value represents the proportion of variance explained by both the fixed effects and the random intercept for 'Country', capturing the total variance explained by the full model.

The following R-squared values were obtained:

- Marginal R-squared (Fixed Effects Only): 0.681
- Conditional R-squared (Fixed and Random Effects): 0.874

These values indicate that, with only 'VOC' and 'Year' as fixed effects, approximately 68.1% of the variance in 'Density' is explained. However, when including the random effect of 'Country', the model explains around 87.4% of the variance in 'Density'.

The relatively high conditional R-squared, compared to the marginal R-squared, suggests that 'Country' as a grouping variable contributes significantly to explaining variability in 'Density' across the dataset. This result highlights the importance of accounting for variation between countries, as it provides additional explanatory power to the model beyond the fixed effects of 'VOC' and 'Year' alone.

A.4. Intraclass Correlation Coefficient (ICC)

The Intraclass Correlation Coefficient (ICC) was calculated to assess the degree of variance explained by the grouping structure in the data (Country):

- Adjusted ICC: 0.605
- Unadjusted ICC: 0.193

The ICC values suggest that a meaningful portion of the variance is attributable to differences between countries. However, the fixed effects also contribute significantly to the model, providing insight into how variations in 'Density' are associated with specific predictor values.

A.5. Likelihood Ratio Test for Model Fit

To evaluate the contribution of the fixed effects ('VOC' and 'Year') to the mixed-effects model, a likelihood ratio test was performed, comparing a null model (random intercept only) to the full model (including both random intercepts and fixed effects).

Table A2—: Likelihood Ratio Test Comparing Null and Full Mixed-Effects Models

Model	npar	AIC	BIC	logLik	Deviance	χ^2	Pr $(>\chi^2)$
Null Model	3	-233.76	-226.77	119.88	-239.76	–	–
Full Model	10	-269.18	-245.87	144.59	-289.18	49.41	1.88×10^{-8}***

The likelihood ratio test statistic ($\chi^2 = 49.41$, df $= 7$, $p < 0.001$) strongly supports the inclusion of 'VOC' and 'Year' as fixed effects, indicating that these predictors significantly improve model fit.

A.6. Overdispersion Check

The model was tested for overdispersion using `check_overdispersion()`, with no significant overdispersion detected:

Table A3—: Overdispersion test results

Dispersion Ratio	1.037
p-value	0.824

A.7. Residual Diagnostics

Residual diagnostics were conducted to assess normality and homoscedasticity. Two diagnostic plots are included:

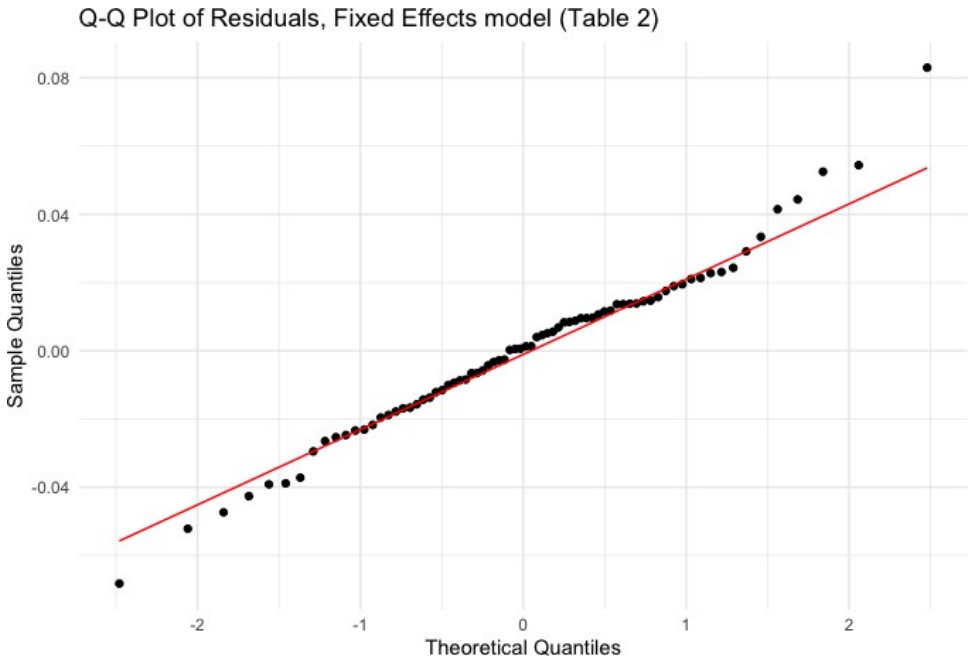

Figure A1. : Q-Q Plot of Residuals

The Q-Q plot demonstrates that the residuals closely follow the theoretical normal distribution, as evidenced by the points aligning along the red line. This supports the assumption of normality for the residuals.

Meanwhile, the Residuals vs Fitted Values plot displays a random scatter of residuals around the zero line, with no obvious patterns. This random distribution of residuals supports the assumption of homoscedasticity, suggesting that the variance of the residuals remains relatively constant across the range of fitted values.

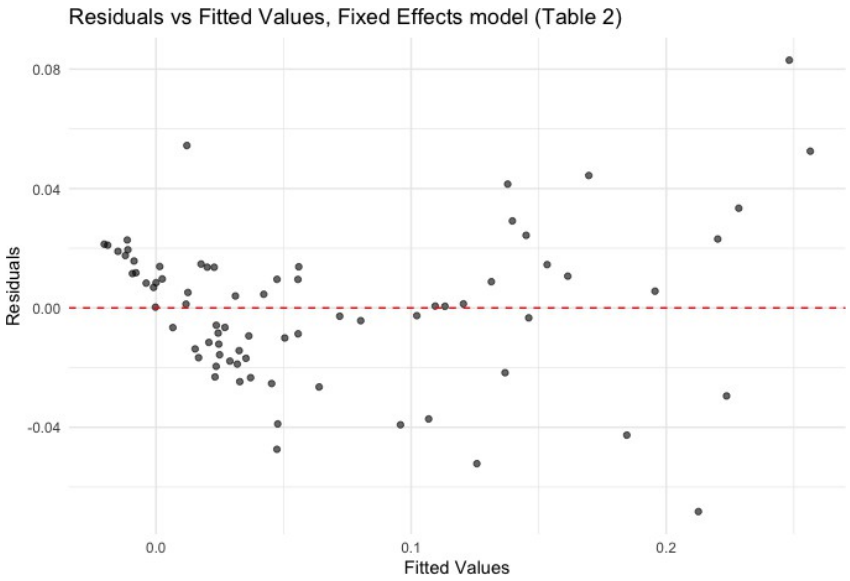

Figure A2. : Residuals vs Fitted Values

A.8. Summary

These diagnostics confirm that the model is well-specified, with no multicollinearity, convergence, or overdispersion issues. The high conditional R-squared and adjusted ICC demonstrate that the model explains a substantial amount of variance in the data, both within and between countries. The inclusion of diagnostic plots further verifies that model assumptions of normality and homoscedasticity are met.