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A COAT OF MANY COLOURS—NEW CONCEPTS AND METRICS OF ECONOMIC POWER IN COMPETITION LAW AND ECONOMICS

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ABSTRACT

The digital economy has brought new business models that rely on zero-price markets and multi-sided platforms nested in business ecosystems. The traditional concept of market power used by competition authorities cannot engage with this new reality in which (economic) power manifests beyond price and output within a relevant market. These developments have culminated in multiple recent calls for a more multidimensional concept of power. Consequently, suggestions over new concepts of power triggering antitrust/regulatory intervention, such as 'strategic market status', 'conglomerate market power', 'intermediation power', 'structuring digital platforms', or 'gatekeepers' have proliferated to complete, or even substitute, the archetypical concept of market or monopoly power in competition law. However, a theoretical framework for this multidimensional concept of power that can set the basis for new metrics is missing. This article makes three contributions in that direction. First, we conceptualize different forms of (economic) power that go beyond competition within a single relevant market in terms of competition law and economics. Second, we propose new metrics to measure two forms of power: panopticon power and power based on differential dependency between value co-creators. Third, we test the latter and show how they could reduce false positives and false negatives when assessing dominance.

JEL: K21; L1; L12; L4; L41; L5; L86; L88; M21.

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I. INTRODUCTION

Because of its goal(s) and institutional design, competition law and competition-oriented sector-specific regulatory intervention put emphasis on conduct that emanates from and/or leads to the acquisition or strengthening of (economic) power.

This can be broadly defined as power to behave independently from other economic actors and overall market forces[1]. Although there is no legal concept of 'economic power', the term is used to provide a generic description of the various dimensions of power that are traditionally taken into account in competition law enforcement. Although Section 2 of the United States (US) Sherman Act refers to monopoly power, and the European systems of competition law employ the concept of 'dominant position', the concept of 'market power' has, during the last three decades, evolved to a unified conceptual framework and has framed the texture of competition law enforcement. This aims to measure the degree of 'horizontal competition', that is, competition from established or potential rivals on a specific relevant market, defined on the basis of relations of substitution, and focuses on the price dimension of competition as economic relations (transactions) between the various market players are coordinated only by prices.

The modularity of the digital economy challenges this conceptual framework. New business models rely on the development of complementarities between otherwise autonomous firms and individuals forming value systems, in which assets are more valuable if used together than separately[2]. Confronted with zero-price markets and multi-sided platforms, competition authorities try to grapple with the broader concern over the asymmetrical power of large digital platforms and the rise of gatekeepers in the digital economy. These developments have culminated in the recent calls for a more multidimensional concept of (economic) power, in particular in the context of competition

[1] The concept of "dominance", which is the closest synonym to power referred to in the EU Treaty provisions, has been traditionally understood as "a position of economic strength" enjoyed by an undertaking to restrict competition "by affording it the power to behave to an appreciable extent independently of its competitors, its customers and ultimately of its consumers." This concept does not necessarily preclude all competition, but indicates that this "position of economic strength" is of the sort to enable the undertaking "if not to determine, at least to have an appreciable influence on the conditions under which that competition will develop, and in any case to act largely in disregard of it so long as such conduct does not operate to its detriment": See, for the seminal definition, Case C-27/76, *United Brands company and United Brands Continental v Commission* [1978] ECR 207, paras 65, 113; and Case C-85/76, *Hoffman-La Roche & Co v Commission* [1979] ECR 461, paras 38–39. We take this legal definition of dominance as a given, and we argue that the different approaches put forward by this paper in determining the existence of economic power are compatible with the legal definition of dominance in EU Competition law.

[2] C.Y. Baldwin, Ecosystems and Complementarities, in Design Rules, Volume 2: How Technology Shapes Organizations, Harvard Business School, Working Paper 21-033, available at https://www.hbs.edu/ris/Publication%20Files/21-033_1591883e-62f8-44aa-b571-fadcb2384120.pdf.

law enforcement against unilateral conduct[3]. Without aiming to present an exhaustive list, various concepts have been put forward as a trigger for regulatory/competition law intervention, such as 'strategic market status'[4], 'conglomerate market power' and 'intermediation power'[5], 'structuring digital platforms'[6], or 'gatekeepers'[7]. These may complete, or even substitute, the archetypical concept of market/monopoly power over price and output in competition law, which is measured in the context of a specific relevant market[8].

The multiplication of new concepts of power signals the creativity and flexibility of the competition law enterprise as it seeks to take into account new economic realities, in particular the emergence of new layers of organization structure, as a result of the development of technical systems characterized by modularity and embedded in relations of economic complementarity[9]. Business models recognize the strong cross-side effects of multi-sided platforms. Platform business models are not geared towards a stable and well-defined

[3] See, CERRE, Making Economic Regulation of Platforms fit for the Digital Age—Part 3 Threshold for Intervention (Issue Paper, 4 September 2020) (on file with the authors).

[4] Report of the Digital Competition Expert Panel, Unlocking digital competition (March 2019), available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/785547/unlocking_digital_competition_furman_review_web.pdf (hereinafter Furman Report), p. 55, §2.10, noting that this term indicates 'those in a position to exercise market power over a gateway or bottleneck in a digital market, where they control others' market access'.

[5] Report for the Federal Ministry for Economic Affairs and Energy (Germany), Modernising the law on abuse of market power (English long abstract), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3250742, the first concept denoting a '(possibly) specific form of power which may significantly endanger competition even below the market dominance threshold', while the second refers to the fact that intermediaries dispose of privileged access to consumer data and/or of 'a significant ability' to steer consumers'.

[6] ARCEP, Plateformes numériques structurantes, (December 2019), available at Plateformes numériques structurantes-Eléments de réflexion relatifs à leur caractérisation (Décembre 201ç) (arcep.fr).

[7] According to the Digital Markets Act (DMA) proposal (Article 3), gatekeepers are entities that (i) have a significant impact on the EU internal market, (ii) operate one or more important gateways to customers, and (iii) enjoy or are expected to enjoy an entrenched and durable position in their operations. The DMA definition is intended to apply to a particular dominant actor, where economic significance, scope, or size provide pragmatic grounds for concern about control over a significant part of the economy, and where the ecosystem in question is global rather than local or regional. See, Proposal for a Regulation of the European Parliament and of the Council on Contestable and Fair Markets in the Digital Sector (Digital Markets Act), SEC (2020) 437 final, available at proposal-regulation-single-market-digital-services-digital-services-act_en.pdf (europa.eu).

[8] See, for instance, R.A. Posner & W.M. Landes, Market Power in Antitrust Cases, (1980) 94 Harvard Law Review 937; M. Motta, Competition Policy—Theory and Practice (CUP, 2004), 39–100; European Commission, Communication from the Commission—Notice—Guidelines on the application of Article 101(3) of the Treaty, [2004] OJ c 101/97, para 25 ("It is when competitive constraints are insufficient to maintain prices and output at competitive levels that undertakings have market power within the meaning of Article [101](1)").

[9] P. Milgrom & J. Roberts, Complementarities and fit strategy, structure, and organizational change in manufacturing, (1995) 19(2) Journal of accounting and economics 179.

final product (for example, an automobile) but are dynamic in themselves, easily moving across sectors and adding new functions to the original portfolio (for example, an e-commerce platform engaging also in financial services). This is not necessarily manifested in the context of a final product market (or 'core competence') but accounts for a process of cross-market activity and cross-market capabilities. This brings into light that traditional conceptions of power and related indicators are insufficient to capture all the dimensions of economic power that are more prominent in these new business architectures that characterize modern digital but also nondigital ecosystems. The concept of ecosystem reflects the emergence of business environments marked by modularity in production, co-evolution, and decisional complexity, where innovation must be coordinated across different hierarchies, markets, and industries, on the basis of complementarity relations, often developed within an evolving technical system [10]. They form 'intentional communities' of economic actors who to a large extent co-evolve their goods and services with aligned visions and 'whose individual business activities share in some large measure the fate of the whole community'[11]. The motivation of the paper is therefore to contribute to the understanding and measurement of these new dimensions of economic power.

We start from the premise that if left untheorized, this trend will generate conceptual incoherence and legal uncertainty. One possible strategy to overcome this problem is to attempt to define precisely the specific field of each of these conceptual categories of power and address any overlaps that may exist between them. Hence, once the field of intervention of each concept, and its necessary elements (their ontology), is delimited, it would be possible to develop hermeneutic tools that ensure the conceptual *and* policy coherence of the overall framework. By having a unified conceptual framework of (economic) power, and its multiple dimensions, and taking a pragmatic approach, we may be able to select which of these concepts may fit better the situation at hand, thus triggering the adequate thresholds for regulatory intervention.

We explore the ontology of (economic) power, first by proceeding to a theoretical inquiry on the meaning of power in competition law. We explore existing concepts of power and new ones emerging in the digital economy and associated to new methods of value generation. This brings the focus to different concepts of power than the traditional horizontal one of power over price or output that a market player detains compared to his rivals in the relevant market. New concepts of power account for the more complex relations of complementarity that characterizes the modern modular economy

[10] J.F. Moore, Predators and prey: a new ecology of competition, (1993) 71(3) *Harvard Business Review* 75–86; C.Y. Baldwin & K.B. Clark, *Design Rules: The Power of Modularity*. Vol. 1. (MIT Press, 2000);

[11] J.F. Moore, 'Business Ecosystems and the View from the Firm', (2006) 51(1) Antitrust Bulletin 31.

and therefore puts emphasis on other dimensions of economic asymmetry observed in modular technical or business ecosystems: 'vertical', positional power or panopticon power. Such concepts of power may either fit existing operational concepts of power/dominant position or may call for the development of new ones[12]. Second, taking a more 'empirical' perspective that explores the various ways these new dimensions of power can be measured, we address the critique that their adoption in competition law enforcement will generate legal uncertainty. In our view, the disadvantages resulting from the current gap in our conceptual understanding of power in competition law outweigh any concerns over the transition costs to a more multidimensional perspective. We thus recognize the importance of culminating this concept-building approach with the more practical undertaking of developing adequate metrics that guide and, by the same, limit administrative discretion in enforcing competition law.

II. TOWARDS A MULTIDIMENSIONAL THEORY OF POWER: THEORY AND CONCEPTS

A. Horizontal and vertical competition: accounting for complementarities

In his 'five forces of competition framework', Michael Porter argues that the profitability of an industry is determined by five sources of competitive pressure: competition from substitutes, competition from new entrants in the industry, competition from established rivals[13]. These can be characterized as sources of 'horizontal' competition. Competition from the bargaining power of suppliers and buyers or between firms generating (mutual) unique or supermodular complementarities[14] can be characterized as sources of 'vertical competition'. Hence, in addition to competition between firms in the same

[12] Existing case law accommodates other conceptions of power than power over price and output, as is indicated by the definition of dominance as explained in footnote 1. Different operational concepts linked to dominance were developed by the jurisprudence of the EU Courts. For instance, the General Court has already referred to the theory of obligatory trading partner'(Case T-219/99, *British Airways v Commission* [2003] ECR II–5925, para. 217), 'economic dependence' (Case T-229/94, *Deutsche Bahn v Commission* [1997] ECR II–1689, para 57) or 'technological dependence' (see Opinion of AG Whatelet in Case C-170/13, *Huawei Technologies Co Ltd v ZTE Corp and ZTE Deutschland GmbH* [2015] ECLI:EU:C:2014:2391, paras 71 and 74). The Commission has also acknowledged different parameters of competition than price and output (see, Communication from the Commission—Notice—Guidelines on the application of Article 81(3) of the Treaty. [2004] OJ C 101/97, para. 5, referring also to 'better quality and a wider choice of new or improved goods and services'). We suggest additional operational concepts under the overall category of 'positional power', which could be used in the case law as referring to different dimensions of dominance/power.

[13] ME Porter, 'The Five Competitive Forces that Shape Strategy' (January 2008) *Harvard Business Rev* 25.

[14] M.G. Jacobides, C Cennamo., & A. Gawer, (2018). Towards a theory of ecosystems. *Strategic management journal*, *39*(8), 2255–2276.

relevant market and/or potential competitors at each segment of a value chain, there is also vertical competition among firms in a relation of complementarity (in value chains or business ecosystems) as to which one will be able to capture the largest share of the surplus value generated by this specific value system. Complementarities can be strong, if in the absence of a component, the value of the system will be destroyed, and weak if the withdrawal of one component does not destroy the value of the others[15]. In a modular economic setting, the concept of 'supermodularity' entails a relation between complements in which 'more of one makes more of the other more valuable in relation to some desirable end result'[16]. The direction of this relation of complementarity can be a two-way one, in case the presence of both complements is equally and mutually reinforcing, and a one-way one, if one component is unique (its withdrawal destroys the value of the system), whereas the others are nonunique[17]. These asymmetric complementarities are particularly relevant in digital ecosystems, where the creation of value is mostly generated through higher market valuation by financial markets. Focusing on expected returns (futurity), financial markets realize that holding gatekeeping positions over unique complements and developing specific competitive strategies to preserve these will bring a sustainable architectural competitive advantage for the specific firm[18].

The framework should also integrate competition from complementary technologies that may challenge the uniqueness of these complements in a value chain or business ecosystem (vertical innovation competition). Competition economics has nevertheless largely focused on horizontal competition from established competitors (producing substitute products), or on the threat of entry of potential competitors and has so far ignored competition in the context of economic relations marked by complementarities although this plays quite an important role in the modern digital economy.

B. Sources of economic power: a conceptual guide

Economic power has been assessed through different angles in social science. For most economists, markets are primarily processes for price formation, and market power denotes the ability to increase prices and consequently to allocate scarce resources in an inefficient manner. In contrast, economic sociologists focus on the social relations formed between market actors when

[15] C.Y. Baldwin, Ecosystems and Complementarities, in Design Rules, Volume 2: How Technology Shapes Organizations, Harvard Business School, Working Paper 21-033, 13–15.
[16] *Ibid*., 14.
[17] *Ibid*.
[18] See, I. Lianos, Competition Law for the Digital Era: A Complex Systems' Perspective (August 30, 2019). Available at SSRN: https://ssrn.com/abstract=3492730.

they interact with each other in the production or exchange of products.[19] Economics' focus on power over price exercised in a specific relevant market describes a great array of specific manifestations of power in the economy, yet it remains incomplete, in particular as new business models marked by modularity and strong complementarities (between firms but also between firms and users) emerge. We observe economic transactions in which zero-price goods offered to the final consumer on one market (such as free storage or email) are subsidized by ad revenue generated in attention markets and in which asset valuation in behavioural future markets[20] becomes the main source of value generation in the digital economy.

It is thus crucial to explore other sources of power and to construct an ontology on the basis of research undertaken in various fields of social science, with a view to develop a multidimensional perspective of power that could be relevant in competition law (and competition-oriented sector-specific regulation). We start from the older but still relevant conception of economic power as coercion that characterized antitrust law enforcement during its formative period, when it focused on the preservation of the freedom of market actors to compete from economic coercion, thus before the development of the 'more economic approach', although the concept of coercion is still present in some areas of competition law enforcement[21]. We then explore more modern conceptions of power, either process-based or relating to some form of resource dependency, the latter category englobing the concept of market power as used in neoclassical price theory–inspired competition law. With the important changes brought to the process of production in the modular digital economy, we witness the appearance of new concepts of power that could be described with the more general term of 'positional power'.

1. *Economic power as coercion*

Exercising (or the ability to exercise) coercion has long been considered as an important property of power. Max Weber's classic definition of power denotes the 'probability that one actor within a social relationship will be in a position

[19] For a discussion, see M. Grannoveter, *Society and Economy: Framework and Principles* (Harvard University Press, 2017), 91; *R. Swedberg, An Introduction and Agenda, in* V. Nee & R. Swedberg (eds.), *The Economic Sociology of Capitalism* (Princeton University Press, 2005), 4, 11.

[20] See S. Zuboff, *The Age of Surveillance Capitalism* (Public Affairs, 2019).

[21] See, for instance, J. May, Antitrust in the Formative Era: Political and Economic Theory in Constitutional and Antitrust Analysis, 1880–1918, (1989) 50(2) Ohio State Journal 257; Coercion is still required for tying agreements (although it does not constitute a sufficient element for the finding of a competition law infringement). See, R.D. Blair & J. Finci, The Individual Coercion Doctrine and Tying Agreements: An Economic Analysis, (1983) 10(4) Florida State University Law Review, Article 2; For a detailed analysis of the link between freedom of competition and the concept of coercion see, I. Lianos, La transformation du droit de la concurrence par le recours à l'analyse économique (Bruylant/Sakkoulas, 2007), 35–48, 295–304, 330–342, 938–949.

to carry out his own will despite resistance, regardless of the basis on which this probability rests'.[22] The focus on the volitional element, the 'will' of a specific actor, as opposed to the 'resistance' of another, indicates that some form of coercion is exercised on one actor by another. Similarly, coercion was closely associated to the existence of power in the writing of the old institutional economists, the archetypical example being that someone who holds a monopoly over some essential commodity would have considerable bargaining power to coerce other individuals[23].

The concept of coercion is notoriously complex and ambiguous. Nozick associated coercion with proposals (conditional threats or offers), excluding direct uses of force or violence and considered that coercion takes place only when the coercee acquiesces to it, thus making coercion explicitly dependent on the coercee's choice to take, or not to take, a specific action (a success condition for a conditional threat to be considered as coercion)[24]. This emphasizes how the coercee is *affected* by coercion, for instance through an alteration of its intentions or dispositions, rather than what the coercer does. However, if one is to take into account as coercion any alteration of the coercee's costs and benefits to acting, it is inevitable that the definition of 'economic coercion' will be expansive, as one should have to perform a causation analysis for each alteration of costs and benefits to determine if the coercee's action would have occurred 'but for' the action of the coercer. What is more, practically *every* form of action in markets is based at a minimum on implicit 'coercion' in Nozick's sense by *all* participants: for instance in a cartel, typically all participants at least implicitly threaten to act competitively (or perhaps even 'hypercompetitively') if the others do not comply with the cartel agreement, and the implicit threat by the other cartel participants is the reason for each participant to abide by the cartel agreement.[25]

A similar conclusion may also apply in a monopoly situation. A monopolist will not charge the highest possible price (for example, an infinite price for his/her product), if, by discouraging consumers with low willingness to pay for it, this action eventually leads to a reduction of profits. In this case, consumers exert some form of implicit coercion on the monopolist. A monopolist's power to charge a high price is ultimately function of the elasticity of demand for his product; that is, the possibility his product may be substituted by another one (cross-price elasticity). Nozick's broad definition is therefore unhelpful.

[22] M. Weber, *The Theory of Economic and Social Organization* (1947, Free Press, first published 1922), 152.

[23] See, J.R. Commons, *Institutional Economics*, (New York: MacMillan Co., 1934), 337.

[24] R. Nozick, 'Coercion', in P. Suppes, and M. White (eds.), *Philosophy, Science, and Method: Essays in Honor of Ernest Nagel*, (Sidney Morgenbesser, New York: St. Martin's Press, 1969), 440–472, 441–445.

[25] Cf. C. Beaton-Wells, 'The ACCC Immunity Policy for Cartel Conduct: Due for Review' (2013) 41 Australian Business Law Review 171, 184: "However, threats between rivals are common in the cut and thrust of business. Something more than a threat should be required."

Another option would be to distinguish the different conditional threats or actions of the coercer by looking to the relationship these have to some baseline representing the situation of the coercee before the proposal, this being the 'normal or natural expected course of events'. The latter concept may be interpreted either as a normative (moral) baseline or as a nonnormative (predictive) one. But what is the 'normal or natural expected course of events' in the course of market competition? In the absence of a theoretical model on how the specific markets should operate, and due to the unrealistic assumptions, the perfect competition model cannot be a practical option for most markets. Hence, the line distinguishing what constitutes coercion from what is 'normal' behaviour becomes blurred. A similar consequentialist approach may be adopted if one moves away from a focus on freedom to competition and takes an equality perspective that focuses on an equal or 'fair' allocation of the economic pie between the various market actors. However, determining what is the 'fair' allocation may be a source of disagreement and is highly context specific[26].

In conclusion, defining 'coercion' is a particularly complex endeavour, as various possible moral baselines may be constructed for judging whether a conditional threat/proposal 'coerces' someone to adopt an action, and there are various ways to take into account what the recipient of the conditional threat/offer would want. It is possible to adopt a narrower definition of coercion that would not only focus on the fact that someone threatens someone else in case her demand is denied but also requires that the coercer will make the alleged 'coercee' worse off than he ought to be. But again, the criterion remains unclear as this is again dependent on the moral baseline chosen.

Some authors have argued that there is coercion when the coercee is forced a choice she has no other reasonable choice than to accept it.[27] The absence of choice may indeed provide a more workable definition of coercion, but again it would require some consideration of the relative bargaining positions of the parties, past imbalances of power, the eventual dependence of one party from another, and the consideration of alternative options available to each of them. One may also focus on the pressure level exerted on the alleged 'coercee's' market autonomy. However, this may also prove problematic, as it is not *a priori* clear which is the boundary that would make compulsion sufficiently strong so as to instigate the 'coercee's' involuntary choice. This scheme is also difficult to apply in practice as it can be interpreted in various ways leading either to an absurdly narrow understanding of coercion or to one that is too broad and would cover mutually beneficial business transactions.

The absence of alternative 'reasonable choices' can easily entail a conception of coercion that is too narrow, particularly as applied to the exercise of

[26] For an interesting analysis, see M.K. Hendrickson, H.S. James Jr, A. Kendall, C. Sanders, The assessment of fairness in agricultural markets, (2018) 96 Geoforum 41.

[27] A. Wertheimer, *Coercion* (Princeton University Press, 1987).

market power. It can be argued that in the absence of a threat that is genuinely life-threatening or in our context leading to economic unsustainability (a survival test), the alleged coercee arguably always has the choice to resist the threat notwithstanding the fact that this choice might make him worse off. A series of hypothetical examples testing the demarcation between coercion and noncoercion would then lead to regress, leaving only direct threats to economic liberty and economic sustainability as instances of coercion.

Such narrow understanding of coercion was advanced by Friedrich A. Hayek.[28] Hayek argues that substantial market power or monopoly could rarely result in true coercion. A monopolist could only exercise true coercion if he where, for example, the owner of the only spring in an oasis, leaving other settlers no choice but to do whatever the spring owner required of them if they want to survive.[29] Hayek's conception of coercion is thus clearly unhelpful, as it would only cover threats to deny goods/assets that are crucial to one's existence.[30]

By contrast, a broader understanding of the absence of reasonable choices would entail that an extremely tempting offer, such as sharing the profits of a long-term joint venture, may be considered as exercising a pressure similar to a conditional threat by a monopolist of a scarce resource to deny access to this facility at a reasonable rate, to the extent that in both cases the presumed 'coercer' is manipulating the incentives (or opportunity costs) that the presumed 'coercee' associates with various courses of action. One may however also object to that being considered as a form of economic coercion, as this would also include situations of mutually beneficial cooperation. Such concept of coercion may face implementation problems in the digital economy, in which ecosystems are formed by economic entities with complementary assets that both cooperate with each other and compete for the largest share of the surplus generated by this cooperation.

2. Process-based definitions of economic power

Rather than defining the properties of power, such as coercion, it may be preferable to focus on indirect methods of observing power, such as the *process* through which economic power is manifested. Some conceptual presumptions about the nature of power are obviously inevitable to select the sources and manifestations that are deemed relevant in this case. For example, Steven Lukes' influential 'three dimensional' approach to power focuses on someone's ability to affect other people's conduct, taking the conflictual aspect of power as a starting point: A exercises power over B when A affects B in a manner

[28] Friedrich A. Hayek, *The Constitution of Liberty* (University of Chicago Press 1960), 133.
[29] *Ibid*., 136.
[30] See e.g., E.F. Paul, "Hayek's Conception of Freedom, Coercion, and the Rule of Law" (1980) 6 Reason Papers 37–52.

contrary to B's interests.[31] In contrast, Peter Morriss argues that our primary understanding of power is the ability to affect outcomes, rather than the ability to affect other people.[32] The conceptual distinction between 'power-over' and 'power-to' affects the degree to which empirical facts are relevant in identifying the exercise of power. However, one can take also a more empirical, inductive approach, focusing on the extension (reference) rather than the intension (meaning) of power.[33] Such an approach would focus on the properties of actors that exercise their power to either influence other actors' conduct and/or to affect outcomes directly in the context of a bargaining process.

Process-based definitions of power focus on the bargaining process and aim to identify situations in which there is some form of asymmetry or inequality on the ability of the actors to influence each other's course of conduct. In economics, the analysis of bargaining power is intrinsically related to the issue of how actors may divide the joint gains resulting from their cooperation, the so-called bargaining problem. Bargaining power will conventionally refer to the relative share of the total surplus gained by an actor in the bargaining problem. People enter into cooperation with other people to the extent that this cooperation may produce a joint surplus that would not be possible absent that cooperation. Assuming that individuals have the incentive to cooperate with others, and consequently limit their freedom of action to a certain extent to increase their welfare, this joint surplus will be 'the difference between the benefits (net of direct costs) each gains from the joint activity and the benefits each would receive in their next best alternative'.[34] Each participant in a joint project should therefore receive benefits at least as great as in their next best alternative, so as to maintain their incentive to participate to the joint project (the so called participation constraint).[35] As long as the 'participation constraints' of all participants to the cooperative project are satisfied, the question of distribution is settled in an economically efficient way.[36]

What matters in this context is not the distributive outcome as such, for instance that each participant enjoys an equal share of the joint profit, but the fact that each participant has been able to get a payoff equivalent to their next best alternative. Absent this rent from the joint surplus collected by the participants, these will have no incentive to enter into the joint activity at the first place.

It is possible to imagine that a single participant could gain the most important part of the joint profit if, for instance, he makes take-it or leave-it offers to the rest of the participants that are only 'barely superior to their

[31] S. Lukes, *Power: A Radical View*, 2nd edn (Palgrave Macmillan 2005), 37.
[32] P. Morriss, *Power: A Philosophical Analysis* (Manchester University Press 2002), chapter 5.
[33] E.g. K. Dowding, *Power* (Open University Press 1996).
[34] *Ibid*., 168
[35] S. Bowles, *Microeconomics—Behavior, Institutions, and Evolution* (Princeton Univ. Press, 2004), 171.
[36] *Ibid*., 171.

next best alternatives'.[37] To the extent that the joint surplus is net of the participants' next best alternatives, the allocational outcome will be deemed Pareto optimal (economically efficient). However, this outcome may not be considered fair to the extent that it leads to an unequal allocation of the joint profit, should one consider that fairness requires that the joint surplus produced is to be allocated equally between the participants.

However, such broad distributive justice concerns are difficult to integrate in competition law analysis, unless one focuses on easy-to-handle quantitative proxies of process-based economic power focusing on Bigness, such as the turnover or number of users/eyeballs of a digital platform, as is the case in the recently proposed Digital Markets Act (DMA)[38], to the extent that it can be assumed that such properties (large size) will affect the bargaining process. In this case, specific quantitative and qualitative criteria would be assumed to determine the specific properties (big, small) of the participants' power in the bargaining process.

These can be legally determined by the legislator and preferably set following a careful impact assessment process. In the DMA Proposal (Article 3), gatekeepers are defined as entities that (i) have a significant impact on the EU internal market, (ii) operate one or more important gateways to customers, and (iii) enjoy or are expected to enjoy an entrenched and durable position in their operations. The DMA definition is intended to apply to a particular dominant actor, where economic significance, scope, or size provides pragmatic grounds for concern about control over a significant part of the economy and without narrowing down this assessment in the context of a relevant product market. The DMA refers to certain quantitative criteria that establish a presumption for the gatekeeper status (see Table 1), thus establishing *ex ante* the properties of the undertaking(s) to which will be imposed specific regulatory duties.

A similar approach will not be possible in the context of a case-by-case *ex post* enforcement of competition law, where other qualitative factors, eventually also outside the framework of a relevant product market, need also to be taken into account to determine the level of economic power that would trigger competition law intervention[39] . The relevance for the assessment of true economic power of qualitative factors that relate to other dimensions of power not captured by the quantitative thresholds is also recognized by the DMA, which provides a number of such qualitative criteria in the procedure

[37] *Ibid*.

[38] Proposal for a Regulation of the European Parliament and of the Council on Contestable and Fair Markets in the Digital Sector (Digital Markets Act), SEC (2020) 437 final, available at proposal-regulation-single-market-digital-services-digital-services-act_en.pdf (europa.eu).

[39] For a discussion of the difficulties of the relevant market framework to take into account the complexity of business ecosystems, see European Commission, Support study accompanying the Commission Notice on the evaluation of the definition of relevant market for the purposes of Community competition law—Final Report (2021), available at https://ec.europa.eu/competition-policy/system/files/2021-06/kd0221712enn_market_definition_notice_2021_1.pdf.

Table 1. Presumptions for designating gatekeepers in the proposed DMA regulations

Gatekeepers' designation	Significant impact	Important gateway	Enduring position
Cumulative Evidential Thresholds (Art. 3 DMA)—Presumption	Annual EEA turnover ≥ €6.5. billion in the last three financial years [OR] Average market capitalization (or equivalent fair market value) ≥ €65 billion in the last financial year [AND] Provides platform service in at least three EU Member States	Core platform has >45 million monthly active end users established or located in the EU [AND] Core platform has >10,000 yearly active business users established in the EU	The Important Gateway thresholds (left) were met in each of the last three financial years

it puts in place in Art. 3(6) of the DMA Proposal to designate as gatekeepers undertakings that do not satisfy the quantitative elements but nevertheless may exercise a significant impact on the internal market and serve as important gateways for a large number of business users, to reach end users, everywhere in the Union and on different markets[40].

A simple process-based definition may thus not be sufficient in all circumstances. In envisaging the various qualitative indicators often referred to in the DMA Proposal, but also in EU competition law, to effectuate the case-by-case analysis, a common approach in designating a powerful entity consists in the analysis of relations of dependency that may have developed vis-à-vis other economic entities, or ultimately the final consumer. This denotes a different dimension of power to which we turn next.

3. Resource-dependence as a source of economic power

Dominant conceptions of economic power link power to dependence: 'someone who controls resources that you value has power over you—can cause you to modify your behavior in an attempt to obtain more of those resources than otherwise'[41]. Hence, power in the economy may derive from 'dependency arising from some particular distribution of resources'[42]. The situation of resource-dependence between two firms or between two ecosystem participants may precede their business relationship, coincide with their relation and the contract/broader context that incepts such relationship, or arise in the implementation of the relation. Most often we have a situation of imbalance (or significant asymmetry) in the business relationship between two firms, which makes impossible or excessively difficult for one to continue with the business without the other, because of a high degree of interdependence between them. This interdependence exists in view of the intraorganizational relation between them, in the context of a supply or value chain or because of broader relations of complementarity (for example, in a business ecosystem). Resource-dependence may also be created by market conditions precedent to the stipulation of the relation; for instance, the high number of users or market share of an entity forces its business partners to accept her terms and to undertake specific investments or actions to maintain and develop that business relationship.

The definition of a situation of resource-dependence relates to the framework of analysis used, for example social exchange theory or standard economics, and in particular the conceptualization of the asymmetrical relation

[40] These constitute the two first elements of a gatekeeper, the third one being that it enjoys an entrenched and durable position in its operations or it is foreseeable that it will enjoy such a position in the near future: DMA Proposal, Art. 3(1).

[41] M. Granovetter, *Society and Economy* (Belknap Press of Harvard University press, 2017), 92.

[42] *Ibid*., 94.

as a binary relation, a network relation or an anonymous spot market(s) interaction.

A standard approach of resource-dependence Contract theory, in particular the theory of 'incomplete contracts'[43], analyses power as resource-dependence. Inter alia, this theory explains that, because parties are not generally able to foresee all the possible evolution of their business relationship, when one of the parties gains a position of superior bargaining power, it will likely exploit this situation. Based on this theory, Klein, Crawford, and Alchian designed an economic model explaining that the intention of the opportunistic behaviour not necessarily preexists to the formation of the contract[44]. This is the case where there is a competitive market where the two firms bargain the contract in power parity[45] but nonetheless the investments done by one of them turn this firm into resource-dependence, exposing that firm to holdup from its business partner. In these cases, it is argued that vertical integration is both a solution to opportunistic holdup[46] and a more convenient alternative to contracting[47].

Beyond this dimension of resource-dependency, determined in the context of an intraorganizational relationship, it is possible to make a similar argument with regard to resource dependence developed in the context of a broader market exchange (interorganizational relation). Price theory traditionally focuses on market power, that is, the ability of an undertaking to charge higher prices and reduce output profitably. This presupposes that the undertaking holds power over consumers, who are dependent on the specific undertaking's offer, as they cannot perfectly substitute this offer with one from another competing undertaking on the specific relevant market. It becomes important to determine the situations where substitution is possible and there is cross-price elasticity of demand between different products so that they will form part of the same relevant market. Market power is therefore defined more generally, in terms of the ability of an undertaking to introduce a deviation from the price or quantity obtained from the competitive situation in the

[43] O. Hart & J. Moore, 'Incomplete Contracts and Renegotiation' [1988] Econometrica: Journal of the Econometric Society 755; O. Hart & J. Moore, 'Foundations of Incomplete Contracts' (1999) 66 The Review of Economic Studies 115; I. Ayres & R. Gertner, 'Filling Gaps in Incomplete Contracts: An Economic Theory of Default Rules' [1989] Yale Law Journal 87; J. Tirole, 'Incomplete Contracts: Where Do We Stand?' (1999) 67 Econometrica 741.

[44] B. Klein, Robert G. Crawford & A.A Alchian, 'Vertical Integration, Appropriable Rents, and the Competitive Contracting Process' [1978] Journal of law and economics 297.

[45] Hence, each of them decides choses the 'best option'.

[46] O. Hart and J. Tirole, 'Vertical Integration and Market Foreclosure' [1990] Brookings papers on economic activity. Microeconomics 205; Ronald H Coase, 'The Nature of the Firm' (1937) 4 Economica 386.

[47] As a response to a situation in which "quasi rents" are created, Klein, Crawford and Alchian (n 16).

market in which the transaction takes place[48]. The approach emphasizes the gain resulting from the presence of market power relative to a situation in which the market power resulting from the conduct found illegal is absent[49].

Market power is assessed in the context of a relevant market of substitutable products, and a high market share denotes a higher impact on the economy. Competition authorities traditionally focus on market structure and concentration as indications of economic power[50]. However, some jurisdictions also include provisions in their competition law about nonstructural market power, such as economic dependence or relative market power[51]. This is not however the only dimension resource-dependence may take.

Exclusionary or bottleneck power New industrial economics have focused on the possibility of incumbents to employ strategic barriers to entry to exclude or marginalize rivals and thus be able to raise prices and harm consumers.[52] Krattenmaker, Lande, and Salop have argued that there are two methods of exercising market power. These correspond, respectively, to the 'power to control price' and the 'power to exclude competitors'[53]. Proof of either power

[48] In this context, buying power denotes the ability of a buyer to achieve more favourable terms than those available to other buyers or it would otherwise be expected under normal competitive conditions.

[49] See, R. Clarke, S. Davies, P.W. Dobson & M. Waterson, Buyer Power and Competition in European Food Retailing, 2 (2002).

[50] J.T. Dunlop & B. Higgins, Bargaining Power and Market Structures, (1942) L(1) The Journal of Political Economy 1, 4–5.

[51] For economic dependence, see for instance, Article L 420-2 of the French Commercial Code or Article 2(5) of the Japanese Anti-Monopoly Act (AMA) which prohibits the abuse of a superior bargaining position. For relative (market) power see, for instance, Sec. 20(1), (2) of the German Act against Restraints of Competition (ARC) concerning the Prohibited Conduct of Undertakings with Relative or Superior Market Power, or more recently the new amendments to the Swiss Cartel Act which extends Article 4 of the Swiss Cartel Act relative to abuse of dominance to also apply to relatively dominant companies. Pursuant to this provision, relatively market power exists if "companies are dependent on it for the supply of or demand for a good or a service in such a way that there are no sufficient and reasonable possibilities to switch to other companies"(art. 4 para. 2bis revCartA). For an overview of these non-structural sources of power in the caselaw of various systems for the protection of competition, see Commission Staff Working Paper accompanying the Report on the Functioning of Regulation 1/2003 SEC(2009) 574 final, paras 162– 9, available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri = SEC:2009:0574:FIN:EN:PDF, noting that '[b] esides rules concerning specifically the abuse of economic dependence, some national provisions regulate behaviour labelled as "abuse of superior bargaining power" or "abuse of significant influence". The aim of these kinds of rules is essentially to regulate disparities of bargaining power in distribution relationships, including where neither the supplier nor the distributor holds a dominant position on a specific market'. For further analysis of the case law, also at the EU context, we refer to the discussion in I. Lianos, V. Korah, P. Siciliani, *Competition Law: Analysis, Cases and Materials* (OUP, 2019), 832–843.

[52] See, A Jacquemin, *Sélection et Pouvoir dans la nouvelle économie industrielle* (Economica, 1985), 118.

[53] T.G. Krattenmaker, R.H. Lande & S.C. Salop, 'Monopoly Power and Market Power in Antitrust Law' (1987) 76 *Geo L J* 241, 248.

should, according to the same authors, lead to the finding of market power or a dominant position.

Controlling a bottleneck or a 'chokepoint' in a network or cutting adversaries off from network flows[54] may qualify another dimension of exclusionary power, 'bottleneck power'. Bottleneck power has been a particular concern in the digital economy in view of the ability of platforms to adopt strategies such as exclusive contracts, bundling, enveloping, or technical incompatibilities to restrict entry of competitors[55]. Bottleneck power does not only result from supply-side conditions, such as the control of an essential facility or an input/component, necessary for competing producers, if they are not to be excluded or marginalized from the market. It may also ensue from demand-side conditions, such as the propensity of consumers to single-home, and thus, not to use more than one platform for the specific functionality[56]. One may also envisage different forms of bottlenecks that may emerge from changes in technology in the specific modular technical system or the creation of new commodities, and scarcities, for instance 'human attention'[57].

One may thus go beyond the existence of a formal 'contractual relationship' between the parties to the transaction and focus on situations that have been qualified by some as 'uncontract', or technological forms of governance (code) of a business ecosystem.[58] Similarly, the fact that data is an important input for a wide array of activities in the digital economy broadens the concept of complementarities usually taken into account in the process of economic production and thus establishes interlinkages between activities that would

[54] H. Farrell & A.L. Newman, Weaponized Interdependence: How Global Economic Networks Shape State Coercion, (2019) 44(1) International Security 42, 46.

[55] For a discussion see, I. Lianos & A. Ivanov (eds.), BRICS 'Digital Era Competition' Report (September 2019), available at bricscompetition.org/upload/iblock/6a1/brics book full.pdf.

[56] See, for instance, the definition of 'bottleneck power' by George J. Stigler Center for the Study of the Economy and the State—The University of Chicago Booth School of Business, Committee for the Study of Digital Platforms Market Structure and Antitrust Subcommittee (Report, May 15, 2019), available at https://research.chicagobooth.edu/-/media/research/stigler/pdfs/market-structure-report.pdf?la=en&hash=E08C7C9AA7367F2D612DE24F814074BA43CAED8C as 'a situation where consumers primarily single-home and rely upon a single service provider (a "bottleneck"), which makes obtaining access to those consumers for the relevant activity by other service providers prohibitively costly'.

[57] See, M. Goldhaber, The Attention Economy and the Net. *First Monday*, 2(4) (1997), <http://www.firstmonday.org/issues/issue2_4/goldhaber/; C.F. Camerer & E.J. Johnson. Thinking about attention in games: Backward and forward induction. In I. Brocas and J.D. Carrillo (eds.), *The Psychology of Economic Decisions (vol. 2.): Reasons and Choices* (Oxford University Press, **2004),** 111–129; J. Falkinger, Limited Attention as the Scarce Resource in an Information-Rich Economy (IZA Discussion Paper No. 153, March 2005), available at Limited Attention as the Scarce Resource in an Information-Rich Economy (iza.org); **A.** Festré **& P.** Garrouste, The 'Economics of Attention': A History of Economic Thought Perspective, (2015) 5(1) Oeconomia 3.

[58] S. Zuboff, *The Age of Surveillance Capitalism* (Public Affairs, 2019), 208 who describes the situation in which the contract rules are supplanted by technology and automatic procedures, allowing to predict behaviour of others through data, and enforcement occurs automatically through technological means.

have otherwise been considered as nonrelated to each other. However, the bottleneck here is not data as such, but, for instance, predictions about consumer preferences or well-performing algorithms. These are neither inputs nor a final product, to the extent they are monetized in advertising markets but may instead be characterized as a form of resource dependence.

Social exchange theory and dependence Resource dependence may also result from the context of a social exchange, such as a relation between two economic actors, one of whom controls some indispensable resource/asset (without that creating a bottleneck at the level of a market or markets). It becomes crucial to explore the relation between social exchange theory and power resulting out of a situation of dependence.

Social exchange theory focuses on power as a form of social interaction. In his seminal conceptualization of power, Emmerson notes that the 'power to control or influence the other resides in control over the things he (the other) values' and that are not available elsewhere. The concept of dependence under the social exchange theory is therefore linked to resource differentials or unbalances between entities (individuals or firms)[59]. Under this conception, the power capability of B in relation to A is the inverse of A's dependence on B. B is dependent on A to the degree that A has power over B. A and B are at the same time of course interdependent, or mutually dependent, but this, on its own, cannot be a source of power. As we have described above, this is associated with the existence of some asymmetrical control of resources or asymmetry in the underlying exchange.

For some, Emerson's exchange theory 'yields two distinct theoretical dimensions of resource dependence: power imbalance, or the power differential between two organizations, and mutual dependence, or the sum of their dependencies'[60]. This needs further elaboration, taking into account that social exchange theory does not analyse the resource differential linked to the individual characteristics of the actor in abstract but conceives power as a 'property of the social relation'[61]. Blau has indeed observed that exchange relations of a person or an entity with another may take different forms: (i) independence (if the outcomes of the exchange depend on one's sole effort), (ii) dependence (if the outcomes depend on the other entity's effort), and (iii) interdependence (the outcomes are based on a combination of the partners' efforts)[62].

[59] R.M. Emerson, Power Dependence Relations, (1962) 27(1) American Sociological Review 31.

[60] T. Casciaro & M. Jan Piskorski, Power Imbalance, Mutual Dependence, and Consraint Absorption: A Closer Look at Resource Dependence Theory, (2005) 50 Administrative Science Quarterly 167, 168.

[61] R.M. Emerson, Power Dependence Relations, (1962) 27(1) American Sociological Review 31, 32.

[62] P.M. Blau, *Exchange and Power in Social Life* (John Wiley, 1964); R. Cropanzano & M.S. Mitchell, Social Exchange Theory: An Interdisciplinary Review, (2005) 31 Journal of Management 874, 876.

If we define power in the context of a dyadic relation as the potential of one party A to obtain favourable outcomes at the other party B's expense, then the dependence of A upon B is function of the value of B's product to A and of the availability of B's product to A from alternate resources[63]. Hence, the power of A over B equates to the dependence of B over A. The source of the power is relational as it is linked to the difference in the power of actor A over actor B, and the inverse. This dyadic (relational) perspective on power is expressed in the two dimensions/metrics previously referred to.

The first dimension, power imbalance, 'captures the difference in the power of each actor over the other', which may be measured concretely, in the context of a dyadic relation, 'by the difference between two actors dependencies, or the ratio of the power of the more powerful actor (or that of the less powerful actor)'[64]. For instance, this could relate to the difference of resources/assets controlled by the specific actors, such as market shares, technology, and so forth.

The second dimension, mutual dependence, 'captures the existence of bilateral dependencies in the dyad, regardless of whether the two actors' dependencies are balanced or imbalanced'[65]. Technically, this measure may be defined as the sum, or the average of actor A's dependence on actor B and actor B's dependence on actor A[66]. It may be possible indeed that a power imbalance, in the sense of the amount of resources controlled, does not necessarily lead to holding power, as both actors are mutually dependent on each other. Both these dimensions need to be considered simultaneously because 'for any value of power imbalance, a power-dependence relation can be characterized by varying levels of mutual dependence' and conversely, 'for any given level of mutual dependence, there can be different levels of power imbalance in the dyad'[67]. However, it is expected that the more the power imbalance increases, the easier it will be for the party that benefits from it to appropriate a larger portion of the surplus value produced by the exchange.

However, power differentials may not only be assessed on the basis of the individual characteristics of the actors in a dyadic relation, such as the control of a superior technology or that of an indispensable input for the production process, but they may also relate to the broader social structure of the exchange, in particular the position of the specific entity in the social network to which it is embedded (positional power). As Willer explains, 'power

[63] K.S. Cook, R.M. Emerson, M.R. Gillmore, T. Yamagishi, The Distribution of Power in Exchange Networks: Theory and Experimental Results, (1983) 89(2) American Journal of Sociology 275 (hereinafter Cook et al. 1983) 275, 285.

[64] T. Casciaro & M. Jan Piskorski, Power Imbalance, Mutual Dependence, and Consraint Absorption: A Closer Look at Resource Dependence Theory, (2005) 50 Administrative Science Quarterly 167, 170.

[65] *Ibid*.

[66] *Ibid*.

[67] *Ibid*.

as potential is located in structures', '(s)ubsequently, actors in structures produce power as activity'[68]. Similarly, others have focused on the network position of the economic actors to determine the power-dependence not in the context of a dyadic relation, but in the context of a network[69].

Taking a sociological perspective, Cook et al. focus on social structure as a possible source of power. Social structure is defined as a configuration of social relations and positions among actors, 'where the relations involve the exchange of valued items (which can be material, informational, symbolic, and so forth)'[70]. These relations are not only linking actors directly but also indirectly[71]. An exchange relation may thus not only occur directly between two actors but also could relate to more complex exchange networks, viewed as 'connected sets of exchange relations'[72]. This calls for an analysis of resource dependence in the context of a network, or a broader ecosystem[73], with the assistance of the tool of social network analysis to explore the patterns of interaction between actors. Network analysis forms part of structural analysis, to the extent that it aims to explain phenomena primarily, if not completely, by social structure. However, it cannot only be subsumed to structuralism, to the extent that it also explores the creation and/or maintenance of networks, and emphasizes the role of the individual actors and their strategies. This is what brings to the picture exchange theory[74].

The empirical dimension of network analysis has been further developed in sociometrics, advanced social network analysis[75], and graph theory[76], which develop practical tools for social structural measures. This research is still under development and has recently attracted considerable interest in view of the emergence of Big Data and the superior computational abilities of modern computing, for instance with the emergence of computational competition

[68] D. Willer, Predicting Power in Exchange Networks: a Brief History and Introduction to the Issues, (1992) 14 Social Networks 187.

[69] K.S. Cook, R.M. Emerson, M.R. Gillmore, T. Yamagishi, The Distribution of Power in Exchange Networks: Theory and Experimental Results, (1983) 89(2) American Journal of Sociology 275 (hereinafter Cook et al. 1983) K.S. Cook & J.M. Whitmeyer, Two Approaches to Social Structure: Exchange Theory and Network Analysis, (1992) 18 American Review of Sociology 109 (hereinafter Cook et al. 1992).

[70] Cook et al. 1993, 110.

[71] See, P.M. Blau, *Exchange and Power in Social Life* (Wiley, 1964).

[72] Cook et al. 1993, 113 referring to the work of R.M. Emerson, Exchange Theory, Part II: Exchange Rules and Networks, in J. Berger, P. Zelditch & B. Anderson (eds.), *Sociological Theories in Progress* (Vol. 2, Houghton Mifflin, 1972), 58.

[73] See, for instance, M.G. Jacobides, and I. Lianos, Ecosystems and Competition Law in Theory and Practice (2021) 30(5) Industrial and Corporate Change 1199–1229.

[74] Cook et al. 1993, 114.

[75] For an introduction see, S. Yang, F.B. Keller & L. Zheng, *Social Network Analysis* (SAGE, 2017).

[76] F. Harary, R.Z. Norman, D. Cartwright, *Structural Models: An Introduction to the Theory of Directed Graphs* (Wiley, 1965).

law and economics[77]. One of the insights of this paper is that competition authorities should engage more seriously with this research.

The choice of adequate tools depends on the prevailing conception of structure. Cook et al. (1993) observe that there are two general conceptions of structure in network analysis: (i) a 'common view' conceiving of structure as 'a pattern of particular ties between actors, where variation in the network in the existence or strength of ties is meaningful and consequential', and (ii) another view that views structure 'as a general deviation from random ties for particular groups'[78]. 'Ties' can be 'strong' or 'weak', although this does not prejudge of the impact these ties may have on a specific outcome, as it all depends on the way the structural mechanisms are socially constructed[79].

Social network analysis may build on both resource dependency theory and on different approaches focusing on the 'centrality' of the actor's position in the network.

With regard to the resource dependency and exchange theory, one should note the seminal work of Cook et al. (1983), which has extended exchange theory beyond the context of a dyadic relation at the level of an 'exchange network', therefore enabling more 'macro, N-actor levels of analysis'[80]. Cook et al. define 'exchange networks' as 'consisting of (1) a set of actors (either natural persons or corporate groups), (2) a distribution of valued resources among those actors, (3) for each actor a set of exchange opportunities with other actors in the network, (4) a set of historically developed and used exchange opportunities called exchange relations, and (5) a set of network connections linking exchange relations into a single network structure'[81]. 'Connections' between actors forming a network, in the simple configuration two exchange relations between actors A-B and actors A-C who are connected to form the 'minimum network B-A-C to the degree that exchange in one relation is contingent on exchange (or nonexchange) in the other relation' can be 'positive' or 'negative'[82]. The connection is positive 'if exchange in one relation is contingent on exchange in the other' and negative 'if exchange in one relation is contingent on nonexchange in the other'[83]. For instance, if B and C are

[77] See, HCC, Computational law and economics: an inception report.

[78] Cook et al. 1993, 118.

[79] For instance, M. Granovetter, The Strength of Weak Ties, (1973) 78 American Journal of Sociology 1360 has shown that job seekers often obtain less useful information from their close contacts than from acquaintances to the extent that those with whom they have close contacts have overlapping networks with them.

[80] Cook et al. 1983, 277.

[81] *Ibid*.

[82] *Ibid*. Note however the different meaning conferred to these terms by M. Grannovetter who distinguishes between 'positive dependence', which 'emphasizes the rewards of gaining valued resources from those who control them' and 'negative dependence', which 'focuses on punishment and the search for ways to avoid it': M. Granovetter, *Society and Economy—Framework and Principles* (The Belknap Press of Harvard University Press, 2017), 94.

[83] Cook et al. 1983, 277.

alternative exchange partners for A and therefore substitutable as sources, then the connection is negative. However, if A requires a resource obtained from B for interaction with C, then the connection at A is positive[84]. For instance, a connection is positive when the purchase of an input requires a complementary purchase of a second input, which is an example of a positive connection in parallel[85]. Parallel connections may also occur in the context of a value chain or a linear ecosystem of complementary assets in an input/output mode (positive connections in series), where all connections are by definition positive, to the extent that the input from one actor[86] at an upper segment of the value chain or business ecosystem serves to constitute the output at a lower segment of the value chain[87]. However, this may appear less relevant in an ecosystem or value chain in which actors cooperate but also compete with each other on the allocation of the surplus. Interestingly, many ecosystems present a mix of positive and negative connections. The fact that ecosystems are 'a set of actors with varying degrees of multilateral, nongeneric complementarities[88]' that are not fully hierarchically controlled by one firm, as should have been the case in the presence of strong two-way supermodular complementarities[89], shows that, like value chains, they always entail positive connections. However, firms within ecosystems coopete (compete and cooperate simultaneously)[90]. For example Google News and news publishers cooperate in that they are vertical complements: news publishers' content helps attract users to Google News (positive connection: without news publishers, Google News cannot exist), and the latter directs traffic to news publishers that would have not visited them directly in turn. However, they also compete (negative connection) for users and advertising revenues[91] (mixed positive and negative connections in series).

In a negatively connected network, the decision of an actor to connect with a node indicates that for this actor connecting with the other nodes is not necessary. The more negative connections in a network an actor disposes, the more options for exchange it has. Fewer negative connections however correspond to greater relative dependency. One can, for instance, observe

[84] *Ibid*.

[85] M.K. Hendrickson & H.S. James, Power, Fairness and Constrained Choice in Agricultural Markets: A Synthesizing Framework, (2016) 29 Journal of Agricultural and Environmental Ethics 945, 954.

[86] *Ibid*., 955.

[87] *Ibid*.

[88] M.G. Jacobides, C. Cennamo, & A. Gawer, Towards a Theory of Ecosystems, (2018) 39(8) *Strategic Management Journal*, 2255–2276.

[89] C. Baldwin, C.Y. Baldwin, Ecosystems and Complementarities, in Design Rules, Volume 2: How Technology Shapes Organizations, Harvard Business School, Working Paper 21-033, Section 5.6.

[90] A. Brandenburger and B.J. Nalebuff, *Co-opetition* (Doubleday, 1997).

[91] D. Geradin, Complements and/or Substitutes? The Competitive Dynamics Between News Publishers and Digital Platforms and What It Means for Competition Policy (TILEC Discussion Paper No. 2019-003, 2019).

negative connections when two suppliers compete for the largest share of the purchases made by a retailer. Positive connections may result in the context of indirect network effects, when there is a positive feedback loop between the number of ties/connections at one side of the platform and those at the other side of the platform. The positive or negative nature of the connections is not however static and can be transformed: for instance, a negative connection may become positive through some form of product differentiation, which reduces the substitutability between the actors of the network. 'Brokerage' brings forward 'mixed structures' in the network to the extent that a broker develops both positive and negative exchange connections with the members of its network.

An increase in the number of positive connections in parallel leads to additional exchanges; hence, it also increases relative dependency to the extent that the interaction with others in the network for the purchase of the complementary products limits the availability of options and establishes some form of path dependence to continue the exchange with the same actors. An increase in the number of positive connections in series may have either the effect to increase or to decrease relative dependency. Such positive connections may facilitate exchange opportunities that previously did not exist (thus reducing relative dependence) or may act as a barrier to entry (thus increasing the dependence of the actors on the intermediaries).

The analysis of the various connections linking different exchange partners in a network or a business ecosystem surely requires some important investment in collecting evidence, although this may be facilitated by the availability of Big Data and advanced computational tools. It is however clear that, as also highlighted by Hendrickson and James, '(i)n defining relative dependency, it is the number and quality of negative connections that matters for each participant [. . .] [M]arket concentration studies do not adequately capture this idea—that is, we cannot look merely at concentration ratios to make assessments about relative dependency, since some markets with relatively smaller concentration ratios might actually create greater relative dependencies for buyers or sellers than markets with larger concentration ratios'[92].

Resource dependence in the context of a dyadic exchange relation or a network has also implications on the conceptualization of power. Dependency is not anymore linked to the exceptional ability of an actor to raise prices, reduce output, as is assumed in the horizontal power paradigm, or to exclude rivals, as is for exclusionary/bottleneck power. Dependency is observed from the way in which the value in the exchange, dyadic or at the level of the network or organization, is divided between the different actors. It is assumed that the

[92] *Ibid*., 954. Hendrickson and James provide the following example drawing on different market configurations: assuming a market with a CR4 of 80 with the four firms holding respectively 77, 1, 1, and 1 percent and a market with a CR4 of 100 with each of the four firms holding a 25 percent market share, they argue that the market with a CR4 of 80 will create higher dependency than the market with the CR4 of 100.

way the value is divided results from the unevenness in dependencies between actors. In that respect, social exchange theory can subsume bottleneck power and the traditional horizontal power approach as particular cases. Power will in this case correspond to some form of imbalance in the division, with the most powerful party typically getting the largest part of the value. An 'unfair' division of the surplus can thus be considered as a manifestation of power linked to the higher dependence of the parties with the smaller share of the surplus on the dominant actor. Unfairness in the division of surplus may also result from the dominant, or central, position of an actor, who in view of the network structure or the structure of the modular technical system, may benefit from asymmetrical advantages vis-à-vis other economic actors. This second dimension of power, positional power, is explored in a separate section.

Note that dependence may be intrinsically relational, when nodes A and C are completely dependent on B for a specific resource or value, but B has multiple alternative sources[93]. In this context, the 'differential dependencies[94]' of A and C on B may constraint their action in a direction that would be less beneficial to their interests and may provide B a higher share of the joint surplus produced. Dependence may also relate to the internal characteristics of the actor. For instance, a rich person will be less dependent than a poorer person on some resource, to the extent that it has diminishing rewards for increased amounts of a product or value, as a result of the satiation principle. Hence, if one member of a network acquires value at a greater rate than others, it can become satiated with the result that it will be interested in maintaining this social relation only if she can receive an 'unequal share' of the surplus value[95]. Hence, that actor will have the additional option of terminating the exchange relation if he judges the share of the surplus value unsatisfactory, an option that is unlikely to be available for an actor that has not arrived at the satiation point.

There is no clear answer as to how one should evaluate the surplus division problem. An approach that would impose a 50 percent/50 percent allocation could be considered as 'fair', but again this depends on the labour and capital each party has contributed to the surplus, assuming one takes a merits-based approach that would value superior competitiveness and efficiency. Determining if an allocation of resources is 'fair' has been the subject of intense controversy among scholars in various disciplines and its lessons for competition law have been examined elsewhere[96].

[93] D. Easley & J. Kleinberg, *Networks, Crowds, and Markets: Reasoning about a Highly Connected World* (CUP, 2010),301.

[94] K.S. Cook, Emerson's Contributions to Social Exchange Theory, in K.S. Cook (ed.) *Social Exchange Theory* (SAGE, 1987) 209, 216.

[95] D. Easley & J. Kleinberg, *Networks, Crowds, and Markets: Reasoning about a Highly Connected World* (CUP, 2010), 301.

[96] See, I. Lianos, Competition Law as a Form of Social Regulation, (2020) 65(1) The Antitrust Bulletin 3.

In conclusion, according to this view, power would be conceived as differential dependencies that do not rely on a specific outcome (distribution of surplus); otherwise, the assessment of the level of power would depend on the (normative) judgement of which distribution of surplus is considered 'fair', something that opens up a broader debate on the policy premises and the social function of competition law.

4. Different dimensions of positional power

The concept of positional power: an introduction As explained in the previous section, a social actor's power does not often relate to his individual characteristics and exceptional attributes but may also be function of the network structure, to the extent that this actor holds a pivotal position in the underlying social structure of the exchange. In view of 'the tendency of complex systems to create asymmetric network structures, in which some nodes are 'hubs', and are far more connected than others', it is essential to examine the topography of such complex systems[97]. Centralized networks provide actors with the necessary levers to extend their influence and thus reach sooner the tipping point toward sustainable dominance, eventually using the networks for their own purposes rather than those that led to the formation of the network at the first place. Centrality measures, such as degree centrality (where the node strength gives a measure of local influence), betweenness centrality (the amount that a node lies on shortest path between other nodes), and closeness centrality (inverse sum of shortest distances), which measure centrality at the level of a specific node, are indeed the most-commonly used indicators to assess the importance of an actor in a network[98]. The greater the centralization of a complex system, such as a network or an ecosystem, the larger the disparity between the nodes' individual centrality measures.

Degree centrality simply counts the number of connections a node has (in terms of potential communication activity): those with a high degree of centrality are more active players. The distribution of degree centrality among the nodes of a network may indicate how equal network actors are.

Betweenness centrality measures are based on the 'frequency with which a point falls between pairs of other points on the shortest paths (or geodescics) connecting them'[99]. Strategic location on paths linking pairs of pairs provides potential influence in the network through 'the withholding or distorting of information in transition'[100].

[97] See also, A.-L. Barabási & R. Albert, Emergence of Scaling in Random Networks, (1999) 286 Science No. 5439, 509; M.E.J. Newman & J. Park, Why Social Networks are Different from Other Types of Networks, (2003) 68 Physical Review E, No. 036122 (2003), 1.

[98] L.C. Freeman, Centrality in Social Networks: Conceptual Clarification (1979) 1 Social Networks 215.

[99] *Ibid*., 221.

[100] *Ibid*.

An example of betweenness centrality is provided by Ronald Burt in his work on 'structural holes' when he suggests that nodes connecting otherwise disconnected nodes or parts of the network may gain from their position through 'brokerage'[101]. One may think for instance of actors such as platforms bringing together various users in multi-sided markets may have a high betweenness centrality without necessarily having a high degree centrality. A node that connects two separate networks may have a low degree centrality but may be highly influential if it sits on the only path through which the nodes of the two networks may reach each other[102]. However, if there are multiple geodesis paths that may connect the two networks, the node will not have a high betweenness centrality. Having a high central point often exhibits potential for control of the network.

Finally, 'closeness-based measures' provide an index to the extent that a particular point is closer to another, by measuring how fast a given node in a network can reach other nodes. This is often calculated by taking the inverse of a given node's geodesic (shortest path or lines length) with all other nodes in a given network[103]. Centrality in this case is indexed by the shortest distance score of one point to all others, thus indicating the extent to which a point can 'avoid the control potential of others[104]'. A node closer to others is less dependent on intermediaries in relaying information.

Of particular interest is also the concept of a 'clique', which once formed may exercise an important influence on its member's behaviour[105]. The clique is characterized by the mutuality of ties between its members, all of which, in the narrow definition of a clique, are directly connected to each other with no other node in the network having ties to every member of the clique[106]. The members of the clique have frequent interactions with each other, as opposed to interactions between the members and outsiders.

These concepts enable researchers to visualize the way a network unfolds and to determine the centrality of a node, according to the prevailing definition of centrality, with the assistance of visualization tools, such as multidimensional scaling (MDS).

However, as is noted by Cook et al. 'the devices we use to represent networks –such as points, lines, edges, and geodesics – and the concepts we use to describe network properties –such as density, centrality, and degree of connectedness- are devoid of specific substantive meaning', which raises the problem of the 'interpretability of findings' and their linkage to the concept

[101] R.S. Burt, *Structural Holes: The Social Structure of Competition* (Harvard Univ. Press, 1992)
[102] S. Yang, F.B. Keller & L. Zheng, *Social Network Analysis* (SAGE, 2017) 62.
[103] G. Sabidussi, The centrality index of a graph, (1966) 31 Psychometrika 581.
[104] L.C. Freeman, Centrality in Social Networks: Conceptual Clarification (1979) 1 Social Networks 215, 224
[105] See, S. Wasserman & K. Faust, *Social Network Analysis: Methods and Applications* (Cambridge Univ. Press, 1994).
[106] S. Yang, F.B. Keller & L. Zheng, *Social Network Analysis* (SAGE, 2017), 71.

of power[107], in particular in competition law. We have previously explored how power may be linked to dependence in an exchange relation, and the way exchange theory may be implemented beyond the situation of a dyadic relation. According to the power-dependence perspective, the dependence of one actor on another is a function of the interest in the resource that actor has and the availability of that resource from alternative sources[108]. These alternative resources may be other nodes in a network, or a structure of connected social actors.

These approaches may nevertheless constrain strategic action to bargaining within existing network configurations and ignore the possibility that the actor may negotiate changes in the network itself. Leik explains how it is possible for an actor to gain power through manipulating the linkages of the network, thus altering the power potential of one's position[109]. These strategies include adding links, deleting links, 'negotiating which position one occupies or what rules the network operates under'[110]. For instance, an actor may gain more power in the network by manipulating the alternatives available to him or the other nodes, generating the possibility of basic shifts in power. For instance, 'a position of lower power can gain power by establishing one or more links to other nodes' or inversely 'a position of higher power may lose power if lower power nodes are able to establish mutual links'[111]. The opportunity of lower power nodes to challenge that of higher power nodes depends on the size of the network. Leik explains that as network size increases, 'while mean network density remains constant, a single change should have less impact on overall power differentiation', hence, 'more successive linkage changes will be needed for any node to experience a given degree of change in relative power'[112]. This finding is of particular interest in the context of the digital networked economy, where established networks already benefit from increasing network effects and increasing returns to scale. Hence, strategic agency will be particularly crucial for low power nodes.

The topology of networks may become a particularly rich resource to understand the quite complex interactions between the participants in ecosystems in which the interrelations between the various participants often lead to nonlinear increases in utility and value. Complex systems, such as the multiactor ecosystems of the digital economy, are not populated by homogeneous predictable agents but by a collection of heterogeneous agents (individuals, organizations, and so forth), the state of who influences and is influenced

[107] Cook et al 1983, 276.

[108] J. Skvoretz & T.J. Fararo, Power and Network Exchange: An Essay Toward Theoretical Unification, (1992) 14 Social Networks 325, 329.

[109] R.K. Leik, New Directions for Network Exchange Theory: Strategic Manipulation of Network Linkages, (1992) 14 Social Networks 309.

[110] *Ibid*., 310–311.

[111] *Ibid*., 311.

[112] *Ibid*., 321.

by the state of others (for instance, situations of social contagion), and the interactions of who gives rise to global systemic properties that equate to more than the sum of individual behaviour. As the interactions within the multiactor ecosystem are not independent, various feedback loops, some of which may be situated outside the subsystem of the relevant market, can enter into the system and affect the individual decisions of the specific relevant market agents. As the focus moves from specific outcomes (prices, output), which have more recently also included different parameters of competition (quality, innovation)[113], to social relations, it becomes important to acknowledge that complex social systems such as multiactor ecosystems are populated by a collection of heterogeneous agents, all influencing each other. Their interactions give rise to global systemic properties that equate to more than the sum of individual behaviour of each actor. Hence, in this complex economy, power may encompass various dimensions beyond that of a simple reduction of output and/or an increase of prices[114].

Multiple dimensions of power To the extent that one focuses on social interactions along the lessons of social exchange theory to define a broader ontology of power, it becomes important to acknowledge various other dimensions than what that has been so far the traditional focus of competition law and economics, market power or power over price and output. This is particularly important in view of the new business models in the digital economy, but also beyond that generate market value through the constitution and exploitation of business ecosystems. Focusing only on output and price does not take adequately into account the importance in such contexts of complex value creation and monetization strategies that impact on other parameters of competition (for example, quality) and involve multiple spaces of competition and forms of value capture (for example, advertising revenue in

[113] Over the last few years, competition authorities have paid increasing attention to the ways in which mergers or other conduct might affect innovation and quality in the relevant markets. See G. Federico, "Horizontal Mergers, Innovation and the Competitive Process", (2017) 8(10) Journal of European Competition Law and Practice, 668—677; G. Federico, G. Langus and T. Valletti, "A Simple Model of Mergers and Innovation", (2017) 157 Economics Letters, 136—140; M. Motta and E. Tarantino, "The Effect of Horizontal Mergers, When Firms Compete in Prices and Investments", (2017) Working Paper 17-01,; P. Régibeau and C. Rockett, "Mergers and Innovation", (2019) 64(1) Antitrust Bulletin, 31; N. Economides, and I. Lianos, Restrictions On Privacy and Exploitation In The Digital Economy: A Market Failure Perspective, (2021) 17(4) *Journal of Competition Law & Economics*, 765–847 (analyzing privacy as a dimension of quality); P. Regibeau, and I. Lianos, Digital Mergers: A Primer (October 30, 2020). Available at SSRN: https://ssrn.com/abstract=3837281.

[114] See, I. Lianos, Competition Law for a Complex Economy, (2019) 50 *International Review of Intellectual Property and Competition Law (IIC)*, 643–648.

attention markets combined with zero-priced services in a multi-sided market context or asset-stocks reevaluation in financial markets).

Power based on the control of the agenda/discourse Granovetter distinguishes three forms of (economic) power: economic power related to dependence, power based on legitimacy (to the extent that someone occupies a position of legitimate authority and thus holds the power to command, whereas others the duty to obey)[115], and economic power based on control of the agenda/discourse, the latter being particularly effective in view of the tendency of power to become less and less visible[116]. It is frequent that some actors may exercise a considerable influence over a network or organization in view of their potential to control the agenda.

Panopticon power The power of specific nodes (actors) does not always result from the dependency of the other nodes of the network to which it forms part, for instance because of certain individual characteristics of this specific actor. Their influence may stem from their strategic position in the network. For instance, this position may enable them to extract an information advantage vis-à-vis potential adversaries, what Farrell and Newman call the 'panopticon effect', as a reference to the institutional building and a system of control designed by English philosopher Jeremy Bentham[117]. This panopticon effect may become a source of (economic) power (*panopticon power*).

Panopticon power may emerge in situations where there is significant and growing learning-by-doing asymmetry between the actor benefitting from this position in the network and the other nodes in the network. In view of the importance of hubs in a decentralized communications structure, Farell and Newman explain that 'hub nodes can use this influence to obtain information passing through the hubs'[118]. These actors may therefore tap, because of their positioning in the network, into the information gathering and generating activities of the whole network, well beyond the nodes with which they have direct, or even indirect, relations. Hence, despite the function of such actors as simple intermediaries who provide an infrastructure of communication, their influence can be quite significant.

Panopticon power therefore results from the position of an actor in a network and is not related as such to the existence of some form of dependence. It is possible that the different actors in a network voluntarily agree to share information through the hub, for instance because they trust it better than directly communicating between them, or because it is more convenient to do so. As each of these nodes is not dependent on the hub, in the context of a dyadic relation, the hub cannot be considered as holding power over them. However, the conclusion changes if one takes into account the fact that the

[115] M. Granovetter, *Society and Economy* (Belknap Press of Harvard University Press, 2017), 97.
[116] *Ibid*. 101–102.
[117] H. Farrell & A.L. Newman, Weaponized Interdependence: How Global Economic Networks Shape State Coercion, (2019) 44(1) International Security 42, 46.
[118] *Ibid*., 55.

actor also serves as a hub for a number of other interactions that provide that actor some superior and more complete information on the strategies of the other members of the network, including its adversaries. For this to occur, the latter should enter into communication interactions with some of the nodes also communicating with the hub. These insights are particularly important in view of the prevalence of business strategies to develop architectural advantage by constituting and dominating ecosystems[119].

Architectural power In addition to these competitive strategies that engage directly with the actual and potential sources of competition, a firm may also acquire a durable competitive advantage if it holds a position that enables it to reshape the 'industry architecture' in its own advantage (*architectural power)*.[120].

Industry architecture is framed by the various economic actors at the birth of a new industry, the new players defining the interfaces (technological, institutional, or social) that allow different entities to cospecialize and divide labour[121]. As the industry progressively matures, we observe the emergence of 'winners' who strive to frame the industry architecture in their own advantage by developing complex strategies. The objective of these strategies is to capture a disproportionate amount of the surplus value created by the innovation. In some situations, the most effective strategy will be to opt for an 'open architecture' that nurtures complementarity through an open ecosystem, should a system of 'open innovation' be the most effective way to generate higher value in this industry. In other situations, firms may opt for a 'walled garden approach', opting for a closed architecture with regard to firms with competing assets and capabilities entering the value chain while keeping it open for firms with complementary assets. Finally, in other circumstances, firms may opt for vertical integration, taking full control over the rents generated by the complementarities brought by the innovation while maintaining the possibility to exclude or marginalize any new entrant, for instance, by denying interoperability with regard to some indispensable technological interfaces.

Industry architectures are not meant to last forever, although they tend to be relatively stable for some time once the technology has sufficiently diffused. There are various reasons for this stability, such as the requirement for any new technology to be interoperable with the technical standards of the industry architect who benefits from an installed base, the quality certification barrier

[119] M. Jacobides, S. Winter & S. Kassberger, "The Dynamics of Wealth, Profit, and Sustainable Advantage", (2012) 33 *Strategic Management Journal*, 1386.

[120] D. Teece, "Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy", (1986) 15(6) *Research Policy*, 285; M. Jacobides, T. Knudsen & M. Augier, "Benefiting from Innovation: Value Creation, Value Appropriation and the Role of Industry Architectures", (2006) 35 *Research Policy*, 1201; M. Jacobides, "Industry Architecture" in The Palgrave Encyclopaedia of Strategic Management (M. Augier & D. Teece eds.), Palgrave Macmillan, London, 2016.

[121] *Ibid*.

from which the technologies of the industry architect benefit, to the extent that consumers' expectations have been framed according to the industry architect's quality standard, the favourable legal framework to the industry architect as this may have been framed so to respond to the risks generated by the technology of the incumbent or to accommodate the needs of the industry architect. This shift from the dyad to industry-wide networks of relationships regarding the allocation of the financial returns of innovation also explains the reason for the competitive game being more complex and certainly wider than the usual focus of competition law on a relevant product market.

Various factors may influence industry architecture. One is technological path dependence. This results from a self-reinforcing process triggered by an event, such as a first mover advantage leading to the choice of a widely used technology standard, which leads to a 'lock-in' to a less optimal, from a quality of technology perspective, equilibrium, without that being the intention of the agents at the first place[122]. The legal/regulatory framework may also play a crucial role in the definition of the boundaries of an industry and of its governance. Quite often it supports the existing industry architecture. Finally, path dependence and 'lock-in' may result from intentional strategies seeking to manipulate the industry architecture so to create a bottleneck and to maintain it by suppressing through mergers and/or exclusionary conduct any strategies of ecosystem differentiation by competing industry architects with the aim to develop close but distinctive competitive alternatives that may provide complementors and/or consumers the opportunity to break their lock-in with the specific ecosystem. The firm controlling the bottleneck is also in a position to extract all surplus value in the specific segment as well as a higher percentage of the surplus generated by innovation in vertically adjacent segments. This may take different forms: manipulating the setting of technology standards as often standards shape industry architecture, or influencing the regulators and/or legislation shaping the architecture of the industry, either directly through lobbying activity and pressure groups or indirectly by developing a narrative that will catch the imagination of policy-makers and legislators so that the emergent regulatory framework serves the interests of industry architect.

In conclusion, being in a position to influence the way the industry is organized or structured, as well as the value allocation between the industry (or ecosystem) actors, provides 'architectural advantage'[123]. This may be a quite important source of sustainable abnormal profits and plays a crucial role in periods of profound technological transformation[124].

[122] B. Arthur, Competing Technologies, Increasing Returns, and Lock-In by Historical Events, (1989) 99 (394) The Economic Journal, 116.

[123] M. Jacobides, T. Knudsen & M. Augier, "Benefiting from Innovation: Value Creation, Value Appropriation and the Role of Industry Architectures", (2006) 35 *Research Policy*, 1201.

[124] C. Ferguson & C. Morris, "How Architecture Wins Technology Wars", (1993) 71(2) *Harvard Business Review*, 86.

According to the architectural advantage approach, the boundaries of an industry should not be considered as a given. Firms with superior performance (due to superior resources and capabilities[125]) aim to shape 'industry architectures' in a way that provides them control of a 'bottleneck', that is, that would enable them to leverage their position of strength over all other companies that collaborate with them in the creation of surplus value[126]. The concept of 'ecosystem' offers an additional field where intra- and interindustry competition occurs[127]. Hence, to understand this process of value extraction that motivates strategies of competition, it is important to examine power both at the market level and the industry and eco-system levels. Contrary to (industrial) economics, which assumes that '(f)irms compete only within a market, and it is their performance, within that market, relative to other firms (in that market), that determines their profitability', the architectural advantage perspective focuses on the role of vertical or positional competition and the way this affects the relative proportion of value (that is, the 'NPV of future profits') that each segment captures, and which may lead to important value shifts from one part of the value chain or business ecosystem to another. The firms acquiring architectural advantage (the 'kingpins') take a central role in the overall industry architecture and/or ecosystem, influencing not only the segment they belong to but also multiple segments within a single industry or ecosystem[128].

C. Some preliminary conclusions

We summarize in Table 2 the various approaches discussed in defining power if one opts for a multidimensional perspective that seems more adequate for a complex economy. The conceptual clarification offered contributes to framing a specific ontology of power in competition law and regulation that takes more fully into account this multidimensionality. Moreover, it highlights how network and ecosystem-level dimensions of power, which are particularly relevant in the digital economy, lack indicators that can render them operational in the context of competition law enforcement.

As Table 2 summarizes from the previous evaluation, there have been developments regarding the concept of (economic) power to capture power exertion beyond horizontal competition within a relevant product market. However, for different reasons, not all of these concepts have been translated into metrics

[125] B. Wernerfelt, "A Resource-Based View of the Firm", (1984) 5(2) *Strategic Management Journal*, 171; C.K. Prahalad and Gary Hamel, "The Core Competence of the Corporation", (1990) *Harvard Business Review*, 79.

[126] M. Jacobides & J. Tae, "Kingpins, Bottlenecks, and Value Dynamics Along a Sector", (2015) 26(3) *Organization Science*, 889.

[127] See, M.G. Jacobides, and I. Lianos, Ecosystems and Competition Law in Theory and Practice (2021) 30(5) Industrial and Corporate Change 1199–1229.

[128] *Ibid*.

Table 2. The multiple dimensions of (economic) power

Power family	Type of power	Source of power	Modality of power exertion	Scope of power sourcing exertion in an economic context	Existence of standard metrics or modelling in competition law
Coercion	Coercion	Capacity to influence other actors' conduct and/or to affect outcomes directly in the context of a bargaining process	Absence of alternative 'reasonable choices'	Value chain/ecosystem and horizontal	No (because the concept is either too broad or too subjective)
Process-based	Process-based	Capacity to apply credible sanctions that affect another agent's gains	Credible sanctions that affect another agent's gains	Value chain/ecosystem and horizontal	Yes
Resource dependence	Standard market power	Market structure	Affecting equilibrium quantities or prices in a market	Horizontal	Yes
Resource dependence	Exclusionary/bottleneck	Supply-side (for example, an essential facility or input, a technology) and demand-side (for example, high switching costs, strong positive network effects) conditions creating a bottleneck	Exclusion from the bottleneck resource	Value chain/ecosystem	Yes
Resource dependence	Social exchange theory	Differential dependency between value cocreators	Obtaining a high share of the cocreated value through bargaining	Value chain/ecosystem	No
Positional	Panopticon	A position in the network of value cocreation that allows to collect valuable information	Strategic use of the information to obtain a higher share of value	Value chain/ecosystem	No
Positional	Architectural	Capacity to influence the industry architecture by affecting at least one of its interphases (technological, institutional, social)	Influencing the industry architecture to obtain a higher share of the value created in the industry	Value chain/ecosystem	No

that could be used by antitrust authorities and regulators. Although interesting to understand many economic dynamics, coercion power remains too broad to be translated into a metric. Process-based, exclusionary/bottleneck and architectural power, in turn, are contextual. Hence, no single metric can be established to measure these types of powers within any given ecosystem/value. Applying these types of power to antitrust cases or to derive regulatory measures requires therefore to rely on contextual behavioural evidence. Finally, power based on differential dependency between value cocreators (social exchange theory) and panopticon power could be translated into metrics that could be applied across different ecosystems or value chains. In the next section, we turn to this endeavour.

III. METRICS OF VALUE CHAIN OR ECOSYSTEM-LEVEL ECONOMIC POWER

Competition law has developed advanced quantitative tools to measure horizontal power (market power), which are frequently employed in competition law analysis. This has not occurred yet for the various theories of vertical power examined in the previous section. The review of theories of power in Section II has shown that they can be divided in two groups in terms of the scope of power sourcing and exertion. On one side, we have 'direct' or 'simple' vertical and/or horizontal power theories. These theories (coercion, process-based, standard market power, and exclusionary/bottleneck) describe situations in which power originates in and is exerted at the immediate vertical (that is, suppliers or clients) or horizontal (competitors within the same market) level. On the other side, we have 'value-chain-level' or 'ecosystem-level' theories. In these theories, the structure and the characteristics of the ecosystem or value chain (that is, the network in which economic agents cocreate value) of value creation affect power allocation between its members. Moreover, the latter can exert power over other members of the ecosystem/value chain even when they are not located in the immediate upstream or downstream tier or when they are not direct competitors within a market by obtaining a higher share of the value created within the value chain or ecosystem.

As mentioned above, social exchange theory and panopticon theories of power have not been translated into metrics that can be used in the context of competition law and economics. In this section, we intend to contribute to bridging this gap. In particular, we will provide metrics of value chain/ecosystem-level power originating in differential dependency (social exchange theory) and unequal information gathering (panopticon) between the firms of a value chain or ecosystem. As mentioned above, we will not address the third type of 'value-chain-level' or 'ecosystem-level' theory of power, architectural power, as its functioning responds to long-term institutional, technological, and social transformations that cannot be at present

translated into metrics. Moreover, a firm exerts architectural power by transforming in the industry architecture in its favour in such a manner that it allows it to exert another type of power. Then, *in fine*, architectural market power can be empirically observed through metrics that translate the type of power(s) it results in. This will be examined in subsequent research.

A. A metric of resource-based value chain or ecosystem-level power based on differential dependency

We have seen in Section II B.3 that a firm's differential dependency within a network (a value chain or ecosystem in the context of economics) can be a source of economic power. Moreover, we mentioned that it is common for theories based on positional power to recur to network analysis and, in particular, to the notion of centrality to represent an agent's level of power. Following positional theories of power, we use centrality indicators to develop metrics of economic power based on differential dependency. Building on the indicator of centrality that better translates the notion of resource-based differential dependency (betweenness centrality), we propose a metric that can be used to assess a firm's power within a value chain or ecosystem arising from this source. We build this indicator in such a manner that, as shown in Section II, the value retained by each firm of the value chain depends positively on its level of power. Then we generalize the indicator to assess the extension of power differentials within a value chain or ecosystem.

1. A metric at the firm level

Before starting to develop the indicator, let us briefly indicate how we will represent the problem in terms of network theory. Firms are denoted by nodes (which are graphically represented as circles) and commercial transactions[129] between them (selling/buying a good or service, licensing a patent, and so forth) as weighted directed vertices (graphically represented as arrows linking the dots). When firm A sells a good or service to firm B, the arrow goes from firm A to firm B. The weight of the vertices represents the unitary cost for purchaser node B of acquiring a good from selling node A[130]. It is graphically

[129] For the sake of simplicity and comparability, we assume that all managerial coordination relations are translated in commercial transactions, which is a realistic assumption. For example, if a firm advices another one on the development of a product, it translates into a contract in which a firm sells consulting to the other.

[130] A second dimension defining the weight graphically represented as the thickness of the vertex could be added to account for the firm's market share. In that way, concentration and economies of scale (a negative relation between a vertex thickness and its length) can be added to our framework. Miberg's (2006) theory of pricing and profits in a global value chains context can be then thought of as a particular case of an extended version of our thesis that includes market shares. This also goes in line with two of the three variables of economic dependence Baudry and Chassagnon (2012) identify within the value chain: "the concentration

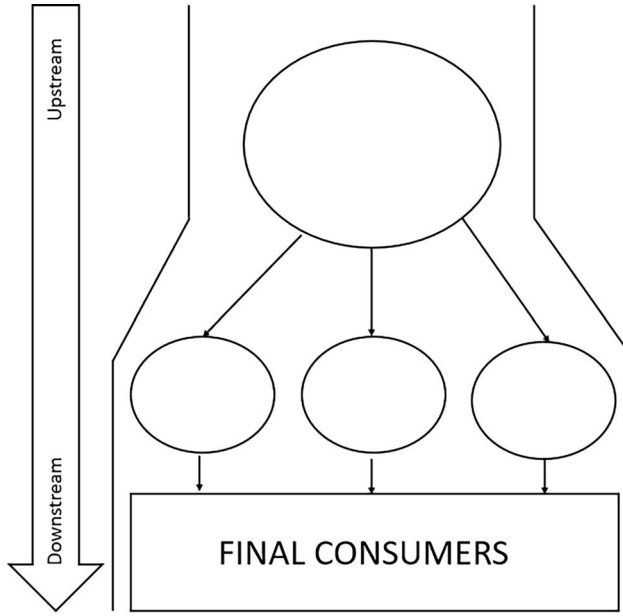

Figure 1. A value chain with one upstream supplier.

represented as the length of the vertex so that the costlier the input is, the longer the vertex is. Following Zhang[131], this cost includes both monetary and nonmonetary costs such as quality and coordination costs. Nevertheless, contrary to Zhang's model, and following the administered prices/normal cost doctrines, monetary costs are not marginal costs but full costs. Firms' vertical positions in the figure represent the tier in which they participate. The lower part of the spectrum corresponds to more upstream activities (for example, the extraction of primary goods) and the upper side of the spectrum corresponds to more downstream activities such as marketing and retail. Institutional and technical conditionings are represented as a two-dimensioned space (that is, as lines on a plan) on which firms (nodes) are contained. Figure 1 illustrates this.

In Figure 1, nodes represent firms and the lines that surround them represent the technical and institutional conditionings affecting the value

of exchanges between member firms" and "the respective sizes of subcontractors". The third one, "the importance of the specific assets engaged in the economic relationship" is implicit in our formulation because the more specific an investment firm A did to work for firm B, the more central firm B will be in respect to firm A. For the sake of simplicity, and in order to highlight what we consider to our main original contribution in this chapter, we have decided not to include market shares and sizes, although they are perfectly compatible with our thesis.

[131] D. Zhang (2006). "A Network Economic Model for Supply Chain Versus Supply Chain Competition". *Omega*, *34*(3), 283–295.

chain. In this example, the combination of technical and institutional conditionings (that is, industry architecture) leaves room for only one firm to exist downstream in the supply chains that can be formed. An example of this can be railway transportation in many European countries, where high fixed costs of having deployed already-existing networks (technical conditioning) and the decision of antitrust agencies to have competition on infrastructure (institutional conditioning) created a monopoly upstream[132]. Technological progress that reduces the high fixed cost of deploying a network or a change in antitrust policy to create competition through infrastructure can be represented by a loosening in the lines that surround the upstream node (firm), opening the possibility to the existence of more firms upstream. Then, changes in any of these two conditionings affect the number of firms in each tier, the scope of their possible vertical integration, and the possibility of relating to each other[133]. In terms of Jacobides, Knudsen, and Augier[134], the latter are the 'technical' and 'legal and regulatory authority' determinants of industry architectures[135].

If a central firm was to leave the value chain, the value loss for the latter would be greater than if a noncentral easy-to-replace firm left[136]. Because 'a node [firm] with high betweenness centrality has a great capacity to facilitate or constrain interactions between other nodes [firms] (Freeman, 1979)'[137], its removal affects the network more than the removal of a node (firm) with a low betweenness centrality. This means that central firms are those on which *all other firms* of the value chain or ecosystem depends *more* to function because they perform tasks and/or handle a considerable volume of transactions (sales, user traffic, and so forth).

As network theory shows, a node's (firm's) centrality, in turn, is a property of the topology of the network (value chain or ecosystem). If we wanted to establish which node is the most central in a network, there would be many ways to do so. Of all the measures of centrality mentioned above, the one that is pertinent to us, as we anticipated a few lines ago, is betweenness centrality.

[132] D. Cayla (2014). "Concurrence, de quoi parlons-nous? Préciser le concept économique pour clarifier le débat politique". halshs-00994773v2.

[133] Let us note that barriers to entry and rent-earning resources can be represented by shaping the contouring lines that would benefit one node over other horizontally competing nodes in, for example, placing it vertically 'closer' to suppliers and/or more far away from clients than other competing nodes (i.e. by making it able to charge more and purchase for less than competing firms).

[134] M.G. Jacobides, T. Knudsen & M. Augier (2006). "Benefiting from Innovation: Value Creation, Value Appropriation and the Role of Industry Architectures". *Research policy*, 35(8), 1200–1221.

[135] The authors also consider path-dependency as a third factors that shapes industry architectures.

[136] T.R. Crook, & J.G. Combs (2007). "Sources and Consequences of Bargaining Power in Supply Chains". *Journal of Operations Management*, 25(2), 546–555.

[137] Y. Kim, T.Y. Choi, T. Yan, & K. Dooley (2011). "Structural Investigation of Supply Networks: A Social Network Analysis Approach". *Journal of Operations Management*, 29(3), 194–211.

Then, if we notate a node as N_x where x identifies a particular node in the network, its betweenness centrality can be calculated using Equation (1).

Equation 1: Formula of betweenness centrality of node *X*

$$\mathrm{BC}\,(N_X) = \frac{\text{Number of paths passing through } N_X}{\text{Number of paths in the network}} \tag{1}$$

where BC stands for 'betweenness centrality' and N_x for 'node *X*'.

Let us note that in most value chains and many ecosystems, because all the vertices have to be transited (that is, all the nodes have to be transited to arrive the final consumer, as all the firms—nodes—participate in value creation at some stage and level), all paths are shortest paths in terms of network theory. In that case, the denominator of Equation (1) is always equal to one, as there is only one path in the network leading to final consumers. However, this is not necessarily the case. In digital ecosystems, for example, users can choose which complementary services (for example, a smartphone that can connect to a smart TV to stream a video, to a connected air conditioning, and so forth) to combine. Nonetheless, the existence of one or more shortest paths does not affect the interpretation of the indicator. Since vertices represent a firm performing a transaction or task (buying something to another to continue with the production process, providing content to users coming from another firm, and so forth), the bigger the share of shortest paths that pass through firm *X* relative to other firms in the network, the more essential that firm's contribution to the value chain/ecosystem is relative to other firms'. In other words, a firm's betweenness centrality relative to other firms' ('relative centrality' hereafter) translates its differential dependency within the value chain/ecosystem. Hence, our metric has to be able to give us two different values for two firms that belong to different value chains/ecosystems and have the same betweenness centrality but different relative centralities. Equation (2) provides an indicator that meets this requirement.

Equation 2: Resource-based vertical market power based on differential dependency for a node *x*

$$\mathrm{SSBC} = \frac{\mathrm{SBC}\,(N_x)}{\sum_{i=1}^{n} \mathrm{SBC}\,(N_x)} \tag{2}$$

where in 'SSBC' (share of square betweenness centrality), SBC stands for 'square betweenness centrality' and N_x for 'node *x*'.

In other words, Equation (2) poses that the level of a firm's resource-based value chain/ecosystem-level metric of economic power can be measured as its share of the sum of the square betweenness centralities of each node (firm) of the value chain/ecosystem. It should be noted that given that the indicator is built as a share and that it includes firms downstream and upstream of the

entire value chain/ecosystem, it can be interpreted as the share of vertical power each firm holds within the value chain or ecosystem.

Because this firm-level indicator incorporates differential dependency between upstream and downstream firms, it could diminish the false negatives and false positives in comparison to a simple market share when assessing a firm's dominance within a value chain or ecosystem. Let us illustrate this with an example.

We applied the SSBC indicator to assess suppliers and retailers' levels of vertical power for 11 product categories in the Greek supermarket sector in years 2015–2019. The results for the 'pasta' product category in 2019 illustrate how using the SSBC indicator could reduce the likeliness of false positives. Figure 2 below represents the network of purchases from retailers to suppliers of that product in 2019. Green nodes correspond to suppliers and red nodes correspond to supermarkets. Links' widths are proportional to the volume of net sales. Nodes' sizes are proportional to the corresponding firm's level of vertical market power calculated using the SSBC indicator. It should be noted that the number of paths passing through a node (N_x) is equal to the share of sales/purchases of the node (supplier/retailer). In other words, it represents the share of sales/purchases of the value chain that goes through a given supplier/retailer weighted by its volume measured in monetary terms.

As Figure 2 shows, supplier 63 concentrates most (55 percent) of vertical power in the value chain. The second firm in terms of vertical power is supplier 1 with an SSBC indicator level of 21 percent. This contrasts with its market share of 36 percent, which would fall short of European Commission's threshold of 40 percent to establish dominance[138]. The reason for this discrepancy between the two indicators lies in the fact that supplier 1's market share is highly concentrated in a single buyer: supermarket 45. The latter, in turn, divides its purchases more equally between suppliers 1 and 63. As a result, provided that we interpret both a market share and the SSBC indicator as shares of market power (a monopolist would have a 100 percent share of market power), we can conclude that supplier 1 has less bargaining power than its market share would suggest. This example illustrates how using an indicator that translates relative dependency could diminish the likeliness of false positives when assessing dominance.

Inversely, the SSBC indicator could reduce false negatives. Let us illustrate it with another example from the Greek supermarket sector. Figure 3 below shows the network of purchases of soft drinks from supermarkets to suppliers in 2018. The same graphic interpretations and underlying calculations employed for Figure 2 apply.

Supplier 21 concentrates most of the vertical market power with an SSBC indicator of 52 percent. However, its market share is 50 percent because the

[138] European Commission, "Antitrust procedures in abuse of dominance (Article 102 TFEU cases)", https://ec.europa.eu/competition/antitrust/procedures_102_en.html.

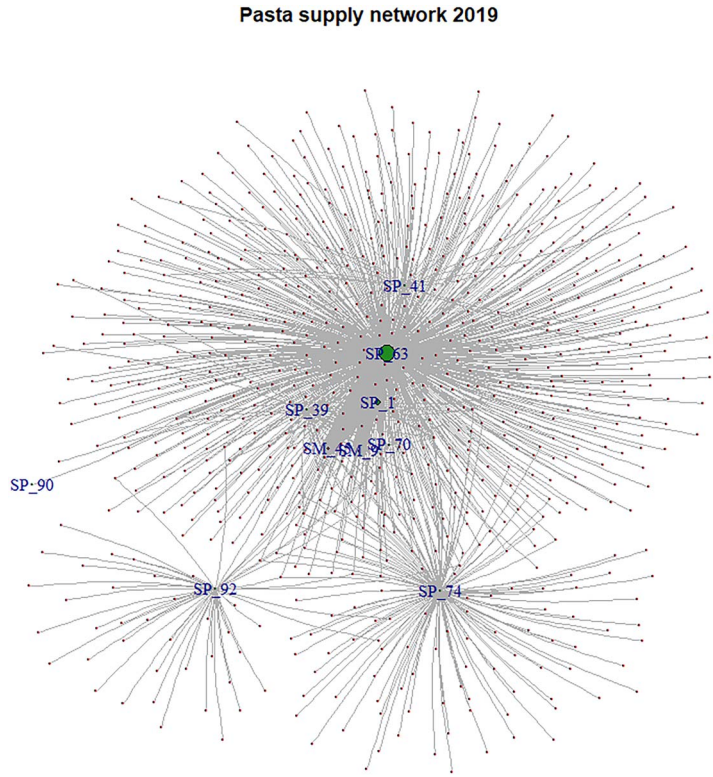

Figure 2. Network of sales/purchases between Greek suppliers and supermarkets for the pasta product category in 2019.

main buyers, supermarkets 45 and 9, are highly dependent on it to obtain their supply. Although slight, provided that we interpret both the market share and the SSBC indicators as shares of market power (we will develop on this below), this discrepancy would have a considerable impact in the less interventionist courts of the United States, which have used a 50 percent threshold to establish dominance[139]. A market share of 50 percent (49.82 percent to be precise) could have raised doubts regarding supplier 21's dominance in the eyes of these courts. However, if the SSBC indicator was to be used, even the less interventionist courts would conclude supplier 21 is dominant in the soft drinks wholesale market. As this example illustrates, using the SSBC indicator could reduce false negatives when assessing dominance.

These two examples illustrate why the SSBC indicator could reduce false positives and false negatives in respect to market shares when assessing dominance in the context of firms located in the same value chain or ecosystem.

[139] See https://www.justice.gov/atr/competition-and-monopoly-single-firm-conduct-under-section-2-sherman-act-chapter-2.

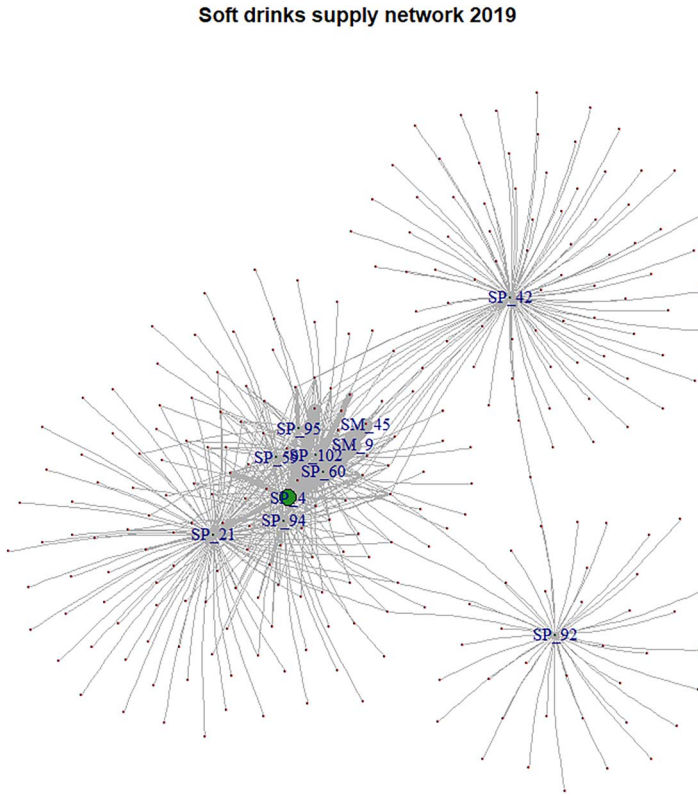

Figure 3. Network of sales/purchases between Greek suppliers and supermarkets for the soft drinks product category in 2019.

If these two alternative indicators are used to assess dominance in such cases, they can lead to opposite conclusions, as illustrated above with the example of the Greek supermarket sector. Given SSBC's capacity to capture relative dependency, it should be a better indicator of dominance than market shares. Hence, using SSBC instead of market shares in such circumstances should lower the probability of false negatives and false positives when assessing dominance.

Although the SSBC indicator has been successfully tested with real data in a sector inquiry, it represents a first step in a research agenda on empirical indicators translating types of power that are currently under the radar of authorities antitrust and regulators. In that respect, several considerations are to be made regarding its workability in general, and in the context of digital ecosystems in particular. Although the SSBC indicator has several advantages, it can benefit from further research in related areas, as well as from being tested in other contexts.

First, the thresholds to be employed to interpret the SSBC indicator are not necessarily the same ones as those established by competition authorities

in terms of market shares. Although the two indicators measure how much one side of the market (for example, the buyer and the seller) depends on a particular firm, they do not measure the same thing. This is all the more so in cases which the indicator is not weighted by the volumes of sales. For example, the SSBC indicator could be used to assess firms' vertical power in terms of dependency on the use of a resource such as know-how, each shortest path representing a production process that requires the firm's intervention within a value chain for the final product to be built. In that respect, the comparisons between market shares and SSBC we did for the supermarkets sector should be interpreted merely as illustrations of SSBC's indicator potential to lower false negatives and false positives when assessing dominance within a value chain or ecosystem, an endeavour that would require empirically establishing thresholds that might differ from the current ones, which are based on market shares. These thresholds, in turn, can vary depending on what type of links between value cocreators are measuring. Although in the case of the supermarket sector example we measured economic transactions of a product between suppliers and retailers, (digital) ecosystems, in which zero-pricing is common, might require measuring other types of links. For example, if data exchanges between platforms of an ecosystem were to be measured with the SSBC indicator, a different threshold than the one used when measuring transactions of a traditional consumer good should be used.

Second, in most cases, the SSBC indicator is easy to calculate in terms of its methodology and the required data. Regarding methodology, the formula is easy to compute and does not require any additional quantitative skills other than those that antitrust agencies' economists currently possess. Regarding data availability, when, as in the supermarket sector example, transactions between firms of the value chain or ecosystem are monetary, the required data does not differ from that used to calculate market shares. However, when the transactions between value cocreators are not (merely) monetary, as in the case of many digital ecosystems (for example, cross-user traffic between digital platforms, data exchanges), alternative data sources are needed. However, this is not an unsurmountable barrier. Several private providers offer data about nonprice links between firms such as cross-user traffic. Moreover, antitrust authorities and regulators can ask firms for any data that is relevant to carry on their mission. In that respect, there is no need to circumscribe data requirements to the data needed to calculate market shares. This is all the more important in a context in which antitrust agencies and regulators are increasingly scrutinizing digital ecosystems, in which market shares are usually not indicative of firms' power[140].

[140] M. Peitz & T. Valletti, (2015). Reassessing Competition Concerns in Electronic Communications Markets. *Telecommunications Policy*, *39*(10), 896–912. J. Krämer, & M. Wohlfarth, (2015). Regulating Over-the-Top Service Providers in Two-sided Content Markets: Insights from the Economic Literature. *Communications & Strategies*, 1(99), 71–90. J. Prüfer & C. Schottmüller, (2019). Competing with Big Data (TILEC Discussion Paper No. 2017–006).

Third, Although shares require defining a relevant market, the SSBC indicator necessitates defining the scope of the value chain or the ecosystem to which it is applied. In the case of value chains, this is a relatively easy task. A product market can be defined following traditional criteria and the firms participating in its creation (suppliers, integrators, retailers, and so forth) throughout the value chain derived from firms' transactions and the analyst's knowledge of the sector. In the case of an ecosystem, and notably a digital ecosystem, defining its scope can be more challenging. Although definitions of the term 'ecosystem' vary[141], they all part from the existence of supply-side and demand-side complementarities between firms. Defining the scope of an ecosystem therefore requires assessing which firms' services or products create complementarities with each other both on the supply (for example, the data collected in the browser market can help a firm improving its search function in e-commerce) and the demand (for example, a user that enjoys a greater utility from seeing the average rating of a movies review website on the TV screen when using a movie streaming service) side, and to which extent. This, in turn, requires developing metrics of supply-side and demand-side complementarities. In this regard, there is a literature that tests methodologies to measure supply-side complementarities that could be of inspiration for competition agencies[142].

Fourth, the construction of the indicator allows for an easy interpretation. Given that the sum of every firm's SSBC score is equal to one by definition, each firm's score can be interpreted as the share of vertical market power it holds within the value chain or ecosystem. As a corollary, as shown below in Section III A.1, an equivalent to the HHI index, the 'VHHI index', can be built to assess how (un)evenly is vertical economic power distributed within the value chain or ecosystem. Although, as explained above, the thresholds to be used should differ from those traditionally applied to interpret an HHI index, the similarity between the two can facilitate interpretation.

2. A metric at the value chain or ecosystem level

We have just shown how the share of square betweenness centrality of a firm can be used as a metric of resource-based value chain/ecosystem-level power that draws on the concept of differential dependency. However, because this

[141] For a recent review of the definition of the term "ecosystem" in the management and economics literatures, see Hou, H., & Shi, Y. (2020). Ecosystem-as-structure and Ecosystem-as-coevolution: A Constructive Examination. *Technovation*, 102193.

[142] See for example: C. Lee & H. Kim (2018). "The Evolutionary Trajectory of an ICT Ecosystem: A Network Analysis Based on Media Users' Data". *Information & Management*, 55 (6), 795–805; C. Battistella, K. Colucci, A.F. De Toni & F. Nonino (2013), "Methodology of Business Ecosystems Network Analysis: A Case Study in Telecom Italia Future Centre". *Technological Forecasting and Social Change*, 80 (6), 1194–1210; R.C. Basole (2009). "Visualization of Interfirm Relations in a Converging Mobile Ecosystem". *Journal of information Technology*, 24 (2), 144–159.

metric is firm-centric, it does not tell us what is the level of vertical power differentials within a value chain or ecosystem, a piece of information that could be useful to do a more aggregated analysis of power, especially from an antitrust perspective. Consequently, with this indicator, we cannot say if there is more power concentration in a certain value chain, or ecosystem, than in another one. Therefore, in this subsection, we will adapt this metric to overcome these difficulties.

Given that each firm's level of power corresponds to its share of the sum of the square betweenness centralities of all of the firms (nodes) of its value chain/ecosystem, a simple way of assessing the level of power imbalances within a value chain/ecosystem consists in calculating the HHI index for all the firms of the value chain/ecosystem using their SSBC instead of their market shares. In that manner, the resulting indicator, 'vertical HHI' (VHHI), measures how (un)evenly vertical power is distributed within a value chain or ecosystem. It is calculated following Equation (3).

Equation 3: Vertical HHI indicator for a value chain or ecosystem with n firms

$$\text{VHHI} = \sum_{i=1}^{n} \text{SSBC}^2 \tag{3}$$

where SSBC stands for 'share of square betweenness centrality' calculated as given by Equation (2).

Then, the higher the indicator in Equation (3) is, the more imbalanced power is in the value chain, or ecosystem. This indicator would then be analogous to HHI. Whereas the latter measures the level of market power in a market resulting from market concentration, the indicator in Equation (3) measures the level of vertical power in a value chain or ecosystem resulting from differential dependency over a resource. Moreover, because the VHHI indicator is, like the HHI, based on shares, it also ranges from 0 (total absence of vertical power imbalances) to 10,000 (absolute concentration of vertical power by one firm). However, as explained for the SSBC indicator, this does not mean that the thresholds established for HHI to assess the competitive level of a given market should apply to assess the degree of (vertical) competition within a value chain or ecosystem.

B. A metric of panopticon power

We have seen in Section II B.4 that one of the positional sources of economic power, 'panopticon power'[143], is based on an actor being able to benefit from its position in a network (a value chain or an ecosystem) to gather valuable information that gives it a competitive advantage. This advantage is more

[143] H. Farrell & A.L. Newman, Weaponized Interdependence: How Global Economic Networks Shape State Coercion, (2019) 44(1) International Security 42, 46.

relevant when there is significant and growing learning-by-doing asymmetry between the actor benefitting from this position in the network and the other nodes in the network. In this subsection, we will develop a metric of this type of power. To do so, we shall start by defining more precisely what makes information valuable and, hence, a source of competitive advantage.

Information or data[144] is valuable because of what it allows to do. Benyayer and Chignard[145] summarize what data allows to do in four verbs: describe, explain, predict, and prescribe. Nevertheless, not any kind of data is valuable. In order for a dataset to allow for proper descriptions, explanations, predictions, and prescriptions, it needs to have certain properties, namely volume, quality, and scope[146]. It is important to notice that each of these three properties have a different ponderation in making the data valuable depending on the use intended. The value of data is therefore contextual to its use[147].

Volume refers to the number of observations of the dataset. The above-mentioned valuable uses of data (describing, explaining, predicting, and prescribing) rely on extracting insightful patterns using statistical techniques. As the results of the latter are more precise and robust as the dataset increases in volume, the more data there is, the more solid the conclusions that can be drawn from it are. The quality of data refers to the characteristics of a dataset that make it easier to extract meaningful information from it. It is difficult to list all the properties that constitute quality. To illustrate the multidimensional nature the term 'quality' acquires to qualify data, we will retain the following categories of quality employed by Floridi[148]: accuracy, objectivity, accessibility, security, relevancy, timeliness, interpretability, and understandability. It is important to stress that the meaning of quality is contextual to the use intended of the data. This implies that any metric of the quality of a dataset requires a qualitative assessment of the importance of the different dimensions of quality for a specific use. The scope of data refers to two related yet distinct properties. One is the fact that a dataset can be easily linked to others. The other property that constitutes the scope of data is what Mayer-Schönberger and Cukier[149] call 'option value of data': how many

[144] For the purposes of developing an indicator of panopticon power, in this subsection we will use the terms "information" and "data" as synonyms as we will use the e-commerce sector as an example.

[145] S. Chignard, & L.D. Benyayer, (2015). *Datanomics. Les nouveaux business models des données*. FYP editions.

[146] B. Carballa Smichowski, The value of data: an analysis of closed-urban-data-based and open-data-based business models. Science Po's Cities and Digital Technologies Chair Working Paper 2018-01.

[147] OECD. (2015). Data-Driven Innovation: Big Data for Growth and Well-Being. OECD Publishing

[148] L. Floridi,(2014). Big Data and Information Quality. In *The philosophy of information quality* (pp. 303–315). Springer, Cham.

[149] V. Mayer-Schönberger, K. Cukier, (2013). *Big Data: A Revolution That Will Transform How We Live, Work, and Think*. Houghton Mifflin Harcourt.

different domains a single dataset can provide information about. Datasets that can create links between seemingly unrelated domains are valuable as they enrich the comprehension of a phenomenon (description and explanation), and hence the possibilities of acting (predicting and prescribing) on it in the 'right' way.

Having briefly introduced the three properties that make data valuable, let us turn now to developing an indicator of panopticon power that takes them into account. In doing so, we will only include volume and quality as dimensions. This is due to the fact that the value coming from the scope of a dataset is purely contextual to the use and the characteristics of its holder. Hence, developing an indicator that takes into account would be difficult and of little replicability across cases. However, a qualitative assessment of the scope of data can be very important in antitrust, notably in data mergers, as the Apple/Shazam[150] and Facebook/WhatsApp merger[151] cases have shown.

To develop the indicator, we will use the example of two competing retailers. Retailer A is a digital e-commerce platform and retailer B is a brick-and-mortar store. For the sake of simplicity, let us assume that they only compete on one product. They both act as intermediaries between three vendors and final consumers. The commercial transactions involving valuable data transfers between these agents are described in Figure 4 below.

The network is a multilayer network in which each of the three layers represents a tier of the value chain: vendors, retailers, and final consumption. Firms are denoted by nodes (which are graphically represented as circles) and commercial transaction between them (selling/buying a good or service) as weighted directed vertices (graphically represented as arrows linking the dots). When firm A sells a good or service to firm B, the arrow goes from firm A to firm B. For every arrow (sell) going from a vendor to a retailer, there is a corresponding arrow (sell) from the retailer to final consumers, as we only represent sells having taken place. The weight of the vertices represents the quality of the information embedded in the sell. Only retailers collect information from consumers and vendors. In our example, we assume that retailer A obtains more information from the vendors it buys from and from the final consumers it resells to than retailer B because the former is an online platform whereas the latter is a brick-and-mortar store. Indeed, being an online platform gives retailer A the possibility of siphoning more data through the use of cookies that track consumer behaviour, the necessary identification of individual buyers, and so forth. It even gives it the possibility to gather valuable consumer behaviour data when consumers do not buy. Indeed, online retailers like Amazon track 'what shoppers are searching for but cannot find, as well as

[150] *Apple/Shazam* (Case M.8788) Commission Decision (11 November 2018), available at http://ec.europa. eu/competition/mergers/cases/decisions/m8788_ 1279_ 3.pdf.

[151] Case No. M.7217 –Facebook/WhatsApp, Commission's decision of 3 October 2014, sections 5.1, 5.2 and 5.3, available at: https://ec.europa.eu/competition/mergers/cases/decisions/m7217_20141003_20310_3962132_EN.pdf.

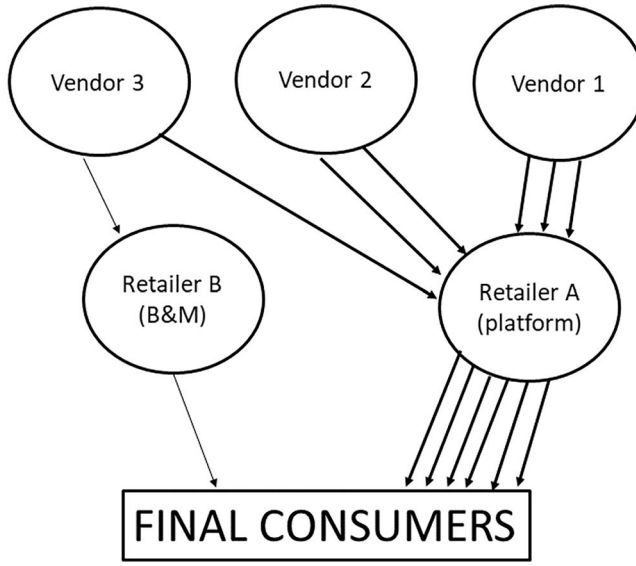

Figure 4. Example of two competing retail value chains.

which products they repeatedly return to, what they keep in their shopping basket, and what their mouse hovers over on the screen'[152]. Online platforms can also gather data on vendors that brick-and-mortar retailers cannot such as vendors' response to consumers' inquiries, returns, the notation of their products, and so forth.

Algebraically, the network described in Figure 4 can be represented by an adjacency matrix A_{ij} coding the data-embedding links between the nodes (sells). The Q_{ij} matrix represents the weight of each link, which in turn translates the quality of the information they embed. The values of this matrix range from 0 (worst possible level of quality) to 1 (best possible level of quality). To calculate the values of this matrix, a qualitative assessment of the importance of the different dimensions of quality (timeliness, relevancy, interpretability, and so forth.) in the specific use of selling the product as a retailer has to be made first. Then, each of this dimension can be given a score ranging from 0 to 1. The quality of the data of each sell would then be a weighted average of each dimension's score in which the weight of the score translates the relevancy of each dimension to assess the quality of the data in the given context.

We can now define indicators of the value of data arising from volume ('$ValV_i$') and quality ('$ValQ_i$') for a given node i in a network with n nodes

[152] L.M. Khan, (2016). Amazon's Antitrust Paradox. *Yale LJ*, *126*, 710, 782.

out of which m nodes are information gatherers (retailers in our example).

$$\mathrm{ValV}_i = \sum_{j=1}^{m} \frac{\mathrm{A}_{ij}}{n-m}$$

In other words, the value of the data gathered by retailer *i*" that is attributable to volume is measured as its degree centrality, regardless of the direction of the vertices. This is because retailers gather information from both vendors and final consumers. The denominator is divided by $n - m$ (all the nodes except retailers) as retailers cannot extract information from other retailers or themselves.

Similarly, we have

$$\mathrm{ValQ}_i = \sum^{m} \frac{Q_{ij}}{n-m}$$

In other words, the value of the data gathered by retailer *i* that is attributable to quality is calculated as the sum of the quality score from each transaction divided by the number of nodes out of which it could extract information.

To obtain a metric of panopticon power from the metrics of value of data, we divide the numerators of ValV_i and ValQ_i by the total volume-related and quality-related value of the data gather by all the data gatherers (retailers in our example) of the network, respectively. In this manner, we obtain the shares of volume-related (SValV_i) and quality-related (SValQ_i) data value.

$$\mathrm{SValV}_i = \frac{\sum_{j=1}^{m} \mathrm{A}_{ij}}{\sum_{1}^{m}\sum_{j=1}^{m} \mathrm{A}_{ij}}$$

$$\mathrm{SValQ}_i = \frac{\sum^{m} \mathrm{Q}_{ij}}{\sum_{1}^{m}\sum^{m} \mathrm{Q}_{ij}}$$

Given the context-dependent relative importance of volume (β^{V}) and quality (β^{Q}) in constituting the value of the data, the share of the value of data captured by a firm *i* attributable to both quality and volume (SValVQ_i) is equal to:

$$\mathrm{SValVQ}_i = \beta^{\mathrm{V}}.\mathrm{SValV}_i + \beta^{\mathrm{Q}}.\mathrm{SValQ}_i$$

where $\beta^{\mathrm{V}} + \beta^{\mathrm{Q}} = 1$.

Finally, we can recur to the methodology of the HHI index to build a Panopticon HHI index which is equal to:

$$\text{PANOPTICON} \quad \mathrm{HHI} = \sum_{i=1}^{m} \mathrm{SValVQ}_i{}^2$$

Then, a certain threshold of the PANOPTICON-HHI index can be established to consider that there is considerable concentration in valuable data

gathering in a market, which would be an indicator of possible panopticon power. The analysis of this type of power could be then complemented with a qualitative analysis of the scope-related value of the data taken into account.

IV. CONCLUSION

The increasing relevance of value chains and new business models in the digital economy has brought to light that economic power is multidimensional. As a result, traditional conceptions and metrics of economic power focusing on horizontal competition within a single relevant market, although useful, are not sufficient if regulators and antitrust authorities want to keep pace with the new ways in which firms produce value and compete, on the basis of complementarities in modular technical or business systems. This endeavour is also relevant for the analysis of power in the context of business ecosystems, which is a topic that is profoundly linked to this refocusing of competition law but will be more deeply explored in subsequent work. Hence, the mainstream concept of market/economic power (over price, quality, innovation) that is profoundly linked to the consumer welfare rhetoric in competition law, should be complemented with other operational concepts/models of power that account for different processes of establishing and exercising power in an (economic) relationship, in particular as we move to a more polycentric competition law model that integrates a variety of other players than just consumers (intermediary or final)[153] and fields of competitive interaction.

This article proposes a threefold contribution toward this research on new forms and dimensions of (economic) power in competition law and economics, but also more broadly on the underlying spaces of competition and fields of competitive interaction, a topic that has been explored in other published work by the authors[154]. First, drawing on different disciplines, we propose a categorization and conceptualization of different dimensions of (economic) power that we translate in terms of different sources of economic power. In that sense, we facilitate their integration within the theoretical framework of competition law and economics. Second, we develop novel metrics that can render operational two concepts that translate value chain or ecosystem-level economic power that had not been translated into indicators so far: panopticon power and power based on differential dependencies as theorized by social exchange theory. Third, using recent data from the Greek supermarket sector, we show how the metric we propose to measure economic power based on differential dependencies within a value chain can reduce false negatives and false positives when identifying firms with a dominant position in comparison

[153] I. Lianos, Polycentric Competition Law, (2018) 71(1) Current Legal Problems 161.

[154] See, N Economides, and I. Lianos, Restrictions On Privacy and Exploitation In The Digital Economy: A Market Failure Perspective, (2021) 17(4) *Journal of Competition Law & Economics*, 765–847;M.G. Jacobides, and I. Lianos, Ecosystems and Competition Law in Theory and practice (2021) 30(5) Industrial and Corporate Change 1199–1229.

to simple market shares, which only capture horizontal competition within a tier of the value chain. A similar analysis may be undertaken in other contexts (for example, digital economy) in subsequent work by the authors. This multidimensional concept of economic power developed in this paper is not only relevant to assess power in a firm-to-firm context but also in all situations in which there are complementary relations for value creation. For instance, it could apply in the context of a firm to final user relation, when users participate through their actions (for example, content creation in a social network) in the cogeneration of value.

We hope this article will spark further contributions both in the legal and economic communities of scholars, regulators, and competition authorities interested in adapting competition thinking to the challenges that new industry architecture pose.