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Economic Power and New Business Models in Competition Law and Economics: Ontology and New Metrics

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Abstract:

European systems of competition law employ the concept of ódominant positionô, the concept of ómarket powerô 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 óhorizontal competitionô, that is, competition from established or potential rivals on a specific relevant market and focuses on the price dimension of competition.

The digital economy challenges this conceptual framework. New business models rely on zero-price markets and multi-sided platforms, while competition authorities try to grapple with the broader concern over the bargaining 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 law enforcement against unilateral conduct[2]. Without aiming to present an exhaustive list, various concepts have been put forward as a trigger for regulatory/competition law intervention, such as ñstrategic market statusò[3], ñconglomerate market power and ñintermediation powerò[4], ñstructuring digital platformsò[5], or ñgatekeepersò[6]. These may complete, or even substitute, the archetypical concept of market or monopoly power in competition law, which is determined in the context of a specific relevant market.

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. Business models recognize the strong cross-side effects of multi-sided platforms. Platform business models are not geared towards a stable and well-defined final product (eg an automobile), but dynamic in themselves, easily moving sectors and adding new ones to the portfolio (eg e-commerce platform engaging also in financial services). This is significant as economic is not necessarily manifested in the context of a final product market (or ñcore competenceò) 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 characterise modern digital and non-

[2] See, CERRE, Making Economic Regulation of Platforms fit for the Digital Age ï

digital 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[7]. They form ñintentional communitiesò of economic actors who to a large extent co-evolve their goods and services with aligned visions and ñwhose individual business activities share in some large measure the fate of the whole communityò[8]. 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 premisse 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

to competing with firms in the same relevant market and/or potential horizontal competitors at each segment of a value chain, there is also vertical competition among the firms forming part of the same value chain or which have a complementary relation in the context of an ecosystem as to which one will be able to capture the largest share of the surplus value generated by the value chain or the ecosystem. This is particularly relevant in digital ecosystems, where the creation of wealth is mostly generated through higher market valuation by financial markets, which due to their emphasis on futurity, realize that holding certain assets or gatekeeping positions and developing specific competitive strategies will bring a sustainable architectural competitive advantage for the specific firm[11].

The framework should also integrate competition from complementary technologies that may challenge the lead position of incumbents in a value chain or an ecosystem (vertical innovation competition). Competition economics has largely focused on horizontal competition from established competitors (producing substitute products), or on the threat of entry of potential

2.2.1. Economic power as coercion

to survive.[21] Hayekôs conception of coercion is thus clearly unhelpful, as it would only cover threats to deny goods that are crucial to oneôs existence.[22]

welfare, this joint surplus will be ñthe difference between the benefits (net of direct costs) each gains from the joint activity and the benefits each would receive in their next best alternativeò.[26] 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).[27] A long as the ñparticipation constraintsò of all participants to the cooperative project are satisfied, the question of distribution is settled in an economically efficient way.[28] What matters 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 ñbarely superior to their next best alternativesò.[29] To the extent that the joint surplus is net of the participantsô 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, 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)[30], to the extent that it can be assumed that such properties (large size) will affect the bargaining process. However, this will require the determination of specific quantitative and qualitative criteria that would define the specific properties of the participants to 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 provide pragmatic grounds for concern about control over a significant part of the economy. 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.

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

Gatekeepers	**Significant Impact**	**Important Gateway**	**Enduring Position**

[26] Ibid., 168
[27] S. Bowles, Microeconomics ï Behavior, Institutions, and Evolution (Princeton Univ. Press, 2004), 171.
[28] Ibid., 171.
[29] Ibid.
[30] 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).

Designation			
Cumulative Evidential Threshol			

envisage different forms of bottlenecks that may emerge from changes in technology or the creation of new commodities, and scarcities, for instance ñhuman attentionò[48].

Hence, one may go beyond the existence of a formal ñcontractual relationshipò between the parties to the transaction and focus on situations that have been qualified by some as ñuncontractò, or technological forms of governance (code).[49]

mutual dependence, or the sum of their dependenciesõ[51]. This needs further elaboration, taking into account that social exchange theory does not analyze the resource differential linked to the individual characteristics of the actor in abstract, but conceives power as a óproperty of the social relationõ[52]. Blau has indeed observed that exchange relations between a person or entity with another may take different forms: (i) independence (if the outcomes of the exchange depend on oneôs sole effort), (ii) dependence (if the outcomes depend on the other entityôs effort and (iii) interdependence (the outcomes are based on a combination of the partnersô efforts)[53].

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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, ópower as potential is located in structuresô, ó(s)ubsequently, actors in structures produce power as activityõ[59]. Similarly, others have focused on the network position of the economic actors in order to determine the power-dependence not in the context of a dyadic relation, but in the context of a network[60].

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, ówhere the relations involve the exchange of valued items (which can be material, informational, symbolic, etc.)õ[61]. These relations are not only linking actors directly, but also indirectly[62]. An exchange relation may thus not only occur directly between two actors, but could

multilateral, nongeneric complementarities that are not fully hierarchically controlledô[79] shows that, like value chains, they always entail positive connections. However, firms within ecosystems can coopete (compete and cooperate simultaneously)[80], For example Google News and news publishers cooperate in that they are vertical complements: news publishersô content helps attracting users to Google News (positive connection: without news publishers Google News cannot exist)

markets with larger concentration ratios[82]. 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% and a market with a CR4 of 100 with each of the four firms holding a 25% market share, they argue that the market with a CR4 of 80 will create higher dependency than the market with the CR4 of 100[83].

Focusing on resource dependence in the context of a dyadic exchange relation or a network has also some implications on the conceptualization of power. This is not anymore linked to the exceptional ability of an actor to raise prices, reduce output, as is assumed in the horizontal power approach, or to exclude rivals, as in the context of bottleneck power, but focuses on 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. The 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

one takes a meritsô 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[87].

Power could thus be conceived as differential dependencies that do not rely on its outcome (distribution of surplus) because otherwise the (positive) assessment of the level of power would depend on the (normative) judgement of which distribution of surplus is considered ó*fair*ô, something that opens up a broader debate on the policy premisses and the social function of competition law.

2.2.4. Different dimensions of positional power

2.2.4.1. The concept of positional power: an introduction

As explained in the previous Section, a social actorôs 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 ó*the tendency of complex systems to create asymmetric network structures, in which some nodes are ó*hubs,ô and are far more connected than othersô, it is essential to examine the topography of such complex systems[88]. Centralised networks provide actors with the necessary levers to extend their influence and thus reach sooner the tipping point towards 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 in order to assess the importance of an actor in a network[89].

The greater the centralization of a complex system, such as a network or an ecosystem, the larger the disparity between the nodesô 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 ó*frequency with which a point falls between pairs of other points on the shortest paths (or geodescics) connecting them*ô[90]. Strategic location on paths linking pairs of pairs provides potential influence in the network through ó*the withholding or distorting of information in transition*ô[91].

An example of betweenness centrality is provided by Ronald Burt in his work on ó*structural holes*ô when he suggests that nodes connecting otherwise disconnected nodes or parts of the

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[87] See, I. Lianos, Competition Law as a Form of Social Regulation, (2020) 65(1) The Antitrust Bulletin 3.
[88] 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.
[89] L.C. Freeman, Centrality in Social Networks: Conceptual Clarification (1979) 1 Social Networks 215.
[90] Ibid., 221.
[91] Ibid.

network may gain from their position through ôbrokerageõ[92]. 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[93]. 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 exhibit potential for control of the network.

Finally, ôcloseness-based measuresô 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 nodeôs geodesic (shortest path or lines length) with all other nodes in a given network[94]. 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 ôavoid the control potential of others[95]ô. A node closer to others is less dependent on intermediaries in relaying information.

Of particular interest is also the concept of a ôcliqueô, which once formed may exercise an importance influence on its memberôs behaviour[96]. The clique is characterised 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[97]. 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. ôthe devices we use to represent networks ï such as points, lines, edges, and geodesics ï and the concepts we use to describe network properties ï such as density, centrality, and degree of connectedness- are devoid of specific substantive meaningô, which raises the problem of the ôinterpretability of findingsô and their linkage to the concept of power[98], 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[99]. 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

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[92] R.S. Burt, *Structural Holes: The Social Structure of Competition* (Harvard Univ. Press, 1992)
[93] S. Yang, F.B. Keller & L. Zheng, *Social Network Analysis* (SAGE, 2017) 62.
[94] G. Sabidussi, The centrality index of a graph, (1966) 31 Psychometrika 581.
[95] L.C. Freeman, Centrality in Social Networks: Conceptual Clarification (1979) 1 Social Networks 215, 224
[96] See, S. Wasserman & K. Faust, *Social Network Analysis: Methods and Applications* (Cambridge Univ. Press, 1994).
[97]

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 oneôs position[100]

To the extent that one emphasizes social interactions along the lessons of social exchange theory in order to define a broader ontology of power, it becomes important to acknowledge various other dimensions than the one that has been 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 advertising revenue in attention markets combined with zero-priced services in a multi-sided markets context and 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 (e.g. quality) and involve multiple spaces of competition and forms of value capture (e.g. in financial markets through asset-stocks re-evaluation).

2.2.4.2.1. Power based on the control of the agenda/discourse

Grannovetter distinguishes economic power based on dependence from economic power based on legitimacy; to the extent that someone occupies a position of legitimate authority and thus holds the power to command, while others the duty to obey[105], and economic *power based on control of the agenda/discourse*, the latter being particularly effective in view 4(nd)] TJf-o(d o)-9(n th)] TJf-o(d o)-9(n t

Panopticon power 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, this conclusion changes if one takes into account the fact that the actor also serves as a hub for a number of other interactions which provide that actor some superior and more complete information on the strategies of the other members of the network, including its adversaries, if the latter enter into communication interactions with some of the nodes also communicating with the hub.

These findings are particularly important in view of the prevalence of business strategies to

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 from which the technologies of the industry architect benefit, to the extent that consumersô expectations have been framed according to the industry architectôs quality standard, the favorable legal framework from which the industry architect benefits as it 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 wider than the usual focus of competition law on a relevant market.

Various factors may influence industry architecture. One is technological path dependence which 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 ólock-inô to a less optimal, from a quality of technology perspective, equilibrium, without that being the intention of the agents at the first place[112]. 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 ólock-inô 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, such as manipulating the setting of technology standards as often standards shape industry architecture or influencing the regulators and/or the legislative framework shaping the architecture

ôbottleneckô, i.e. that would enable them to leverage their position of strength over all other companies that collaborate with them in the creation of surplus value[116]. The concept of ôecosystemô offers an additional space where intra- and inter-industry competition occurs[117]. 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 indus

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				

As Table 2 summarizes from the previous discussion, there have been developments regarding the concept of (economic) power to capture power exertion beyond horizontal competition within a relevant market. However, for different reasons, not all of these concepts have been transalted into metrics 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 behavioral evidence. Finally, power based on differential dependency between value co-creators (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.

3. Metrics of value chain or ecosystem-level vertical economic power

Competition law has developed advanced quantiative 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 I 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 ódirectô or ósimpleô 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 (i.e. suppliers or clients) or horizontal (competitors within the same market) level. On the other side, we have óvalue-chain-levelô or ócosystem-levelô theories. In these theories, the structure and the characteristics of the ecosystem or value chain (i.e. the network in which economic agents co-create 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 óvalue-chain-levelô or ócosystem-levelô 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.

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

We have seen in subsection 2.1.2.3 that a firmôs differential dependency within a network

a two-dimensioned space (i.e. as lines on a plan) on which firms (nodes) are contained. Figure 1 illustrates this.

Figure 1: A value chain with one upstream supplier

In Figure 1, nodes represent firms and the lines that surround them represent the technical and institutional conditionings affecting the value chain. In this example, the combination of technical and institutional conditionings (i.e. 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 (Cayla, 2014). 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[121.] In terms of Jacobides, Knudsen and Augier (2006), the latter are the ñtechnicalò and ñlegal and regulatory authorityò determinants of industry architectures[122].

If a central firm was to leave the value chain, the value loss for the latter would be greater (n
than if a non-central easy-to-replace firm left (Crook & Combs, 2007). Because ña node [firm] with high betweenness centrality has a great capacity to facilitate or constrain interactions between

to function because they perform tasks and/or handle a considerable volume of transactions (sales, user traffic, etc.).

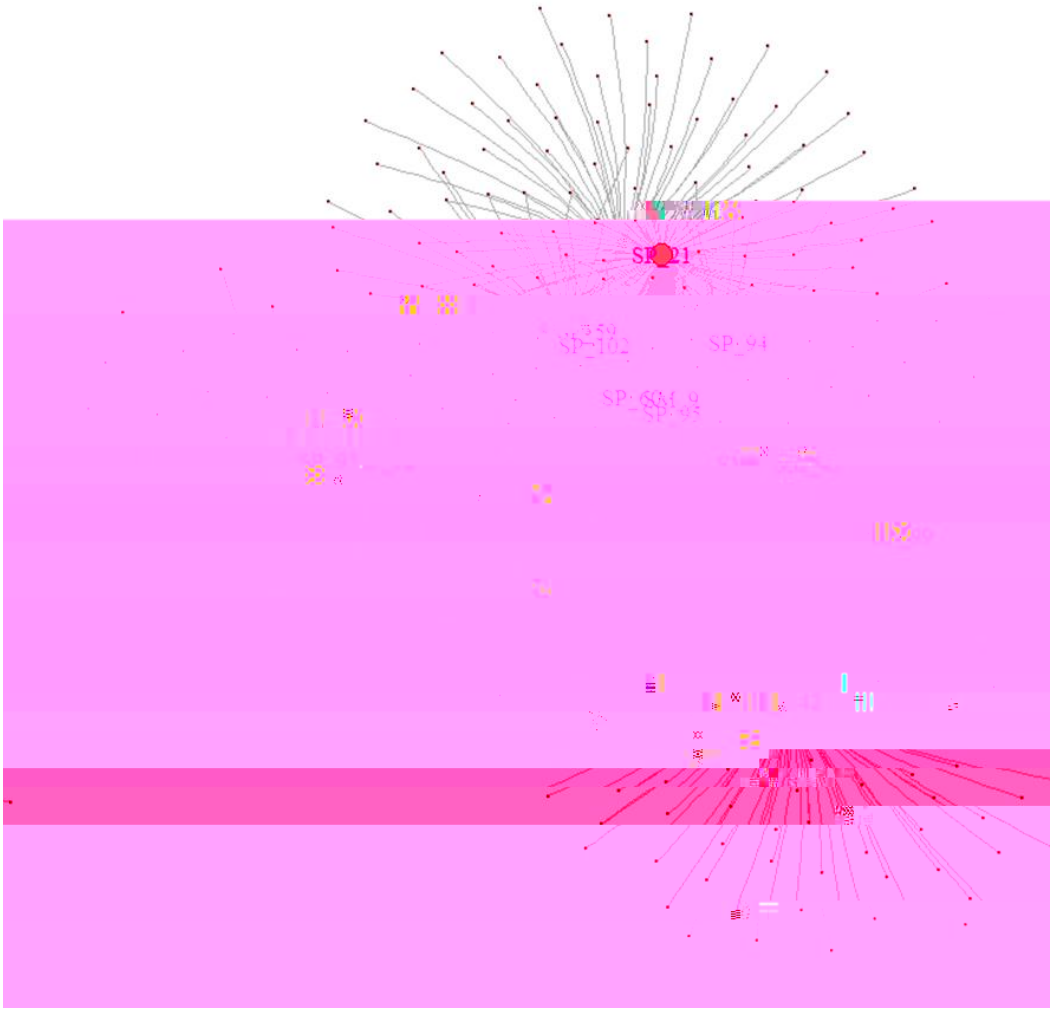
simple market share when assessing a firm´s dominance within a value chain or ecosystem. Let us illustrate this with an example.

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

As Figure 2 shows, supplier 63 concentrates most (55%) of vertical power in the value chain. The second firm in terms of vertical power is supplier 1 with a SSBC indicator level of 21%. This contrasts with its market share of 36%, which would fall short ofEuropean Co

soft drinks from supermarkets to suppliers in 2018. The same graphic interpretations and underlying calculations employed for Figure 2 apply.

Figure 3: Network of sales/purchases between Greek suppliers and supermarkets for the soft drinks product category in 2018



Supplier 21 concentrates most of the vertical market power with a SSBC indicator of 52%. However, its market share is 50% because the main buyers, supermarkets 45 and 9, are highly dependent on it to obtain their supply. Although slight, this discrepancy would have a considerable impact in the less interventionist courts of the United States, which have used a 50% threshold to establish dominance[124]. A market share of 50% (49.82% to be precise) could have raised doubts regarding supplier 21ός 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 can reduce false negatives when assessing dominance.

Two relevant considerations regarding the application of the SSBC indicator should be pointed out. First, the thresholds to be employed are not necessarily the same ones as those established by competition authorities in terms of market shares. While the two indicators (market share and SSBC) measure how much one side of the market (the buyer or 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 firmsôvertical 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 endeavor that would require empirically establishing thresholds that might differ from the current ones, which are based on market shares. Second, the SSBC indicator can be of particular relevance in the context of digital ecosystems, and notably those based on the monetization of data. It can be used to assess how much vertical power a firm has in terms of how much other firms depend on it for the data or their derivatives (e.g. predictions over preferences) to flow within an ecosystem. In a context in which digital ecosystems are under increasing scrutiny from antitrust agencies and regulators, there is a promising avenue for research in applying this indicator for ecosystems, as it is also acknowledged that in this context market shares are usually not indicative of firms´ power[125].

3.1.2. 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 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 firmôs 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, ñvertical HHIò (VHHI), measures how (un)evenly

[125] 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. 2017ï 006).

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

$$= \sum_{=1} \quad ^2$$

Where SSBC stands for ñshare of square betweenness centralityò 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. While 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, since 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.

3.2.A metric of panopticon power

We have seen in sub-Section 2.2.4.2.2. that one of the positional sources of economic power, ñpanopticon powerò[126], 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 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. In order to do so, we shall start by defining more precisely what makes information valuable and, hence, a source of competitive advantage.

Information or data[127] is valuable because of what it allows to do. Benyayer and Chignard[128] 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[129]. It is important to notice that each of these three properties have a

[126] H. Farrell & A. L. Newman, Weaponized Interdependence: How Global Economic Networks Shape State Coercion, (2019) 44(1) International Security 42, 46.
[127] For the purposes of developing an indicator of panopticon power, in this subsection we will use the terms ñinformationò and ñdataò as synonyms as we will use the e-commerce sector as an example.
[128] S. Chignard, & L.D. Benyayer, (2015). *Datanomics. Les nouveaux business models des données*. FYP editions.
[129] B. Carballa Smichowski, The value of data: an analysis of closed-urban-data-based and open-data-based business models. Science Poôs Cities and Digital Technologies Chair Working Paper 2018-01.

different ponderation in making the data valuable depending on the use intended. The value of data is therefore contextual to its use[130].

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.

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 while 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 behavior, the necessary identification of individual buyers, etc. It even gives it the possibility to gather valuable consumer behavior data when consumers do not buy. Indeed, online retailers like Amazon track ñwhat shoppers are searching for but cannot find, as well as which products they repeatedly return to, what they keep in their shopping basket, and what their mouse hovers over on the screenò[135]. Online platforms can also gather data on vendors that brick-and-mortar retailers cannot such as vendorsô response to consumersô inquiries, returns, the notation of their products, etc.

Algebraically, the

average of each dimensionôs 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 (ôValV$_i$ô) and quality (ôValQ$_i$ô) for a given node i in a network with n nodes out of which m nodes are information gatherers (retailers in our example).

$$= \sum_{j=1} \frac{\quad}{\quad}$$

In other words, the value of the data gathered by retailer i that is attributable to volume s measured as its degree centrality regardless of the direction of the vertices, as retailers gather information from 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:

$$= \sum \frac{\quad}{\quad}$$

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.

In order 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.

$$= \frac{\sum_{j=1}}{\sum_1 \sum_{j=1}}$$

$$= \frac{\sum}{\sum_1 \sum}$$

Given the context-dependent relative importance

lHlQ DWLY8ŽW L P S R ñ P € ð @ ş lf ¯ ḥ

Where $\delta^{V} + \delta^{Q} = 1$

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

$$- = \sum SValVQi^{2}$$