Abstract

This paper examines whether sustainability concerns play and should play any role in EU merger control. Sustainability concerns are currently cognizable as innovation-related issues as evidenced in *Dow/Dupont* and *Bayer/Monsanto.* In these cases, the Commission pioneered a novel approach aimed at predicting the impact of a merger not only on prices, but also on innovation competition. This theory of harm grounds in a rich conception of innovation and marks a tangible improvement in the current framework of analysis. Yet, it fails to give full effect to all competition-relevant sustainability concerns because of its exclusive focus on innovation capabilities, efforts and output. On this basis, we argue that innovation competition should not be understood only as an output-maximising device but also as a polycentric process under which independent decision-makers pursue various innovation paths. Such an approach puts an emphasis on the diversity, quality and direction of innovation and constitutes an alternative to the predominant output-centred understanding of innovation and a complement to the resources/capability-based analysis of innovation. To operationalise the notion of innovation competition as a polycentric process we explore four pathways: quality-related and sustainability-sensitive innovation metrics, indicators of industry-wide structural effects, a structural filter and ways to protect nascent competitors. Adding such an approach to the existing analytical framework would, arguably, enable the Commission to deal with all competition-relevant sustainability concerns.

1. INTRODUCTION

There is increasing awareness that the existing linear model of production puts unprecedented stress on the planet's ecological boundaries, beyond which lie 'unacceptable environmental degradation and potential tipping points'[1] In 2015, the United Nations General Assembly put forward its 'Transforming our world: the 2030 Agenda for Sustainable Development' in which it articulated a 'plan of action for people, planet, and prosperity' with the aspiration to attain 17 Sustainable Development Goals (SDGs) by 2030.[2] Along similar lines, the European Union intends to transition to a digital and green economy.[3] For this purpose, the European Commission launched the European Green Deal aimed at making Europe the first carbon-neutral continent by 2050,[4] and currently explores how competition rules and sustainability policies could work together in pursuing this objective.[5] Against this backdrop, the question about the appropriate role of sustainability in EU competition law has gained momentum. This

[1] K. Raworth, *Doughnut economics: Seven ways to think like a 21st-century economist* (Random House Business Books 2017) 12-13, 37. Drawing on several scientific studies Raworth identifies earth's 'ecological ceiling' by using certain planetary boundaries and key indicators. Beyond this ceiling lies planetary degradation such as climate change and biodiversity loss. Such ecological degradation is, according to Raworth, the result of degenerative industrial design.

[2] United Nations, 'Transforming our world: the 2030 Agenda for Sustainable Development' <https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf> accessed 22 October 2021.

[3] M. Vestager, 'Keeping the EU competitive in a green and digital worlds: Speech, 2 March 2020' <https://ec.europa.eu/commission/commissioners/2019-2024/vestager/announcements/keeping-eu-competitive-green- and-digital-world_en> accessed 22 October 2021.

[4] Communication from the European Commission - The European Green Deal 11 December 2019. COM(2019) 640 final.

[5] European Commission, 'Competition Policy in Support of Europe's Green Ambition' (2021). Competition Policy Brief 01.

question is by no means new and has already attracted considerable academic attention.[6] What is new, though, is the urgency to rethink EU competition law in light of the economic, environmental and societal challenges of the 21st century and to ensure that it is sufficiently responsive to the changing circumstances.[7]

While the current debate primarily focuses on the role of sustainability under Art. 101 and 102 TFEU, the way in which sustainability considerations can be taken into consideration under EU Merger Control has so far attracted only limited attention in the scholarly literature.[8] For this reason, the present study examines whether and how sustainability[9] concerns play out in EU merger control and assesses whether the current state of play is satisfactory. Two recent merger cases, *Dow/Dupont*[10] and *Bayer/Monsanto*[11], are particularly relevant in this regard. When examining these cases, the Commission received thousands of petition emails and letters by experts, NGOs, civil society associations and politicians urging it to block them.[12] The various stakeholders were not only concerned about the adverse effects that these agrochemical mergers could have on prices or innovation. They were also wary that the concentration and consolidation of the agrochemical sector would make farmers increasingly dependent upon the products and services of vertically integrated global conglomerates, and, thereby, entrench an industrial model of agriculture heavily reliant on chemical crop protection products, fertilizers and genetically modified organisms. On this account, they warned that if these mergers were allowed to go forward, they would seriously undermine environmental protection, food safety, food security, biodiversity and marginalise more sustainable models of agriculture.[13]

To the disappointment of many, the Commission in *Bayer/Monsanto* explicitly refused to review the merger on sustainability grounds. Instead, it clarified that its merger assessment would focus exclusively on the competitive effects of the transaction at hand. [14] The Commission, however, did not entirely dismiss all sustainability concerns. Instead, it addressed the ones that could be the by-product of a 'significant impediment of effective competition'.[15] In other words, the Commission used a clear-cut 'threshold test' to determine which

[6] G. Monti, 'Article 81 EC and Public Policy' (2002) 39(5) Common Market Law Review 1057; O. Odudu, 'The Wider Concerns of Competition Law' (2010) 30(3) Oxford Journal of Legal Studies 599; O. Odudu, *The boundaries of EC competition law : the scope of Article 81* (Oxford University Press 2006); H. Schweitzer, 'Competition Law and Public Policy: Reconsidering an Uneasy Relationship: The Example of Art. 81' (EUI Working Papers 2007/30, Florence 2007); S. Kingston, *Greening EU competition law and policy* (Cambridge University Press 2012); C. Townley, *Article 81 EC and public policy* (Hart 2009); J. Nowag, *Environmental integration in competition and free-movement laws* (Oxford University Press 2016); A. C. Witt, 'Public Policy Goals Under EU Competition Law—Now is the Time to Set the House in Order' (2012) 8(3) Euro Comp J 443.

[7] S. Holmes, D. Middelschulte and M. Snoep, *Competition law, climate change & environmental sustainability* (Concurrences 2021). J. Nowag, 'OECD Background Note - Sustainability and Competition' (2020). OECD Competition Committee Discussion Paper <https://www.oecd.org/daf/competition/sustainability-and-competition-2020.pdf> accessed 22 October 2021.

[8] See for a rare exception T. Kuhn and C. Caroppo, 'Sustainability in merger control - time to broaden the discussion' (2020) 41(12) European Competition Law Review 596; D. Reader, 'Accommodating Public Interest Considerations in Domestic Merger Control: Empirical Insights' . CCP Working Paper 16-3.

[9] While this paper focuses primarily on environmental sustainability, our approach is consistent with the UN SDGs, and understands the term 'sustainability' broadly as encompassing environmental, economic and social sustainability. See for this definition Nowag (n 9) 12–15.

[10] Case No COMP/M.7932 Dow/DuPont. C(2017) 1946 final.

[11] Case No COMP/M.8084 Bayer/Monsanto 2018.

[12] EU Commission, 'Response to a petition regarding the Bayer/Monsanto Merger' (22 August 2017) accessed 22 October 2020.

[13] G. T. Gundlach and D. L. Moss, 'Non-Price Effects of Mergers' (2018) 63(2) The Antitrust Bulletin 155 156.

[14] Case No COMP/M.8084 Bayer/Monsanto (n 13) para. 3020.

[15] ibid para. 3011.

sustainability concerns are cognisable under the EU Merger Regulation. This has been a significant development, as the Commission signalled for the first time that it remained open to considering the adverse effect of the mergers on sustainability as long as this effect resulted from a decrease in competition between the merging and/or non-merging parties. The Commission emphasised the crucial relationship between sustainability and innovation in the agrochemical sector, highlighting that the development of new crop protection products or plant varieties importantly contributes to greater food safety, food system resilience and reduced pollution.[16] On this basis, it examined not only how the mergers would affect prices, but also innovation competition, and, thereby, indirectly incorporated a wide array of sustainability considerations in its merger analysis.

Without doubt, by following such an approach, the Commission was able to account for a broad range of sustainability concerns. Yet, certain sustainability-related issues, such as the impact of the merger on regenerative agriculture or biodiversity, remained incognizable even though they met the threshold test. The main reason for this failure is that the innovation-sensitive theory of harm advanced in *Dow/Dupont* and *Bayer/Monsanto* focused almost exclusively on how the merger will affect the innovation incentives, efforts and output of the merging parties. It spotlighted the adverse effects of the merger on the merging parties' incentives to invest in innovation paths that closely overlap or are adjacent to each other pre-merger. Nonetheless, the impact of the merger on the diversity, quality and direction of innovation was not sufficiently examined. Hence, by understanding innovation competition as an output-maximising device the Commission turned a blind eye to sustainability concerns pertaining to the direction, diversity and quality of innovation.

Against this backdrop, we argue in this paper that there is an alternative way to conceptualise innovation competition which allows for incorporating the sustainability concerns that pass the threshold test but were 'left unheard' in the said cases, due to the Commission's output-centred conceptualization of innovation competition. Drawing upon the work of Michael Polanyi,[17] Friedrich August von Hayek,[18] and Elinor and Vincent Ostrom,[19] we suggest that innovation competition could be understood as a polycentric process driven by a multitude of autonomous decision-making centres which independently engage in scientific inquiries and embark on autonomous, often diverse avenues and discoveries. This understanding of polycentric innovation competition suggests that enforcers should analyse the impact of a merger on the diversity, quality and direction of innovation paths in addition to its impact on innovation incentives, efforts and output. Such an approach could enhance enforcers' ability to deal with competition-related sustainability concerns that are independent of the impact of a merger on innovation output. In addition, such an approach could make the EUMR more compatible with

[16] Case No COMP/M.7932 Dow/DuPont (n 12) paras. 1972–1980; Case No COMP/M.8084 Bayer/Monsanto (n 13) paras. 3007-3012.
[17] M. Polanyi, *The Logic of Liberty* (Routledge 1951) 34–36.
[18] Hayek, Friedrich A. von, 'The Use of Knowledge in Society' (1945) 35(3) American Economic Review 519; Hayek, Friedrich A. von, *The Road to Serfdom* (Routledge 2001); Hayek, Friedrich A. von, 'Competition As A Discovery Procedure' (2002) 5(3) Quarterly Journal of Austrian Economics 9.
[19] V. Ostrom, C. M. Tiebout and R. Warren, 'The Organization of Government in Metropolitan Areas: A Theoretical Inquiry' (1961) 55(4) American Political Science Review 831; E. Ostrom and V. Ostrom, 'The Quest for Meaning in Public Choice' in F. Sabetti and P. Dragos Aligica (eds), *Choice, Rules and Collective Action: The Ostroms on the Study of Institutions and Governance* (ECPR Press 2014); V. Ostrom, 'Polycentricity: The Structural Basis of Self-Governing Systems' in F. Sabetti and P. Dragos Aligica (eds), *Choice, Rules and Collective Action: The Ostroms on the Study of Institutions and Governance* (ECPR Press 2014); E. Ostrom, 'Why Do We Need to Protect Institutional Diversity?' (2012) 11(1) Eur Polit Sci 128.

a more 'holistic approach' which requires the EU institutions to take into account the so-called 'cross-sectional goals'[20] in all their policy actions and tasks.[21]

To operationalise the notion of innovation competition as a polycentric process, we explore four pathways. First, we argue that the Commission could use quality-adjusted and sustainability-sensitive innovation metrics. Second, we contend that the Commission could analyse the industry-wide effects of horizontal mergers and put greater weight on their structural effects. Third, we advocate the use of structural rules of thumb or presumptions to ensure diverse and independent innovation choices and paths; and fourth we explain how the protection of nascent competitors could significantly contribute to maintaining polycentric innovation competition. The aim of these proposals is to flesh out the notion of polycentric innovation competition and to show how in practical terms merger analysis could take into consideration not only the output-related dimensions of innovation but also its quality, direction and diversity. Incorporating innovation diversity concerns into competition analysis, we argue, enhances the ability of enforcers to accommodate all competition-relevant sustainability concerns.

The remainder of the paper unfolds as follows. Section 2 shows how the threshold test allows the Commission to discern from the general category of sustainability concerns the ones that are competition-relevant. Section 3 describes how the competition-relevant sustainability concerns were factored in *Dow/Dupont* and *Bayer/Monsanto* through a novel theory of harm which relies on the notion of innovation competition. Section 4 reveals that such a theory of harm hinges upon a broad-minded[22] consequentialist understanding of innovation competition as an output-maximisation device, and argues that, despite its analytical strengths and practical benefits, this approach cannot account for all competition-relevant sustainability concerns as it overlooks the direction, diversity and quality dimensions of innovation. Section 5 proposes an alternative conception of innovation competition as a polycentric process, suggesting that this approach is capable of accommodating the remaining competition-relevant sustainability concerns. Section 6 explores four pathways for operationalising the notion of innovation competition as a polycentric process maintaining that through these pathways enforcers will be able to integrate the remaining competition-related sustainability concerns into merger control.

[20] These goals encompass for instance: environmental protection (11 TFEU), economic cohesion (175 (1) TFEU), culture (Art. 15 TFEU), health (Arts. 168 (1) and 9 TFEU), industrial policy (Art. 173 (3) TFEU), development (Art. 208 (1) TFEU), employment (Art. 147 (2) and Art. 9 TFEU), consumer protection (Art. 12 TFEU), Services of General Economic Interest (Art. 14 TFEU), animal welfare (Art. 13 TFEU), non-discrimination (Arts. 8 TFEU), social protection, inclusion and education (Art. 9 TFEU), good administration (Art. 15 TFEU), data protection (Art. 16 TFEU), gender equality (Art. 8 TFEU).

[21] Numerous commentators argue that a teleological and systematic interpretation of the Treaties as well as the introduction of the coherence principle by the Treaty of Lisbon (Art. 7 TFEU) demand a holistic approach under which economic and social policies should reconciled and integrated into one overall policy. According to Art 7 ''the Union *shall* ensure *consistency* between its policies and activities, *taking all of its objectives into account*'. Kingston 126; Monti (n 1), 1069 f; Townley (n 22) 47–55; Schweitzer (n 22) 5; Schweitzer (n 28) 24–25.(in both articles referring to the German principle of interpretation of '*praktische Konkordanz*'). Kingston (n 22) 97–126. This is also supported by *Case 6/72 Europemballage Corporation and Continental Can Company v Commission* ECLI:EU:C:1973:22 para. 24.. See, however, for the opposite view Odudu (n 22) 169–171.

[22] By this we mean that Commission's consequentialist approach is not exclusively focused on price effects and quantifiable parameters.

2. SUSTAINABILITY CONCERNS UNDER THE EUMR AND THE THRESHOLD TEST

Over the last three decades, the agrochemical sector has seen a steady wave of concentration and consolidation. Two merger waves in the 1980s and 2000s significantly diminished the number of producers in the pesticides, seeds, traits and fertilizer industries and triggered the emergence of large, integrated players active on various levels of the relevant value chains.[23] Before 2016, the agrochemical industry was dominated by the so-called 'big six' players: Syngenta, Bayer, Monsanto, Dow, Dupont and BASF. All six players were vertically integrated and benefited from large economies of scale. Apart from BASF, all players were also active on all stages of the relevant value chains (i.e. discovery, development, and commercialisation of crop protection products or seeds).[24]

Along with increased concentration and vertical integration, three major trends characterised the business model of the big six. First, most players increasingly offered integrated package solutions which allow farmers to source seeds, crop protection products, fertilisers and technology from the same firm. Second, this trend towards one-stop-shop solutions was compounded by a growing shift towards the use of genetically modified (GM) crops with traits that are resistant to specific crop protection products often developed and sold by the same integrated firm. Recent advances in biotechnology, most notably with respect to RNA sequencing and gene editing, are likely to reinforce this move towards the use of genetically modified or so-called 'optimised' crops.[25] A third trend relates to the growing importance of data collection and analytics for farming. All large integrated players invested in the development of digital farming services analysing vast amounts of data to predict the specific needs of plants and soils and to optimise the use of crop protection products and fertilisers. In other words, the advent of 'big data' in the agrochemical sector prompted the main players to expand their integrated solutions by developing so-called 'precision farming solutions.'[26]

Sustainability concerns in the agrochemical sector

In 2016, the agrochemical sector experienced a new consolidation wave. Three mega-deals between Dow/Dupont, ChemChina/Syngenta and Bayer/Monsanto further reduced the number of industry players, thereby concentrating the control over the agrochemical market in the hands of three fully integrated players. Numerous competition experts and NGOs warned that all three deals may lead to substantial price increases in agricultural and foods products. They were also worried that industry consolidation could further dampen the already sluggish rate of R&D investments and output in the sector,[27] and centralise the industry leaders' control over a large amount of patents, inventions and data.[28] Furthermore, given the steady trend towards

[23] See for a discussion of the consolidation waves I. Lianos, 'The Interaction of Competition, Regulation and IP Rights in Agriculture: Towards a Dynamic Equilibrium?' in G. Muscolo and M. Tavassi (eds), *The interplay between competition law and intellectual property: An international perspective* (International competition law series v. 77. Wolters Kluwer 2019) 343–345.
[24] Case No COMP/M.7932 Dow/DuPont (n 12) para. 222.
[25] ibid para. 248-249.
[26] ibid para. 246.
[27] ibid para. 243.
[28] D. Moss, 'AAI Says Monsanto-Bayer Merger is Too Big to Fix – Enforcers Should Reject Proposed Remedies and "Just Say No"' (2018) <http://www.antitrustinstitute.org/content/aai-says-monsanto-bayer-merger-too-big-fix-–-enforcers-should-reject-proposed-remedies-and-> accessed 22 February 2018; I. Lianos and D. Katalevsky,

integrated farming solutions and digital agriculture, these stakeholders were worried that horizontal and vertical integration combined with the accumulation of large amounts of data would further increase the economic and technological dependence of farmers on single platform solutions offered by a few agrochemical giants. [29]

Yet, the concerns aired against these three mega-deals went beyond price and innovation effects. Several stakeholders argued that these mergers, by increasing the dependence of farmers and raising barriers to entry, would further entrench a model of agriculture that heavily relies on the intensive use of chemical products, genetically modified crops and monoculture at the expense of alternative modes of agriculture. They also noted that the said mergers could further decrease the pool of available agricultural products and increase the reliance of farmers and growers on the limited tools and agricultural solutions provided by the large conglomerates. The increased role of these 'mainstream' solutions would, in turn, stymie the development and production of seeds and crop protection solutions for marginal products (e.g. 'orphan' crops or 'minor uses' crops), as the merged companies would concentrate their innovation efforts on major global crops such as maize, wheat, rice.[30] As a result, an increasing number of farmers and growers would be left without effective alternatives to an industrialised mode of agriculture.[31] This, in turn, would further reduce biodiversity and accentuate the growing resistance of pests against the existing crop protection solutions.[32] Further industry consolidation and homogenisation, it was feared, could cement the path-dependence of the agriculture and food sector towards an industrialised, large-scale mode of production, diminish consumer choice and protection, undermine food safety and security, harm biodiversity and degrade the environment.[33]

Against this background, numerous stakeholders urged the Commission during the market investigation of *Dow/Dupont* and *Bayer/Monsanto* to take into consideration the loss of biodiversity and harm to the environment which would be likely caused by the mergers.[34] They called upon the Commission to not only assess whether the merging parties would raise prices, reduce output and discontinue their innovation efforts, but also to review the type and quality of innovation to which these innovation efforts would be directed.[35] They also asked the Commission to examine whether the merged firms could engage in 'misuse of innovation',[36] as they would lack the incentives to deploy their innovation efforts to develop 'healthier' or more resilient farming solutions that require the use of fewer chemicals or GM-products.[37] Overall, these critical voices were worried that the said mergers, by entrenching the path-dependence of the existing modes of agriculture, would not only entail environmental degradation, but also undermine the resilience of food systems.[38]

'Merger Activity in the Factors of Production Segments of the Food Value Chain: - A Critical Assessment of the Bayer/Monsanto merger' (2017). CLES Policy Paper Series 2017/! 19–23.

[29] Lianos and Katalevsky (n 30) 23–28; P. Woodall and T. L. Shannon, 'Monopoly Power Corrodes Choice and Resiliency in the Food System' (2018) 63(2) The Antitrust Bulletin 198 206–216; Gundlach and Moss (n 15), 156.

[30] Case No COMP/M.7932 Dow/DuPont (n 12) para. 244, 2137.

[31] ibid para. 2136.

[32] ibid paras. 2017; 2136-2137.

[33] Lianos and Katalevsky (n 30) 23-24, 27-28.

[34] Case No COMP/M.8084 Bayer/Monsanto (n 13) para. 3007.

[35] ibid.

[36] ibid.

[37] ibid.

[38] Gundlach and Moss (n 15), 156.

The Threshold Test

Confronted with this wide range of sustainability concerns regarding 'the potential implications of a possible reduction of competition caused by the merger on human health, food safety, consumer protection, environmental protection and climate,'[39] the Commission articulated a threshold test: for a sustainability concern to be considered a legitimate consideration for merger enforcement, it has to be the consequence of a 'significant impediment of effective competition'.[40] This means that to be cognizable under the EUMR the adverse effect of the merger on sustainability must be caused by some form of restriction of competition effectuated by the merger.

In crafting this threshold test, the Commission made an important point of law that crucially advances the current debate on the role of sustainability concerns in competition law. The Commission made it clear that from the general category of sustainability concerns only competition-related sustainability concerns are relevant under the current EUMR regime, while stand-alone sustainability concerns would lie outside the scope of merger control.[41] Sustainability concerns are only relevant under EU merger control (and EU competition law in general) if, and only if, they result from the decrease in competition between the merging firms or the structural change within the industry brought about by the merger.[42] If, for instance, a merger causes a reduction in competition by dampening the incentives of the merging or non-merging entities to compete with respect to a sustainability parameter or by eliminating a sustainability-relevant player, then it could lead to competition-related sustainability harm.

This threshold test does not mark any sea change.[43] Pursuant to the case law of the EU Courts, the Commission 'may declare a concentration incompatible with the internal market only if the significant impediment to competition is the direct and immediate effect of the concentration.'[44] Such would be the case if the alleged adverse effect results from future conduct that is 'made possible and economically rational by the alteration of the characteristics and the structure of the market caused by the concentration.'[45] Hence, accounting for sustainability harm flowing from a merger-induced reduction in competition is fully consistent

[39] Case No COMP/M.8084 Bayer/Monsanto (n 13) para. 3011.

[40] ibid para. 3020. The Commission said that it can only assess and block a merger based on the legal test and the assessment criteria set out in the EU Merger Regulation

[41] ibid para. 3022. The Commission, moreover, pointed out that regardless of the outcome of the assessment of the merger under the EU Merger Regulation, the merged entity will continue to be bound by EU and national rules on human health, food safety, consumer protection and environmental and climate protection (para 3029).

[42] Contrast this approach with the Commission's denial to take into consideration privacy concerns in Case COMP/M.7217 Facebook/Whatsapp. C(2014) 7239 final para. 164. Case COMP/M.4731 Google/DoubleClick. C(2008) 927 final para. 368.

[43] For instance, in *IAZ* the Court stroke down a collective standard setting process though which Belgian water suppliers and the producers of washing machines adopted a minimum standard for water pollution by washing machines. This standard prevented parallel imports of washing machines that complied with this standard and thus, potentially, decreased competition on sustainability parameters (i.e. reduced water pollution) *Case 96/82 IAZ v Commission* ECLI:EU:C:1983:310 para. 25. The recent truck cartel case also shows that EU competition law can address environmental harm that results from a restriction of competition. In this case, the Commission made it clear that an agreement whereby truck manufacturers coordinated the delay of the introduction of new emission standards and technologies constituted a restriction of competition within the meaning of Art. 101 (1) TFEU Commission Decision in Case AT.39824 -Trucks paras. 214, 264, 302-304.

[44] *Case T-79/12 Cisco v Commission* ECLI:EU:T:2013:635 para. 118.

[45] *Case T-79/12 Cisco v Commission* (n 46) para. 118; *Case T-342/99 Airtours v Commission* ECLI:EU:T:2002:146 para 58; *Case T-102/96 Gencor v Commission* ECLI:EU:T:1999:65 para. 94.

with the existing case law,[46] as well as the legal test and assessment criteria set out in the EU Merger Regulation.[47]

The threshold test laid down in *Bayer/Monsanto* provides us with a yardstick to decide when certain harm to sustainability is to be addressed by merger policy (and competition law in general), and when it should be tackled through specific regulation or legislation. If a merger dampens merging parties' incentives to compete on producing more sustainable or environmentally friendly products, which they would have otherwise produced absent the merger, *such* sustainability harm could be considered a legitimate concern under EUMR.[48] This is particularly important when the merger-driven reduction in the output of environmentally friendly products does *not* constitute a violation of any environmental standard or sector-specific regulation.[49] According to the EU Courts' case law, on such occasions antitrust enforcers remain competent to intervene, even though the merging parties remain subject to sector-specific regulation and the decrease in the level of environmental protection post-merger does not fall short of the minimum thresholds set by environmental regulation.[50]

Under this test, competition law and sectoral regulation are given a clear division of labour (see Table 1). Finding a competition law violation does not require an infringement of any other sector-specific legislation. Rather, competition law deals with the market failures that result from a reduction in competitive pressure and the ensuing alteration of the incentives of market players. Therefore, competition law does not only address market problems that are not tackled by other sets of norms (Scenario B), but it may also apply in parallel to sector-specific regulation (concomitant application) where firms' failure to comply with sector-specific regulation is the by-product of market power or of a restriction of competition brought about by a merger or anti-competitive conduct (Scenario C). Sustainability harm that does not result from an alteration of the market structure or restriction of competition but stems from the mere fact that firms cannot appropriate the positive externalities of more sustainable production methods falls outside the realm of competition law and should be addressed by regulation alone (Scenario A)

[46] However, how tenuous or strong the causal link between the alleged harm and the concentration has to be remains a contentious issue. See *Case C-413/06 P Bertelsmann and Sony Corporation of America v Impala* ECLI:EU:C:2008:392 paras. 50-53; *Case T-79/12 Cisco v Commission* (n 56) para. 47; *Case T-399/16 CK Telecoms UK Investments v Commission* not yet published para. 118; *Opinion of Advocate General Kokott in Case C-23/14 Post Danmark II* ECLI:EU:C:2015:343 paras. 80, 94.

[47] Council Regulation (EC) No 139/2004 on the control of concentrations between undertakings. OJ [2004] L 24/1 Art. 2.

[48] However, this approach does not account for the scenarios where a merger enhances merging parties' incentives to engage in unsustainable commercial practices which they would have been able to absent the merger. In other words, under this approach a merger that intensifies competition in unsustainable commercial practices would be cleared.

[49] For a similar reasoning Commission Decision in Case AT.39824 -Trucks (n 45) para. 304.

[50] *Case C-280/08 P Deutsche Telekom v Commission* ECLI:EU:C:2010:603 paras. 80–96. *Case T-398/07 Spain v Commission* ECLI:EU:T:2012:173 para. 55. The EU Court of Justice has also repeatedly clarified that the (non-) compliance with existing national or EU regulation can constitute an important reference point for the competitive analysis of certain practices *Case C-32/11 Allianz Hungária Biztosító and Others* ECLI:EU:C:2013:160 paras. 46–47. *Case C-457/10P AstraZeneca AB and AstraZeneca plc v European Commission* ECLI:EU:C:2012:770 paras. 74–75, 93. *Case C-179/16 F. Hoffmann-La Roche and Others* ECLI:EU:C:2018:25 paras. 92–93.

Table 1 - The division of labour between sector-specific regulation and competition law

Scenarios	Does sector-specific regulation apply?	Does competition law apply?
(A) A negative sustainability effect occurs when firms have no incentive to produce sustainably because they cannot appropriate the gains.	Yes. The role of regulation (or subsidies) here is to address a market failure.	No. This is not a competition problem.
(B) A negative sustainability effect does not respect the minimum requirements set by regulation and occurs due to market power or restriction of competition.	Yes. There is an infringement of a specific provision	Yes. There is a competition problem
(C) A negative sustainability effect respects the minimum requirements set by regulation and occurs due to market power or restriction of competition.	No. The behaviour is lawful in this regard.	Yes. There is a competition problem

In addition, this threshold test is in line with a 'holistic approach' to EU law. The text of the Treaties, their teleological and systematic interpretation, and the introduction of the 'coherence' principle with the Treaty of Lisbon (Art. 7 TFEU)[51] direct the EU institutions to take into account the 'cross-sectional clauses' (one of which is the protection of the environment) in all their policy actions and tasks. In *Bayer/Monsanto*, the Commission examined for the first time this argument and acknowledged that said clauses and Recital 23 EUMR[52] compel it to carry out its assessment within the general framework of the fundamental objectives of the EU Treaties.[53] Yet, the Commission considered that, when asserting the impact of mergers on sustainability parameters, the constitutional principle of conferral and the legal basis of the EUMR required it to act within the contours of Art. 2 EUMR and within the perimeters of competition policy 'in order to achieve, an "not go beyond", the objective of ensuring that competition in the Internal Market is not distorted."'[54]On this basis, the Commission concluded that it was precluded from engaging in a freewheeling analysis of the effects of mergers on stand-alone or competition-unrelated sustainability or other public interest considerations.[55] The Commission's reading of Art. 7 TFEU in light of the constitutional limiting principles does not only respect the cross-sectional clauses but it also strikes a fair balance between EU competition law's openness and integrity as it allows EUMR to take into consideration new societal challenges and epistemic change (e.g. new research on the relationship between innovation and sustainability), but in a principled way that would not undermine legal clarity, predictability and coherence.[56]

[51] Kingston (n 8) 126.
[52] Case No COMP/M.8084 Bayer/Monsanto (n 13) para. 3011.
[53] ibid para. 3010.
[54] ibid para. 3016.
[55] This strict interpretation of the assessment criteria is also supported by the express reference to a public interest exception in Art. 21 (4) EUMR, which allows Member States to rely on the need for the protection of specific public interest in front of the Commission ibid para. 3022.
[56] For a discussion of the concepts of openness and integrity of competition law S. Makris, 'Openness and Integrity in Antitrust' [2020] Journal of Competition Law & Economics.

3. A NOVEL APPROACH: ASSESSING A MERGER'S IMPACT ON INNOVATION COMPETITION

At this stage, it is worth asking how the Commission analysed the sustainability concerns that passed the threshold test. In *Dow/Dupont* and *Bayer/Monsanto*, the Commission addressed competition-relevant sustainability concerns (i) by forging a link between sustainability and innovation and (ii) by articulating a theory of harm assessing how the said mergers might affect price and non-price innovation effects. While the Commission had examined in the past how a merger might affect dynamic competition, it has done so without carrying out an independent, fully-fledged analysis of these innovation effects. Rather, it simply mentioned that the merger would reduce innovation in addition to causing prices to rise. [57]This changed radically in *Dow/Dupont* and *Bayer/Monsanto* where the Commission decoupled for the first time the assessment of price and non-price innovation effects and developed a stand-alone theory of harm that revolved around the notion of innovation competition.

Linking sustainability with innovation

In *Dow/Dupont* and *Bayer/Monsanto*, the Commission clarified that at least some of the sustainability concerns raised by the numerous stakeholders – e.g. issues related to the impact of the mergers on environmental protection, biodiversity, food safety and food-security – could be tackled by assessing the effects of both mergers on innovation. [58] The Commission's analysis relied on the premise that a high level of post-transaction innovation would alleviate any competition-relevant sustainability issues.

In particular, the Commission noted that innovation in the form of developing new and better active ingredients (AIs) is necessary to ensure effective crop protection as pests develop resistance to existing AIs.[59] By boosting the effectiveness of crop protection and crop varieties, innovation in the agrochemical sector contributes to food security and improves the resilience of food systems. This is because the innovation-induced increased effectiveness of crops and crop protection could help the sector address the twin challenges of an increasing global population and decreasing available arable land per capita.[60] In addition, the Commission pointed out that innovation in the agrochemical sector contributes to environmental protection, food safety and human health as the development of more effective AIs leads to a reduction in toxicity of crop protection and a better management of chemical residues.[61] Furthermore, for the Commission, innovation is essential in this sector due to the role of regulation: by imposing increasingly stricter environmental and food safety requirements, regulations drive market participants to invest in R&D and compel them to come up with better and safer crop protection. Such investments are necessary for companies to avoid authorities prohibiting or refusing to renew the market authorisation of their AIs.

[57] See for instance I. Kokkoris and T. Valletti, 'Innovation Considerations in Horizontal Merger Control' (2020) 16(2) Journal of Competition Law & Economics 220.
[58] Case No COMP/M.8084 Bayer/Monsanto (n 13) para. 3011.
[59] Case No COMP/M.7932 Dow/DuPont (n 12) para. 1975,1986. ibid paras. 1975-1980, 1986.
[60] ibid para. 1978.
[61] Case No COMP/M.7932 Dow/DuPont (n 12) para. 1977, 1980; Case No COMP/M.8084 Bayer/Monsanto (n 13) para. 3007.

Under this line of thinking, the Commission assumed that there is a link between innovation and sustainability in the agrochemical sector. It considered that by assessing the impact of the said mergers on innovation, it would be able to address all the competition-relevant sustainability concerns. Ensuring that a merger does not undermine post-merger innovation could thus guarantee 'the emergence of more effective, healthier, safer and more environmentally-friendly products.'[62]

A novel theory of harm

Against this backdrop, the Commission developed a new framework for assessing the impact of a merger on innovation competition.[63] The Commission's assessment of the stand-alone impact of mergers on innovation competition was closely modelled upon the analysis of unilateral price effects. Like in the context of the analysis of unilateral price effects, the Commission identified two channels through which a merger could affect innovation competition: first, it can reduce the innovation incentives of the merging parties by suppressing innovation competition between them (first-order effect) and second, it can reduce the merging and non-merging parties' incentives to innovate by reducing the overall competitive pressure within the market (second-order effect).[64]

With regards to the first-order effect, noted that, prior to the merger, the merging parties have an incentive to innovate because they capture current and future sales from each other when introducing new and improved products ('business stealing effect'[65] or 'innovation diversion effect'[66]).[67] At the same time, they face a disincentive to innovate because the introduction of a new product could lead to the cannibalisation of their own existing product lines ('cannibalisation effect' or 'replacement effect').[68] Hence, firms must trade off their profits from the business stealing effect against the opportunity costs resulting from the cannibalisation effect before engaging in innovation projects.[69] If a merger combines firms that compete closely with respect to the development of new products pre-merger, the merging firms' may see their incentives to compete fiercely (and engage in post-merger innovation)

[62] Case No COMP/M.8084 Bayer/Monsanto (n 13) paras. 3011-2012.

[63] The Commission's attempt to incorporate innovation effects into the unilateral effects analysis has been importantly shaped by the theoretical work by M. Motta and E. Tarantino, 'The Effect of Horizontal Mergers, When Firms Compete in Prices and Investments: Working Paper 1570, Department of Economics and Business, UPF' (2017); G. Federico, G. Langus and T. Valletti, 'A simple model of mergers and innovation' (2017) 157 Economics Letters 136; G. Federico, G. Langus and T. Valletti, 'Reprint of: Horizontal mergers and product innovation' (2018) 61 International Journal of Industrial Organization 590.

[64] Case No COMP/M.7932 Dow/DuPont paras. 2005, 2044-2048, 3285

[65] Kokkoris and Valletti (n 59), 228.

[66] B. Jullien and Y. Lefouili, 'Horizontal Mergers and Innovation' (2018) 14(3) Journal of Competition Law & Economics 364 374–379.

[67] Case No COMP/M.7932 Dow/DuPont (n 12) para. 2043. Case No COMP/M.8084 Bayer/Monsanto (n 13) paras. 1013, 1025-1033, 1058.

[68] Case No COMP/M.7932 Dow/DuPont (n 12) para. 2001. Case No COMP/M.8084 Bayer/Monsanto (n 13) paras. 1013, 1022, 1037.

[69] This trade-off estimation is quite similar to the trade-off firms face in the context of price competition. On the one hand, firms have an incentive to compete more fiercely on prices to capture sales from other competitors. On the other hand, cutting prices creates opportunity costs for them as it leads to the cannibalisation of the profitability of the existing sales base. R. D. Willig, 'Merger Analysis, Industrial Organization Theory, and Merger Guidelines' [1991] Brookings Papers on Economic Activity. Microeconomics 282, 299.C. Shapiro, 'The 2010 Horizontal Merger Guidelines: From Hedgehog to Fox in Forty Years' (2010) 77 Antitrust Law Journal 701 724; J. Farrell and C. Shapiro, 'Antitrust Evaluation of Horizontal Mergers: An Economic Alternative to Market Definition' (2010) 10(1) The BE Journal of Theoretical Economics 1 7–9.

reduced. This is because the merger will allow each party to internalise the negative externalities that the other poses on its profitability by engaging in innovation efforts. As a result, the merging parties' incentives to innovate post-merger will be reduced.[70] The internalisation of such externalities will increase the opportunity cost of the cannibalisation effect and depress the merged entity's incentives to innovate.[71]

Under this line of reasoning, the merged entity is likely to have a stronger incentive to discontinue or reposition one line of research to prevent the cannibalization effect if it acquires a closely competing innovator. Consequently, the first-order effect is likely to be significant if the merger brings together two out of a limited number of effective innovators, who in the absence of the merger would have been likely to divert significant sales from each other by investing in innovation.[72] The Commission's analysis of innovation competition, thus, assumes that the first-order effect of the merger on non-price competition could be measured in a similar way as its effect on price competition, by establishing some type of 'innovation diversion ratio' that gauges the extent to which the merging parties impose important competitive constraints on each other. This entails that the focus of the analysis is on the degree of substitutability or closeness of competition between the merging parties' innovation projects, lines of research and pipeline products.[73] On this basis, the closeness of competition between their innovation activities constitutes a metrics to gauge the 'downwards innovation pressure' caused by the merger and assess the likelihood and magnitude of the merger's adverse effect on innovation competition.[74]

The Commission's analysis of the second-order effect of mergers on innovation also followed the standard model used for the assessment of unilateral effects on price competition.[75] The Commission considered that the second-order effect tends to compound the first-order effect and further reduces the incentives of the merged entity and the non-merging parties to innovate because the merger will reduce the overall level of competition in the product market.[76] Therefore, according to the Commission, the anti-competitive effect of the mergers would not consist solely in the loss of innovation competition between the merging parties but also in the reduction of competitive pressure exerted by the remaining competitors. [77]

The takeaway of the Commission's analysis is the insight that the extent to which a merger could generate first- and second-order adverse effects on innovation depends on the innovation-

[70] Case No COMP/M.7932 Dow/DuPont (n 12) para. 2002, 2043; 3017-3022; Case No COMP/M.8084 Bayer/Monsanto (n 13) paras. 281, 1041.

[71] Case No COMP/M.7932 Dow/DuPont (n 12) para. 2856 f,n. 2016; 3018; Case No COMP/M.8084 Bayer/Monsanto (n 13) para. 1059. This analysis closely follows the model developed by Federico, Langus and Valletti (n 65); Federico, Langus and Valletti (n 65); Kokkoris and Valletti (n 59), 228–229.

[72] Case No COMP/M.7932 Dow/DuPont (n 12) para. 2007; Case No COMP/M.8084 Bayer/Monsanto (n 13) paras. 281, 1164-1170.

[73] Case No COMP/M.7932 Dow/DuPont (n 12) para. 2006.

[74] Federico, Langus and Valletti (n 65), 597. Case No COMP/M.7932 Dow/DuPont (n 7) paras. 2009, 2043 (from this perspective, if the merger is likely to remove an important competitive force or a 'maverick firm', the likelihood and scale of the adverse effects on innovation competition are likely to be even higher).

[75] R. Deneckere and C. Davidson, 'Incentives to Form Coalitions with Bertrand Competition' (1985) 16(4) The RAND Journal of Economics 473 475; M. Ivaldi and others, 'The Economics of Unilateral Effects: Interim Report for DG Competition, European Commission' (2003) 12, 22 ff.

[76] Case No COMP/M.7932 Dow/DuPont (n 12) para. 2044-2045, 2005, 3285. For further discussion of the analysis of the second order effect in the context of innovation competition, Federico, Langus and Valletti (n 65); Federico, Langus and Valletti (n 65); Kokkoris and Valletti (n 59).

[77] Case No COMP/M.7932 Dow/DuPont (n 12) para. 2044.

based contestability of pre-merger sales. If competitors have the prospect of successfully capturing each other's sales by introducing a novel product – i.e. if their sales are contestable by engaging in inventive activities – rivalry (or competitive pressure) drives innovation and, therefore, a loss in rivalry – e.g. a merger between two close competitors – is likely to reduce innovation.[78] This is why the Commission emphasized the degree of closeness of innovation competition between the merging parties as a central factor to determine how the merger affects innovation.

In line with the standard model of unilateral effects analysis, the Commission also considered whether the merger's first- and second-order anti-competitive effects on innovation competition could be alleviated or offset by countervailing factors, such as entry, expansion or efficiencies. However, in both decisions, it found that high barriers to entry[79] and expansion,[80] characteristic to the agrochemical sector, prevent new entrants and existing competitors from defeating the reduction of the merging parties' incentives to innovate.[81] On the contrary, due to the strategic complementarity between the merging and non-merging parties, competitors may have an incentive to reduce their innovation efforts post-merger.[82] Moreover, the Commission acknowledged that a horizontal merger may, at least in theory, enhance innovation, by increasing the merging parties' ability to appropriate or license their innovations, [83] or by creating important spill-overs, synergies and complementarities between the parties' research efforts.[84] For this reason, the Commission examined whether the appropriability effect of the merger and any other merger-specific efficiencies would mute the adverse effects of the merger on innovation-based market contestability,[85] and it concluded that the merging parties had failed to proffer evidence of such merger-specific efficiencies.[86]

All in all, the Commission's innovation theory of harm developed in *Dow/Dupont* and *Bayer/Monsanto* suggests that mergers will adversely affect innovation if the following elements are present: (i) the relevant product markets are contestable on the basis of

[78] C. Shapiro, 'Competition and Innovation: Did Arrow Hit the Bull's Eye?' in J. Lerner and S. Stern (eds), *The Rate and Direction of Inventive Activity Revisited* (University of Chicago Press 2012) 362, 364 386

[79] Case No COMP/M.7932 Dow/DuPont (n 12) para. 2007; Case No COMP/M.8084 Bayer/Monsanto (n 13) paras. 1062-1080.

[80] Case No COMP/M.7932 Dow/DuPont (n 12) para. 3240-3256.

[81] ibid para. 2008, 2019.

[82] Case No COMP/M.7932 Dow/DuPont (n 12) para. 2018; Guidelines on the assessment of horizontal mergers under the Council Regulation on the control of concentrations between undertakings. OJ [2004] C 31/5 para. 31.

[83] Bourreau et al., show that mergers may lead to increase research efforts by allowing the merging firms to internalise the demand-enhancing spill-over effects of innovation for competitors. M. Bourreau, B. Jullien and Y. Lefouili, 'Mergers and Demand-Enhancing Innovation' (2018 (revised 2019)).

[84] Challenging the model developed by Federico/Langus/Valletti, Denicolò and Polo show that mergers may lead to an increase of R&D efforts, by allowing the merging parties to eliminate (inefficient) duplication of their research efforts post-merger V. Denicolò and M. Polo, 'Duplicative research, mergers and innovation' (2018) 166 Economics Letters 56; V. Denicolò and M. Polo, 'The Innovation Theory of Harm: An Appraisal Symposium: Innovative Antitrust' (2019) 3(82) Antitrust Law Journal 921. See also Bourreau, Jullien and Lefouili (n 85). Jullien and Lefouili (n 68), 385, 388-389.

[85] Shapiro 365, 389 (noting that a merger-induced reduction in rivalry may intensify innovation competition, if it enhances the merged entity's capabilities to appropriate post-merger innovation).

[86] Case No COMP/M.7932 Dow/DuPont (n 12) paras. 3264-3278. Case No COMP/M.8084 Bayer/Monsanto (n 13) paras. 70, 76, 87, 99. This conclusion is in line with the findings by Motta/Tarantino and Federico/Langus/Valletti that even though horizontal mergers may lead to innovation-enhancing efficiencies, they are unlikely to outweigh the adverse first-order effect of the merger on innovation incentives. Motta and Tarantino (n 65); Federico, Langus and Valletti (n 65); Federico, Langus and Valletti (n 65).

innovation;[87] (ii) appropriability of post-innovation rents is high due to strong IPR protection;[88] (iii) consolidation between rival innovators is unlikely to be associated with efficiencies in the form of greater appropriability or innovation synergies; (iv) the parties are close and important innovation competitors; (v) the fear of cannibalisation of own existing products can function as a disincentive to innovate; (vi) the structure of the market is already oligopolistic; and (vii) the remaining R&D players are unlikely to significantly increase or reposition their innovation efforts so as to profitably offset the reduction of innovation competition from the parties.

4. INNOVATION COMPETITION AS AN OUTPUT-MAXIMISING DEVICE

The previous section highlighted the key elements of the Commission's novel theory of innovation harm in these two landmark decisions. In this section, we identify the conception of innovation competition that underlies this theory of innovation harm.[89] Our main point is that *Dow/Dupont* and *Bayer/Monsanto* suggest that the Commission is primarily well versed in the consequentialist tradition as it understands innovation competition as an output-maximising procedure. Owing to this output-based understanding of innovation, it analyses innovation competition in terms of innovation incentives, capabilities, efforts, and output. This approach considers 'closeness of competition' as the central driver of unilateral effects and looks primarily at the behavioural effects of industry concentration on firms' incentives to invest in innovation efforts. In so doing, it uses backward-looking metrics and remains focused on directed and commercially relevant innovation. This emphasis on closeness of competition and the merging firms' incentives to innovate, however, fails to accommodate all competition-relevant sustainability concerns as it turns a blind eye on the direction, quality and diversity of innovative activity. The rest of this section unpacks and assesses the Commission's understanding of innovation competition.

An outcome-based understanding of innovation competition

In both mergers, the crucial question the Commission sought to address was whether the combination of the two merging parties will lead to less innovative efforts, and, hence, less innovation output in similar areas of application. The Commission, therefore, relied on quantitative metrics, which exclusively focused on innovation output, such as the number of patent citations[90] and newly AI launches.[91] Some effort was made to incorporate the quality dimension in the analysis. For instance, the Commission chose the number of patent citations rather than the number of patent filings as a proxy for innovation output, recognising the difference in quality between patents filed and patents granted.[92] Yet, since such research efforts are driven by the ultimate commercial success, it is rather safe to assume that the patent citations indicator reveals only the contribution of a certain firm to the currently predominant

[87] Case No COMP/M.7932 Dow/DuPont (n 12) para. 2001.
[88] ibid para. 2046.
[89] A concept can have multiple conceptions and certain concepts can be essentially contested. Gallie; Hart. We argue here that innovation belongs to these essentially contested concepts. W.B. Gallie, Essentially Contested Concepts, 56 Proceedings of the Aristotelian Society 167, 179, 189, 191 (1955). H.L.A. Hart, *The Concept of Law* (OUP 1961) 157-160
[90] Case No COMP/M.7932 Dow/DuPont (n 12) paras. 387-395; Case No COMP/M.8084 Bayer/Monsanto (n 13) paras. 271-273, 1109-1163.
[91] Case No COMP/M.7932 Dow/DuPont (n 12) 396-398, 401. Based on both proxies, the Commission calculated the innovation competition market shares of the merging parties, as well as their most important innovation competitors, which turned out to be the remaining integrated R&D players (in Dow/Dupont: Bayer, Syngenta and BASF; in Bayer/Monsanto: Dow/Dupont, Syngenta, BASF and FEC).
[92] ibid para. 392.

innovation path, and not the diversity of its innovation ventures. Similarly, the 'new AI launch' benchmark used by the Commission focuses on innovation output and gauges its quality exclusively with respect to its commercial success. It measures, thus, how the firms contribute to maximising the output of the predominant and commercially most successful innovation paradigm, instead of revealing any meaningful information on whether the firms are about to break new grounds or discover new paths.

The key concern of the consequentialist understanding of innovation underpinning the Commission's approach is, thus, whether post-merger the parties will produce more or less 'innovation quantity and quality', while quality is understood in single-dimensional terms, alongside quantity. Such an approach ignores the multi-dimensional aspects of quality of innovation as it examines whether a merger can undermine the process of innovation that is geared towards conventional agriculture.[93] Yet, quality-related questions such as whether the firms will, after the merger, still have an incentive to explore more diverse innovation paths or remain able to block alternative innovation paths (e.g. non-chemical or non-GMO driven forms of plant protection and traits) fall outside the realm of the Commission's analysis. In addition, by focusing on innovation output, the Commission refrained from second-guessing the quality of innovation efforts and their environmental impact (e.g. their positive or negative environmental externalities on biodiversity). As a result, sustainability concerns pertaining to the quality of innovation were overlooked.[94]

Under the Commission's consequentialist approach, only if the merging parties are close or very close competitors prior to the merger, their integration within a single firm is likely to reduce innovation competition. This entails that a scenario where a merger reduces the incentives or efforts of the merging and non-merging parties to pursue more divergent innovation paths will not raise any concerns. The potential 'crowding-out' effects of a merger on the innovation efforts of firms competing in more remote innovation paths will also be deemed largely irrelevant. More than this, if the merging parties were to redirect their innovation efforts from the conventional into more remote and alternative innovation paths and to render their innovation efforts more diverse post-merger, this behaviour – under the current approach – will be considered as harmful to innovation competition. Likewise, innovation competition would be deemed as intensified if the non-merging parties would, in response to the merger, reposition their efforts towards more established innovation paths and thus render their innovation efforts *less* diverse. However, under such an approach, merger control is more likely to thwart than promote sustainable innovation that deviates from the existing paradigm.

The Commission's consequentialist understanding of innovation, hence, ignores that mergers may not reduce (or even increase) the amount of innovation efforts and still undercut another

[93] For a discussion of the analysis of various non-price parameters of competition in merger control OECD, 'Considering non-price effects in merger control – Background note by the Secretariat' (2018).

[94] W. Kerber, 'Competition, Innovation and Maintaining Diversity Through Competition Law' (2009) 27, (criticising mainstream economic analysis for focusing on the impact of industry concentration on firms' incentives to innovate and ignoring quality and direction. The mainstream economic approach focuses on the scale of R&D investments as innovation input and innovation as output. S. Bhattacharya and D. Mookherjee, 'Portfolio Choice in Research and Development' (1986) 17(4) The RAND Journal of Economics 594. D. L. Rubinfeld and J. Hoven, 'Innovation and Antitrust Enforcement' in J. Ellig (ed), *Dynamic competition and public policy: Technology, innovation, and antitrust issues* (Cambridge University Press 2001) 74; C. A. Tisdell, 'Mainstream Analyses of Innovation: Neoclassical and New Industrial Economics' in S. Dowrick (ed), *Economic Approaches to Innovation* (Edward Elgar 1995) 30; I. Letina, 'The road not taken: Competition and the R&D portfolio' (2016) 47(2) The RAND Journal of Economics 433 435; I. Kwon, 'R&D Portfolio and Market Structure' (2010) 120(543) The Economic Journal 313 318–319.

important dimension of innovation competition, namely innovation diversity. Suppressing innovation competition in this way has key sustainability implications in the context of food value chains. Ignoring innovation diversity can tip the agrochemical sector towards a certain innovation path or paradigm. On this basis, it could be argued that by clearing these mergers the Commission may have facilitated the entrenchment of a model of innovation and agriculture that relies heavily on chemicals and GMO crops and further homogenise or standardise agriculture and food systems by reducing the number of innovation projects that would have explored alternative (more sustainable) technological solutions in the absence of the merger. In such a context, product and innovation output may well increase. What could decrease, though, is the degree of decentralised and diverse innovation that would yield more sustainable forms of crop protection products or traits. [95]

A focus on directed innovation

Another crucial element of the Commission's output-focused understanding of innovation is its emphasis on directed innovation (i.e. innovation efforts that are already directed at specific discovery targets and innovation spaces). The Commission relied on the 'innovation capabilities' and considered 'development efforts for product innovation' and 'discovery efforts for new products' as indicators of innovative behaviour.[96] It analysed the lines of research in which the R&D organisations are active and lead to given discovery targets,[97] but also the early pipeline products, whose likelihood of successful launch is much lower than that of products which have already reached the development stage.[98] Thus, the Commission understood innovation in broad consequentialist terms as an activity that is channelled towards specific discovery targets and could be maximised if rational agents have the right incentives. If the expected benefits of innovation efforts outweigh the expected costs, then the activity will be undertaken.

The Commission's focus on directed innovation efforts also becomes apparent in its novel approach towards market definition. Instead of delineating clearly circumscribed 'innovation markets' or 'research and development markets',[99] the Commission identified and analysed the impact of the merger on a number of 'innovation spaces',[100] loosely defined as spaces in which innovation competition occurs between R&D players.[101] The Commission followed this approach because it considered that innovation is better understood as an 'input activity for both the upstream technology markets and downstream markets' rather than as a separate

[95] Lianos and Katalevsky (n 30) 23–28; Woodall and Shannon (n 31), 206–216; Gundlach and Moss (n 15), 156.
[96] Case No COMP/M.7932 Dow/DuPont (n 12) para. 349. Case No COMP/M.8084 Bayer/Monsanto (n 13) paras. 53, 59, 60, 165-170, 836-841, 866, 870-876.
[97] Case No COMP/M.7932 Dow/DuPont (n 12) para. 1958; Case No COMP/M.8084 Bayer/Monsanto (n 13) paras. 1017-1019.
[98] Case No COMP/M.7932 Dow/DuPont (n 12) para. 1959. In the traits sector, the likelihood is above 60% Case No COMP/M.8084 Bayer/Monsanto (n 13) para. 1020.
[99] This approach is followed by the FTC and the DOJ. 2017 Antitrust Guidelines for the Licensing of Intellectual Property 2017 11.Case No COMP/M.7932 Dow/DuPont (n 12) para. 346 quoting US guidelines. The concept of ‚research and development' or ‚innovation markets' has first been coined by R. J. Gilbert and S. C. Sunshine, 'Incorporating Dynamic Efficiency Concerns in Merger Analysis: The Use of Innovation Markets' (1995) 63(2) Antitrust Law Journal 569. The DoJ and FTC referred to this concept for the first time in 1995 Antitrust Guidelines For The Licensing Of Intellectual Property 10–11.
[100] Case No COMP/M.7932 Dow/DuPont (n 12) para- 342.
[101] ibid para. 350.

market in its own right.[102] By following this approach, the Commission was able to recognise that competition does not only take place at the very bottom of the relevant value chains,[103] and to examine how the merger will affect the parties' R&D efforts as important in-puts for product innovation.[104]

Nonetheless, analysing innovation competition in clearly delineated innovation spaces where the R&D activities of the merging parties are closely overlapping has a serious shortcoming. Inventive activity within innovation spaces is directed towards very specific discovery targets which have been – at least to some extent – already clearly defined by the parties pre-merger. Under this lens, 'directed innovation' and innovation paths whose direction has been pre-defined at an earlier stage become the focal points of the analysis.[105] As a result, the Commission turns a blind eye to undirected innovation which is particularly relevant for sustainable agriculture. In addition, by analysing innovation competition in innovation spaces the Commission focuses on the innovation efforts of closely competing parties. This approach, however, overemphasises how a merger can affect rivalrous innovation efforts which are heading towards very much the same direction and the same research target and asks whether the merger will reduce the duplication of innovation efforts with respect to similar or identical research projects. Yet, it leaves aside the effect of a merger on the diversity of innovation paths.

As a result, under the current approach a merger will appear suspicious only if the merging parties are close or very close competitors prior to the merger and their integration into a single firm is likely to reduce innovation efforts and output towards a specific target. On the contrary, a merger that reduces the incentives or efforts of the merging and non-merging parties to pursue more divergent innovation paths will not raise any concerns. The potential 'crowding-out' effects of a merger on the innovation efforts of firms competing in more remote innovation paths will be deemed largely irrelevant. More than this, if the merging parties were to redirect their innovation efforts from the conventional into more remote and alternative innovation paths and to render their innovation efforts more diverse post-merger, this behaviour – under the current approach – will be considered as harmful to innovation competition. Likewise, innovation competition would be deemed as intensified if the non-merging parties would, in response to the merger, reposition their efforts towards more established innovation paths and thus, render, their innovation efforts *less* diverse. However, under such an approach merger control is more likely to thwart than promote sustainable innovation (i.e. the forms of diversified undirected innovation that could reform and/or disrupt the existing paradigm of agricultural production).

[102] Case No COMP/M.7932 Dow/DuPont (n 12) para. 348; Case No COMP/M.8084 Bayer/Monsanto (n 13) paras. 279, 867, 1008-10023, 1089.

[103] Case No COMP/M.7932 Dow/DuPont (n 12) para. 351; Case No COMP/M.8084 Bayer/Monsanto (n 13) paras. 1090. For instance, in the case of crop protection products, the R&D players focus on certain lead crops and/or lead pests to develop active ingredients that can, then, be used in a number of downstream (formulated) product markets. The Commission, therefore, underlined that these innovation spaces might be often broader than an individual downstream (crop protection) product market.

[104] In this respect, the Commission adopted an approach that differs from the current practice of the US competition authorities of analysing innovation effects.

[105] Case No COMP/M.8084 Bayer/Monsanto (n 13) para. 1010, 1018,1090, 113. Directed innovation could for instance, pertain specific functionalities of crop protection products (e.g. tolerance of a specific crop to a specific herbicide; or crop/pest combination).

Backward-looking metrics

Another feature of the Commission's assessment of innovation in *Dow/Dupont* and *Bayer/Monsanto* is that it remained largely backward-looking.[106] For instance, the Commission used backward-looking innovation metrics such as patent shares[107] and new active ingredients (AI) shares and launches.[108] Both metrics rely on historic data, and put the emphasis on commercially successful innovation.[109] However, as noted by Bower and Christensen, 'most well-managed, established companies (…) are rarely in the forefront of commercializing new technologies that don't initially meet the needs of mainstream customers.'[110] In general, incumbent firms who owe their market position to successful innovation in the past are most likely to further pursue the predominant, conventional or commercially most successful innovation paths in the industry. On this basis, it could be argued that the Commission's approach may reduce the preconditions for disruptive innovation and enhance the risk of path-dependency as it overlooks how the combination of two key industry players might affect the incentives and capacity to venture on alternative and perhaps more sustainable innovation paths (e.g. innovation on non-conventional crop protection products or traits/seeds which are less commercially successful but also less detrimental to the environment) of other, commercially less successful innovators. Thus, under such an approach merger control may end up forestalling instead of spurring innovation.

By focusing on directed innovation, the Commission examined innovation pertaining to relatively homogenous innovation targets as well as innovation in already existing lines of research and innovation paths which are either at a very early (e.g. lines of research, early pipeline products) or already quite advanced stage (e.g. pipeline products in the development process).[111] The uncertainty underpinning this kind of innovation does not concern the features of the discovery target but rather the best way or method to reach this target. Furthermore, under such an approach, the acquisition of a nascent, distant competitor with low market shares by an incumbent would not raise any red flags due to the emphasis on directed innovation. Yet, such acquisitions could be particularly harmful for competition as they can eliminate important innovation players.[112] The latter could significantly contribute to economic growth[113] as they may come up with new valuable inventions, exercise significant pressure on incumbents to innovate, facilitate the entry of new players in the relevant innovation spaces and replace

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[106] Case No COMP/M.7932 Dow/DuPont (n 12) paras. 2032 - 2034. To address the criticisms about the long timeframe of its analysis, the Commission affirmed that the consumer harm identified was an immediate effect of the merger which materialises within the regular timeframe of 2-5 years, although it might be felt by consumers only in 10-15 years' time.

[107] Case No COMP/M.7932 Dow/DuPont (n 12) paras. 387-395; Case No COMP/M.8084 Bayer/Monsanto (n 13) paras. 271-273, 1109-1163.

[108] Case No COMP/M.7932 Dow/DuPont (n 12) 396-398, 401.

[109] ibid para. 401.

[110] Joseph L. Bower & Clayton M. Christensen, Disruptive Technologies: Catching the Wave (1995) Harvard Business Review 43-44.

[111] Closeness of competition.

[112] *United States v. Microsoft Corporation* 253 F.3d 34 (D.C. Cir.2001) 79. ('it would be inimical to the purpose of the Sherman Act to allow monopolists free reign to squash nascent, albeit unproven, competitors at will.....').

[113] Small and large firms have different advantages and disadvantages when it comes to innovation: the relevant point here is that both have been, over history, important contributors. T. Wu, *The Master Switch: The Rise and Fall of Information Empires* (Atlantic Books 2010) 19–20.

competition in the market with competition for the market.[114] Hence, the adverse impact of further consolidation of the agrochemical industry may not (only or primarily) consist in reducing the innovation paths that are already directed towards specific innovation targets but in reducing the diversity of 'undirected innovation'.[115] In other words, undirected innovation could be harmed even if (or especially when) directed innovation is maximised. This is particularly relevant in the agri-food sector, where the preservation of undirected innovation is crucial for ensuring the existence of alternative forms of agriculture that enhance sustainability, food safety, environmental protection, food security and biodiversity.

The hidden foundation of the Commission's output-maximisation approach: a narrow conception of consumer welfare

Another feature of the Commission's theory of innovation harm is its focus on a narrow conception of consumer welfare. For example, the Commission was alert to the impact of the mergers on innovation competition not only because the merged entities would likely discontinue existing pipelines, but also because they would face reduced competitive pressure to innovate in the long run, harming thereby the consumers.[116] Consumers were also assumed to likely suffer not only due to reduced product variety but also due to reduced intensity of future product market competition.[117] Therefore, the ultimate measure of innovation's social value was couched in consumer welfare terms. However, this understanding of consumer welfare ignores that environmental gains can be part of consumers' welfare and casts a blind eye to 'objective sustainability harms' and 'out-of-market' effects (e.g. positive or negative environmental or economic externalities).[118]

Recently the Dutch competition authority has pioneered a fresh approach to calibrate the relationship between sustainability and competition law. In one of its key documents, the Dutch enforcer describes 'objective sustainability benefits' as the benefits that are useful not only to the consumers, but to society in a broader sense, and could pertain to a reduction of so-called negative externalities. Such benefits may also involve 'reducing operational costs, increased innovation, quality improvements, or a greater diversity of products on offer, including the introduction of, for example, animal-friendly products or products that guarantee a fair income'.[119] In a similar manner, the Commission could have identified objective sustainability harms and demonstrated how they can lead to diminished consumer welfare. Such an exercise is feasible under the merger control counterfactual which examines how a concentration might *alter* the factors which determine the state of competition *by comparing* the competitive

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[114] Antitrust Division of the US Department of Justice/Federal Trade Commission - Merger Guidelines 2010 6.4. (describing, as possible effects from a horizontal merger, a "reduced incentive to continue with an existing product-development effort or . . . to initiate development of new products");Wu (n 115) 18-22, 159..

[115] For the distinction between directed and undirected innovation P. Régibeau and K. E. Rockett, 'Mergers and Innovation' (2019) 64(1) The Antitrust Bulletin 31 41, 45; Antitrust Division of the US Department of Justice/Federal Trade Commission - Merger Guidelines 2010 (n 116) 6.4.

[116] Case No COMP/M.7932 Dow/DuPont (n 12) para. 283, 2016.

[117] ibid paras. 2032, 2034, 3019.

[118] Such an approach is pioneered by the Dutch Competition Authority. Dutch Cometition Authority (ACM), 'Guidelines: Sustainability Agreements: Opportunities within Competition Law' (26 January 2021) 12–21 <https://www.acm.nl/en/publications/second-draft-version-guidelines-sustainability-agreements-opportunities-within-competition-law> accessed 26 October 2021. See contra L. Peeperkorn, 'Competition Policy is not a Stopgap!' (2021) 12(6) Journal of European Competition Law & Practice 415. (arguing that taking into consideration out-of-market effects would undermine the predictability, rigour and uniformity of EU competition policy).

[119] Dutch Cometition Authority (ACM) (n 120) 11.

conditions that would result from the notified merger with the conditions that would have prevailed in the absence of the merger.[120]

In addition, there is a wide range of economic methods that the Commission could have used to assess more fully the environmental benefits or costs of the said mergers for the consumers. For instance, it could have used existing data to map out consumers revealed preferences about a state of affairs with and without the mergers; conduct contingent valuation (i.e. ask consumers how much they would be willing to pay for the beneficial products deriving from the mergers); run a conjoint analysis (i.e. ask consumers to rank various desirable alternatives); estimate 'defensive expenditures' to value the environmental degradation caused by the mergers as consumer welfare reductions; or attach 'bequest value' to certain environmental resources to account for future consumers.[121] These economic tools would have enabled a type of environmental impact assessment that can account for a wide array of sustainability concerns and is fully in line with consumer welfare (understood broadly).[122]

The Commission's narrow understanding of consumer welfare in these cases could also be traced in its assumption of a positive link between innovation and sustainability. The Commission was adamant in pointing out that more innovation output and more innovation efforts within the existing innovation paths will generate considerable positive externalities and contribute to the attainment of sustainability goals. For instance, the Commission observed that a higher level of innovation and innovation output may have positive externalities on food security and food safety, because they might lead to higher crop yields or lower toxicity rates. [123] Yet, this approach leaves aside the crucial question of whether maximising innovation competition understood as output in certain lines of research could be sustainability-inimical and thus harm other dimensions of consumers' welfare. In other words, distinguishing between sustainable and unsustainable innovation and taking into consideration the quality, diversity and direction of innovation are also required from a consumer welfare perspective.[124]Hence, the Commission used merger control to protect output-related innovation competition as if the maximisation of innovation output is the one and only dimension of consumer welfare. It thereby ignored that the diversity, direction and quality of innovation competition are also crucial for consumers' welfare.

5. INNOVATION COMPETITION AS A POLYCENTRIC PROCESS

The previous section showed that the Commission's theory of harm failed to accommodate a broad range of competition-relevant sustainability concerns because it underplayed the impact of the merger on the quality, direction and diversity of innovation. The main reason for this failure lies in the fact that the Commission conceptualised innovation competition as a process where close rivals compete with each other in similar or adjacent lines of research, innovation

[120] Commission Guidelines on the assessment of horizontal mergers 2004. O.J [2004] C 31/5 para. 9.
[121] It is not beyond the capacity of environmental economics to find rigorous ways of measuring a wider range of benefits as part of consumers' welfare. A. M. Hussen, *Principles of Environmental Economics* (Taylor & Francis 2018) Chapters 7 and 8.
[122] These points are not a critique to the Commission's consequentialist approach as such but to its narrow contours. Hence the concerns raised here could be accommodated by a broader output-maxmisation approach.
[123] Case No COMP/M.7932 Dow/DuPont (n 12) paras. 1977, 1980.
[124] A. M. Rietveld and Groot, Jeroen C.J. van der Burg, Margreet, 'Predictable patterns of unsustainable intensification' International Journal of Agricultural Sustainability(2021). (showing that the intensification of banana production increased the average income level indicating improvement in the economic dimension, but it did not yield sustainable outcomes in the other dimensions)

spaces and paths and strive towards roughly similar innovation targets. Under such an approach, if a merger does not reduce merging and non-merging parties' innovation incentives, capabilities, efforts and output, it does not harm innovation, and should be cleared. The problem with this approach is – as already noted – that competition enforcers may end up thwarting instead of protecting or promoting sustainable innovation (to the extent that it is linked to the diversity, quality and direction of innovation diversity). Understanding innovation competition as an output-maximising tool may tilt the innovative process towards the more conventional paradigms of industrial agriculture at the expense of agricultural diversity and sustainability. We, therefore, argue in this section that taking into consideration the competition-relevant sustainability concerns requires the adoption of an alternative, polycentric conception of innovation competition that gives more weight to the quality, direction and diversity of innovation.

The concept and its value

We suggest that these concerns can be best understood through theories that concentrate less on outcomes and quantifiable metrics of innovation and more on the process of innovation and scientific discovery. This process-oriented notion of innovation has been emphasized by Michael Polanyi and Friedrich August von Hayek. Polanyi considered that scientific discovery and knowledge creation are trigged by the interaction between decentralised and autonomous, decision-making centres which pursue diverse approaches and paths to solve a given problem. He described this process of spontaneous coordination of decentralised, independent decision-making as 'polycentricity'.[125] Polycentricity – further refined by the Nobel Laureates of economics Elinor and Vincent Ostrom – refers to processes of social organisation that are structured by many decision-making centres which are formally independent of each other and coordinate their activities through mutual self-adjustment.[126] In other words, polycentric processes are shaped by '(1) many autonomous units formally independent of one another, (2) choosing to act in ways that take account of others, (3) through processes of cooperation, competition, conflict and conflict resolution.'[127]

Central to Polanyi's account of scientific discovery and innovation is the proposition that this decentralised, polycentric interaction between scientific teams as independent decision-making centres is more effective in exploring the avenues of potential discovery than any centrally-administered process of knowledge creation and scientific research. Polanyi posited that a scientific problem is more effectively resolved if all scientists or teams of scientists choose their 'own problems' and set their discovery targets independently and in a decentralised manner.[128] This mode of spontaneous self-coordination is particularly more effective in solving tasks whose ultimate solutions are uncertain.[129]

Along similar lines, Hayek stressed that the decentralised processing of knowledge does not only harness more – often unorganised and localised – knowledge than centralised planning, but it also enhances the capacity of the relevant system to adapt to change.[130] This capacity of

[125] Polanyi (n 19) 34–36.
[126] ibid 170–180.Ostrom, Tiebout and Warren (n 21), 831; Ostrom (n 21) 45.
[127] Ostrom (n 21) 46.
[128] Polanyi (n 19) 36.
[129] ibid 37.
[130] In the Use of Knowledge, Hayek develops a knowledge-based argument in favour of capitalism. His key point is that capitalism is essential a process of decentralised information processing and that this process is superior to centralised information processing. The reasons for this superiority lie in the fact that polycentric decentralized

decentralised, polycentric systems in generating knowledge and discoveries is prominently captured by Hayek's concept of competition as a 'discovery procedure'.[131] Hayek, like Polanyi, underlined the importance of decentralised, polycentric and competitive decision-making for new discoveries and innovation, and put the emphasis on the process of parallel searches and experimentation rather than on outcomes and output.[132] For both thinkers, a polycentric and versatile structure and process that relies on and triggers different mixtures of cooperation and competition is what enables scientific paradigm shifts, adaptations and mutual learning. Both also perceived the existence of multiple and diverse parallel trials pursued by independent decision-makers as a key reason explaining why competition as an evolutionary trial-and-error process enhances society's welfare and facilitates its technological progress.[133]

Two are the main virtues of the polycentric systems and processes. First, polycentricity can enhance the endogenous capability of a system to develop better solutions to existing problems.[134] A decentralised pursuit of innovation paths by multiple teams ensures that, within the same time, multiple alternative approaches and experiments are undertaken. Such a 'parallel paths' strategy is likely to be much quicker in solving technological problems than a process where a few teams engage in sequential processes of trial-and-error within an already entrenched paradigm.[135] A greater number of independent approaches by independent teams creates more opportunities of simultaneous mutual learning than the sequential pursuit of a single research project one at a time. Simultaneously, a larger number of independent players may lead to a higher number and variety of research projects.[136] Thus, a polycentric innovation process increases the probability of 'doing things better' and 'doing better things'.[137]

The second virtue of polycentric processes lies in the fact that they can increase a system's capacity to absorb or respond to endogenous and exogenous shocks.[138] Polycentric processes decentralize and diversify errors and risks. The more polycentric a system is, the lower the probability of simultaneous system-wide failure would be, as there will be several parallel,

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planning by individual decision-makers has a greater capacity of gathering and processing information and localised knowledge than a central planning authority. Thus, it would be simply impossible for the central planner to collect and process a sufficient amount of information in order to be in the position to coordinate and micro-manage the economic decisions of the individual market participants. Hayek, Friedrich A. von (n 20) 36.

[131] Hayek, Friedrich A. von, 'Competition as A Discovery Procedure: Translated by Marcellus S. Snow' (2002) 5(3) The Quarterly Journal of Austrian Economics 9.

[132] On Hayek's notion of competition as process of parallel experimentation and mutual learning Kerber (n 96) 2, 6-7; W. Kerber and N. J. Saam, 'Competition as a Test of Hypotheses: Simulation of Knowledgegenerating Market Processes' (2001) 4(3) Journal of Atificial Societiesand Social Simulation 2.1-2.20.

[133] Kerber (n 96) 2. By progress, here, we mean revolutionising the means and modes of production. Such progress has a value in itself yet it is also likely to bring dynamic efficiency gains that by far outway static efficiency and, therefore, has an independent value irrespective of welfare considerations. Robert Solow won the Nobel Prize in economics for demonstrating that gains in wealth are due primarily to innovation – not to marginal improvements in the efficiency of what already exists. See Royal Swedish Academy of Sciences, *Press Release* (1987).

[134] Kerber (n 96) 3, 9.

[135] Polanyi (n 19) 171–175. The virtues of 'parallel path strategies' relative to sequential strategies has been further analysed by R. R. Nelson, 'Uncertainty, Learning, and the Economics of Parallel Research and Development Efforts' (1961) 43(4) The Review of Economics and Statistics 351; W. J. Abernathy and R. S. Rosenbloom, 'Parallel Strategies in Development Projects' (1969) 15(10) Management Science B-486-B-505; F. M. Scherer and W. S. Commanor, 'Mergers and innovation in the pharmaceutical industry' (2013) 32(1) Journal of Health Economics 106.

[136] Kerber and Saam (n 134), 1.4-1.5, 2.4-2.8.

[137] Kerber (n 96) 13–15. W. M. Cohen and S. Klepper, 'The tradeoff between firm size and diversity in the pursuit of technological progress' (1992) 4(1) Small Bus Econ 1 2.

[138] K. Carlisle and R. L. Gruby, 'Polycentric Systems of Governance: A Theoretical Model for the Commons' (2017) 47(4) Policy Stud J 927 936–937. Polanyi (n 2) 117–122; Ostrom (n 4), 139.

redundant teams striving to find the best solution to a certain problem.[139] If one team choses the wrong path, there will still be numerous other teams pursuing a different path and, thus, being one step closer towards the solution. By contrast, if all teams were to follow the same path, the risk of system-wide failure would increase. Consequently, by mitigating the risk of errors through decentralisation and redundancy, the polycentric pursuit of parallel paths reduces the probability of simultaneous failure.[140] Such diversification of the risk of failure across various research paths[141] makes the relevant system more 'resilient'[142] and capable of responding to unexpected changes.[143]

The virtues of a notion of innovation competition that turns on innovation diversity and polycentricity raise the question as to whether and the extent to which the size and number of rivals present in a market affect innovation diversity. This issue is relevant here because even a reader that is convinced by the value of polycentricity as a complement to the Commission's understanding of output-focused innovation competition, could reasonably argue that an industry with a few large players engaging in various innovation paths can perform this function.[144] However, several economic studies suggest that a large number of small firms is more likely to pursue a more diverse portfolio of research projects than a small number of large firms.[145] This greater innovation diversity is not – as it has been often argued – the result of greater creativity of small firms, but simply the consequence of a greater number of firms pursuing various approaches because an increase in the number of parallel experimenting competitors enhances the knowledge and mutual learning within an industry.[146]

[139] Ostrom (n 21), 129; Carlisle and Gruby (n 140), 944–947; Nelson (n 137); Abernathy and Rosenbloom (n 137); Scherer and Commanor (n 137).

[140] Ostrom (n 21), 129; Carlisle and Gruby (n 140), 944–947. On the relationship between decentralised decision-making, multiplicity and diversity of sources of innovation Kerber (n 96) 13.

[141] ibid 15. J. Farrell, 'Complexity, Diversity, and Antitrust' (2006) 51(1) The Antitrust Bulletin 165 167.For the positive contribution of diversification of sourcing as an ‚insurance strategy' to the resilience of systems and integrated value chains P. Régibeau and K. Rockett, 'Economic analysis of resilience: A framework for local policy response based on new case studies' (2013) 11(1) Journal of Innovation Economics 107 131, 133-134; V. Babich, 'Vulnerable Options in Supply Chains: Effects of Supplier Competition' (2006) 53(7) Naval Research Logistics 656; V. Babich, A. N. Burnetas and P. H. Ritchken, 'Competition and Diversification Effects in Supply Chains with Supplier Default Risk' (2007) 9(2) Manufacturing & Servie Operations Management 123; L. V. Snyder and others, 'OR/MS models for supply chain disruptions: A review' (2016) 48(2) IIE Transactions 89 96-97, 102; S. Hosseini, D. Ivanov and A. Dolgui, 'Review of quantitative methods for supply chain resilience analysis' (2019) 125 Transportation Research Part E: Logistics and Transportation Review 285 293–294.

[142] We use the term 'resilience' in line with the definition provided by Régibeau/Rockett as 'ability of an economy, society, organisation, or individual to *recover* effectively from an unexpected shock' Régibeau and Rockett (n 143), 109. Kerber (n 96) 15. Régibeau and Rockett (n 143), 131, 133-134; Babich (n 143); Babich, Burnetas and Ritchken (n 143); Snyder and others (n 143), 96-97, 102; Hosseini, Ivanov and Dolgui (n 143), 293–294.

[143] The number of relations or actions adjusted per decision-maker per minute in polycentric, self-coordinated orders or teams is thus higher than in monolithic authoritatively controlled teams or social orders. Polanyi (n 19) 115–117; Nelson (n 137); F. M. Scherer, 'Time-cost tradeoffs in uncertain empirical research projects' (1966) 13(1) Naval Research Logistics 71; Abernathy and Rosenbloom (n 137); Scherer and Commanor (n 137), 107–109. Carlisle and Gruby (n 140), 936–937.

[144] A seminal paper by Sah and Stiglitz makes this point showing that the diversity of innovation approaches does not necessarily depend on market structure and that the portfolio of innovation projects undertaken in a given market does not necessarily vary with market structure. Hence a highly concentrated market structure may thus

Several studies also show that certain organisational factors support this conclusion.[147] Decision-making on innovation projects in large firms is often characterised by a greater number of hierarchical levels compared to small firms. For example, within large firms innovation projects are first proposed by the technical staff, then reviewed by several decision-making levels and finally approved by a single or a few high-level decision-makers. Given the greater number of hierarchical decision-making levels, the likelihood of a research project being approved decreases with firm size. Hence, even in a scenario where a large firm pursues multiple research projects, organisational dynamics may prompt each intramural organisation to rely on one or a cluster of similar approaches.[148] While the positive relationship between greater number of firms and innovation diversity does not always hold, there is, at least, some reason to believe that the greater the number of firms, the more likely polycentric innovation competition to be intense,[149] and that a decrease in the number of firms through a horizontal merger can adversely affect the variety of approaches to innovation pursued within an industry.[150]

The benefits of polycentric innovation competition

Innovation diversity is particularly relevant in market contexts where sustainability is important – such as the agrochemical and agri-food sectors. First, innovation diversity can enhance the technological resilience of agricultural and food-value chains by leading to the development of a greater variety of plant varieties or alternative methods of agriculture and crop protection.[151] Studies on food security and biodiversity, for instance, suggest that diversification of crops, seeds, technology and sources enhance food security because they make crops and food supply less vulnerable to external variability shocks (e.g. climate, pest resistance or market

give rise to the same total number of research projects as a less concenctrated one. See K. Sah and J. E. Stiglitz, 'The Invariance of Market Innovation to the Number of Firms' (1987) 18(1) The RAND Journal of Economics 98 98–99. For a critique of this model see R. K. Sah and J. E. Stiglitz, 'The Invariance of Market Innovation to the Number of Firms' (1987) 18(1) The RAND Journal of Economics 98 106–107; S. S. Reynolds and M. R. Isaac, 'Stochastic innovation and product market organization' (1992) 2 Economic Theory 525 526–527. R. J. Gilbert, J. Farrell and M. L. Katz, 'Market Structure, Organizational Structure, and R&D Diversity' in J. E. Stiglitz and R. Arnott (eds), *Economics for an imperfect world: Essays in honor of Joseph E. Stiglitz* (MIT Press 2003) 195. Letina (n 96), 436, 442; R. J. Gilbert, 'Competition, Mergers, and R&D Diversity' (2019) 54(3) Review of Industrial Organization 465 469; Kerber (n 96) 17–18.

[145] Cohen and Klepper (n 176) 7-9 (noting that as long as the assumption holds that the likelihood of a firm exploring an approach to innovation is independent of firm size, a greater number of firms suggests that an industry will produce a greater amount of technological diversity. Hence, a more polycentric market structure will lead to the exploitation of beneficial approaches to innovation that otherwise would not have been explored The authors therefore suggest that "having a greater number of different minds (i.e. firms) evaluate the possible approaches to innovation, will diminish the chance that a beneficial approach to innovation will be overlooked"); Letina (n 165), 433, 441.

[146] Cohen and Klepper (n 139), 7.

[147] Cohen and Klepper (n 139), 8; Gilbert, Farrell and Katz (n 146) 210–217. This argument draws on the seminal work by R. K. Sah and J. E. Stiglitz, 'The Architecture of Economic Systems: Hierarchies and Polyarchies' (1986) 76(4) The American Economic Review 716; R. K. Sah and J. E. Stiglitz, 'Committees, Hierarchies and Polyarchies' (1988) 98(391) The Economic Journal 451. For similar organisational arguments Nelson (n 137), 363.

[148] Farrell (n 143), 167–168.

[149] Sah and Stiglitz argue that the diversity of innovation approaches does not necessarily depend on market structure and that the portfolio of innovation projects undertaken in a given market does not necessarily vary with market structure. Hence a highly concentrated market structure may thus give rise to the same total number of research projects as a les concentrated one. See K. Sah and J. E. Stiglitz, 'The Invariance of Market Innovation to

volatility).[152] While consolidation, homogenization and intensification of the current modes of agriculture may produce short-term efficiency gains by reducing wasteful duplication or by promoting the currently most efficient production techniques, they can also make agricultural systems more vulnerable to exogenous economic or environmental changes and lead to long-term failures.[153] Such shocks may be unmanageable under the technological capabilities of a consolidated agricultural sector, while technological diversity could allow food systems to switch to alternative options, if a predominant technology (e.g. the use of genetically modified organisms) turns out to have devastating consequences for the environment, biodiversity or human health. Polycentric innovation thus makes agricultural systems and value chains more resilient by creating technological 'option value'[154] and thereby enhances their technological flexibility.[155]

Second, polycentric innovation competition can enhance the long-term environmental sustainability of food systems by favouring the use of less intensive production methods and by reducing the contribution of agriculture to climate change and biodiversity degradation.[156] Various studies on biodiversity and evolutionary economics suggest that diversity and heterogeneity enhance the resilience, stability and sustainability of ecological and economic systems.[157] There is also a broad scientific consensus that biodiversity enhances the stability and resilience of ecosystems because a broader pool of genetic material species with diverse characteristics enable ecosystems to swiftly respond to exogenous shocks and adapt to new

the Number of Firms' (1987) 18(1) The RAND Journal of Economics 98 98–99. For a critique of this model see Sah and Stiglitz (n 146), 106–107; Reynolds and Isaac (n 146), 526–527. Gilbert, Farrell and Katz (n 146) 195. Letina (n 96), 436, 442; Gilbert (n 146), 469; Kerber (n 96) 17–18.

[150] Cohen and Klepper (n 122); Rubinfeld and Hoven (n 79) 72, 75; C. K. Robinson, ''Leap-Frog and Other Forms of Innovation: Protecting the Future for High-Tech and Energing Industries through Merger Enforcement: Address by Constance K. Robinson Director of Operations and Merger Enforcement Antitrust Division U.S. Department of Justice Before the American Bar Association Chicago, Illinois June 10, 1999' <https://www.justice.gov/atr/speech/leap-frog-and-other-forms-innovation> accessed 7 July 2020; Kerber (n 164); Kerber and Saam (n 177); Scherer and Commanor (n 129).

[151] For the argument that technological change is a self-reinforcing process that constantly pushes the economy into a permanent state of disruption see W. Brian Arthur, Complexity and the Economy (OUP 2015) 5-7.

[152] M. E. Schipanski and others, 'Realizing Resilient Food Systems' (2016) 66(7) BioScience 600 602-603, 605 <https://academic.oup.com/bioscience/article-pdf/66/7/600/7454833/biw052.pdf>.

[153] C. A. Tisdell, 'Economics and the Debate About Preservation of Species, Crop Varieties and Genetic Diversity' (1990) 2 Ecological Economics 77 87–88.

[154] For the notion of option value, B. A. Weisbrod, 'Collective-Consumption Services of Individual-Consumption Goods' (1964) 78(3) Q J Econ 471. K. J. Arrow and A. C. Fisher, 'Environmental Preservation, Uncertainty, and Irreversibility' (1974) 88(2) The Quarterly Journal of Economics 312.

[155] Kerber (n 96) 9, 15.

[156] Intergovernmental Panel on Climate Change (IPCC), 'Climate Change and Land: An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems - Summary for Policy Makers' (2020) 30 <https://www.ipcc.ch/site/assets/uploads/sites/4/2020/02/SPM_Updated-Jan20.pdf> accessed 1 March 2020. Currently, the contribution of agriculture, forestry and other land use activities account for about 13% of the total

circumstances.[158] Therefore, innovation diversity that enhances biodiversity is likely to strengthen biological stability and, thereby, enhance the sustainability of food systems.[159]

Third, polycentric innovation competition can strengthen the economic sustainability of agricultural and food value chains by enabling farmers to multi-source agricultural inputs, such as crop protection products, seeds or plant varieties. Diversification and multi-sourcing may protect farmers against exercises of market power by the large sellers of agricultural inputs, by bolstering their bargaining power and increasing their opportunities to diversify their sources of livelihoods. As a result, farmers could become more able to protect themselves against unforeseen changes in the upstream level of the agrochemical value chain.[160]

6. OPERATIONALISING POLYCENTRIC INNOVATION

This section identifies and discusses four options through which merger control could operationalise the notion of polycentric innovation competition, which is aimed at grasping the adverse effects of mergers not only on innovation output, but also on the direction, quality and diversity of innovation. These options are: (i) using quality-related and sustainability-sensitive innovation metrics; (ii) analysing the industry-wide effects of horizontal mergers; (iii) using structural rules of thumb or presumptions; (iv) focusing on the protection of nascent competitors.

A quality-related and sustainability-sensitive innovation metrics

As already noted, the key question underlying Commission's theory of harm in *Dow/Dupont* and *Bayer/Monsanto* is whether a merger leads to more or less innovation efforts and output. To answer this question, the Commission heavily relied on backward-looking and output-related metrics of innovation and predominantly examined the impact of the mergers on directed innovation. The Commission's unilateral effects analysis, therefore, only measured the incentives of the firm to raise or lower their innovation efforts post-merger, without assessing the diversity, direction or quality of this innovation output.

To account for the quality-dimensions of innovation efforts, the Commission could have used quality-related and sustainability-sensitive innovation metrics. For instance, instead of measuring the AI output based on commercial success, the Commission could have weighed

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CO_2 emissions ibid 10–15, 468-472. In general, food systems (including production, packaging, transport, distribution) account for about 21-37% of all total greenhouse gas emissions. ibid 476. Intergovernmental Panel on Climate Change, 'Climate Change and Land: An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems - Chapter 5 - Food Security' (2020) 476 <https://www.ipcc.ch/site/assets/uploads/sites/4/2020/02/SPM_Updated-Jan20.pdf> accessed 1 March 2020.

[157] For an overview R. R. Nelson, 'Recent Evolutionary Theorising About Economic Change' (1995) 33 Journal of Economic Literature 48. C. A. Tisdell, 'Economic Competition and Evolution: Are There Lessons from Ecology?' (2004) 22(2) Contemporary Economic Policy 179 184–191; C. A. Tisdell, 'Diversity and Economic Evolution: Failures of Competitive Systems' (1999) 17(2) Contemporary Economic Policy 156 158–159; C. A. Tisdell, *Competition, diversity and economic performance: Processes, complexities and ecological similarities* (Edward Elgar 2013); Farrell (n 143), 168. C. A. Tisdell, 'Economics and the Debate About Preservation of Species, Crop Varieties and Genetic Diversity' (1990) 2 Ecological Economics 77 78 (Conversely, a smaller gene pool will make it more difficult for ecosystems to adapt to and withstand weaknesses).

[158] K. S. McCann, 'The diversity-stability debate' (2000) 405(6783) Nature 228. Kerber (n 164) 8.

[159] Tisdell (n 155), 79.

[160] Régibeau and Rockett (n 143), 133–134.

this output with regards to its environmental impact (e.g. environmental index of AIs and traits) or with regards to the degree of homogeneity or heterogeneity of the innovation efforts, paths or agricultural models (e.g. diversity index). Another option could be to attribute different weights to innovation paths depending on their impact on sustainability and environmental protection. A fourth option could be to use quality as a filter to identify a nascent competitor that may constitute, in the future, an 'important competitive force' and whose acquisition may lastingly reduce innovation diversity.[161] Such market players may divert from the predominant technological paradigm and challenge incumbents by exploring fresh innovation paths.[162] These players are instrumental for greater innovation diversity.[163] Hence, by factoring the quality of innovation efforts into its analysis the Commission would be able to attribute greater weight to innovation harm caused by mergers that reduce innovation diversity by removing an important competitive force or nascent competitor, and, thereby, reduce innovation efforts towards more sustainable innovation paths.[164]

Such quality-adjusted analysis – which would be more sensitive towards concerns related to the direction and diversity of innovation – would not necessarily marginalise, but only complement Commission's output-oriented unilateral effects analysis. Quality considerations could, for instance, play the role of a tie-breaker, if a merger is likely to generate anti-competitive and procompetitive effects of a similar order of magnitude and the analysis of its overall effects on prices or innovation output remains inconclusive. A relevant question in this regard is what the Commission would need to do if an output-oriented analysis points to the opposite direction of a quality-oriented analysis. If, for instance, a merger maximises innovation output but harms innovation diversity and sustainability, what should be the enforcer's response? Would enforcers be entitled to block a merger that harms certain modes of sustainable agriculture or reduces the likelihood of nascent competitors coming up with more sustainable modes of production, even if they have strong indications that the said merger will lead to higher levels of output? Our response to these queries is that the notion of innovation diversity does not compel a specific trade-off on the part of the enforcer. Different enforcers might decide to attribute different weights to diversity-related (or quality-related) and output-related concerns. Yet, it is important to identify the existence of such trade-offs and grapple with them.

One might argue that in such situations enforcers would engage in impermissible value judgments and maintain that for this reason unilateral effects analysis should be exclusively

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[161] S. C. Hemphill and T. Wu, 'Nascent Competitors' (2020) 168 University of Pennsylvania Law Review 1879. (defining a nascent competitor as "a firm whose prospective innovation represents a serious threat to an incumbent" and arguing that "protecting such competition is a critical mission for antitrust law, given the outsized role of unproven outsiders as innovators and the uniquely potent threat they often pose to powerful entrenched firms"). Commission Guidelines on the assessment of horizontal mergers (n 122) para. 37. For a discussion of the use of the 'maverick firm' concept. J. Bromfield and M. Olczak, 'The Role of the Maverick Firm Concept in European Commission Merger Decisions' (2018) 14(2) Journal of Competition Law & Economics 179.

[162] Rubinfeld and Hoven (n 96) 72.

[163] The Commission has regularly used the concept of an important competitive force to challenge mergers that gave rise to competition issues, even though the merging firms were not particularly close competitors Case No COMP/M.6992 Hutchison 3G UK/Telefónica Ireland 28 May 2014. C(2014) 3561 final paras. 206, 208, 451-456. Case No COMP/M.7018 Telefónica Deutschland/Eplus 2 July 2014. C(2014) 4443 final para. 348. Case No COMP/M.7612 Hutchison 3G UK/Telefónica UK. C(2016) 2796 final para. 318-326. See however for a stricter standard under the concept of 'important competitive force' adopted by the General Court in the recent CK Telecoms ruling *Case T-399/16 CK Telecoms UK Investments v Commission* ECLI:EU:T:2020:217 paras. 170, 174, 216.

[164] Case No COMP/M.7932 Dow/DuPont (n 12) paras. 2009, 2043.

focused on output. Yet, escaping value judgments and normative choices in EU competition law is not an option as this law is a relatively open normative system which allows for different interpretive struggles and cannot be applied without value judgments.[165] Taking or not taking into account quality-related, sustainability-sensitive metrics in merger analysis requires a value judgment. Hence, instead of disguising their value judgments in legal and economic technocracy, enforcers could make them explicit in their decisions.

Taking structural effects seriously

A second, more direct way to account for the effect of mergers on polycentric innovation competition would consist in placing greater weight on their structural effects. In *Dow/Dupont* and *Bayer/Monsanto*, the Commission conceived competition as rivalry between firms whereby the innovation activity of one firm imposes immediate constraints or imposes externalities on the profitability of the innovation activity of the other. Such an analysis focuses on directed innovation towards specific innovation targets and closely overlapping innovation paths where externalities are high and the firms face a major incentive to internalise them post-merger. On the contrary, polycentric innovation competition is less concerned about such immediate externalities firms impose on each other and more worried about whether a merger will reduce the number of independent decision-making centres.[166] This approach highlights the importance of preserving a polycentric structure with a certain number of independent decision-makers who do not necessarily impose externalities onto each other at the time of the merger. The openness and diversity of innovation paths is of essence in this respect.

Undoubtedly, certain structural effects were taken into consideration in *Dow/Dupont* and *Bayer/Monsanto* as the Commission did not confine its analysis to the transactions' impact on competition in specific innovation spaces but found that the mergers would also have an adverse effect on innovation competition at an industry-wide level. Pre-merger the parties were operating two of only a few competing global R&D organisations. Post-merger, the parties would have the incentive to discontinue one of their two R&D centres to avoid cannibalization and duplication. Such discontinuation would significantly reduce the overall level of innovation competition.[167]

This focus on the industry-wide effect of mergers can at least in part accommodate concerns about the diversity and polycentricity of innovation. Polycentric innovation competition is negatively affected if, for instance, each of the two merging parties operate pre-merger a R&D organisation capable of pursuing 10 parallel innovation goals/paths (i.e. 20 goals in total) and one of those independent centres is removed post-merger to avoid duplication and "rationalise" R&D expenses.[168] The elimination of one R&D organisation may also significantly lessen the pressure of innovation competition on other non-merging players, who in turn might have fewer incentives to engage in more diverse innovation. Such concerns could be dealt with, if more weight is attributed to a merger's structural effects on the direction, quality and diversity

[165] S. Makris, 'EU Competition Law as Responsive Law' (2021) forthcoming Cambridge Yearbook of European Legal Studies.

[166] The externality that the innovation-decision making centres and paths are imposing on each other prior to the merger is not necessarily representative of their importance in ensuring the diversity of innovation paths.

[167] Case No COMP/M.7932 Dow/DuPont (n 12) paras. 278, 1956.

[168] Note that this conclusion hinges on the assumption that the merging parties do not use the synergies arising from the integration of their innovation centres to pursue the same or even a higher number of innovation paths post-merger. At least the empirical evidence from previous consolidation waves both in the pharmaceutical and the agrochemical industry suggests that this will not necessarily be the case.

of innovation. For example, if the authority establishes a correlation between the number of R&D centres (market structure) and the diversity of innovation targets and paths, then it can assume that such a merger would have a negative impact on polycentric innovation competition. Structural factors, such as the number of innovation centres and paths, their size, importance and variance, as well as market shares and HHI thresholds, could be used for this purpose. Such an analysis would enable the Commission to take into account certain competition-relevant sustainability concerns that go beyond the paradigm of output-maximising innovation competition.

The independent choice filter

The structural analysis of a merger on innovation diversity does not necessarily have to take the form of a casuistic effects-based analysis. An alternative option would be to introduce a structural rule of thumb or presumption against horizontal mergers in markets where there is considerable uncertainty about the direction, quality and diversity of innovation.[169] Rubinfeld/Hoven, for instance, argue that merger policy should preserve a larger number of firms and diversity in firm size in industries in which the best technological development or innovation strategy remains unpredictable.[170] Along similar lines, Farrell advocates in favour of a 'procompetition' presumption against mergers in complex markets where the adverse effects of industry concentration on innovation diversity are difficult, if not impossible, to prove.[171] In these markets, instead of a 'modern', effects-based analysis, a more 'naïve', structural understanding of competition may be necessary to preserve the often uncertain benefits of innovation competition.[172]

There are various options as to how a structural rule of thumb or presumption that preserves 'ecodiversity' could be designed. One promising option, discussed by Kerber[173] and Lianos,[174] consists in transposing the so-called '4-plus-rule' developed in the *US Antitrust Guidelines for the Licensing of Intellectual Property* and the *EU Transfer of Technology Guidelines* into merger control.[175] The latter suggest that 'Article 101 of the Treaty is unlikely to be infringed where there are four or more independently controlled technologies *in addition to* the technologies controlled by the parties to the agreement that may be substitutable for the licensed technology at a comparable cost to the user'.[176] According to US Guidelines if 'four or more independently controlled entities *in addition to* the parties to the licensing arrangement possess the required specialized assets or characteristics and the incentive to engage in research and development that is a close substitute of the research and 'development activities of the parties to the licensing agreement' an antitrust problem is unlikely to arise.[177] Hence, both

[169] Cohen and Klepper (n 139), 9.
[170] Rubinfeld and Hoven (n 96) 75–76, 86. F. M. Scherer and D. Ross, *Industrial market structure and economic performance* (Houghton Mifflin 1990) 654.
[171] Farrell (n 143), 168–173.
[172] ibid 171–173.
[173] Kerber (n 96) 24–28.
[174] Lianos (n 25) 358–359.
[175] 1995 Antitrust Guidelines For The Licensing Of Intellectual Property (n 101) 22–23; 2017 Antitrust Guidelines for the Licensing of Intellectual Property (n 101) 24–25. Guidelines on the application of Article 101 of the Treaty on the Functioning of the European Union to technology transfer agreements. OJ [2014] C 89/3
[176] Ibid para. 157 (emphasis added). Note that according to these Guidelines if the licensed technology benefits from considerable network effects, alternative technologies are unlikely to offer a 'real' or 'viable' alternative and will impose only a 'limited constraint' upon the licensed technology.
[177] 2017 Antitrust Guidelines for the Licensing of Intellectual Property (n 101) 25. The US Guidelines do not only account of existing technologies in the product/technology market (as their European equivalent), but also look

Guidelines establish a minimum number of alternative and independent technologies or research paths to be protected by competition law. This approach is clearly geared towards preserving a certain degree of meaningful innovation and technological diversity.[178]

The application of the 4-plus rule to merger control would provide competition authorities with a structural filter to assess the extent to which a merger can affect innovation diversity. Of course, the specific number could vary (e.g. 3 or 5) and the authority can arrive at such a policy decision after investigating the particular features of the specific market (e.g. innovation-related fixed/sunk costs, minimum efficient scale, network effects, common ownership). Such a rule can be used to estimate whether a merger is likely to lead to a reduction of the technological choice within a given industry or market and can be applied at three levels. First, it can be utilised at an industry level: if a merger leads to a reduction in the number of independent R&D organisations below the critical number of independent R&D centres, the merger could be considered as significantly reducing the choice between independent technologies. Second, it can be harnessed to assess whether within an innovation space a merger leads to a reduction in the number of alternative innovation paths below a critical threshold, Third, it can be applied, as under the EU Technology Transfer Guidelines, at the technology or product market level.

The role and weight attributed to such an x-plus-rule could vary. It could function as a safe harbour akin to the HHI and market share ratios under the EU Merger Guidelines.[179] Such a safe harbour would be in line with the current EU case law, which clearly precludes any form of legal presumptions of (il)legality in merger control,[180] and consistent with the original use of the 4-plus rule in the EU and US Technology Transfer Guidelines.[181] Another option could be to forge a rebuttable structural presumption of illegality under which the Commission would challenge any merger that reduces the number of independently controlled innovation paths below the critical threshold, and the merging parties would have to proffer evidence that the adverse effect on innovation diversity is counteracted. For example, the merging parties would be able to rebut the presumption by showing that the transaction will enable other innovation paths or generate specific efficiencies (e.g. economies of scale or scope in innovation or appropriability advantages associated with greater firm size).[182] This allocation of the evidential burden is in line with the principle of proof proximity which suggests that the

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further upstream at the number of independent research paths in research and development markets Kerber (n 96) 26.

[178] ibid.

[179] Commission Guidelines on the assessment of horizontal mergers (n 122) paras. 17-21.

[180] *Case C-413/06 P Bertelsmann and Sony Corporation of America v Impala* ECLI:EU:C:2008:392 para. 48; *Case T-79/12 Cisco v Commission* (n 46) para. 46, 48. By contrast, a structural presumption against mergers leading to an undue level of concentration exists under the US merger regime *United States v. Philadelphia National Bank* 374 U.S. 321 (1963); S. C. Salop, 'The Evolution and Vitality of Merger Presumptions: A Decision-Theoretic Approach' (2015) 80(2) Antitrust Law Journal 269.

[181] According to these guidelines finding that an agreement falls within the safe harbour only suggests that it is unlikely to raise any competitive concerns, while finding that it falls outside of it, does not entail by any means that it is anticompetitive. 2017 Antitrust Guidelines for the Licensing of Intellectual Property (n 101) 25; Guidelines on the application of Article 101 of the Treaty on the Functioning of the European Union to technology transfer agreements (n 178) para. 158.

[182] Farrell (n 143), 172.

evidential burden should lie on the party that is more likely to have access to the relevant evidence.[183]

One might argue that while the economic literature indicates some relationship between market structure and innovation diversity, this relationship is often ambiguous and might be affected by different trade-offs. As a consequence, a structural presumption could be over-inclusive and entail too many type I errors (i.e. prohibit innovation-enhancing or welfare-maximising behaviour). However, economic literature argues in favour of a qualified positive relationship between the number of firms and the variety of approaches to innovation,[184] and suggests that trade-offs between diversity and firm size emerge only if the innovation gains are difficult to appropriate.[185] On the basis of this literature, it is argued here that the proposed structural presumption could be limited to markets where increased firm size does not entail appropriability advantages[186] and where concentrations are unlikely to generate economies of scale or scope.[187] Such a cautionary approach would limit the scope of the said presumption to markets in which the gains of innovation diversity are most acute. This would minimise the costs of reducing firm size and maximise the net benefit of innovation diversity.[188]

Such a structural presumption might also seem at odds with the existing standard of proof, pursuant to which prohibiting a concentration requires showing that on the balance of probabilities it is more likely than not to significantly impede effect competition.[189] This balance of probabilities standard encodes a decision-theory approach according to which the likelihood of anti-competitive effects must be equal to or exceed 51%.[190] However, a standard of proof should not only account for the likelihood of anti-competitive harm but also for its magnitude.[191] If, for instance, the magnitude of harm of a merger and the expected gains of intervention are disproportionately large, a less demanding standard might be more

[183] O. E. Williamson, 'Economies as an Antitrust Defense: The Welfare Tradeoffs' (1968) 58(1) The American Economic Review 18 24. C. Ritter, 'Presumptions in EU competition law' (2018) 6(2) Journal of Antitrust Enforcement 189 206.

[184] W. M. Cohen and S. Klepper, 'A Reprise of Size and R & D' (1996) 106(437) The Economic Journal 925 931-936, 940. Cohen and Klepper (n 139), 4–7.

[185] Gilbert (n 146), 466, 477--479, 481.

[186] The appropriability advantage of firm size is muted in the presence of strong IP protection and product (as opposed to process) innovation ibid 481. Cohen and Klepper (n 122) 943–944.

[187] The advantages of economies of scale in R&D may also be limited if the returns to innovation are not determined by pre-innovation sales and if firms can reap the returns to innovation through rapid expansion of their market share Cohen and Klepper (n 139), 7–9, 11.Cohen and Klepper (n 186), 947–948.

[188] Error costs are likely to be kept low also because the presumption is rebuttable. Farrell (n 143), 172–173.

[189] *Case C-413/06 P Bertelsmann and Sony Corporation of America v Impala* (n 182) para. 47; *Case C-12/03 P - Commission v Tetra Laval* ECLI:EU:C:2005:87 para. 43; *Case C-265/17 P Commission v United Parcel Service* ECLI:EU:C:2019:23 para. 32; *Case T-79/12 Cisco v Commission* (n 46) para. 47; *Case T-399/16 CK Telecoms UK Investments v Commission* (n 165) para. 108.

[190] *Opinion of Advocate General Kokott in Case C-413/06 P Bertelsmann und Sony Corporation of America/ Impala* ECLI:EU:C:2007:790 paras. 209-211. See for a critical discussion A. Kalintiri, *Evidence Standards in EU Competition Enforcement: The EU Approach* (Hart 2019) 91–94.

[191] C. F. Beckner, III and S. C. Salop, 'Decision Theory and Antitrust Rules' (1999) 67 Antitrust L.J. 41 60–63; S. C. Salop, 'An Enquiry Meet for the Case: Decision Theory, Presumptions, and Evidentiary Burdens in Formulating Antitrust Legal Standards' (2017) 17 <https://scholarship.law.georgetown.edu/facpub/2007/>. M. L. Katz and H. A. Shelanski, 'Merger analysis and the treatment of uncertainty: Should we expect better?' (2007) 74(3) Antitrust Law Journal 537 546.

appropriate.[192] For such mergers that can result in a high-impact/low-probability harm[193] antitrust intervention might be warranted even if the posterior probability of anti-competitive harm is lower than 51% due to the broader implications that a reduction of innovation diversity may have (e.g. adverse effects on technological resilience, biodiversity and sustainability). Especially in markets with 'fundamental uncertainty'[194] a balance of probability standard[195] or an even more demanding standard advocated by the General Court recently in *CK Telecoms*[196] may generate considerable type II errors.

The presence of uncertainty and complexity, thus, may justify a structural presumption based on which merger policy, in the case of doubt, errs on the side of the preservation of a polycentric market structure and innovation diversity.[197] Such a 'precautionary' approach should carry some particular weight in cases – such as *Dow/Dupont* and *Bayer/Monsanto* – where competition and innovation concerns are intermingled with sustainability issues.[198] Leaving aside the particularities of its concretisation, an X-plus rule bears several advantages. One of them is that it escapes the behavioural strictures of the unilateral effects analysis, which requires the showing of closeness of competition between the innovation paths or technologies for inferring horizontal non-coordinated effects. In addition, this rule takes into consideration the substitutability between the innovation paths or technologies, and it allows enforcers to address adverse effects on more distant innovation paths. The 'independent technological choice' filter, thus, might serve as an additional tool to catch the broader implications of a horizontal merger on innovation diversity. Furthermore, such a filter gives clear signals to the market players and its enforcement would remain predictable and consistent, while the relevant administrative, enforcement and error costs are likely to remain low. To these it should be added that such a rule constitutes a workable way to give effect to the precautionary principle

[192] Imagine for instance that the Commission finds that a merger will reduce consumer welfare by 150 EUR and generate efficiencies of 100 EUR. Assume further that the probability of the expected harm to materialise is 45%. Under the balance of probability standard requiring that the merger is more likely than not (i.e. 51% or more) to harm competition, the Commission could not to block the merger, even though the expected net benefit of intervention is positive and blocking the merger would minimise consumer harm.

[193] Beckner, III and Salop (n 193), 61–62. Salop, 'An Enquiry Meet for the Case: Decision Theory, Presumptions, and Evidentiary Burdens in Formulating Antitrust Legal Standards' (n 193) 13, 17- 20; L. Kaplow, 'Burden of Proof' (2012) 121(4) The Yale Law Journal 738 772–786; L. Kaplow, 'Likelihood Ratio Tests and Legal Decision Rules' (2014) 16(1) American Law and Economics Review 1 13–20.

[194]Frank Knight's seminal dichotomy between uncertainty and risk draws a strict distinction between risk as 'measurable uncertainty' that can be captured by assigning probabilities to specific events or outcomes and (non-measurable) uncertainty to which no probabilistic value can be attributed. F. Knight, *Risk, Uncertainty and Profit* (The Riverside Press Cambridge 1921) 20. Uncertainty (in the strict, Knightian sense) about the future development of markets would prevent competition authorities from assigning probabilities to various multiple scenarios and to pick, in keeping with the balance of probabilities standard, the most likely one. Such uncertainty is particularly relevant when it comes to innovation and technological development; it makes it hard to attribute specific probabilities to the harm resulting from an elimination of an innovation path and makes case-specific evidence unreliable. Salop, 'An Enquiry Meet for the Case: Decision Theory, Presumptions, and Evidentiary Burdens in Formulating Antitrust Legal Standards' (n 317) 3. See also Farrell (n 143), 170–172.

[195] *Case C-413/06 P Bertelsmann and Sony Corporation of America v Impala* (n 182) para. 47; *Case C-12/03 P - Commission v Tetra Laval* (n 191) para. 43; *Case C-265/17 P Commission v United Parcel Service* (n 191) para. 32; *Case T-79/12 Cisco v Commission* (n 46) para. 47; *Case T-399/16 CK Telecoms UK Investments v Commission* (n 165) para. 108.

[196] *Case T-399/16 CK Telecoms UK Investments v Commission* (n 165) para. 118.

[197] Farrell (n 143), 170–173.

[198] For this reason, environmental economics literature advocates in favour of a 'safe minimum standard' decision-rule geared towards minimizing the maximum possible biodiversity loss resulting from a specific practice. This approach suggests that the optimal minimax loss strategy consists in preserving a species, unless it is proven that such preservation is not socially optimal. Thus it prefers to err on the side of preserving biodiversity. S. V. Ciriacy-

which the Commission is required to integrate into its competition policy under Arts. 11 and 191 (2) TFEU and general principles of EU law.[199]

Protecting nascent competitors

The elimination by acquisition of a smaller innovator (e.g. a small seed breeder producing traits for orphan crops) may be particularly harmful for the direction, quality and diversity of innovation even though it may have a trite impact on innovation efforts and output. The notion of polycentric competition suggests that enforcers should not be alarmed only about mergers between two closely competing large incumbents but also about mergers between distant competitors or acquisitions of smaller players by larger incumbents. In a recent study Cunningham et al. analysed acquisitions of innovative targets by incumbents in the pharmaceutical industry. They showed that some of these are 'killer acquisitions' in the sense that the acquirer buys the innovative target solely to discontinue its project and pre-empt future innovation competition from emerging rivals.[200] On certain occasions, it might be more profitable for a firm to buy and shut down a nascent competitor's product than suffering the expected losses of revenue or investing in developing its own new product and cannibalize on its revenue from its existing products. This is particularly likely when the target's product overlaps with the acquirer's existing product portfolio, and when the acquirer's market power is large.[201]

In a similar vein, Hemphill and Wu argue that protecting nascent competitors is a critical mission for antitrust law, 'given the outsized role of unproven outsiders as innovators and the uniquely potent threat they often pose to powerful entrenched firm.[202] Nascent acquisitions refer to acquisitions of young firms with products or services whose competitive significance remains highly uncertain. The parties to such acquisitions might have minor or no current overlaps, potential overlaps in existing markets or potential overlaps in future markets.[203] Both types of nascent and killer acquisitions fly under the radar as they do not meet the EUMR notification thresholds and even if these thresholds were modified, they would hardly raise any red flags in light of the Commission's output-centred conceptualisation of innovation competition.

The process of polycentric innovation competition, thus, could be profoundly undermined by niche acquisitions that crowd out alternative and more sustainable innovation paths and curtail innovation diversity. On this basis, it could be argued that enforcers should be particularly alert to horizontal mergers capable of inhibiting innovation not only between close but also between

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Wantrup, *Resource conservation: economics and policies* (University of California Press 1968). R. C. Bishop, 'Endangered Species and Uncertainty: The Economics of a Safe Minimum Standard' (1978) 60(1) American Journal of Agricultural Economics 10 11–12. Tisdell (n 155), 81–82.

[199] According to the precautionary principle in case of scientific uncertainty about the (irreversible) environmental risks, a decision-maker should defer to the anticipation and prevention of such risks For a more detailed discussion of the role of the precautionary principle for EU competition law see Nowag (n 8) 175-176, 255-256.

[200] C. Cunningham, F. Ederer and S. Ma, 'Killer Acquisitions' (2019) <https://ssrn.com/abstract=3241707> accessed 28 September 2019. Some of the acquisitions of Monsanto during the 1980s and 2000s may be considered as killer acquisitions Case No COMP/M.8084 Bayer/Monsanto (n 13) paras. 1305-1306.

[201] Ibid. Their model looks at acquisitions that occur when the innovative target firm's project is still under development, and therefore further development is necessary and costly and the ultimate project success is uncertain, and shows that an incumbent acquirer has weaker incentives to continue development than an entrepreneur if the new project overlaps with a product or project in the incumbent's portfolio.

[202] Hemphill and Wu (n 163)..

[203] OECD 10.

distant competitors. Such mergers can significantly weaken or drive out of the market potential or nascent innovators who pursue more remote and diverse innovation targets.[204] Similarly, non-horizontal mergers may have foreclosure effects that would harm polycentric innovation competition.[205] Such mergers can thwart nascent competitors that are active in different levels of the value chain and lead to the lock-in of farmers in integrated crop management ecosystems.[206] Such ecosystems could offer all-inclusive data-driven digital tools to farmers, combine larger datasets and customer networks, preclude breeders of alternative, non-GM orphan traits, and inhibit firms offering alternative crop protection solutions from reaching a minimum efficient scale.[207]

For this reason, the Commission needs to identify certain criteria which would identify an acquisition as a 'killer acquisition' or a target as a 'nascent competitor' and adjust its analysis accordingly. The Commission needs to craft a counterfactual (e.g. would the target be likely to remain independent, and if so, how strong a competitive constraint would it impose on the incumbent) which will allow it to assess the impact of a nascent or a killer acquisition on the merging and non-merging firms' incentive and ability to raise prices, or to reduce quality or innovation. For this purpose, the Commission will have to assess the likely future competitive constraints that the target imposes upon the acquirer's product and its role in enhancing innovation diversity.

7. CONCLUSION

Even though Alfred Marshall, the founder of neoclassical economics, stressed the importance of diversity and variety as a driver of technological competition and progress, this process-based understanding of innovation competition is only captured to a limited extent by the mainstream legal and economic thinking on merger control.[208] The analysis of *Bayer/Monsanto* and *Dow/Dupont* mergers put forward in this study suggests that the Commission conceptualised innovation competition on broad output-centred terms but anchored its analysis in a narrow understanding of consumer welfare. By focusing on innovation efforts and output, the Commission underplayed the impact that the said mergers might have on the quality, diversity and direction of innovation. This output-centred approach attributes insufficient weight to innovation competition as a polycentric process under which independent actors pursue multiple and diverse parallel innovation paths.[209] Such innovation competition can neither be fully reduced to quantifiable metrics nor evaluated solely on terms of outcomes.

Consequently, by emphasising the output-related parameters of innovation competition and by neglecting the role of the quality, diversity and direction of innovation in agrochemical markets, the Commission was not able to take into consideration all competition-relevant sustainability concerns. The said mergers raised certain sustainability concerns pertaining to their impact on environmental protection, biodiversity, food security and food safety. Some of these concerns could have passed the threshold test endorsed in this paper and be considered

[204] Case No COMP/M.8084 Bayer/Monsanto (n 13) paras. 1274-1317.
[205] Note that a *killer* acquisition theory is that the concerns are horizontal in nature, and that the outcome is that product development is terminated OECD, 'Start-ups, Killer Acquisitions and Merger Control – Background Note' (2020) <https://one.oecd.org/document/DAF/COMP(2020)5/en/pdf> accessed 9 November 2021.
[206] M. G. Jacobides and I. Lianos, 'Ecosystems and Competition Law in Theory' .
[207] Case No COMP/M.8084 Bayer/Monsanto (n 13) paras. 2442-2736 and access to data 2715, 2736.
[208] Marshall and Alfred, *Principles of economics : an introductory volume* (Macmillan 1920) 355.
[209] Kerber (n 96) 4–6. Hayek, Friedrich A. von (ed), *Individualism and Economic Order* (University of Chicago Press 1948) 92–94. Hayek, Friedrich A. von (n 20), 319-320, 330.

as within the ambit of the EUMR since they were the immediate results of a reduction in competition triggered by the mergers. Had the Commission conceptualised innovation competition as *both* an output maximising device and a polycentric process, it would have been able to account for the potential adverse effect of industry consolidation on all competition-relevant sustainability parameters (i.e. not only the ones that are related to innovation efforts and output, but also the ones that are related to the diversity, quality and direction of innovation).

To address this shortcoming, this paper proposes a complementary understanding of innovation competition as a polycentric discovery process characterised by a diversity of parallel paths and independent decision-making centres. In addition, to operationalise this approach we explore four possible options. We argued that merger control can preserve polycentric innovation by placing a greater weight on quality-adjusted theories of harm; by focusing on the industry-wide effects of mergers; by using structural filters, and/or by protecting nascent competitors from killer acquisitions. These proposals are informed by the realisation that there is an intricate relationship between innovation, competition and sustainability, and are aimed at enabling merger control to account for all competition-related sustainability concerns. EU merger control does and should play a key role in ensuring a high level of and a wide variety of sustainable innovation. This being said, the relationship between competition and innovation remains complex and more theoretical and empirical research is necessary to obtain a better understanding of the various, often conflicting effects and trade-offs that a merger may have on the direction, quality and diversity of innovation.[210]

[210] See for a similar conclusion Kerber (n 96).