COMPETITION AND INNOVATION
A THEORETICAL PERSPECTIVE

OECD Competition Policy Roundtable Background Note

OECD

Please cite as: OECD (2023), Competition and Innovation: A Theoretical Perspective, OECD Competition Policy Roundtable Background Note, www.oecd.org/daf/competition/competition-and-innovation-a-theoretical-perspective-2023.pdf.

This document was originally released on O.N.E. as an unclassified document under the reference code: DAF/COMP(2023)2.

Foreword

While there is long-standing view that competition drives innovation and that innovation, in turn, drives higher welfare and economic growth, there is no theoretical consensus on the precise relationship between these two important components of a market economy. This background note reviews the relationship between competition and innovation in both directions. This is, how competition can help boosting innovation and how innovation can shape competition. It focuses on the theoretical perspective to try to understand whether competition is indeed a driver of innovation and how it interacts with other drivers.

It concludes that the complexity of the relationship between the two variables have led to a variety of results, making the discussion far from reaching consensus but that there are common insights from the different efforts. First, that the effect competition has on innovation depends on whether the market is contestable, whether the innovation is appropriable, and whether there are synergies from innovating in the markets. Second, that innovation can also have an impact on dynamics and structure of markets and, if breakthrough, it can create new markets entirely and disrupt existent ones. Third, that there are many factors that drive innovation, some of which interact with competition and some that come from other contexts where competition does not necessarily play a key role. Finally, that competition policy has a key role to play in driving innovation, including facilitating other drivers to generate incentives to innovate and allowing innovations to spread across markets.

This note was written by Aura García Pabón and Antonio Capobianco (OECD Competition Division) and benefited from comments by Ori Schwartz and Wouter Meester from the OECD Competition Division. It was prepared as a background note for discussions on “The Relationship between Competition and Innovation” taking place at the June 2023 session of the OECD Competition Committee, *https://www.oecd.org/competition/the-relationship-between-competition-and-innovation.htm*. The opinions expressed and arguments employed herein are those of the authors do not necessarily reflect the official views of the Organisation or of the governments of its member countries.

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1 Introduction

Competition promotes consumer welfare and growth, as well as makes markets more flexible, resilient and innovative. While there is a long-standing view that competition drives innovation and that innovation, in turn, drives higher welfare and economic growth, there is no theoretical consensus on the precise relationship between these two important components of a market economy.

The OECD Competition Committee has discussed issues associated with the relationship between competition and innovation in the past, mostly focused on the implications of innovation for competition enforcement cases[1]. Nevertheless, to date, it has not focused its discussions on the fundamental relationship between both variables, to try and better understand whether competition is indeed a driver of innovation (and/or vice versa) and how competition interacts with other drivers of innovation. In turn, such analysis could clarify the role of competition policy and enforcement to foster innovation. For this reason, it will discuss in a first session the theoretical perspective of this relationship and in a second session it will focus on the implications on competition enforcement. The core of this paper is, therefore, reviewing the most recent developments in the thinking about the relationship between competition and innovation, analyse the many factors that drive innovation, such as firm-specific characteristics and external factors that impact firms' ability and incentives to innovate, and how these factors interact with competition. The considerations from the enforcement perspective are left for a second paper.

In the past years, governments have adopted unprecedented measures to contain the effects of the COVID-19 pandemic, extraordinary inflation rates, energy crisis and supply chain disruptions. Moreover, new challenges for achieving sustainable growth have also arisen. Policies related to digital economy and the green transition involve significant public funds directed towards meeting international climate goals and adopting technology. These measures range from fiscal policies, monetary policies, trade policies to industrial policies, and include tax relief, wage subsidies, grants, preferential loans, loan guarantees and State equity (OECD, 2020[1]). In light of these measures, there is a need to discuss the role of public funding and other external factors, that do not necessarily relate to competition, in generating incentives and ability of firms to innovate and how these policies should go hand-in-hand with well-functioning markets that can bring these investments to final products and technologies.

In this sense, the paper will introduce a discussion on how competition could facilitate innovation, interact with other drivers of innovation and generate possibilities for such innovations to spread across markets and increase consumer welfare and economic growth. While the core of this paper is not competition enforcement, it recognises that there is a need to find the right balance in its enforcement activities, since over-enforcement could lead to lower incentives to innovate while under-enforcement could result in more concentrated markets, which in turn, could lead to a lower rate of innovation. In this sense, it sets up the scene for the future discussion by the OECD Competition Committee on implications of the relationship between competition and innovation on enforcement.

This paper concludes that:

- Understanding the impact of competition on innovation and vice versa is a key consideration when designing and implementing economic policy. The complexity of this interaction has led to a variety of results, as both theoretical and empirical studies have found relationships in different directions, making the discussion far from reaching consensus.

- The consideration of a dynamic perspective in the analysis is fundamental since not only competition has an impact on innovation, but also successful innovation could lead to evading competition.
- As the literature has approached the relationship from different perspectives, such as considering static and dynamic competition or introducing heterogeneity of firms and industries, it has commonly recognised that the effect competition has on innovation depends on whether the market is contestable, in the sense that innovators could successfully escape competition or not, and whether the innovation is appropriable, meaning that the successful innovators could capture, at least temporarily, the benefit from innovation.
- Innovation can also have an impact on dynamics and structure of markets, can drive competitors out of those markets, block entry of new competitors or change the business models for those who want to stay and compete. A breakthrough innovation can create new markets entirely and disrupt existent ones.
- There are many factors that drive innovation, such as firm-specific characteristics, differences in business models, the role of financing agents, geographical considerations (including regulatory differences, location of clusters, and characteristics of the geographical markets), network effects, among others.
- Competition policy has a key role to play in driving innovation, including facilitating other drivers to generate incentives to innovate and allowing innovations to spread across markets. A sound competition policy that creates a level playing field, facilitates the entry of new players into markets and the introduction of new products and processes.

The paper is organised as follows: **Section 2** describes the notion of innovation and the different types of innovations, how to measure them and discusses the main theoretical insights of the relationship between competition and innovation. It also presents some mechanisms through which competition could drive innovation. **Section 3** explores the main drivers of innovation, including company-specific and external factors, as well as collaboration. **Section 4** describes future work of the OECD Competition Committee on the discussion about the implications of the relationship between competition and innovation on competition enforcement. Finally, **Section 5** presents the conclusions.

2 Types of innovation and the relationship with competition

2.1. What is innovation and the types of innovation

The OECD has defined innovation as "*the successful development and application of new knowledge*" (OECD, 2006[2]). This means that innovation involves invention, but also other stages up to practical applications of such inventions. According to this definition, different types of innovation can be identified, depending on their magnitude or intensity, as well as on the impact they have in value chains and markets.

Innovation can take the form of an improvement in production or distribution technologies, which would in turn result in cost reduction. This is a so-called process innovation. It can also consist of the introduction of new products or further developments of existing ones, changing their characteristics. This is referred as product innovation (European Commission, 2016[3]).

Another distinction that is frequently made is between breakthrough and incremental innovations which separate innovations by their magnitude. They can also be referred to as sustaining and disruptive innovations, which separates them by their impact on their value chain and surrounding processes (Bower and Christensen, 1995[4]).

Disruptive innovations drastically alter markets. They are not regular or predictable improvements but innovations that bring radical, unforeseen changes to the markets and occur irregularly (OECD, 2015[5]). Disruptive innovations normally reduce or significantly alter market shares of incumbent firms in existing markets or create new markets and business models.

While sustaining innovations maintain a rate of improvement on attributes that add value to products, disruptive technologies introduce a distinct set of attributes than those already valued by consumers. This latter takes place outside the value network of the established firms (OECD, 2015[6]). Finally, innovations can be either product or process innovations, the former improving existent products or bringing new ones to the market, while the latter implying improvements in productivity (UEA, University of East Anglia, 2021[7]). Box 2.1 presents an example to understand the different types.

Box 2.1. Different types of innovations in the TV industry

As innovation can be defined and categorised in many ways, including ones that may somehow overlap, examples to understand the different types of innovation are useful.

Television was invented in the late 1920s and after several years of experiments, it became available to consumers. While before the Second World War the number of homes with televisions was low, in the 1990s, at least in the United States, 98% of households had at least one. This innovation can be considered a breakthrough one, as it soon became the prominent source for news, education, and culture, as well as advertising to the population. Nowadays, televisions are classic examples of incremental innovations. They do not create new markets anymore and they rely on the same core idea and components, but instead, are constant upgrades of previous models, containing new or modified features to attract more the consumers.

In the same industry, in the 1980s, home videocassette recorders (VCR) became widely available. They allowed viewers to record and replay programs for the first time, as well as rent and watch movies in their own homes. This product innovation was also disruptive at the time. And posteriorly, adding fast forward to VCRs was incremental. The transition from VCRs to DVDs (Digital Versatile Discs) was again a breakthrough, given the magnitude of the innovation, but sustaining, as it did not alter the process of selling video content. However, the shift to streaming did, making it a disruptive innovation. While initially streaming services such as Netflix were not as attractive to households that were not used to online services, it subsequently has become the most common tool used to access video content. Such disruptive innovations displace the value network and redefine it.

Source: Stephens, M. (2014[8]), NYU - History of Television, https://stephens.hosting.nyu.edu/History%20of%20Television%20page.html#:~:text=Electronic%20television%20was%20first%20successfully,electricity%20until%20he%20was%2014.

2.2. How to measure innovation

As innovations come in different forms, their magnitude and impact can also be measured in different ways. This, in turn, may result in opposite outcomes when discussing their relationship with competition and other macro variables such as productivity and growth, as empirical literature has shown. As policy can contribute to setting the direction of innovation and shaping its effects in the markets, sound measurement can help policymakers better understand the impact of innovation and its contribution to economic goals (OECD/Eurostat, 2018[8]). While this note will not focus on measurement related issues, for the purposes of understanding the dynamics behind innovation, it is useful to briefly explore the diverse ways to measure innovation and if they have the ability to capture and distinguish between the different types.

There are different dimensions that can be used to measure innovation: knowledge, novelty, implementation and value creation (OECD/Eurostat, 2018[8]). An adequate measure for innovation would allow capturing knowledge-based activities, ideas or methods that are novel with respect to their potential uses and that can be implemented for an actual use in the markets to generate value.

Two of the most commonly used variables to measure innovation are R&D expenditure and patent activity (see Box 2.2). The former is a measure via inputs and, because it normally increases with firm size, it is usually considered as a proportion of total revenues (so-called R&D intensity). Patent activity, which is a measure of outputs, is calculated through the number of patents requested or granted.

Box 2.2. R&D expenditure and patent activity in OECD Countries

The OECD Main Science and Technology Indicators (MSTI) is a database that reflects R&D performance of 37 OECD countries.[1] The database serves as a key source to understand and monitor investment in innovation activities and provides company-specific, government and sectoral insights of R&D dynamics. It includes a set of indicators that reflect the level and structure of the efforts of such countries in the field of science and technology since 1981 and includes information on R&D expenditures and patent activity in R&D intensive industries.

In March 2023, key findings based on these indicators were:

- R&D expenditures in OECD jurisdictions continued to grow in 2021 at pre-COVID-19 rates (4.1% adjusted by inflation).
- Businesses were the main drivers of R&D growth, while R&D expenditure in government and higher education institutions barely increased.
- However, R&D intensity declined in 2021 because GDP outpaced growth in R&D expenditure.
- Analysis of R&D expense growth in 2022 reveals a return to the pre-COVID-19 patterns of differential growth performance between companies in ICT industries and those elsewhere. Companies in ICT are maintaining high inflation-adjusted growth rates for R&D expenses while companies in industries like “pharma and biotech”, which were core to the resilience of business R&D in 2020, appear to have been reducing their R&D spending in 2022.
- R&D expenditure from government in 2021 was focused on health, energy and environment. Investment in innovation for defence declined.

Note: 1. Data for Costa Rica, which became the 38th member of the OECD in May 2021, have not yet been included in MSTI as of March 2023 pending final verification of their statistics.
Sources: OECD MSTI database and OECD Statistical brief with highlights from March 2023 MSTI data, available at: https://www.oecd.org/sti/msti2023.pdf.

Drawbacks exist with the use of either measure. As some literature has highlighted[2], it is challenging to accurately capture contestability of markets where innovations take place and to measure the appropriability of innovation’s returns.

For R&D expenditures, different definitions used by businesses or ways of allocating the expenditure among various products or markets could affect the measure. Activities that a company includes in their measure of R&D expenditures might also vary, considering additional actions such as training, software development, innovation management, acquisition of assets, engineering and design, among others, as part of such expenditures. Moreover, they could be affected by exogenous variables, such as tax incentives (Lapante et al., 2019[9]) or costs that might or might not be included (Grassano et al., 2020[10]). Other challenges can arise if R&D expenditures are not directly observable from a firm’s accounting systems (OECD/Eurostat, 2018[8]). More importantly, R&D measurements do not capture success in innovation. Hence, the use of output measures such as patent activity.

However, this measure also brings challenges. For instance, the lack of differentiation between intensity of the innovation, the fact that companies might use defensive patents[3] that do not represent actual innovation or that some of the outputs to be measured are less quantifiable might under or overestimate the importance of patent activity by a company. Moreover, patents reflect the trade-off of firms between their choice to protect the innovation with the expected benefits of the granted protection and the costs of disseminating sensitive information to rivals. Using them as a measure to relate to competition could reflect changes in such trade-off instead of changes in the firms’ incentives to innovate (Frésard and Phillips,

2022[11]). Furthermore, there are other types of IP rights that protect innovation that are not considered when measuring it through patents, thus, other output measures that complement patent activity include number of scientific papers published, software updates, new products or productivity improvements might be needed.

It is important to highlight that, linked to the definition of innovation, measurements of its intensity should also involve the diffusion of technologies across industries in an economy (OECD/Eurostat, 2018[8]). For that reason, measurements of innovation can be complemented with data on follow-on activities such as marketing, training, after-sale services that can also provide an idea on the success of implementation of the innovation.

Regardless of the variable used to measure innovation, it seems that innovations are not well captured by a single indicator[4] or their relationship with other variables, such as competition, might be sensitive to the measure used. In the case of R&D expenditures or intensity, these do not necessarily reflect the success and use of innovation, and to a lesser extent consider the strength of such innovations. Same levels of expenditure can represent both incremental and disruptive processes. Furthermore, disruptive innovations may not necessarily be identifiable via patents. For instance, software codes might be business secrets or features solely protected by copyright (UEA, University of East Anglia, 2021[7]). Finally, measures that rely on businesses definitions of the different degrees of innovation might overestimate or underestimate the amount of disruptive innovation happening in the markets, as subjectivity in the definition could led to errors or incomparable values, while measures that relate only to the implementation phase of an innovation leave out a very high proportion of efforts that companies did to get to such phase.

2.3. Theoretical insights on how competition affects innovation

There is extensive economic literature on the relationship between competition and innovation. In the past century, this has been of particular interest to academics given their role in industrial policy, economic growth, and social welfare. As previous roundtables have discussed this relationship more extensively[5], this section will provide an updated background that will then serve to deepen into the study of what drives innovation.

Understanding how competition affects innovation and vice versa is a key consideration when designing and implementing economic policy. The complex interaction has led to theoretical and empirical studies finding relationships in different directions, preventing a consensus between scholars on their mutual impact. These different outcomes are also affected by differences in the used definition of competition and innovation as well as measurement challenges. Moreover, the consideration of a dynamic perspective in the analysis is fundamental since not only competition has an impact on innovation, but also successful innovation could lead to escaping competition. This means that, while the question that generally arises refers to the way different competition intensities motivate companies to invest in R&D and develop innovations (does stronger competition in markets boost or hamper technological developments?), the answer should also include considerations on how these innovations impact the competitive dynamics of markets.

2.3.1. The classic discussion

Overall, the theoretical relationship between competition and innovation has been analysed around two central economic ideas. The first one relates to a positive relationship between competition and technological progress that is based on the assumption that competitive market structures generate the need to adopt efficient production methods, thus leading to the development of innovative processes (Smith, 1776[12]). This positive association is supported by the fact that competitive environments can generate greater incentives for firms to differentiate themselves, gain a competitive advantage and earn

profits (so-called “escape effect” that arrives from the prospect of additional profits from a certain degree of future market power) (Arrow, 1962[13]).

The second one refers to an inverse relationship between competition and innovation based on an idea of creative destruction (Schumpeter, 1942[14]), according to which the existence of a limited number of large firms in the markets, i.e. with less competition, leads to progress in the long run. This phenomenon (so-called Schumpeterian Effect) happens because profits earned in non-competitive markets increase the incentives to innovate. In other words, according to this theory, markets with increased competition will tend to discourage innovation by laggard firms, as it decreases the short-term extra profit from catching up with the leader. In this sense, too much competition can lead to short-term thinking and discourage firms from investing in longer-term, riskier research and development projects. Contrarily, the rents that can be captured by a firm who succeeds in catching-up with its rival by innovating are larger in markets with less competition, increasing the incentives to pursue such innovations.

While these two economic ideas have been constantly seen as opposing views, posterior research has focused on the conditions under which any of the previous effects is likely to dominate or if there are scenarios where the two are compatible and can exist. Besides, regardless of where a theoretical model stands in the Schumpeter-Arrow debate, some useful insights have been gained on the sources of incentives to innovate and their relationship to competition.

The most common and accepted development is the assumption of an inverted-U relationship between competition and innovation. When the degree of competition is low, there is a positive impact of increased competition on innovation efforts (Arrow’s approach), while at a certain significant level of competition, a further increase reduces incentives for innovation (Schumpeter’s approach) (Scherer, 1967[15]; Kamien and Schwartz, 1975[16]; Aghion et al., 2005[17]). This suggests that there is an optimum level of competition that produces the highest levels of innovation (Griffith and Reenen, 2021[18]).

This inverted-U relationship is also related to the different states of technology across firms. In industries where the state of technology across firms is similar (so-called levelled sector with neck-and-neck competing firms), increased competition raises incentives to innovate, as the escape effect prevails in line with Arrow’s proposal of competition increasing the incentives to innovate. Conversely, in industries where firms differ in terms of technology (so-called unlevelled sector where usually a technologically advanced firm is one step ahead of a laggard firm), innovation incentives would come from the profits earned from the lack of competition. This is the Schumpeterian effect. The latter happens as there is little incentive for the laggard firm or firms to innovate because their reward for catching up with the leader is low.

2.3.2. The new developments

As the debate on the complex relationship between competition and innovation has evolved and literature have tried to explain how traditional theories, that were seen almost as opposing, could converge, there are three basic principles that have emerged (Shapiro, 2012[19]).First, innovation is encouraged if the market is **contestable**. A contestable market is one where entry barriers are low and conditions in general allow for companies to easily compete when offering a product that is attractive to consumer. In this sense, if the market is contestable, there is the possibility for a firm to make profitable sales by offering greater value to the consumers than its rivals. This implies that firms interested in keeping a *status quo* would have smaller incentives to innovate as they have consumers already captured, while entrants have the purpose of disrupting such *status quo* and gain market shares in a context where consumers react to new or different choices. This also suggests that a monopolist, who is not exposed to any actual or potential competition, has low or no incentives to innovate, as there is no basis for earning substantially higher profits in the future, such as in more competitive markets. Market contestability can be affected by different factors, such as switching costs, brand loyalty and access to technology for new entrants (Kokkoris and Valetti, 2020[20]).

Appropriability is the second principle. For firms to have an incentive to innovate in the first place, the prospect of obtaining market power and, thus, having the ability to reap profits from the innovation – referred to as appropriating the benefits of innovating – is also a necessary reward. Firms' ability to appropriate the benefits of their innovations might also depend on demand and costs characteristics since changes in production technologies or costs might also change customers' willingness to pay (Spence, 1975[21]). Besides, the existence of imitation also affects incentives to innovate since appropriability would be limited.

Finally, the third principle refers to **synergies**. The possibility of combining assets to produce greater benefits than when used separately increases incentives to innovate. In this sense, depending on the characteristics of the assets necessary to engage in a particular R&D project, companies could see their ability to innovate enhanced or restricted. This means that combining complementary assets enhances innovation capabilities, hence increasing the firm's ability to innovate, while having assets that do not necessarily relate might restrict the possibility for firms to engage in specific innovation projects (Shapiro, 2012[19]).

In sum, it is commonly recognised that the link depends on whether the market is contestable, in the sense that innovators could successfully or not escape competition, whether the innovation is appropriable, meaning that the successful innovators could capture, at least temporarily, the benefit from innovation and on the extent of synergies between assets that companies have, since increased synergies lead to more abilities to innovate.

Empirical research that focused on the relationship between competition and innovation has found different results. Such results often depended on several factors that differed per study, including the industries analysed, the type of innovations considered and how they are measured, the definition of competition and variable used to quantify the degree of competition in the markets, and the characteristics of firms. Some studies have focused on a sample including multiple sectors to conclude whether the relationship between both variables could be affected by the different characteristics of the products in the markets (see Box 2.3).

Box 2.3. Empirical relationship between competition and innovation

There is extensive empirical research on the relationship between competition and innovation in specific sectors. The results are highly dependent on the industry and measurements used, leading to no one-size-fits-all explanation on the relationship between competition and innovation.

Sectorial evidence

One usual way to analyse the relationship is to study the dynamics of both variables in specific sectors. For instance, Blundell, Griffith and Van Reenen (1999) demonstrated that competition encouraged innovation at firm level, using a sample of 340 UK manufacturing firms for the period between 1972 and 1982. However, they also found that the relationship was conditional to initial high market shares. Poldahl and Tingvall (2006) predicted an inverted-U relationship between competition and innovation in the manufacturing sector in Sweden when using the Herfindahl-Hirschmann Index (HHI) to measure competition. Nevertheless, they found a negative relationship when using the Lerner Index.

Similarly, Berubé, Duhamel and Ershov (2012) used three different measures of competition intensity, with data from Canadian manufacturing enterprises, and found a consistent positive relationship with R&D expenditure. However, when the authors accounted for heterogeneity of firms, via a relative distance to the technological frontier measure, they found evidence that suggested a negative (Schumpeterian) impact. Finally, Ganglmair et al. (2020) found that competition is a stronger driver of

innovation activities both in manufacturing and service sectors in Germany, based on a sample of 12 000 companies.

Other recent empirical studies include Hober, Li and Phillips (2020), where the authors studied the competitive impact of Chinese innovators and competition on U.S. innovation and Thakor and Lo (2022) that analysed the interaction between competition and innovation along the interplay between competition and financing in the biopharmaceutical industry.

Evidence based on a multi-sector approach

Another approach to review empirically the relationship between the two variables has been to perform multi-sectorial analysis. In Colombia, the Competition Authority (Superintendence of Industry and Commerce) published in 2019 an academic study that examined the relationship between the two variables based on the estimation of panel data models with information for 75 countries between 2007 and 2015 (Superintendencia de Industria y Comercio, 2019). Their results supported the existence of an inverted-U relationship between innovation and competition and were robust to different variables used for competition and innovation.

Raymond and Plotnikova (2015) also revisited the relationship using panel data from the innovation survey in Luxembourg. The authors used a model with four different measures of competition and three indicators of innovation and found that the relationship between the two variables depended on product characteristics. Particularly, the authors observed that higher competition also implied higher innovation, and that this relationship was stronger in markets characterised by rapid obsolescence of products.

Sources: Blundell, R., R. Griffith and J. Van Reenen (1999), "Market Share, Market Value and Innovation in a Panel of British Manufacturing Firms.", The Review of Economic Studies, Vol. 66/3, pp. 529-554; Poldahl, A. and P. Tingvall (2006), "Is there really an inverted U-shaped relation between competition and R&D?", *Economics of Innovation and New Technology*, Vol. 15/2, pp. 101-118; Berubé, C., M. Duhamel and D. Ershov (2012), "Market incentives for business innovation: results from Canada.", *J Ind Compet Trade*, Vol. 12; Ganglmair, B. et al. (2020), "Price Markups, Innovation, and Productivity: Evidence from Germany", *Bertelsmann Stiftung;* Hober, G., Y. Li and G. Phillips (2020), "Internet Access and U.S. - China Innovation Competition", *NBER*, Vol. Working Paper No. w28231; Thakor, R. and A. Lo (2022), "Competition and R&D Financing: Evidence from the Biopharmaceutical Industry", *Journal of Financial and Quantitative Analysis*, Vol. 57/5, pp. 1885-1928; Superintendencia de Industria y Comercio (2019), "Competition policy and Industrial property: relationship through panel data approach 2007 – 2015.", Vol. 23; Raymond, W. and T. Plotnikova (2015), "How does firms' perceived competition affect technological innovation in Luxembourg?", *MERIT Working Papers*, Vol. 1.

In general, the results from both theoretical and empirical research suggest a complex relationship between competition and innovation that is dependent on the features of the markets and firms analysed and sensitive to the methods and data used. In other words, there is no single-direction relationship between the two variables that is valid across markets and sectors. However, all studies seem to point at the importance of the contestability in the market, characteristics of the products and appropriability of the innovation. Understanding these aspects and taking them into account when reviewing innovation abilities and incentives of firms in the markets should have an impact on the way competition enforcement addresses the effects of behaviour on innovation (see section on Future work).

More recently, economists have been using insights from business and management theories to understand the drivers of innovation and how they relate to competition, mostly in a dynamic context. These theories highlight the value of specific assets and resources such as knowledge, skills and capabilities that are decisive for competing in innovative markets. This are called dynamic capabilities as it is considered that a firm's success in the market depends on its ability to create value and adapt to changes in the environment, with the purpose of achieving a competitive advantage (Wójcik, 2015[22]). Competition can be seen as one of the sources of such dynamic capabilities, as it might generate the incentives for firms to differentiate themselves, which in turn, involves companies adjusting through innovation (Teece, 2007[23]). In other words, while competition does not necessarily act as the sole driver

of innovation (as will be discussed in section 3), it can help promote it. There are some pathways through which this could happen (Gilbert and Melamed, 2022[24]). The first one is that the higher the number of players engaging in R&D efforts, the higher the probability of a new innovation. *Ceteris paribus*, the more agents involved in innovation activities, the faster these activities would lead to a result. A second one refers to the number of competitors being positively related to the possibility of stealing sales by a successful innovator. Having competitors with a relevant market share implies that innovating may allow to capture those customers. A third pathway refers to the fact that the higher the rents for the incumbent (as a result of limited competition), the lower incentives it has to innovate, as it is cannibalizing or replacing its older products with the inventions.

Another aspect to consider with regards to how competition affects innovation is related to the perception of mergers and acquisitions as an exit strategy to some innovators. The prospect of being acquired is sometimes considered as a relevant ex-ante incentive for companies to engage in innovation projects in the first place. This applies to both innovators seeking financial rewards only, such as venture capitalists, and for small firms that, although interested in reaching the market, do not have capacity to bring the innovation to commercialization stages. This latter is intensified by the fact that start-ups realise that integrating their innovations into an established company, as will be discussed in the section related to Economies of scale and network effects, can yield synergies that promote higher returns on investment (Barnett, 2021[25]).

Moreover, there is also a role for competition enforcement. There has been an increased concern on the possibility of firms engaging in anti-competitive behaviour to try and escape competition while reducing incentives to innovate or engaging in mergers instead of innovation races (Griffith and Reenen, 2021[18]).

2.4. Theoretical insights on how innovation affects competition

While most of the literature has focused on the impact of competition on incentives and abilities to innovate, there have also been studies that focus on the effect of innovation on the competitive dynamics of markets. Regardless of the factors driving innovation, successful innovations are normally associated with lower costs of production, higher quality or variety of products and services, which in turns increases the welfare of producers and/or consumers. Innovation can have an impact on the dynamics and structure of markets, can drive competitors out of those markets, block entry of new competitors or change the business models for those who want to stay and compete.

Innovation is associated with companies achieving a competitive advantage for many reasons. There is a strong relationship between introducing new products into a market and the market performance of the company introducing those products (Tidd, Bessant and Pavitt, 2007[26]). This involves, first, performance growth through non-price variables, such as design and quality, but also increases in market share which also improve profitability. Moreover, innovation processes could lead to production efficiencies (such as cost reductions or time shortening), which in turn speed up the development of more innovations in comparison to competitors. In this sense, sustained innovation would also be essential to keep the competitive advantage (Martín-de Castro, G.; Delgado-Verde, M.; Navas-López, J.E.; Cruz-González, J., 2013[27]).

To understand this, the analytical frameworks have focused on dynamic competition (see Box 2.4). They consider situations where firms compete for future rents instead of existing ones, by using innovation to introduce new products or processes in their businesses. In these scenarios, competition also results in more variety from product differentiation, diversification of activities or even creation of ecosystems with multiple products that complement each other (Petit and Teece, 2021[28]).

Box 2.4. Dynamic competition and innovation in the digital economy

The digital economy is characterised by unprecedented productivity growth, rapid innovation, and firm entry with simultaneous disruptive changes in products and business models. The creation and use of new technical input, such as big data and algorithms, is also widespread and may significantly impact market structure and firms' performance. For those reasons, different approaches have been used when analysing competition and innovation dynamics in digital sectors.

Petit and Teece (2021) propose the use of what they call a dynamic competition paradigm, which considers that both competition and innovation determine changes in market structure and firms' positions in those markets. In this context, firms compete for future rents instead of existing ones, by introducing new products, processes and services through innovation, which allows them to differentiate from their rivals. The main source of rivalry is innovation instead of short-term price differences.

One key aspect of applying a dynamic theory is the acknowledgement of heterogeneity between firms in aspects such as business models, organisational processes and management, or what the authors call dynamic capabilities. Dynamic capabilities in a digital economy include management strategies to co-specialise and jointly use assets, resources and data to create value, while coordinating and, if needed, integrating complementary activities and assets. The main purpose is to achieve harmonisation that leads to innovation. Besides, distinctive human capital as well as technical inputs such as big data and artificial intelligence, which grant competitive advantages to tech firms, require specific managerial and entrepreneurial skills. This is what the authors refer to as strong dynamic capabilities needed to succeed in acquiring future rents from innovation (Teece, 2020).

These capabilities, which will be discussed in the next chapter, are drivers of innovation and also impact competitive performance because they allow firms to incorporate uncertainty in their business' decisions in exchange for future competitive advantages. The idea behind applying this perspective is to recognise that innovation drives competition as much as competition drives innovation.

Sources: Petit, N. and Teece, D. (2021), "Innovating Big Tech firms and competition policy", *Industrial and Corporate Change*, Vol. 30, pp. 1168-1198; Teece, D. (2020), "Innovation, governance, and capabilities: implications for competition policy: A Tribute to Nobel Laureate Oliver Williamson", *Industrial and Corporate Change*, Vol. 29/5, pp. 1075-1099.

Product innovation is, therefore, recognised as a provider of differentiated competitiveness in terms of quality and function of the new products and services. This, in turn, gives consumers the incentives to choose the innovations and allows companies to secure a market-leading position and increase their performance, as long as the product fits customers' needs and demands. While the competitive advantage mostly comes from the positioning of the new products, it might also be complemented with the companies' capabilities to implement strategies that create more value from those products, including the appropriate business model, allocation of resources and strategies of commercialisation of the innovations (Lee and Yoo, 2019[29]).

Although dynamic models have shown that innovation incentives in a market depend on the possibility for innovators to appropriate future gains, at least in a temporary basis, it has also been well-recognised that in highly innovative markets, dynamic considerations mean that this market power might be less sustainable and that other capabilities of the firm are needed to complement the innovation process and preserve the gains from it. In other words, that high innovation levels lead to dynamics of constantly changing market structures and fast replacement of incumbents by newcomers (Segal and Whinston, 2007[30]).

What this means is, in practice, that appropriability of profits from innovation is a must but not sufficient to keep a competitive advantage. Innovation leads to temporary market power and how temporary would

depend on how fast innovators can replace incumbents in the markets. The extent of the innovation plays a key role as breakthrough innovations guarantee less threats of competition, while constant rates of innovation could be a method to secure competitive advantage in rapidly changing environments when the innovations are not as structural.

The need for using this dynamic perspective to appropriately account for the impact of innovation in competition analysis has also been studied (OECD, 2015[6]). Causation running also in the opposite direction, this is, innovation also affecting competition, means that technological innovation, business model innovation and how both generate new possibilities for companies to operate in the markets shape market structures (Teece, 2013[31]). For competition policymaking, this means that recognising dynamic effects in the assessment of mergers or potential anticompetitive conduct implies focusing on the effects of reduced competition in the ability and incentives to innovate, but also on how this affects, in the longer run, competition levels in the market analysed. In other words, this means that if competition authorities want to promote competition overall, they should in turn, acknowledge that "*competition and innovation are co-determinant[s] of changes in market structure and firm positions*" (Petit and Teece, 2021[28]). In order to support this, it is important to understand better the drivers of innovation and the role of competition, which will be developed in the following section.

3 Drivers of innovation

While many innovations have occurred in market-based economies and with arguments of companies gaining a competitive advantage, many others have risen from objectives that do not necessarily relate to competition or in contexts where competition was not an originator of the innovation (see Box 3.1 for an example). Some innovations are sufficiently breakthrough that when created, no market for them was even conceived.

As the previous chapter discussed, there is an important and complex relationship between competition and innovation, which in turn determines the role of competition policy in wider economic policy objectives. To understand how, it is important to first establish if competition is indeed a driver of innovation, in which cases does competition play a key role to incentivise innovation or generates the ability for businesses to innovate, what are other relevant drivers of innovation and how they can interact with competition.

Box 3.1. The origins of the high-speed rail

Since the origins of the rail mode of transport in Europe in the 19th century, the history of developments in railway has been delimited by efforts for increasing speed. Particularly during the industrial revolution, the speed of trains to connect cities was a symbol of technological development of the countries and there seemed to be a competition between them to reach the most impressive performances. In France, for instance, the government started a process of electrification of its railways with the purpose of increasing speed and modernise the railways. However, the emergence of other transport modes such as aviation and private cars, slowed down the innovation in the sector.

Nevertheless, after World War II, Tokyo was facing serious problems of density of its population and significant congestion on roads and rail. Moreover, for security reasons, the Japanese government had a strong preference of limiting the imports of petroleum. For these reasons, the Japanese National Railways (JNR) engaged in a process of development of a new project which, given the novelty and unfamiliar technologies, initially received low funding[1]. While different successful tests were done in Europe and Japan to increase speed of traditional trains, only in 1964, the first mass, high-speed train line, between Tokyo and Osaka, the "Shinkansen" was born as a completely new transport system that allowed a significant number of passengers (500 000 per day) to travel at 210 km/h[2].

This new technology quickly spread to other parts of the world. Different countries such as Italy, France, Germany, Canada and the United Kingdom opened high-speed train lines in the following decades introducing incremental innovations towards safety improvements, energy consumption, pollution, among others.

Notes:
1. The project faced restrictions in public funding given the size of investments. Moreover, JNR also looked for a loan from the World Bank, which ended to support the project less since its criteria to fund projects excluded experimental techniques.
2. The average speed of commercial trains before Shinkansen was 70km/h and previous non-commercial trials reached records of 200km/h.
Sources: Picard, J. and Beltran, A. (1994), *D'où viens tu TGV?*, Revue Générale des Chemins de Fer, http://archivchemindefer.free.fr/dossierTGV/DouviensTGV.pdf; Shima, H. (1994), "Birth of the Shinkansen - A Memoir", Japan Railway & Transport Review; UIC (2015), High-Speed Rail History, https://uic.org/passenger/highspeed/article/high-speed-rail-history.

Finally, innovations were also conceived in context of competition between economies rather than companies in a market. For instance, the so-called space race between the United States and the Soviet Union to develop aerospace capabilities has been the perfect ground for the creation of breakthrough innovations in the field (see Box 3.2).

To understand the origins of innovations, and whether competition has a role to play or not, there is a need to firstly identify the characteristics of innovators, as they vary according to their objectives for innovating. They could be solely developers of ideas, that might or might not translate into products, including governments with no intent to commercialise the inventions; they could be developers of ideas that are complementary to others (i.e. ideas that, if implemented, would be part of an ecosystem) or they could be agents interested in entering and competing independently in the markets or strengthening their position if they are already present. In the latter case, objectives might vary from generation of profits to changes in the firm's position in the market, increases in production or distribution capabilities, types of customers to serve or obtaining access to new markets. However, if innovators do not engage in innovative activities with purposes of competing in a market, the role of competition would then be less relevant.

Box 3.2. The space race between the United States and the Soviet Union

During the Cold War, the United States and the Soviet Union competed in different arenas, including innovation in the space. In order to prove the superiority of their technologies and military power, space exploration also became a field of innovations that nowadays are considered to be breakthrough.

For instance, in 1957, the Soviet Union launched Sputnik, the world's first artificial satellite and the first man-made object to be placed into the earth's orbit. As a response, in 1958, the National Aeronautics and Space Administration, a federal agency dedicated to space exploration, was created. During the same year, the first satellite designed by the US Army was also launched.

Both powers made subsequent innovations in the field. While in 1961 a Soviet cosmonaut was the first person to orbit Earth, by 1962 the first NASA's lunar landing programme, Project Apollo, was in place with an announcement that the US would land a man on the moon before the end of the decade. In 1968, an American cosmonaut became the first man to walk on the moon's surface.

Future joint missions such as the International Space Station and the Shuttle-Mir programme followed. While the space race was initially conceived with military and political purposes, the technological efforts produced ground-breaking innovations in fields such as telecommunications, with the introduction of broadband and satellite networks; medical, with the introduction of image processing initially conceived for space; and technology in general, with products that later were adapted for commercial purposes.

Sources: Davis, M. (2023), The Space Race, Miller Center University of Virginia, https://millercenter.org/the-presidency/educational-resources/space-race; Royal Museums Greenwich (2014) *Space Race Timeline*, https://www.rmg.co.uk/stories/topics/space-race-timeline.

Understanding the objectives of an innovator may allow for the identification of factors that affect its incentives and ability to innovate. For instance, agents decide whether to invest in an innovation project or not by weighing the costs (investments) and its potential rents, estimating the risk-adjusted rate of return on the investment. However, the fact that such earnings might result from the sale of the development (e.g. start-up exit) can also intensify or reduce the incentives to invest for capital ventures or innovators that have no intentions to compete in the market. In some scenarios, innovation can emerge from actors that, participating in competitive processes, want to differentiate themselves from their competitors but, in many others, innovations can be the result of other objectives, such as broader policy ones, that do not involve competition considerations.

It is well-known that innovation drives productivity, which in turn promotes growth (Ezrachi and Stucke, 2022[32]). To analyse how competition can foster innovation, especially given their complex relationship discussed in the previous chapter, it is important to establish the scenarios where competition might drive innovation or at least interact with the relevant drivers.

Different scholars have identified various factors that influence the possibility of firms to innovate, including, but not limited to, competition[6]. These factors include internal aspects, specific to each firm, and external ones, i.e. those that normally affect the general competitive environment of the sector in which the firms operate or where the innovations take place. Finally, collaboration has also been identified as an important driver of innovation, as more open innovation models, in which firms work together to develop new products and services, have recently emerged (see the discussion in the dedicated section on Collaboration and Box 3.9). It is important to highlight that some of these drivers affect the firms' ability to innovate, while others impact their incentives.

In industrial economics, different game theory models have tried to analyse the innovation incentives of firms in the markets (Bundeskartellamt, 2017[33]). One example is dynamic patent race scenarios where firms compete with each other to get the first patent. In such models, intensity of innovation depends not only on factors such as the degree of homogeneity of firms, their cost structure and the information they have; the existence of entry barriers; whether patent protection is assumed and works well, meaning that there might be a possibility of knowledge spill-over effects; among others. This factors, undoubtedly also affect competition and have a different impact when the innovation is in a product or in a process (Kerber, 2018[34]). Another example is the modelling of data-driven innovation markets, such as digital ones, where characteristics of the market itself, such as the direct and indirect network effects and the existence of platforms, significantly influence the outcomes of innovation efforts (OECD/Eurostat, 2018[8]).

Finally, public programmes also have a vital role in the incentives of firms and public bodies to invest in some cases. State provisions to achieve broader policies (e.g. environmental or transport, among many others), might be important sources of financing that boost companies' incentives and ability to innovate (Bundeskartellamt, 2017[33]). In multiple occasions, innovation arise from public investments in contexts where it would have never happened if the markets and businesses were left to do it alone, such as the example described in Box 3.2 (Mazzucato, 2018[35]).

While this section does not pretend to present an exhaustive list of factors that drive innovators, it will discuss some of them and how they might or not relate to competition. This allows to understand how competition can foster innovation. The idea is that when innovations translate into products in the market, regardless of the initial objective for their conception, competition and market forces can trigger all the benefits, while lack of it could stifle potential disruptions coming from such innovations (Ezrachi and Stucke, 2022[32]).

The resources that a company has available have a strong influence on its ability to engage in innovative activities (OECD/Eurostat, 2018[8]). From its workforce, assets and experience to available financial resources, these firm-specific aspects will shape different results for firms that share the same business environment. Main features include the magnitude and maturity of the firm, including management decisions and size of the skilled workforce, as well as the business model and processes. These company-specific features interact with others such as the ecosystem structure and functioning where the firm operates and a sufficient access to finance. There are other external factors that also affect innovation and normally affect the business environment as a whole. This happens because innovation activities of firms are embedded in political, social, organisational and economic systems (OECD/Eurostat, 2018[8]). Regulations, such as IP rights, trade and customs ones, permits and licenses to operate in the markets, for instance, have an important impact on the performance of innovative firms (EBRD, 2014[36]). Successful innovation in the markets relies on a supportive business environment.

3.1. Size of the firm

Studies have shown positive correlations between the age of firms, their size and the propensity to introduce new products, partially explained by experience[7], economies of scale, and better access to external finance (OECD, 2009[37]) (see sections on Economies of scale and network effects and Access to finance).

Young firms or start-ups that are normally smaller than incumbents, are usually considered to be innovators or at least to be the most likely to introduce innovations that are disruptive. When they do not innovate, or their innovation is unsuccessful, the probability of running out of funding and exit the market is high (EBRD, 2014[36]). While incumbents in markets also engage in innovation (mostly process innovation), new agents are often the ones willing to take bigger risks.

Nevertheless, small firms tend to be less productive than large firms and productivity relates directly with innovation, making large firms have the most important role, particularly at stages after invention, namely development, pre commercialization and commercialization. Moreover, large firms are better able to undertake multiple R&D projects at the same time and, hence, spread the risks of R&D or at least be at a better position to exploit unforeseen results of its innovation efforts. Other characteristics that contribute to large companies having a higher potential to engage and succeed in innovation are the number of employees and the size of their business assets, including technological capabilities and other intangible assets, as well as capital and investments that can be used as a source of funding. Sectoral differences exist in the size of innovators, which account for characteristics in the sector, technology needed, and demand faced. For instance, better and more access to resources is particularly important when innovation is taking place in a context of high sunk costs and economies of scale or scope.

3.2. Business models and the role of experience and maturity

The age of a firm and its maturity might also impact its ability to innovate, as they capture its experience accumulated over time. This is, with age, companies acquire a stock of knowledge that includes modifying their business strategies to adapt and generate different results from investments.

Related to a company's level of experience, human capital is another relevant factor to consider. Appropriate skilled workers, including management, are key for the success of an innovation. The diversity of skills of a firm's workforce can influence innovation performance, as it can stimulate (or hamper) the exchange and dissemination of knowledge and the generation of ideas (Østergaard, Timmermans and Kristinsson, 2011[38]). While workers produce ideas, other processes are needed for those ideas to be successfully introduced into the markets. Effective human resources management can influence the ability of the firm to profit from the creative ideas of its workforce. For instance, adequate business plans are often particularly important for a successful innovative process.

Business strategies might include plans and policies on how the firm will generate, through innovation, competitive advantages or unique selling positions, including common strategic choices and how they should be adapted according to performance (OECD/Eurostat, 2018[8]). This goes in hand with the managerial capabilities of the company, which are used to meet the firm's strategic goals. Experience and maturity of the firm are key in both aspects. Firms that are capable of assessing innovation results and learning from past innovation experiences can help maximise the returns from innovation activities.

3.3. Economies of scale and network effects

While it is recognised that start-ups have a role in bringing disruptive innovations into the markets and generating new business practices, in many cases incumbents also play a key role in innovating. This

happens because R&D efforts are sometimes associated with economies of scale, as previously discussed, large investments and extensive experience in the market (Federico, Scott Morton and Shapiro, 2020[39]).

In some cases, probability of market entry of an innovation, its development and diffusion also depend on network effects. While they do not necessarily affect early stages of the innovation, they can act as structural barriers to entry, determining the success of the commercialisation stage of the new product (Bundeskartellamt, 2016[40]). This is specially the case in markets that include intermediaries for the transactions between customers and suppliers, which also involve transmission of knowledge, or in markets where there is space for innovators to develop and sell complementary technologies or products (Evans and Gawer, 2016[41]).

The relevance of network effects in innovation decisions from incumbents might increase in scenarios where consumers value the product or technology not only because of their intrinsic preferences, but also for the number of consumers that have already adopted it. In this sense, in markets where network effects are strong, firms, mostly entrants, find low or no incentives to innovate and enter the market, since there will not be space for appropriating consumers and, therefore, profits. Contrary, in markets where network effects are weak, mainly as a result of big heterogeneity between the consumers' preferences, disruptive innovations are most likely to occur. This happens because in such scenarios, innovators might be able to penetrate the market, co-exist with the incumbent and acquire a relevant market share, allowing for competitive convergence in the market (Prasetio, 2022[42]).

3.4. Access to finance

Finance also plays an important role on the decision of firms to engage in innovation. Access to sufficient funding, either from internal or external sources, is key for the continuity of R&D projects, but also for later stages in the innovative process, as inventions might be costly to integrate into a firm's production structure (EBRD, 2014[36]).

There are many potential sources of funding, including own capital, transfers from affiliates, customers contracts, shareholder loans, debt from commercial loans, loans from international organisations, loans from governments, equity from venture capital firms, grants or subsidies, bonds and obligations and other sources like crowdfunding (OECD/Eurostat, 2018[8]).

Nevertheless, financing of innovation is affected by its uncertain nature and timing; probable volatile and unpredictable returns and cash flows; and the lack of skills from providers of financing, such as banks, to assess early-stage technologies. These factors make innovation projects to be perceived as risky investments, even more so, when performed by nascent companies (start-ups). More profitable firms or those with a high share of capital can then find it easier to invest in activities with uncertain outcomes, such as those relating to innovation. However, for companies who lack own resources, the uncertainty and risk of innovative activities make most of the traditional sources of funding unavailable (Schneider and Veugelers, 2010[43]).

3.4.1. Venture capital and other private sources of financing

In light of the above, access to private or public funds is often necessary for firms to conduct R&D projects. Indeed, private equity and venture capital funds often provide equity to a diverse portfolio of companies that engage in R&D activities. This equity could also involve knowledge, improvements in corporate governance, better management capacity and access to human capital, to increase the probability of success of the innovation[8]. The reason why these actors do their investments is pure profit-maximising. Their seeking to access transactions and projects that although present a high risk, may also have an attractive return perspective. Thus, venture capitals are normally associated with some of the most

innovative firms in the world such as GAFAM, but also with a growing number of start-ups producing new products and services (Lerner and Nanda, 2020[44]). For the former, more mature firms, funds are a common source of capital, while for the latter, alternative sources like crowdfunding platforms are more relevant. During the past decade, private venture capital seems to have gained importance in R&D activities related to the information technology and diffusion of communications involving platforms (see Box 3.3).

Box 3.3. Role of venture capitals in technology in the last decades

Since the 2010s, private venture capital has played a key role in the supply of capital for information technology and communications innovators. Many companies that develop platforms in the so-called sharing economy have been backed by venture capitals.

Most of the prominent venture capital firms, such as Sequoia Capital, Kleiner Perkins and New Enterprise Associates, which were formed to invest in innovative industries in the 1970s, have invested in the past decades in platform-based innovations such as Airbnb and Uber, which now are publicly traded firms with remarkably high returns. Between 1995 and 2020, close to 47% of the publicly traded firms in the United States were backed by venture capital investors prior to their initial public offering.

Venture capital has also contributed significantly to the growth of fintech innovations. Examples such as Grab in Singapore, which started as a ride-hailing services platform but then expanded to digital payments, loans and insurance products, and Gojek in Indonesia, which provides similar services as Grab, received important resources from private venture capitalists, including SoftBank, Toyota, Google and Tencent. Airwallex, a global payments company from Australia that provides cross-border payments and foreign exchange services to businesses, also received significant funding from investors, including Tencent and Sequoia Capital.

Sources: Lerner, J. and Nanda, R. (2020), "Venture Capital's Role in Financing Innovation: What We Know and How Much We Still Need to Learn", *Journal of Economic Perspectives*, Vol. 34/3, pp. 237–261; Mohamed, T. (2020), *Markets Insider*, https://markets.businessinsider.com/news/stocks/airbnb-investor-sequoia-capital-bought-shares-1-cent-now-140-2020-12-1029885671; Storm (2023) The Role of Venture Capital in Fintech Innovation, https://storm2.com/resources/venture-capital/role-of-venture-capital-fintech-innovation/#:~:text=Provide%20funding%3A%20VC%20firms%20invest,experience%20in%20the%20FinTech%20industry.

Nonetheless, venture capital funds tend to be highly concentrated in areas with strong potential growth, low capital intensity and low tolerance to failure (Ewens, Nanda and Rhodes-Kropf, 2018[45]). Moreover, they tend to have limited period objectives to reach profits, which tends to draw their funds to ideas that can be commercialised or have a value realised in such term. That is the main reason why, in countries such as the United States, private funds do not invest as much in basic research (Mazzucato, 2018[35]).

As a result, not all the innovators can always access venture capital and private equity. The attractiveness of projects for equity financing depends on certain characteristics of the firms and the markets where the innovations are taking place, the reason why the innovation is being pursued as well as the existence of viable exit strategies, like mergers and acquisitions, that sometimes are definitive for the realisation of the financial returns.[9] One example of strategy that could increase attractiveness of an innovative firm is the possibility to then being acquired by an incumbent due to its human resources (see Box 3.4).

Box 3.4. Acqui-hire strategies of start-ups

When companies engage in mergers or acquisitions, whether as acquirees or acquirers, they do so to increase their value. Different ways to increase value through mergers and acquisitions in innovative markets exist, including acquiring IP rights, refining product strategy, increase capital and develop new R&D projects. Most of these strategies involve either already successful innovations or high probability of success. When the uncertainty is high, other strategies can still lead to companies willing to engage in mergers or acquisitions. Acqui-hires are one of the most common exit strategies for start-ups these days. They refer to situations where companies buy others not for their products but specifically to take their employees and accelerate product development and innovation. In these scenarios, the objective is to access specific and specialised knowledge and skill sets and, therefore, the value of the transaction is determined based on employees' perceived value.

While acqui-hires might be a signal of a company with an innovation not likely to succeed, since otherwise purchasers would also be interested in the company's product, they are also understood as a way to save start-ups with failing products and recoup the initial investments made. Therefore, their existence is key for start-ups to get access to funding in situations where, otherwise, such access will not be granted.

Sources: Blackwood, P. and Ferguson, T. (2022) "The Complete Guide to Acquihires", *Andreessen Horowitz*, https://a16z.com/2022/06/15/the-complete-guide-to-acquihires/; Founders Network (2023), Acquihire: Everything You Need to Know, https://foundersnetwork.com/blog/what-is-acquihire/.

3.4.2. Public sources of financing

In scenarios where innovators cannot access private sources of funding, the role of the government in financing innovation has been vast, and sometimes underestimated. Moreover, markets where research is fragmented and there is less coordination between innovative agents may also highly benefit from public intervention to direct the innovation efforts (Urbancová, 2013[46]). As governments identify that investing in innovation might generate positive externalities and knowledge spill overs that are good for society, they are normally willing to fund higher risk, early-stages research that private investors are not interested in and decide how to direct such investments (Van Reenen, 2019[47]). By investing in early stages of innovative projects, governments have allowed multiple innovations to develop when venture capitalists were not available[10] (Mazzucato, 2018[35]).

In a risk-taking role, the State has taken a leading position in shaping and creating new markets. In light of broader public policy objectives, public investments have directed innovation, impacting ability of firms to produce new products and services and pushing for early-stage projects that later ended up in significant innovations. Examples of scenarios where government research and funding acted, at least, as a starting point or support for further innovations are present in many industries, from technology to aviation and agriculture (see Box 3.5 for an illustration in the case of the US).

Box 3.5. The Internet and the green transition: examples of the US government directing innovation

The Internet

One of the governmental agencies in the **United States** with the most prominent role in generating innovation is DARPA (the Defense Advanced Research Projects Agency), created in 1958 with the purpose of developing breakthrough technologies for national security use by the military[1]. While the origin was a response to the launch of Sputnik in 1957 to give the US technological superiority in national defence (see Box 3.2), since then, DARPA has been targeting resources in specific areas to reach its objective.

DARPA has also collaborated with other agencies in the government to develop technologies such as the National Aeronautics and Space Agency (NASA). From the list of innovations that had origins in such projects, computers, operating systems, jet planes, civilian nuclear energy, lasers and biotechnology are a definite highlight (Block, 2008).

For instance, DARPA funded the formation of computer science departments at various US universities, provided early financing and research supports to companies, mainly start-ups, and assumed the expenses associated with designing and developing semiconductor devices like microchips in special laboratories. These strategies led to a faster development of the Internet and the computer industry in the 1960s and 1970s. DARPA's role was also to link and spread knowledge between firms, government and universities. Many of the technologies developed or funded by DARPA were later included in the design of personal computers, introduced by Apple for the first time in 1976 (Abbate, 1999).

While the efforts of DARPA were vast, and sometimes underestimated, in the computer industry, they were not unique or isolated. Other successful innovations that benefited from early R&D funding in IT were automated voice recognition, language processing and translation services, Global Positioning System (GPS) receivers and stealth technologies. While the resources to develop these innovations pursued particular policy objectives (security), their creation has impacted many and diverse industries. Some of these products are now part of core technologies embedded in consumer electronics like smart phones, storage devices and tablet computers (Mazzucato, 2018).

The green transition

More recently, in 2009, a similar agency withing the US Government was created with analogous purposes. An Advanced Research Projects Agency for Energy (ARPA-E) was created to develop high-impact energy technologies that are "*too early for private-sector investment*"[2] in a context of developing a green industrial policy. This recognises that the innovative projects that benefit from these public funds as they relate to the green industrial policy, would have not emerge otherwise. While the strategy is not for the Agency to pick winners and losers, the expectation is that it should be able to direct resources to high-risk ideas that have the potential to become disruptive energy technologies.

Notes:
1. DARPA, About us, Available at: https://www.darpa.mil/about-us/about-darpa
2. ARPA-E, About us, Available at: https://arpa-e.energy.gov/about
Sources: Block, F. (2008), "Swimming against the Current: The Rise of a Hidden Develomental State in the United States", *Politics and Society*, Vol. 36/2, pp. 169-206; Abbate, J. (1999), *Inventing the Internet*, MIT Press; Mazzucato, M. (2018) The Entrepreneurial State: Debunking public vs. private sector myths, Penguin.

In fact, one of the fields where innovators have benefited the most from government support is medicine (see Box 3.6). This support has included direct funding through grants, but also tax benefits and the creation of public-private partnerships.

Box 3.6. Innovations arising from public funding in the US: the medicine field

In the United States, many vaccines had their origins in government research programmes. In 1940's the first flu vaccine, which was given to citizens, was developed by researchers from the National Institutes of Health (NIH) at the University of Michigan, with support from the U.S. Army (CDC, 2023). Since then, the NIH also engaged in the research and development of vaccines against hepatitis B, licensed in 1986, HiB in 1987, hepatitis A in 1995, and HPV in 2006. The most recent coronavirus vaccine was also developed in 2021 within a public-private partnership named Operation Warp Speed. In all these cases, the objectives of the government went towards a quicker finding of solution for diseases that were strongly affecting population.

In 1983, the Orphan Drug Act included tax incentives, R&D subsidies, fast-track drug approval and strong intellectual property rights for products developed for treating rare conditions or diseases. This allowed for a rapid development of orphan drugs, which today are a relevant source of revenue for big pharmaceutical companies, which in turns support further advancements (Mazzucato, 2018).

Other developments in the field also had significant funding from the Government, such as magnetic resonance imaging (MRI) and the kidney matching program for transplants, which were developed with grants from the Public Health and Safety Organization (NSF) (Monteil, 2020). In the case of MRIs, while considered nowadays a relevant medical tool to detect potential health problems, they were developed with the purposes of studying atomic nuclei, showing how innovations and knowledge could spread between markets and have significant spill over effects.

Sources: CDC, (2023), Influenza Historic Timeline, https://www.cdc.gov/flu/pandemic-resources/pandemic-timeline-1930-and-beyond.htm#:~:text=1940s,produce%20most%20flu%20vaccines%20today; Mazzucato, M. (2018) The Entrepreneurial State: Debunking public vs. private sector myths, Penguin; Monteil, A. (2020). 50 inventions you might not know were funded by the US government. Stacker. Available at: https://stacker.com/business-economy/50-inventions-you-might-not-know-were-funded-us-government.

Regardless of whether the objective is to increase the speed of an R&D project to obtain a successful innovation in a shorter period, which was the case in the development of the coronavirus vaccines in 2021, or when the innovation emerges as a result of the government aiming at solving other macroeconomic or social challenges, breakthrough innovations that have changed market structures and dynamics have been created with public funding.

Given the scope of impact of such innovations, governments have incorporated innovation policies as part of their working programmes. Normally, these programmes pursue multiple economic objectives, but tend to focus on areas where innovators can engage in breakthrough solutions for challenges in fields of interest of the governments, such as environmental, energy, and digital in more recent years[11].

3.5. Regulation and government policies

There is a range of regulatory measures that can act as entry barriers to market and that can limit the possibility of new technologies or products being actually offered to consumers and competing successfully with existing products (Blind, 2013[48]). Absolute restrictions on the number of firms, unnecessarily high administrative costs and excessive licenses or certificates to operate might reduce firms' incentives to produce innovations that need to access such markets to be successful.

However, regulation may also help create incentives to innovate as the prospect of future regulations could induce agents in engaging in innovation to preserve their competitive presence in the markets (Sanchez and Deza, 2015[49]). Innovation support policies include financial grants or tax breaks, capital investments, lowering costs to educate human resources, among others (Ezrachi and Stucke, 2022[32]).

Macroeconomic policy environment, including government's monetary and public expenditures, as well as taxation policies, can influence firm's plans for its innovation activities. Variables such as inflation rates and expectations, exchange rates and consumer demands are taken into account when defining whether to engage in an innovative project (OECD/Eurostat, 2018[8]). Geographical differences also play a role in this sense. A firm's location affects proximity to input and labour markets and determines the size of the demand it faces. While assets, input and skill sets needed for develop a new product depend on its characteristics and industry, inputs tend to be specific and technology-related, while human resources tend to be highly skilled. Moreover, knowledge spill overs also play a role as they bring together innovative actors and enable knowledge diffusion through faster and interactive learning (Boschma, 2005[50]).

Additionally, some aspects on social and natural environment that are generally linked to geographical differences, and which affect regulations and government policies, can also drive innovation. Consumers' preferences and behaviour, cultural characteristics, environmental aspects, formation of clusters of businesses and consumers, and the presence of other actors in the innovative processes, such as universities, can act either as boosters or as barriers to innovation (D'Este et al., 2012[51]).

3.5.1. Innovation policies

While governments are a relevant source of financing for innovation (as discussed in the section related to Access to finance), they can also provide a complete framework of innovation policies that involve indirect financial support on outputs of the innovation activity (such as reductions in taxes or subsidies on innovative products), as well as sponsor transfers of technology and knowledge or support through the adequate award of intellectual property rights (OECD, 2021[52]). These rewards to innovation efforts, in turn, boost companies' incentives to engage in such projects. Examples of these policies include easiness of doing business, targets of jurisdictions' GDP to be invested in R&D and policies on flows of knowledge between businesses, government and universities. Box 3.7 describes the European State aid Framework for research, development and innovation, one of the most relevant examples of recent innovation policies.

Box 3.7. EU State aid Framework for research, development and innovation

European Union Member States may grant State aid for research, development and innovation activities that may be considered compatible with the Internal Market. To do so, they have to follow the rules set by the European Commission State Aid Framework for research, development and innovation (2022 RDI Framework). It applies to all technologies, industries and sectors, guaranteeing competitive neutrality, and, since its last update in 2022, is aligned to the European Green Deal and the industrial and digital strategies. The rules ensure that aid is limited to what is necessary and does not lead to undue distortions of competition, in line with antitrust rules.

One of the reasons why the Framework was created was to facilitate R&D activities which would not occur in the absence of public support, acknowledging the role of public funding on innovation and on generating incentives to companies to conduct such activities.

In 2020, the European Commission published results on the evaluation of EU State aid rules. It found that, with respect to the RDI Framework, rules fit for purpose and while they needed to be aligned with more recent strategies, as highlighted before, it has served as an important tool to promote innovation and create links between industries, universities and other R&D institutions.

Source: European Commission C (2022) 7388. Communication on the Framework for State aid for research and development and innovation (2022).

Differences in innovation policies, including levels of public and private spending on R&D can also affect incentives to innovate, or at least, determine where innovations would take place (OECD/Eurostat, 2018[8]).

OECD countries, on average, spend 2.67% of their GDP on R&D,[12] but the dispersion is large enough that jurisdictions such as Israel and Korea spend close to 5% of their GDP, while others in Europe and Latin America spend less than 1%. Other sources of disparities between innovation policies relate to how this spending is used, what sectors are benefited and whether some of this funding has also been assigned to disseminating the research, improving technical skills of workforces and bringing the innovations to the market (Mazzucato, 2018[35]). Recent policies have been directly focused at fostering innovation and supporting R&D efforts in different industries, while having broader objectives, such as the green transition (see Box 3.8).

Box 3.8. The green transition – policies towards clean innovations

Taking urgent action to combat climate change is in the priorities list of countries around the world. The Paris Agreement, adopted by 296 parties at the UN Climate Change Conference requires governments to engage in action plans for an economic and social transformation based on the best available technologies. It recognises the need for long-term strategies involving capacity building and technological development and transfer. In the past decades, this has been the basis for policies in many jurisdictions, such as the United States and the European Union, focused on fostering innovation to achieve the green transition.

The US Inflation Reduction Act of 2022

For example, in 2022, the Government of the United States signed into law the Inflation Reduction Act, which marks one of the most significant actions taken by the country on investments towards clean energy and climate change. The Act includes strategies to accelerate private investments in clean energy solutions and emission reduction innovative technologies to be used in multiple sectors of the economy to strengthen supply chains in manufacturing, transport and other industries. The funds will be delivered through tax incentives, grants and loan guarantees. The objective of the Act is to reduce US greenhouse emissions by 40% below 2005 levels by 2030. The Act complements two other pieces of legislation passed since 2021 that seek to increase innovation activity and improve competitiveness and productivity of multiple sectors in the US economy. First, the Bipartisan Infrastructure Law focused on innovation projects in transportation, broadband and other types of infrastructure. Second, the Chips and Science Act, aimed at catalysing investment in R&D and commercialisation of leading-edge technologies, such as AI, clean energy and nanotechnologies.

The EU proposal for the creation of an EU Sovereignty Fund

During the past years, the EU has also developed an industrial policy focused on the green transition to meet international climate goals. To achieve those goals, it has aimed at directing funds to the development of new technologies and innovations that speed up the process to a low-carbon economy.

One example is the State aid Framework, described in Box 3.7, which sets out rules under which Member States can grant aid to companies for R&D activities. Another example is the EU Chips Act. It has as an objective to create a state-of-the-art European chip ecosystem by using EU budget to support R&D and production of these technologies, modifies State aid rules to facilitate investments in the area, and boosts industrial alliances to increase industrial capacity. Markets such as batteries, solar energy, semiconductors, and hydrogen have already benefited from green policy strategies.

More recently, in September 2022, the European Commission announced the creation of a European Sovereignty Fund and a Net Zero Industry Act to boost clean technologies. While details on the fund are still on the planning phase, the idea behind this new policy, which was also a reaction of the previously discussed US Inflation Reduction Act, is to invest significantly in the energy mix

transformation, develop next generation capacities and new alternatives for energy supply. The fund will be created to support projects of interest for EU sovereignty across any sector of the industrial spectrum, though, preserving the integrity of the single market and maintaining a level playing field in the markets.

Sources: US White House (2022). The Inflation Reduction Act Guidebook. Available at: https://www.whitehouse.gov/cleanenergy/inflation-reduction-act-guidebook/; European Commission (2022). Press release: A European Sovereignty Fund for an industry "Made in Europe" Available at: https://ec.europa.eu/commission/presscorner/detail/en/STATEMENT_22_5543.

Challenges arise for governments to effectively target policies to innovators who create value, offer sufficient support to bring such innovations to the markets and do it without unnecessarily distorting competition or innovation incentives (Ezrachi and Stucke, 2022[32]). In this context, advocacy efforts from competition authorities become relevant (see section on Future work).

3.5.2. Protection of innovation – intellectual property rights

IP protection is critical to fostering innovation (Coro, M. and Burtchaell, 2021[53]). Intellectual Property Rights (IPR) seek to promote innovation by striking a balance between protecting the inventor or creator's rights and fostering follow-on or cumulative developments. IPR grant inventors exclusive rights to exploit their inventions, gaining a competitive advantage during a certain period. In other words, IPRs compensate those who invest in innovation.

Patents, copyright and trade secrets, play an important role during the earlier R&D phases, when there is a high probability of competitors infringing on a company's innovative effort. Other IPR such as trademarks and designs come into play in the commercial phase of the innovation process, when products must be distinguished from those of competitors (EUIPO, 2021[54]).

For these reasons, by effectively protecting their intellectual property, companies can protect themselves and even secure more financing. Besides, IPRs can be used as strategies for innovative companies to generate more value from their innovations. Strategies to open up their IPRs for use by others, including their competitors, through licensing agreements or R&D joint activities could also generate incentives to engage in such innovations in the first place. Hence, the availability of a range of tools for an adequate protection of intellectual assets is of significance for companies when deciding on whether to innovate.

3.5.3. Collaboration

Different literature has also identified collaboration[13] as a key driver of innovation, both from a private and a public perspective[14]. Innovation is most often the result of interactions between actors from different levels and organisations and that communication has a positive impact on innovation levels (Damanpour, 1991[55]) and a growing number of R&D programmes are being carried out within different forms of partnerships (Chen and Yu, 2022[56]).

Collaboration can strengthen innovation at different stages of the process. First, defining and framing problems might be improved through different experiences and perspectives brought together. Second, generating innovative solutions might be enhanced by contrasting and challenging ideas to build on the solution while assessing risks ad gains. Third, implementation can be improved by using complementary assets and resources. And fourth, diffusion of the innovation can also be increased (Hartley, Sorensen and Torfing, 2013[57]). In these stages, both horizontal and vertical collaborations have a role to play.

For instance, collaboration in standards can influence the characteristics of future innovation and provide companies important sources of knowledge. Following specific standards, and being accredited for that, could give a company guarantee of success of future products and processes (Frenz and Lambert, 2014[58]). This, in turn, would affect its incentives in engaging in innovative projects.

In high-tech industries and other resource intensive ones, generating network effects and economies of scale and scope through collaborative process might also provide an important driver of innovation (Tidd and Bessant, 2009[59]); (Powell and Grodal, 2004[60]). For the diffusion of innovation, vertical information transfer and exchanges between the innovative firm and its suppliers and customers could increase the probability of success of the innovation, as it enhances the value-added capability of the firm. Moreover, cooperation with suppliers can help complement technological assets and save costs (Chen and Yu, 2022[56]).

However, collaboration in specific instances could reduce and distort competition, mainly if it involves cooperation agreements between direct or potential competitors, or agents belonging to the same value chain. Given the key role collaboration can play in generating incentives to innovate, and its potential harm to competition, the need for competition policy to draw clear lines between what companies can and cannot collaborate with each other is crucial (see section on Future work). One example of this distinction is the block exemptions regulations for horizontal R&D agreements done by the European Union (see Box 3.9). Analogous distinctions exist in competition provisions from other jurisdictions.

Box 3.9. Block exemptions in the EU – horizontal R&D agreements

The **Horizontal** Block Exemption Regulations in the EU (HBER) define certain R&D (R&D BER) and specialisation (Specialisation BER) agreements that can be considered more beneficial than harmful and are, therefore, allowed under antitrust rules (this is, exempted from the prohibition on Article 101 (1) TFEU).

For R&D agreements to be exempted, some conditions must apply, such as all parties having access to the final results of the R&D activities, including the know-how for its exploitation; combined market shares not exceeding 25% on the relevant markets; and the agreements not being hardcore restrictions of competition. The idea behind the exemptions is that such agreements help improving the production or distribution of goods or promote technical and economic progress, while allowing consumers a fair share of the resulting benefits and without eliminating competition.

Whenever none of the exemptions apply, because for instance parties surpass the market share thresholds, the agreements might still be assessed individually on their own merits to balance their anticompetitive effects to the pro-competitive ones and determine whether the efficiency conditions on Article 101 (3) are fulfilled:

1. The agreement must contribute to improving the production or distribution of goods or contribute to promoting technical or economic progress.
2. Consumers must receive a fair share of the resulting benefits.
3. The restrictions must be indispensable to the attainment of these objectives.
4. The agreement must not afford the parties the possibility of eliminating competition in respect of a substantial part of the products in question.

Note: An updated HBER is expected to be adopted by June 2023.
Source: Regulation EU No. 1217/2010 on the application of Article 101(3) of the Treaty on the Functioning of the European Union.

4 Future work

The activities of competition authorities are based on the premise that anti-competitive behaviour, that has the effect of restricting or lessening competition, is likely to hurt consumers. As competition impacts innovation outcomes, competition authorities understand the role their activities play to ensure that innovation processes can occur in well-functioning markets. The need to analyse innovation is not new for competition authorities, however, the most recent developments in the markets, such as the introduction of concepts like data-driven innovation, and the recognition of the relevance of innovation in such markets is what keeps the discussion live, as new considerations change the way innovation is taken into account.

In its advocacy activities, competition authorities traditionally advocate for open and contestable markets which provide incentives to, and allow for, innovation by both incumbents and entrants. In its enforcement proceedings, whilst competition authorities typically focus on actual or expected price effects, impacts on the ability and incentives to innovate can have much larger effects over time, including on prices (Gilbert, Riis and Riss, 2022[61]). Consequently, competition authorities may need to make a trade-off between negative short-term effects, such as price increases, and positive long-term effects, such as increased incentives to innovate (Bundeskartellamt, 2017[33]).

As there is no one-size-fits-all explanation of the magnitude and direction of the effect between a reduction in competition and subsequent incentives and abilities to innovate, competition authorities have had to evaluate, case-by-case, the effects of reduced competition on innovation and whether such effects compensate or not for the behaviour or transaction at hand. An important feature that is present in the analysis is that firms must undertake risky investments to develop innovations with an uncertain outcome. Aspects related to quality and choice for consumers have also been relevant in these assessments. In general, these elements have been considered assuming that competition encourages innovation, but also vice versa; that innovation may drive competition.

This happens because there seems to be a consensus that a properly enforced competition policy is beneficial to innovation. On one side, over-enforcement could lead to discourage innovation and harm long-term innovation dynamics, while, on the other, underenforcement could impede competition, which in turn might reduce incentives to innovate. Hence, the need for competition authorities to find the right balance in its assessments to help provide the business environment that allows firms to fulfil their competitive potential and develop their R&D projects with subsequent successful results.

There have been different approaches to innovation under competition law enforcement. When reviewing mergers and acquisitions or potentially anticompetitive behaviour, authorities have analysed innovation on existing product markets, in future product markets, and as an efficiency consideration.

For instance, in merger review, innovation has been considered a relevant factor by competition authorities when defining relevant markets, when assessing the effects of the transaction, as part of a theory of harm and as countervailing factor or an efficiency gain, and in the design of remedies.[15] These considerations, while on a case-by-case basis, have been done based on the economic principles of competition fostering innovation and innovation, while initially generating market power, intensifying competition post-merger, predominantly taking into account dynamic approaches. Given that the relationship between competition and innovation is complex, there are no presumptions that mergers between innovative firms or firms engaged in R&D are likely to diminish innovation (Shapiro, 2012[19]).

Similar to merger review, a review of co-operation agreements is sometimes needed for the competition authorities to determine their legality, since they might have ambiguous effects on both competition and innovation. While there are agreements whose clear objective is distorting competition through a restriction on innovation, and hence, are unlawful under competition rules, there are multiple forms of co-operation between market players that do not create or strengthen market power, raise barriers to entry or, in general, distort competition (OECD, Forthcoming[62]).

Innovation-based theories and the way competition authorities approach them in mergers can play a significant role in abuse of dominance investigations. There are different business practices that might be considered abusive, mostly exclusionary, as they imply delaying or eliminating innovation by rivals by the dominant firm. When considering impact on innovation of an abusive conduct, competition authorities are interested in determining whether the conduct that potentially had the effect of excluding a rival would end up benefiting consumers since it protected innovation of the dominant firm in the first place, or whether it would harm them as it retarded or deterred innovation from the excluded rival (Shapiro, 2012[19]).

Finally, procompetitive regulations can also play a key role in fostering innovation (OECD, Forthcoming[62]). As discussed previously (see section on Regulation and government policies), regulation is indeed a driver of innovation and can affect firms' incentives and abilities to do so, while public financing is one of the main sources for funding innovation projects. Competition authorities are well placed to provide advocacy advice in the design of measures to ensure that the role of the government and its measures are pro-competitive, especially in the long run (OECD, 2020[1]).

A future background note, which focuses the implications of the relationship between competition and innovation in competition enforcement will be presented and discussed in a subsequent Competition Committee meeting. A deeper analysis, therefore, is left for such future paper.

5 Conclusions

This paper revisited the ongoing debate on the relationship between competition and innovation. It reviewed the main factors that drive innovation, how competition interacts with such factors, and the ways in which it can impact innovation as a driver itself.

Understanding the impact of competition on innovation and vice versa is a key consideration when designing and implementing economic policy. However, the complexity of this interaction has led to a variety of findings, as both theoretical and empirical studies have discovered relationships in various directions, making the discussion far from reaching consensus. Moreover, some of the most breakthrough innovations have arisen in context where other policies had the lead role and the objectives pursued were not related to competition in or for a market.

Although literature has approached the relationship from different perspectives, it is commonly recognized that the effect of competition on innovation depends on whether the market is contestable, in the sense that innovators can successfully escape competition, and whether the innovation is appropriable, meaning that successful innovators can capture the benefit from innovation, at least temporarily.

The paper also addressed the relationship in the opposite direction, as innovation also changes competitive dynamics and structure of markets. A dynamic perspective is essential in the analysis since not only does competition have an impact on innovation, but successful innovation can also lead to escaping competition, ultimately having an impact on dynamics and structure of markets. Innovation can drive competitors out of those markets, block entry of new competitors, or change the business models for those who want to stay and compete as well as create markets for products that did not have one yet.

The paper identified and discussed many factors that drive innovation, such as firm-specific characteristics, differences in businesses models, the role of financing agents, network effects, among others. It also presented some external factors that generally affect the markets and are relevant for agents to decide whether to engage in innovative activities. This includes regulation, geographical considerations (including regulatory differences, location of clusters, and characteristics of the geographical markets) and collaboration. While these factors generally interact with competition, they provide a wider window for innovation to happen even when there is no competition at all or when competition is not a criterium to determine whether to engage or not in an innovation project.

In order to build and enforce competition policy that fosters innovation, it is important to recognise the different factors that affect innovation, including how competition interacts with such drivers. A future OECD Secretariat paper will deal with these issues. Particularly, how competition authorities should acknowledge that conduct and performance of firms, including their decisions on engaging in innovation, are impacted by competitive dynamics, as well as by other factors such as differences in business models and processes, the existence of ecosystem structures and the management decision-making (Petit and Teece, 2021[28]). Competition is intertwined with these aspects. When companies in competitive markets engage in innovation, market forces trigger all the benefits, meaning consumers' welfare and economic growth. Moreover, a sound competition policy that creates a level playing field also facilitates the entry of new players to the markets and the introduction of new products and processes and these innovations, in turn, also affect market structures. Scenarios where competition did not drive innovation might still benefit from the benefits of competition as once they reach the markets, increased competition could help the spread of such innovations.

For these reasons, the activities of competition authorities play a key role in fostering innovation. A discussion on recent developments on how they should include innovation considerations in their assessment of transactions or potential anticompetitive behaviours to reach such balance is needed.

Endnotes

[1] Including Merger review in emerging high innovation markets (2002); Competition, Patents and Innovation (in 2006 and 2009); Competition and innovation in financial markets (2015); The impact of disruptive innovation and competition law enforcement (2015); Disruptive innovations and their effect on competition (2015); Disruptive innovations in legal services (2016); Competition and innovation in land transport (2016); and Radical innovation in the electricity sector (2017). More recent roundtables such as Start-ups, Killer Acquisitions and Merger Control (2020) also included consideration on the assessment of innovation.

[2] See for instance (Cohen, 2010[63]) and (Gilbert, 2060[64]).

[3] Defensive patents refer to a strategy that some companies follow of obtaining patent protection without the intend of producing or commercialising products out of that patent. The main objectives of a defensive patent are to avoid infringement suits or to negotiate a cross-license to another patent.

[4] A comprehensive review of how to measure innovation, advantages and drawbacks of each indicator and recommendations for the collection of data can be found in OECD/Eurostat 2018.

[5] See the roundtables on Patents and Innovation (2006 and 2009), the Impact of Disruptive Innovation and Competition Law Enforcement (2015), and Disruptive Innovations and their Effect on Competition (2015).

[6] This means that competition is neither a necessary nor a sufficient condition for innovations to arise in the markets. See, for example, (Petit and Teece, 2021[28]). A discussion on the drivers of innovation can also be consulted in (EBRD, 2014[36]).

[7] This refers to the possibility of having specialised employees in areas such as marketing, pricing, commercial agents, among others that are relevant for selling a product in a market.

[8] See (Acharya et al., 2013[75]) and (Bernstein, Giroud and Townsend, 2016[76]).

[9] These factors have been well-recognised as determinants for accessing private equity and include both macro and microeconomic considerations. For instance, a Venture Capital and Private Equity Country Attractiveness Index produced by IESE and EMLYON Business Schools is built every year since 2006 based on macroeconomic factors, characteristics of the capital markets, entrepreneurial opportunities and environments, ease of doing business, among others.

[10] This refers to scenarios where risk was high enough for private venture capital to not invest. In the contrary, public venture capital has proven to be more willing to invest in these high-risk projects, with greater patience and lower expectations of future returns (Mazzucato, 2018[35]).

[11] Examples of these programmes are the EU Horizon Europe Work Programme 2023-2024 and Germany's innovation policy on Building Agility for Successful Transitions, based on the principle "From concept to market success", among many others. The OECD Reviews of Innovation Policy offer an assessment of the innovation systems of individual jurisdictions, focusing on the role of the government.

[12] OECD Main Science and Technology Indicators, Gross domestic spending on R&D as percentage of GDP in 2020.

[13] Collaboration understood as "*the process through which two or more actors engage in a constructive management of differences in order to define common problems and develop joint solutions based on provisional agreements that may coexist with disagreement and dissent*" (Hartley, Sorensen and Torfing, 2013[57]).

[14] See (Eggers and Singh, 2009[78]) and (Sorensen and Torfing, 2011[79]) for reviews related to drivers of public innovation and (Saunière and Leroyer, 2013[80]) for a discussion of collaboration in private innovation contexts.

[15] For example, a survey of US merger cases found that between 2004 and 2014, one-third of all merger challenges by US antitrust agencies have included allegations of harm to innovation (Gilbert and Green, 2015[87]).

References

Abbate, J. (1999), *Inventing the Internet*, MIT Press. [101]

Acharya, V. et al. (2013), "Corporate Governance and Value Creation: Evidence from Private Equity", *Review of Financial Studies*, Vol. 26/2, pp. 368-402. [75]

Aghion, P. et al. (2005), "Competition and innovation: An inverted- U relation", *Quarterly Journal of Economics*, Vol. 120, pp. 701–728. [17]

Barnett, J. (2021), *Startup Exit Strategies in the New Antitrust Era*. [25]

Bernstein, S., X. Giroud and R. Townsend (2016), "The Impact of Venture Capital Monitoring: Evidence from a Natural Experiment", *The Journal of Finance*, Vol. 71/4. [76]

Berubé, C., M. Duhamel and D. Ershov (2012), "Market incentives for business innovation: results from Canada.", *J Ind Compet Trade*, Vol. 12. [67]

Blackwood, P. and T. Ferguson (2022), "The Complete Guide to Acquihires", *Andreessen Horowitz*, https://a16z.com/2022/06/15/the-complete-guide-to-acquihires/ (accessed on March 2023). [98]

Blind, K. (2013), "The impact of standardization and standards on innovation", *Nesta Working Papers*, Vol. 15. [48]

Block, F. (2008), "Swimming against the Current: The Rise of a Hidden Develomental State in the United States", *Politics and Society*, Vol. 36/2, pp. 169-206. [102]

Blundell, R., R. Griffith and J. Van Reenen (1999), "Market Share, Market Value and Innovation in a Panel of British Manufacturing Firms.", *The Review of Economic Studies*, Vol. 66/3, pp. 529-554. [65]

Boschma, R. (2005), "Does geographical proximity favour innovation?", *Économie et Institutions*. [50]

Bower, J. and C. Christensen (1995), "Disruptive Technologies: Catching the Wave", *Harvard Business Review*, Vol. 43. [4]

Buccirossi, P. et al. (2013), "Competition Policy and Productivity Growth: An Empirical Assessment", *The Review of Economics and Statistics*, Vol. 95/4, pp. 1324-1336. [73]

Bundeskartellamt (2017), *Innovationen – Herausforderungen für die Kartellrechtspraxis [Innovations - challenges for antitrust law practice]. Conference of the working group on antitrust law, October 5.*. [33]

Bundeskartellamt (2016), *Working Paper on Market Power of Platforms and Networks. June 2016*. [40]

CDC (2023), *Influenza Historic Timeline*, https://www.cdc.gov/flu/pandemic-resources/pandemic-timeline-1930-and-beyond.htm#:~:text=1940s,produce%20most%20flu%20vaccines%20today. [108]

Chen, S. and D. Yu (2022), "Exploring the impact of external collaboration on firm growth capability: the mediating roles of R&D efforts", *Humanities and Social Sciences Communications*, Vol. 9/404. [56]

Cohen, W. (2010), *Fifty Years of Empirical Studies of Innovative Activity and Performance*, Elsevier. [63]

Coro, D., M. and L. Burtchaell (2021), *Managing intellectual property rights in innovation: the key to reaching the market*, https://www.wipo.int/wipo_magazine/en/2021/01/article_0009.html. [53]

Cunningham, C., F. Ederer and M. Song (2021), "Killer Acquisitions", *Journal of Political Economy*, Vol. 129/3, pp. 649-979. [85]

D'Este, P. et al. (2012), "What hampers innovation? Revealed barriers versus deterring barriers", *Research Policy*, Vol. 41/2, pp. 482-488. [51]

Damanpour, F. (1991), "Organizational Innovation: A Meta-Analysis of Effects of Determinants and Moderators", *Academy of Management Journal*, Vol. 34/3, pp. 555-590. [55]

Das, K. and A. Nikandrova (2021), "The Effect of Mergers on Innovation", *Oxford Abstracts*. [82]

Denicolò, V. and M. Polo (2018), "Duplicative research, mergers and innovation", *Economics Letters*, Vol. 16, pp. 56-59. [83]

EBRD (2014), *Transition Report: Innovation in Transition*, https://www.ebrd.com/news/publications/transition-report/transition-report-2014.html. [36]

Eggers, W. and S. Singh (2009), *The Public Innovator's Playbook: Burtirung Bold Ideas in Government*. [78]

EUIPO (2021), *Intellectual property rights and firm performance in the European Union*. [54]

European Commission (2016), *Competition Policy Briefs: EU merger control and innovation*, https://ec.europa.eu/competition/publications/cpb/2016/2016_001_en.pdf. [3]

Evans, P. and A. Gawer (2016), "The rise of the platform enterprise: A global survey", *The Emerging Platform Series No. 1 - The Center of Global Enterprise*. [41]

Ewens, M., R. Nanda and M. Rhodes-Kropf (2018), "Cost of Experimentation and the Evolution of Venture Capital", *Journal of Financial Economics*, Vol. 128/3, pp. 422–42. [45]

Ezrachi, A. and M. Stucke (2022), *How Big-Tech Barons Smash Innovation – and How to Strike Back*, Harper Collins Publishers. [32]

Federico, G., G. Langus and T. Valletti (2018), "A simple model of mergers and innovation", *Economics Letters*, Vol. 157, pp. 136-140. [84]

Federico, G., F. Scott Morton and C. Shapiro (2020), "Antitrust and Innovation: Welcoming and Protecting Disruption", *Innovation Policy and the Economy*, Vol. 20/1, pp. 125-190. [39]

Founders Network (2023), *Acquihire: Everything You Need to Know*, https://foundersnetwork.com/blog/what-is-acquihire/ (accessed on March 2023). [99]

Frenz, M. and R. Lambert (2014), "The economics of accreditation", *NCSLI Measure*, Vol. 9/2, pp. 42-50. [58]

Frésard, L. and G. Phillips (2022), "Product Markets, Competition and Corporate Finance: A Review and Directions for Future Research", *SSRN*, https://ssrn.com/abstract=4247331 or http://dx.doi.org/10.2139/ssrn.4247331. [11]

Ganglmair, B. et al. (2020), "Price Markups, Innovation, and Productivity: Evidence from Germany", *Bertelsmann Stiftung*. [68]

Gilbert, R. (2060), "Competition and Innovation", *Journal of Industrial Organization Education*, Vol. 1/1, pp. 1-23. [64]

Gilbert, R. and H. Green (2015), "Merging Innovation into Antitrust Agency Enforcement of the Clayton Act", *The George Wahington Law Review*, Vol. 83/6, pp. 1919-1947. [87]

Gilbert, R. and A. Melamed (2022), "Innovation: A Bridge to the New Brandeisians?", *Competition Policy International Columns*. [24]

Grassano, N. et al. (2020), *The 2020 EU Industrial R&D Investment Scoreboard*, Publication Office of the European Union. [10]

Griffith, R. and J. Reenen (2021), "Product Market Competition, Creative Destruction and Innovation", *EPR Discussion Paper* 16763. [18]

Griffith, R. and J. Van Reenen (2021), "Product market competition, creative destruction and innovation", *CEP Discussion Papers*, Vol. dp1818. [81]

Haltiwanger, J., R. Jarmin and J. Miranda (2010), "Who Creates Jobs? Small vs. Large vs. Young", *US Census Bureau Center for Economic Studies Paper No. CES-WP- 10-17*. [74]

Hartley, J., E. Sorensen and J. Torfing (2013), "Collaborative Innovation: A Viable Alternative to Market Competition and Organizational Entrepreneurship", *Public Administration Review*, Vol. 73/6, pp. 821-830. [57]

Hober, G., Y. Li and G. Phillips (2020), "Internet Access and U.S. - China Innovation Competition", *NBER*, Vol. Working Paper No. w28231. [70]

Kamien, M. and N. Schwartz (1975), "On the degree of rivalry for maximum innovative activity", *Quarterly Journal of Economics*, Vol. 90, pp. 245–260. [16]

Kerber, W. (2018), "Competition, Innovation, and Competition Law: Dissecting the Interplay", in *Dynamic Markets and Dynamic Enforcement - The impact of the digital revolution and globalisation on the enforcement of competition law in Europe*, Bruylant - Gerard, Damien (Ed.), pp. pp. 33-62. [34]

Kokkoris, I. and T. Valetti (2020), "Innovation Considerations in Horizontal Merger Control", *Journal of Antitrust Enforcement*, Vol. 16/2, pp. 220–261. [20]

Koltay, G., S. Lorincz and T. Valletti (2021), *Concentration and Competition: Evidence from Europe and Implications for Policy*, https://doi.org/10.2139/ssrn.39925. [109]

Lapante, S. et al. (2019), “Limits of tax regulation: Evidence from strategic R&D classification and the R&D tax credit”, *Journal of Accounting and Public Policy*, Vol. 38/2, pp. 89-105. [9]

Lee, K. and J. Yoo (2019), “How does open innovation lead competitive advantage? A dynamic capability view perspective”, *PLoS ONE*, Vol. 14/11. [29]

Lerner, J. and R. Nanda (2020), “Venture Capital’s Role in Financing Innovation: What We Know and How Much We Still Need to Learn”, *Journal of Economic Perspectives*, Vol. 34/3, pp. 237–261. [44]

Marshall, G. and Á. Parra (2019), “Innovation and competition: The role of the product market”, *International Journal of Industrial Organization*, Vol. 65, pp. 221-247. [94]

Martín-de Castro, G.; Delgado-Verde, M.; Navas-López, J.E.; Cruz-González, J. (2013), “The moderating role of innovation culture in the relationship between knowledge assets and product innovation”, *Technological Forecasting and Social Change*, Vol. 80/2, pp. 351-363. [27]

Mazzucato, M. (2018), *The Entrepreneurial State: Debunking public vs. private sector myths*, Penguin. [35]

Mohamed, T. (2020), *Markets Insider*, https://markets.businessinsider.com/news/stocks/airbnb-investor-sequoia-capital-bought-shares-1-cent-now-140-2020-12-1029885671. [97]

Monteil, A. (2020), *50 inventions you might not know were funded by the US government*, https://stacker.com/business-economy/50-inventions-you-might-not-know-were-funded-us-government. [77]

Nelson, R. (ed.) (1962), *Economic welfare and the allocation of resources for invention*. [13]

OECD (2021), *Science, Technology and Innovation Outlook 2021: Times of Crises and Opportunity*. [52]

OECD (2020), *Background Note on Start-ups, killer acquisitions and merger control*, https://www.oecd.org/competition/start-ups-killer-acquisitions-and-merger-control.htm. [86]

OECD (2020), *Start-ups, Killer Acquisitions and Merger Control*, https://www.oecd.org/daf/competition/start-ups-killer-acquisitions-and-merger-control-2020.pdf. [90]

OECD (2020), *The Role of Competition Policy in Promoting Economic Recovery*, https://www.oecd.org/daf/competition/role-of-competition-policy-in-promoting-economic-recovery.htm. [1]

OECD (2018), *Gun jumping and suspensory effects of merger notifications*, https://one.oecd.org/document/DAF/COMP(2018)11/en/pdf. [93]

OECD (2018), *Market Concentration*, https://one.oecd.org/document/DAF/COMP/WD(2018)46/en/pdf. [89]

OECD (2016), *Reference Guide on Ex-Post Evaluation of Competition Agencies’ Enforcement Decision*, https://www.oecd.org/daf/competition/Ref-guide-expost-evaluation-2016web.pdf. [91]

OECD (2015), *Background Note on Disruptive Innovation*, https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DAF/COMP(2015)3&docLanguage=En. [5]

OECD (2015), *Background Note on the impact of disruptive innovations on competition law enforcement*, https://www.oecd.org/competition/globalforum/disruptive-innovations-competition-law-enforcement.htm. [6]

OECD (2014), *Investigations of Consummated and Non-Notifiable Mergers*, https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DAF/COMP/WP3(2014)1&doclanguage=en. [88]

OECD (2011), *Impact Evaluation of Merger Decisions*, https://www.oecd.org/daf/competition/Impactevaluationofmergerdecisions2011.pdf. [92]

OECD (2009), *Innovation in Firms: A Microeconomic Perspective*, https://www.oecd.org/sti/inno/innovationinfirmsamicroeconomicperspective.htm. [37]

OECD (2006), *Background Note on Competition, Patents and Innovation*, https://www.oecd.org/daf/competition/39888509.pdf. [2]

OECD (Forthcoming), *Discussion Paper on Pro-competitive Policies for a Sustainable Economy*. [62]

OECD/Eurostat (2018), *Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition*, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris/Eurostat, Luxembourg, https://doi.org/10.1787/9789264304604-en. [8]

Østergaard, C., B. Timmermans and K. Kristinsson (2011), "Does a different view create something new? The effect of employee diversity on innovation", *Research Policy*, Vol. 40/3, pp. 500-509. [38]

Petit, N. and D. Teece (2021), "Innovating Big Tech firms and competition policy.", *Industrial and Corporate Change*, Vol. 30, pp. 1168-1198. [28]

Picard, J. and A. Beltran (1994), *D'où viens tu TGV?*, Revue Générale des Chemins de Fer, http://archivchemindefer.free.fr/dossierTGV/DouviensTGV.pdf. [103]

Poldahl, A. and P. Tingvall (2006), "Is there really an inverted U-shaped relation between competition and R&D?", *Economics of Innovation and New Technology*, Vol. 15/2, pp. 101-118. [66]

Powell, W. and S. Grodal (2004), "Networks of Innovators. In Oxford Handbook of Innovation", *Oxford University Press*. [60]

Prasetio, E. (2022), "Investigating the Influence of Network Effects on the Mechanism of Disruptive Innovation", *Journal of Open Innovation: Technology, Market, and Complexity*, Vol. 8/157. [42]

Raymond, W. and T. Plotnikova (2015), "How does firms' perceived competition affect technological innovation in Luxembourg?", *MERIT Working Papers*, Vol. 1. [72]

Reenen, F. (ed.) (2022), *Innovation, Antitrust Enforcement and the Inverted-U - The Economics of Creative Destruction*, Harvard University Press. [61]

Royal Museums Greenwich (2014), *Space Race Timeline*, https://www.rmg.co.uk/stories/topics/space-race-timeline. [106]

Sanchez, A. and X. Deza (2015), "Environmental policy instruments and Eco-Innovation: An Overview of Recent Studies", *Innovar: revista de ciencias administrativas y sociales*, Vol. 25/58. [49]

Saunière, J. and S. Leroyer (2013), *Collaborative innovation and intellectual property – Best practices*. [80]

Scherer, F. (1967), "Market structure and the employment of scientists and engineers", *American Economic Review*, Vol. 57, pp. 524–531. [15]

Schneider, C. and R. Veugelers (2010), "On Young Highly Innovative Companies: Why They Matter and How (Not) to Policy Support Them", *Industrial and Corporate Change*, Vol. 19/4, pp. 969-1007. [43]

Schumpeter, J. (1942), *Capitalism, Socialism and Democracy*, Harper and Brothers,. [14]

Segal, I. and M. Whinston (2007), "Antitrust in Innovative Industries", *The American Economic Review*, Vol. 97/5, pp. 1703-1730. [30]

Shapiro, C. (2012), "Competition and Innovation. Did Arrow Hit the Bull's Eye? In The Rate and Direction of Inventive Activity Revisited", *University of Chicago Press*. [19]

Shima, H. (1994), "Birth of the Shinkansen - A Memoir", *Japan Railway & Transport Review*. [104]

Smith, A. (1776), *An inquiry into the Nature and Causes of the Wealth of Nations*, Cadell, W. Strahan and T. [12]

Sorensen, E. and J. Torfing (2011), "Enhancing Collaborative Innovation in the Public Sector", *Administration & Society*, Vol. 43/8, pp. 842-868. [79]

Spence, C. (1975), "Monopoly, Quality and Regulation", *Bell Journal of Economics*, Vol. 6/2, pp. 417-429. [21]

Stephens, M. (2014), *NYU - History of Television*, https://stephens.hosting.nyu.edu/History%20of%20Television%20page.html#:~:text=Electronic%20television%20was%20first%20successfully,electricity%20until%20he%20was%2014. (accessed on March 2023). [95]

Storm (2023), *The Role of Venture Capital in Fintech Innovation*, https://storm2.com/resources/venture-capital/role-of-venture-capital-fintech-innovation/#:~:text=Provide%20funding%3A%20VC%20firms%20invest,experience%20in%20the%20FinTech%20industry. (accessed on March 2023). [96]

Superintendencia de Industria y Comercio (2019), "Competition policy and Industrial property: relationship through panel data approach 2007 – 2015.", Vol. 23. [69]

Teece, D. (2020), "Innovation, governance, and capabilities: implications for competition policy: A Tribute to Nobel Laureate Oliver Williamson", *Industrial and Corporate Change*, Vol. 29/5, pp. 1075-1099. [100]

Teece, D. (2013), "Next-Generation Competition: New Concepts for Understanding How Innovation Shapes Competition and Policy in the Digital Economy", *Journal of Law, Economics and Policy*, Vol. 9/1, pp. 97-118. [31]

Teece, D. (2007), “Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance”, *Strategic Management Journal*, Vol. 28/13, pp. 1319-1350. [23]

Thakor, R. and A. Lo (2022), “Competition and R&D Financing: Evidence from the Biopharmaceutical Industry”, *Journal of Financial and Quantitative Analysis*, Vol. 57/5, pp. 1885-1928. [71]

Tidd, J. and J. Bessant (2009), *Managing Innovation: Integrating Technological, Market and Organizational Change*, Willey. [59]

Tidd, J., J. Bessant and K. Pavitt (2007), *Managing Innovation: Implementing Technological, Market and Organizational Change*, Brno Computer Press. [26]

UEA, University of East Anglia (2021), *Competition and Innovation in Digital Markets*. [7]

UIC, U. (2015), *High-Speed Rail History*, https://uic.org/passenger/highspeed/article/high-speed-rail-history. [107]

Urbancová, H. (2013), “Competitive Advantage Achievement Through Innovation and Knowledge”, *Journal of Competitiveness*, Vol. 5/1, pp. 82-96. [46]

Van Reenen, J. (2019), *Can Innovation Policy Restore Inclusive Prosperity in America?*. [47]

Virginia, U. (ed.) (2023), *The Space Race*, https://millercenter.org/the-presidency/educational-resources/space-race. [105]

Wójcik, P. (2015), “Exploring Links Between Dynamic Capabilities Perspective and Resource-Based View: A Literature Overview”, *International Journal of Management and Economics*, Vol. 45/1, pp. 83-107. [22]

www.oecd.org/competition