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Quarterly R&I literature review 2020/Q4

Business, innovation and productivity



R&I PAPER SERIES
LITERATURE REVIEW



Research and
Innovation

Business, innovation and productivity

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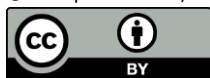
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Literature review

TABLE OF CONTENTS

INTRODUCTION.....	3
DECLINING BUSINESS DYNAMISM.....	4
COMPETITION AFTER COVID-19.....	5
INTANGIBLE CAPITAL AND PRODUCTIVITY.....	6
BUSINESS ENVIRONMENT REFORMS FOR INNOVATION.....	7
R&D AND KNOWLEDGE SPILLOVERS FOR PRODUCTIVITY.....	8
AI AND PRODUCTIVITY IN E-COMMERCE & FIN-TECH.....	9
INNOVATION POLICIES TO BOOST PRODUCTIVITY.....	10
VENTURE CAPITAL FOR INNOVATION.....	11
ADOPT OR INNOVATE FOR DECARBONISATION.....	12
THE ELASTICITY OF SCIENCE.....	13
REFERENCES.....	14

INTRODUCTION

This review is developed by the 'Economics of R&I' team of the Chief Economist unit of DG Research and Innovation. It provides a brief summary of a selection of recent publications on R&I economics and policy. Contributors: Lukas Borunsky, Ana Correia, Radka Fleglova, Ruzica Rakic (coordinator of the review), Julien Ravet (team leader).

This edition of the review includes recent papers linking businesses to research and innovation (R&I), with a focus on how R&I performance enhances productivity.

Business dynamism appears to be declining worldwide over the last years, and the COVID-19 crisis risks accelerating this trend (see also review 2020/Q2 and Q3). On the other hand, some superstar firms seem to have reached higher market shares during the pandemic, which has several implications, including for competition policy.

In this context, it is important to understand business dynamics related to productivity. Productivity is a fundamental driver of sustainable economic growth and prosperity. This review highlights the role of different factors that stimulate productivity growth: investments in intangibles, the complementarity between R&D and knowledge spillovers, and the adoption of digital technologies such as AI.

Policymakers have several instruments at their disposal to boost productivity, and a few ones are covered in this review. These are notably R&I instruments (direct R&D subsidies and indirect support through R&D tax incentives), human capital and skills policies and reforms of the business environment, which reach from taxation to customs and trade regulations. The role of venture capital as an important source for the financing of innovation, and the related constraints, should also be properly considered.

At the same time, spurring innovation should be done in the right direction. Mission-oriented policies contribute to addressing the challenges of our time. Evidence shows that initiatives like the European Carbon Market stimulated low-carbon patenting and R&D spending. However, changing direction could also generate switching costs, as examined in this review in the context of scientific research.



DECLINING BUSINESS DYNAMISM

Calvino, F., Criscuolo, C. and Verlhac, R. (2020). Declining business dynamism: structural and policy determinants. OECD Science, Technology and Innovation Policy Papers, No. 94.

Research funded from Horizon 2020 under grant No. 811181 (MapProdIGI).

Messages

1. Business dynamism is declining with different magnitude and speed across countries and sectors. 2. Various factors such as institutions and framework conditions are behind many of the observed differences. 3. Reforms reducing barriers to entrepreneurship or enhancing innovation potential and skills can help to limit these declines.

The authors present their recent research on trends in business dynamism over the last two decades, by using entry rates and job reallocation as the key indicators. Signs of declining dynamism are observed across different measures: entry rates, job reallocation, share of activity in young firms, etc.

Although declines in business dynamism have been pervasive in many countries, there is significant heterogeneity across them and these trends also differ across sectors. The analysis points to the fact that declines in business dynamism are driven by dynamics occurring at a sectoral level, rather than through reallocation across sectors.

Moreover, the paper looked at the main determinants of these declines and identified prominent role of market structure and firm heterogeneity. Other factors such as increasing investment in

intangibles, globalisation, and changes in demographics are also affecting this trend. The discussion section provides policy makers with possible actions to boost business dynamism, such as reducing barriers to entry and to knowledge diffusion, favouring experimentation and creative destruction, while increasing absorptive capacity and the potential of firms to benefit from technological change. It is expected that a joint policy action on the different areas analysed in the report could help firms to benefit from technological change.

This paper and many others were discussed during the EC-OECD Innovation and Growth Webinar Series. Available at: https://ec.europa.eu/info/events/ec-oecd-innovation-and-growth-webinars-2020_en



EC-OECD Innovation and Growth Webinar Series

October-December 2020



COMPETITION AFTER COVID-19

Rose, N. L. (2020). Will Competition Be Another COVID-19 Casualty? Policy Proposal 2020-13, The Hamilton Project.

Messages 1. In the United States, some 'superstar firms' have reached higher market shares during the pandemic. 2. To preserve competitive markets, competition and antitrust policy should assess the effects of the acceleration of this trend during and post-COVID. 3. This trend may also have implications for product and labour markets.

While some firms are struggling to remain financially healthy during this pandemic, others seem to have benefitted tremendously and are gaining even greater market shares.

The author calls for antitrust policy and agencies to preserve the benefits of competitive markets derived from the sanitary and economic crisis. In particular, the author mentions that this would entail "blocking anticompetitive mergers, (...), combatting exclusionary behaviour that disadvantages rivals" and keep an active and careful look to collusion behaviour. This is to ensure appropriate competition and adequate product markets.

Indeed, the paper points to the rise of very large firms measured both in absolute terms and as market shares, as well as the decreasing labour income shares. These have been largely covered by the literature. However, the author clarifies that these findings have not been clearly linked to shrinking competition in many markets, or insufficient action by antitrust and regulatory policy.

The growth of very large firms may well be linked to the higher productivity and efficiency gains and more value to consumers, while it is verified that employment intensity and labour income shares have declined. A central issue is then to assess whether those "winners" are expanding because of competition and innovation, or by "exclusionary behaviour, cartelization, or buying up rivals."

Another concern is the declining business dynamism, as new company birth rates have declined. As a result, this poses ultimately important questions for overall productivity and economic growth via potentially less 'creative destruction' in the economy.

Additionally, the paper reflects upon Big Tech getting bigger amidst the pandemic due to the move to an online personal and work life. This may have given them more network advantages that make it hard for new competitors to thrive. Finally, the author stresses the important role of antitrust regulators and enforcers to monitor developments and to be strong in preserving competition in markets.



INTANGIBLE CAPITAL AND PRODUCTIVITY

Kaus, W., Slavtchev, V. and Zimmermann, M. (2020). Intangible capital and productivity: Firm-level evidence from German manufacturing. IWH Discussion Papers, No. 1/2020.

Research funded from Horizon 2020 under grant No. 822390 (MICROPROD).

Messages 1. Investment in intangible assets increased over time. 2. Firms that invest more intensively in intangibles also tend to be more productive. 3. Data showed positive output elasticities for R&D and software investment, while mixed evidence for patent investment.

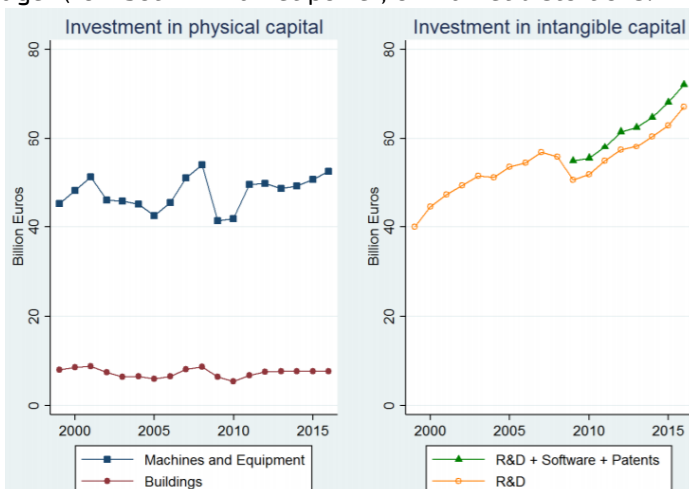
The authors analyse the importance of intangible capital (such as R&D, software and patents) for the measurement of firm productivity using data from German manufacturing. After description of development in intangible investment and its distribution across firms, the paper shows that on the aggregate level, intangible investment has increased over time and surpassed investment in machinery and equipment in recent years (see the graph).

However, the distribution of intangible investment, as well as physical investment, is very unbalanced with many firms investing nothing or little, while few others invest a lot. Consequently, the paper found that firms with higher intangible intensity are more productive on average (for both labour productivity and total factor productivity). Other findings concern other characteristics of low- and high-intangible intensity firms and distribution of investment within firms. The intangible investment shows a higher concentration in the year with higher investment, while physical capital seems

to be more spread over the observed periods.

When looking at more detail patterns, the paper found the effects of intangible capital to be heterogeneous across industries (within the manufacturing sector) and firms.

Furthermore, the paper estimated production functions with and without intangible capital and found that development (R&D) and, to a lesser extent, software and patent investment, have a positive effect on output. Nevertheless, more research is required to determine the role of the remaining factors, such as other forms of intangible capital (e.g. organization and branding capital), management quality, market power, or market distortions.



BUSINESS ENVIRONMENT REFORMS FOR INNOVATION

Gogokhia, T. and Berulava, G. (2020). Business environment reforms, innovation and firm productivity in transition economies. Eurasian Business Revie.

Messages 1. Business environment reforms in transition economies represent an important factor for firm’s development. 2. Reforms in the business regulatory environment reach from taxation to customs and trade regulations. 3. Other factors such as human capital or ICT investment can improve innovation performance and productivity growth.

The paper explores the role of business environment reforms in enhancing innovation and the productivity performance of individual firms across transition economies. The focus on transition countries is due to substantial disruptions in the business environment and market relevant institutions in these countries throughout the post-Communist transition period. The paper examines the link between business environment reforms, firm R&D, innovation and productivity performance within a unified structural model. This novel approach to measurement of business environment reforms is based on a business environment reforms index, which calculates difference between the aggregated mean scores for innovator and non-innovator firm (further differentiated by country and size of location). The paper determines better business environment in areas with smaller difference between the two groups.

The authors found a strong support for the impact of the business environment reforms index on the intensity of R&D and innovation as well as on labour productivity. Thus, this paper supports and complements earlier findings on the importance of R&D for innovation performance and on contributions of innovation to labour productivity.

However, the results showed that the impact on a firm’s performance differs across various dimensions of the business environment.



The main contribution of this study are the new empirical insights into the structural relationship between business environment reforms and the performance of firms in transition economies. Overall, the results suggest that business environment reforms represent an important external determinant of a firm’s innovative and productive performance in transition economies as they providing incentives for investing in knowledge, innovation activities that contribute to productivity. This further implies that business environment reforms enhancement across transition economies represent an important factor for a firm’s growth.

R&D AND KNOWLEDGE SPILLOVERS FOR PRODUCTIVITY

Audretsch, D. B. and Belitski, M. (2020). The role of R&D and knowledge spillovers in innovation and productivity. *European Economic Review*, Volume 123.

Messages 1. Complementarities between R&D and knowledge spillovers are strongly associated with firm productivity rather than firm innovation. 2. R&D is important for both innovation and productivity. 3. Knowledge spillovers are more important for firm productivity than R&D.

This paper investigated the relationship between investments in R&D, knowledge spillovers and three innovation strategies: 1. Firms that develop new products in-house (“make”); 2. Firms that imitate new products (“buy”); 3. Firms that co-create new products with external partners (“ally”).

It also looks at the effects of these three strategies as well as investments in R&D and knowledge spillovers on labor productivity in the UK. The authors use data of 9213 UK firms constructed from six consecutive waves of a community innovation survey (CIS) during 2002–2014.

The findings suggest that the internal R&D investment and knowledge spillovers are complementary for labor productivity. There was no

complementarity between R&D and knowledge spillovers in their relation to innovation strategies, while firms who aimed to buy or imitate innovation invested less in R&D in regions and industries where knowledge spillovers are high.

This study provides evidence that R&D and knowledge spillovers complement each other in boosting firm productivity. Furthermore, the likelihood to co-create innovation with other partners (ally) and to develop innovation internally (make) does not change with an increase in the size of internal R&D and knowledge spillovers. This finding demonstrates that internal and external knowledge may complement each other and support the development of new products within closed and open innovation models.

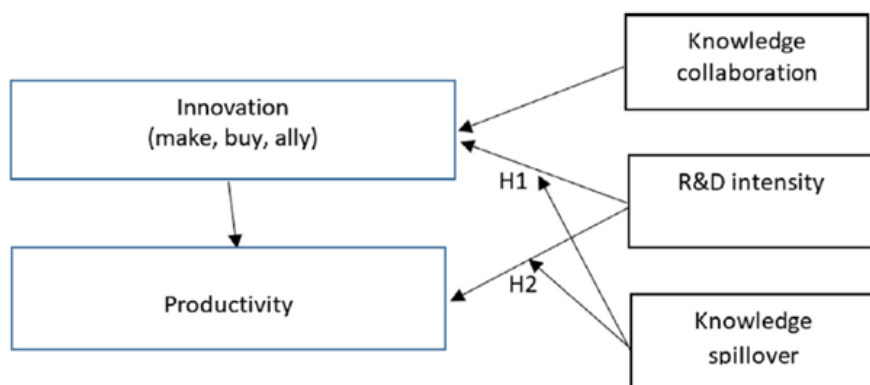


Fig. 1. The Knowledge-spillover augmented CDM model and research hypotheses.

AI AND PRODUCTIVITY IN E-COMMERCE & FIN-TECH

Bassetti, T., Borbon Galvez, Y., Del Sorbo, M. and Pavesi, F. (2020). Artificial Intelligence – impact on total factor productivity, ecommerce & fintech. EUR 30428 EN, Publications Office of the European Union, Luxembourg.

Messages

1. AI patents in e-commerce and fin-tech affect total factor productivity and wages at the firm level. 2. E-commerce and fin-tech firms achieve productivity gains through granted AI patents, which brings them closer to the technological frontier. 3. Firms that are currently lagging behind are most likely to adopt productivity-boosting AI technologies intensely.

The study explores the effect of artificial intelligence (AI) patents on company productivity gains with a specific focus on e-commerce and fin-tech sectors, which are extensively adopting AI and rapidly growing. The paper presents a preliminary analysis. However, it offers a starting point for assessing the future prospects of these technologies.

The authors evaluate the extent to which firms adopt AI and whether it positively affect productivity and wages by exploiting a novel data set of AI patents. This dataset consisted of AI and non-AI patent data and accounting data of firms across sectors and countries in the 2010-2016 period. By processing the data using the Tools for Innovation Monitoring, the authors compared the average firms with the e-commerce and fin-tech firms in

terms of granted AI patents and then analysed the impact of AI innovation on total factor productivity (TFP) in relation to wage growth.

The results indicate that AI patents have an impact on both TFP and wages. More specifically, the e-commerce and fin-tech firms, compared to other sectors, achieve productivity gains through granted AI patents, which bring them closer to the technological frontier. The analysis also proved that a part of the productivity gain from AI innovation is reflected in higher wage growth rates. Furthermore, the authors provide evidence that less productive firms invest more in productivity-improving AI technologies, in order to recover from their initial productivity gap. Successfully obtaining AI patents reduces the TFP gap. However, the analysis has shown that AI innovations have not yet impacted the more productive firms, which might change in the future with growing competition.

The findings are consistent with the previous research and can lead to policy implications concerning facilitation of AI technology adoption and encouraging a more competitive environment. Finally, the authors infer that AI does not necessarily contribute to labour reduction or labour substitution by capital.

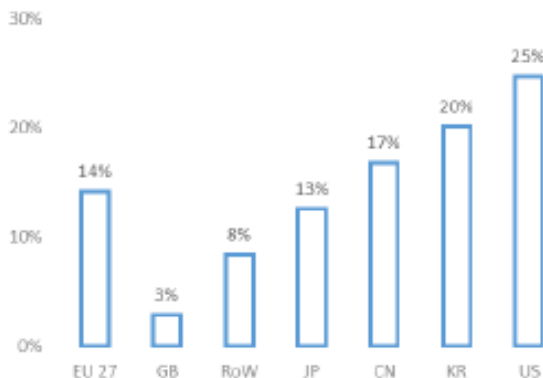


Figure 1. Share of firms with AI patenting activities by country

INNOVATION POLICIES TO BOOST PRODUCTIVITY

Van Reenen, J. (2020). *Innovation Policies to Boost Productivity. Policy Proposal 2020-13, The Hamilton Project.*

Messages 1. Demand-based policies (direct R&D grants and R&D tax incentives) are the most effective for increasing innovation in the short run. 2. Policies that increase the supply of human capital are more effective in the long run. 3. Mission-oriented policies are probably necessary to address the challenges of our time, such as climate change, clean water and air, as well as dealing with global pandemics and fighting cancer.

This paper discusses strengths and weaknesses of different innovation policies, such as tax incentives for R&D, government research grants, human capital policies for innovation, and competition and trade policies.

The author assesses the quality of currently available empirical evidence in terms of quality of papers and credibility of the evidence provided by those studies. In addition, time frame, impacts on inequality and the conclusiveness of evidence (i.e. how clear are the policy implications of the available findings) are also evaluated. The table below summarizes the findings.

Literature suggests positive effects of both **R&D tax credits** and **direct R&D grants** on R&D inputs and innovation outputs already in the short run. The quality of evidence is stronger for tax credits than for direct grants, but direct R&D grants seem to be slightly more cost effective, and it is easier to direct technological change with direct grants than it is with fiscal policies.

Among the **human capital policies**, **skilled immigration** has large effects in the short run and is inexpensive. Expanding **university STEM admissions**, combined with improved neighborhoods, better school quality, and greater **exposure to inventor role models** and mentoring could arguably increase innovation in the longer run.

Competition and trade policies have modest innovation benefits, but are inexpensive in financial terms. In general, greater competition and trade openness typically increase innovation.

Finally, the paper proposes a **mission-oriented innovation policy**, with a budget of \$100 billion per year (Grand Innovation Fund) to set up new technology hubs across the United States. The proposed distribution of this fund (column 4 in the table) represents a composite of the strength of the evidence as well as the magnitude of average effects.

Innovation Policy Menu

(1)	(2)	(3)	(4)	(5)	(6)
Policy	Quality of evidence	Conclusiveness of evidence	Suggested budget allocation	Time frame	Effect on inequality
Direct R&D grants	Medium	Medium	30%	Medium run	↑
R&D tax credits	High	High	25%	Medium run	↑
Skilled immigration	High	High	–	Short run	↓
Universities: STEM supply	Medium	Medium	20%	Long run	↓
Exposure policies	Medium	Low	25%	Long run	↓
Trade and competition	Medium	Low	0%	Medium run	↑

VENTURE CAPITAL FOR INNOVATION

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*, 34 (3): 237-61.

Messages 1. Venture capital is an important source for financing innovation 2. However, it has limitations: the strong focus of venture capitalists on software and service businesses, the concentration of VC investments by a few VC firms and investors, and a more “hands-off” behaviour of venture capitalists on corporate governance 3. The paper calls for a deeper reflection of the social welfare impact of VC and the direction of innovation.

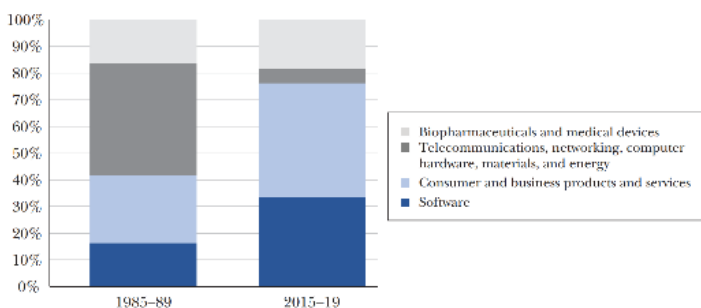
The paper discusses the evolution of the US venture capital industry using data from the National Venture Capital Association. It also analyses the role of venture capital in boosting innovation and the limitations that the current industry faces to generate higher societal impact.

The authors show that only a few (0.5%) firms that were venture-backed have a disproportionate role in the US economy. Moreover, in terms of characteristics, these firms are on average less labour intensive, reach higher market capitalization, and account for 89% of the surviving public firms. In particular, regarding the high R&D intensity of publicly-listed VC-backed firms, the authors add that this “relates to the role of VC in financing repeated waves of technological innovation such as the semiconductor revolution” or the Internet.

Another issue raised by the paper, is whether the current focus of VC

investments is socially optimal. Indeed, the authors show that once the internet era initiated in the US, venture capitalists shifted the focus of their investments towards software and consumer service businesses, in detriment of less investments in biopharmaceutical and health startups. This is because with software and consumer services it is in principle more likely that they will receive the return on their investment faster, while deep-tech innovations are more risky and may require a longer time span to be market ready. One of the identified obstacles is structural: VC investors raise funds for a specific (usually a ten-year) period. This short timeframe puts additional pressure for VCs to invest in sectors that offer faster commercialized solutions and “exit” opportunities for them to cash-in. As a result, considering the urgent clean energy and health challenges we face, there may be disconnect between VC investments and what would be socially optimal. Other important considerations include the concentration in VC investors,

Venture Capital Investment into US Startups between 1985 and 2019, by Sector



the geographical concentration of such investments, and a decline in recent years in promoting active corporate governance by VC funds.

ADOPT OR INNOVATE FOR DECARBONISATION

Calel, R. (2020). *Adopt or Innovate: Understanding Technological Responses to Cap-and-Trade*. *American Economic Journal: Economic Policy*, 12 (3): 170-201.

Messages 1. The European carbon market has encouraged low-carbon patenting and R&D spending among regulated firms. 2. These results are in contrast to the past cap-and-trade programs, which have primarily spurred adoption of existing abatement technologies, while barely stimulating innovation.

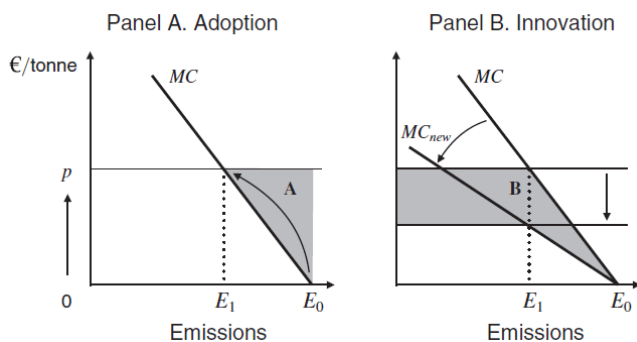
Historically, the cap-and-trade programs¹ have mostly led to the adoption of already existing technologies designed to reduce undesirable substances. Such programs barely led to the innovation of new technologies.

This paper analyses whether the [EU emissions trading system](#) (EU ETS) - the first and the biggest carbon market - would lead to the similar pattern by analyzing British firms. The author provides the most comprehensive firm-level database yet on three important measures of abatement technologies adoption and innovation: CO₂ intensity of production, low-carbon patenting, and low-carbon R&D expenditures. These measures provide the best picture so far of how firms have responded to the EU ETS.

The paper finds that under EU ETS, regulated firms have not widely adopted technologies that reduce their CO₂ intensity, but they have increased their low-carbon patenting and low-carbon R&D spending.

One explanation for this innovation activity could be that the EU ETS regulates carbon, a pollutant of relatively recent concern, whereas past programs addressed pollutants that have been targets of regulations for a long time. As a result, there are not enough low-carbon technologies that could be used.

Increased patenting and R&D indicate that new low-carbon technologies are being developed. These technologies are expected to decline abatement costs. Therefore, this could lead to the greater cost-savings from carbon markets than we have seen from previous cap-and-trade programs. This positive developments in the low-carbon technologies could lead to setting of more ambitious emissions caps in the future, which would give us better chance of avoiding the worst effects of climate change.



¹ Designed to regulate SO₂, NO_x, lead, and ozone-depleting substances.

THE ELASTICITY OF SCIENCE

Myers, K. (2020). *The Elasticity of Science*. *American Economic Journal: Applied Economics*, 12 (4): 103-34.

Messages 1. Inducing scientists to slightly change direction of their research requires substantial funding. 2. The additional costs of targeted research may be offset by more productive scientists pursuing targeted grants. 3. Recipients of targeted funding appear to revert to their original research direction eventually.

The theme of the article - the elasticity of science - reflects how costly it is to encourage changes in the direction of scientists' work in exchange for resources. Hence, the author assesses the degree to which scientists are willing to adjust their course of work by exploring scientists' responses to targeted funding opportunities.

The author concentrates on government intervention in the market of science and reactions of scientists. Furthermore, the paper examines the opportunities using a novel administrative dataset of targeted funding at the world's largest scientific agency, US National Institutes of Health, in 2006-2009 period. It offers three consequent analyses concerning: 1) scientists' entry decisions and elasticity estimates; 2) the difference between open and targeted grant opportunities in terms of the amount of funding; 3) the

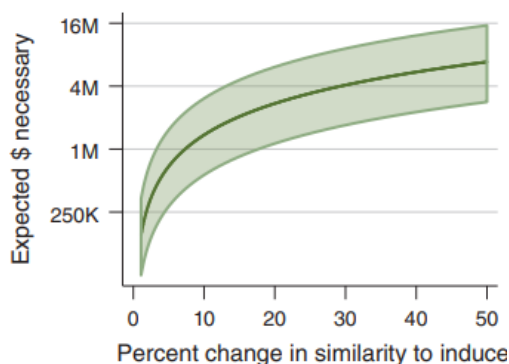
productivity related to targeted funding.

By measuring the "scientific similarity" between abstracts and research objectives, the author concludes that the scientists most responsive to targeted grants are already operating relatively close to the targeted topics. The switching costs to change research direction appear very large. However, the second analysis indicates that these costs can plausibly explain why the targeted funding grants tend to be larger than the open grant calls. Moreover, regarding productivity, the targeted grants lead to more publications than their open counterparts. Nevertheless, it appears to be caused by a specific composition of scientists and different types of science than the targeted grants fund. Thus, the additional costs of targeted research may be offset by more productive scientists pursuing these grants.

Additionally, although the targeted funding leads to new publications that match the original objectives, the recipients appear to return to their original research directions eventually. Hence, more sustained funding would be necessary to make changes to the long-term research direction.

The findings are relevant for both policymakers and managers, and also for spurring the debates over the optimal structure of grants.

Panel D. Costs of inducing redirections



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The “Quarterly R&I Literature Review” provides a brief summary of a selection of recent publications on R&I economics and policy.

The aim of the Review is to inform policymakers on the latest findings from the literature that links R&I economics to R&I policy.

This edition of the review includes recent papers linking businesses to research and innovation (R&I), with a focus on how R&I performance enhances productivity.

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Studies and reports

