



MONTHLY REVIEW OF ACADEMIC LITERATURE ON RESEARCH AND INNOVATION AS SOURCES OF GROWTH

Contact: DG RTD, Directorate A, A4, Diana Ognyanova, Tel. 69750, diana.ognyanova@ec.europa.eu

1. R&D and non-linear productivity growth

Kancs d'A, Siliverstovs B (2016). R&D and non-linear productivity growth. *Research Policy* 45(3): 634-646.

- The paper studies the relationship between R&D investment and productivity growth by modelling non-linearity in the relationship.
- Two firm-level panel data sets for OECD countries are matched: ORBIS and SCOREBOARD.
- The impact of R&D investment on firm productivity differs at different levels of R&D intensity.
- Higher R&D investment leads to higher elasticity and higher per-unit returns.

The paper studies the relationship between R&D investment and firm productivity growth by explicitly modelling non-linearities in the R&D–productivity relationship. The authors employ a two step estimation approach, and match two firm-level data sets, ORBIS and SCOREBOARD, for OECD countries, which allows them to relax the linearity assumption of the Griliches (1979) knowledge capital model. The results suggest that: (i) R&D investment increases firm productivity with an average elasticity of 0.15; (ii) the impact of R&D investment on firm productivity is different at different levels of R&D intensity at the firm level – the productivity elasticity ranges from -0.02 for low levels of R&D intensity to 0.33 for high levels of R&D intensity implying that the relationship between R&D expenditures and productivity growth is highly non-linear, and only after a certain critical mass of knowledge is accumulated, is productivity growth significantly positive; (iii) there are important inter-sectoral differences with respect to R&D investment and firm productivity—firms in high-tech sectors not only invest more in R&D, but also achieve more in terms of productivity gains related to research activities.

2. The impact of R&D subsidies on firm innovation

Bronzini R, Piselli P (2016). The impact of R&D subsidies on firm innovation. *Research Policy* 45(2): 442–457.

- This paper evaluates the impact of an R&D subsidy program implemented in Italy on firm innovation.
- It finds that the program had a significant impact on the number of patent applications.
- It finds a positive effect on the likelihood of applying for a patent, but only for small firms.
- One additional patent application requires grants of between €206,000 and €310,000.

This paper evaluates the impact of an R&D subsidy program implemented in a region of northern Italy in the early 2000s on innovation by beneficiary firms. The authors use a regression discontinuity design strategy to assess the effect of the grants on the number of patent applications and the likelihood of submissions by subsidized firms. The study finds that the program had a significant impact on the number of patent applications, more markedly in the case of smaller firms. The results also show that the program was successful in increasing the likelihood

of applying for a patent, but only for smaller firms. The estimates show that one additional patent application requires grants of between €206,000 and €310,000 to the firms.

3. Differential effects of intellectual property rights on innovation and economic performance: A cross-industry investigation

Cho K, Kim C, Shin J (2016). Differential effects of intellectual property rights on innovation and economic performance: A cross-industry investigation. *Science and Public Policy* 42(6):827-840.

- The study explores the relationship between intellectual property rights (IPR) protection, innovation and economic growth.
- It finds that causal paths vary not only by industry but also by firm size.
- Stronger IPR are beneficial to R&D-intensive industries where large domestic firms have strong R&D and IPR capabilities and detrimental to industries and to SMEs characterised by limited resources.
- To boost innovation and economic growth, IPR policies need to be customised to industries as well as SMEs.

Despite many previous studies, the causal relationship between intellectual property rights (IPR) protection, innovation and economic growth remains ambiguous. Using firm-level panel data in semiconductor, pharmaceutical and shipbuilding industries in Korea, the authors find that effective causal paths vary not only by industry but also by firm size. Stronger IPR are beneficial to R&D-intensive industries where large domestic firms have strong R&D and IPR capabilities, but have no impact on globalised industries. On the other hand, stronger IPR are detrimental to industries and to small and medium enterprises (SMEs) characterised by limited resources. Thus, to boost innovation and economic growth, IPR policies need to be customised to industries as well as SMEs. Universally strong IPR policies are likely to discourage innovation and growth, causing some industries to suffer.

4. Chinese university governance: Tensions and reforms

Serger S S, Benner M, Liu L (2015). Chinese university governance: Tensions and reforms. *Science and Public Policy* 42(6):871-886.

- The paper explores the transformation of Chinese universities:
 - dramatic increase in the number of universities and students
 - shift from primarily providing education to emphasising research
 - stronger academic self-organisation
- The result so far is a growing stratification of Chinese universities, with a few select research universities receiving the bulk of government research funding.
- The rapidly changing landscape with conflicting relations between political control and self-organisation, has given rise to tensions.
- The authors identify these tensions and discuss their implications for China's quest to establish world-class universities and to achieve the transition to an innovation-oriented nation.

The paper explores the transformation of Chinese universities. Chinese universities have undergone a massive transformation in recent decades. In addition to a dramatic increase in the number of universities and students, universities have shifted from primarily providing education to emphasising research. Furthermore, omnipresent political control is to be replaced by stronger academic self-organisation. The result so far is a growing stratification of Chinese universities, with a few select research universities receiving the bulk of government research funding and a large number of universities with very little public funding for research which focus primarily on education. The rapidly changing landscape, with growing numbers but also increasing stratification and with conflicting relations between political control and self-organisation, has given rise to tensions within universities and within the higher education system. The authors identify these tensions and discuss their implications for China's quest to establish world-class universities and to achieve the transition to an innovation-oriented nation.

5. International mobility: Findings from a survey of researchers in the EU

Børing P, Flanagan K, Gagliardi D, Kaloudis A, Karakasidou A (2015). International mobility: Findings from a survey of researchers in the EU. *Science and Public Policy* 42(6):811-826.

- The study analyses survey data on the mobility experience of researchers in the EU.
- It finds that 57% of university respondents and 65% of institute respondents have experienced international mobility at least once in their careers.
- Research visits are the most commonly experienced form of international mobility but job migration is also common.
- International student mobility and industrial placement experience are good predictors of subsequent mobility during the research career.

International mobility of researchers is increasingly constructed both as a science policy problem to be solved and as a goal to be pursued. Yet evidence on the experience of mobility and the factors associated with propensity to mobility remains patchy. The authors analyse comprehensive survey data on the mobility experience of university and non-university research institute researchers in the EU. They find that 57% of university respondents and 65% of institute respondents have experienced international mobility at least once in their research careers. Research visits are the most commonly experienced form of international mobility but job migration (cross-country changes of employer) is also surprisingly common. International student mobility, and also industrial placement experience, seems to be a good predictor of subsequent mobility during the research career.

6. Agency models in different stages of CEO tenure: The effects of stock options and board independence on R&D investment

Zona F (2016). Agency models in different stages of CEO tenure: The effects of stock options and board independence on R&D investment. *Research Policy* 45(2):560-575.

- The study examines how R&D investment is shaped by corporate governance devices.
- Early in CEO tenure, R&D investment is reduced by stock options and board independence, whereas in later stages these effects reverse.
- The study implies that R&D investment can be enhanced by setting rules and standards of good governance that take into account CEO time in office.

This study examines how R&D investment is shaped by corporate governance devices. Combining the two agency models of limited competence and managerial opportunism, it suggests that governance devices exert differing effects, in early vs. later stages of CEO tenure. Early in CEO tenure, R&D investment is reduced by stock options and board independence, whereas in later stages these effects reverse: R&D investment is enhanced by stock options and board independence. Board independence refers to the degree to which board configuration favors an independent assessment of the CEO's proposals, and encompasses CEO duality and outsider ratio. CEO duality means that the CEO is also the chair of the board. Outsider ratio refers to the proportion of independent directors on the board, that is, directors whose only tie with the CEO/organisation is the directorship. An empirical test on a sample of U.S. companies provides support for the hypothesised effects. For policy makers, this study implies that R&D investment can be enhanced by setting rules and standards of good governance that take into account CEO time in office and firm context.

7. Does it pay to stand on the shoulders of giants? An analysis of the inventions of star inventors in the biotechnology sector

Hohberger J (2016). Does it pay to stand on the shoulders of giants? An analysis of the inventions of star inventors in the biotechnology sector. *Research Policy* 45(3):682-698.

- The paper investigates the extent to which star inventors influence the value of subsequent inventions in the biotechnology sector.
- Building on the inventions of stars is positively related to invention performance.
- However, stars are not better than non-stars at building upon earlier star inventions.
- Stars building upon their own ideas negatively affects invention value.

Previous research has highlighted the importance of star inventors for invention success and firm performance. However, there is limited knowledge regarding the indirect influence of star inventors on knowledge generation and how the ideas of star inventors influence subsequent invention performance. Therefore, this study uses biotechnology patents to investigate the extent to which star inventors influence the value of subsequent inventions. It explores whether non-star inventors can build, just as successfully, on the ideas of star inventors as star inventors. The results show that having a star directly involved in the generation of an invention, and building upon other star invention/s, is positively related to invention performance. However, stars are not better than non-stars at building upon earlier star inventions, and in fact, stars building upon their own, previous, inventions negatively affects the outcome/s of their future inventions. Furthermore, these results hold true for both general and high-value inventions. Overall, this study highlights the importance of stars in cumulative knowledge generation, but also shows the limits of self-referencing and individual path-dependency.

8. Reverse international knowledge transfer in the MNE: (Where) does affiliate performance boost parent performance?

Driffield N, Love J H, Yang Y (2006). Reverse international knowledge transfer in the MNE: (Where) does affiliate performance boost parent performance? *Research Policy* 45(2):491-506.

- The study links effective technology sourcing to firm performance.
- It finds evidence of enhanced parent productivity as a result of their affiliates' performance.
- Both physical and strategic location affects the affiliate-parent relationship.
- Distance reduces the positive impact that affiliate performance has on that of the parent.

The paper examines the extent to which the knowledge or technological capability of foreign affiliates actually enhances the performance of their parent companies. The results draw on a firm-level panel of more than 1600 multinationals and more than 4000 of their overseas affiliates, covering 46 home and host countries. The study finds considerable evidence of enhanced parent productivity as a result of their affiliates' performance, which the authors interpret as evidence of reverse knowledge transfer from affiliates to parents. This effect is robust to different tests including IV estimation and a falsification exercise based on unconnected 'matched' affiliates. The authors find that both physical and strategic location markedly affects the affiliate-parent relationship, and that distance reduces the positive impact that affiliate performance has on that of the parent.

9. Mixing and matching research and innovation policies in EU countries

Veugelers R (2015). Mixing and matching research and innovation policies in EU countries. *Bruegel Working Paper 2015/2016*.

http://bruegel.org/wp-content/uploads/2015/12/WP-2015_16.pdf

- The paper assesses whether the mix of innovation policy instruments in EU countries matches their innovation capacity.
- It finds a relative homogeneity of policy mixes in EU countries, despite wide and stable differences in innovation capacities.
- It provides a rationale for a more comprehensive review of innovation policy mixes to assess their adequacy in addressing country-specific innovation challenges.

The paper examines EU Member States' research and innovation policies and assesses whether the deployment of innovation policy instruments in EU countries matches their innovation capacity relative to other EU countries. Based on Erawatch/TrendChart data (which excludes institutional funding), the paper finds that all member states spend most of their programmed innovation budget on a six-pack of instruments including competitive public research funding, collaborative RDI programmes, direct business support for R&D, direct support for innovation, loans for firms and tax incentives. The paper finds a relative homogeneity of policy mixes in EU countries, despite the fairly wide and stable differences in their innovation capacities. The analysis therefore provides a rationale for a more comprehensive review of innovation policy mixes to assess their adequacy in addressing country-specific innovation challenges.

10. The Fourth Industrial Revolution

Schwab K (2016). *The Fourth Industrial Revolution*.

In his book K. Schwab argues that we stand on the brink of a technological revolution that will fundamentally alter the way we live, work, and relate to one another. The Fourth Industrial Revolution is characterised by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres. There are three reasons why today's transformations represent not merely a prolongation of the Third Industrial Revolution but rather the arrival of a Fourth and distinct one: velocity, scope, and systems impact. The speed of current breakthroughs has no historical precedent. When compared with previous industrial revolutions, the Fourth is evolving at an exponential rather than a linear pace. Moreover, it is disrupting almost every industry in every country. And the breadth and depth of these changes herald the transformation of entire systems of production, management, and governance.

The possibilities of billions of people connected by mobile devices, with unprecedented processing power, storage capacity, and access to knowledge, are unlimited, K. Schwab claims. And these possibilities will be multiplied by emerging technology breakthroughs in fields such as artificial intelligence, robotics, the Internet of Things, autonomous vehicles, 3-D printing, nanotechnology, biotechnology, materials science, energy storage, and quantum computing.

K.Schwab claims that the changes are so profound that, from the perspective of human history, there has never been a time of greater promise or potential peril. He spells out some of those perils: the unequal division of the spoils of technological advances, the disruption of labour markets and the threat of unemployment; the erosion of global governance; the potential abuse of robotics, genetic engineering and cyber weapons; the disruption of many established businesses. However, promise can ultimately triumph over peril. The Fourth Industrial Revolution can empower the economically excluded of the world by giving them access to digital networks, it can increase the efficiency of organisations, accelerate the development of personalised drugs and — perhaps — provide a technological solution to climate change.

Shaping the Fourth Industrial Revolution is necessary to ensure that it is empowering and human-centred, rather than divisive and dehumanizing. The fundamental and global nature of this revolution means it will affect and be influenced by all countries, economies, sectors and people. It is, therefore, critical that attention and energy is put in multistakeholder cooperation across academic, social, political, national and industry boundaries.