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

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### 1. A macroeconomic analysis of the returns to public R&D investments

van Elk R, Verspagen B, ter Weel B, van der Wiel K, Wouterse B (2015). A macroeconomic analysis of the returns to public R&D investments. CPB Discussion Paper 313.

- This paper analyses the economic returns to public R&D investments in 22 OECD countries.
- It uses a broad variety of models to assess the the impact of of public R&D spending on economic growth and productivity.
- The estimated returns to public R&D investments are not unambiguously positive, i.e. public R&D investments do not automatically foster GDP and TFP growth.
- The relationship between public R&D and economic performance is highly country-specific, and only models that allow for heterogeneity across countries provide positive and statistically significant estimates of the rates of return.
- The relationship between scientific research and economic growth is indirect and long term, and the underlying mechanism involves many complex interactions with other relevant actors in the innovation system.

This paper analyses the economic returns to public R&D investments in 22 OECD countries. The study exploits a dataset containing time-series from 1963 to 2011 and estimates and compares the outcomes of different types of production function models. Robustness analyses are performed to test the sensitivity of the outcomes for particular model specifications, sample selections, assumptions with respect to the construction of R&D stocks, and variable definitions. Analyses based on Cobb-Douglas and translog production functions mostly yield statistically insignificant or negative returns. In these models the authors control for private and foreign R&D investments and the primary production factors. Models including additional controls, such as public capital, the stock of inward and outward foreign direct investment, and the shares of high-tech imports and exports, yield more positive returns. The findings suggest that public R&D investments do not automatically foster GDP and TFP growth. The economic return to scientific research seems to depend on the specific national context, in which institutions and government policies play an important role. Therefore, complementary research on optimal ways of spending public funds is needed. Microeconomic evaluations can provide insights into the effectiveness of specific institutions or science policy measures. However, as micro studies are also often focused on a narrow context that makes it difficult to capture the full effects of public R&D, studying knowledge networks is of interest too because of the importance of spillovers for the economic impact of public efforts to foster economic development. Finally, the authors argues that the societal value of scientific research is broader than its economic value in terms of growth or productivity, as a large fraction of public R&D spending is not specifically targeted at direct productivity improvement. Medical research, for example, can enhance health outcomes without directly affecting economic growth. In addition, much of the basic research performed at universities and public institutions is at best only indirectly related to long run economic growth. Therefore, it is difficult to identify the return to public R&D only by macro-economic approaches.

## 2. Research assessment in the UK and Italy: Costly and difficult, but probably worth it (at least for a while)

Geuna A, Piolatto M (2015). Research assessment in the UK and Italy: Costly and difficult, but probably worth it (at least for a while). *Research Policy*. 45(1):260-271

- This paper provides a comparative analysis of the development of the UK and Italian university research funding systems with a special focus on Peer Review-Based Research Assessment and its cost.
- Peer review-based research assessment funding systems are complex and difficult to implement.
- Research funding allocation via research assessment-like methods is costly when based on peer review (costs increase going from metrics to PRBRA to Research Council allocation), and as such might not be advisable for small countries.
- Performance-based allocation systems are much easier to introduce during a period of expansion in total public funding.

This paper provides a comparative analysis of the development of the UK and Italian university research funding systems with a special focus on Peer Review-Based Research Assessment (PRBRA) and its cost. Much of the debate surrounding the value of performance-based allocation systems hinges on the disadvantages versus the benefits of their implementation, and there is very little evidence on either their absolute cost or their cost relative to other allocation systems. The objective of the study is to fill this gap, collating the best possible estimates of the costs of alternative research funding methods to inform the ongoing policy debate. First, the paper compares funding in the UK and Italy during the period 2005–2012 and analyzes the development of performance-based allocation in the two systems. Second, based on public reports and documents collected from universities, the study discusses the public agency and university costs of the UK RAE2008 (Research Assessment Exercise) and REF2014 (Research Excellence Framework) and provides some estimates for the Italian VQR2012 (Valutazione della Qualità della Ricerca). The authors find that RAE2008 costs accounted for less than 1% of the total performance allocation in the related period while the VQR2012 efficiency ratio is estimated at around 2.5%. Finally, the authors compare the costs and efficiency ratios of PRBRA with metrics-based assessment and Research Council allocations and show that costs increase going from metrics to PRBRA to Research Council allocation.

## 3. Does going public affect innovation?

Bernstein S (2015). Does going public affect innovation? *The Journal of Finance*. 70(4)1365–1403

- This paper investigates the effects of going public on innovation.
- The quality of internal innovation declines following the IPO and firms experience both an exodus of skilled inventors and a decline in productivity of remaining inventors.
- However, due to increased access to capital, IPO firms can rely on acquisition of technologies as a source of external innovation and can attract new human capital.
- Going public changes firms' strategies in pursuing innovation.

This paper investigates the effects of going public on innovation by comparing the innovation activity of firms that go public with firms that withdraw their initial public offering (IPO) filing and remain private. NASDAQ fluctuations during the bookbuilding phase are used as an instrument for IPO completion. Using patent-based metrics, the author finds that the quality of internal innovation declines following the IPO, and firms experience both an exodus of skilled inventors and a decline in the productivity of the remaining inventors. However, public firms attract new human capital and acquire external innovation. The analysis reveals that going public changes firms' strategies in pursuing innovation.

## 4. Financing constraints, R&D investments and innovative performances: new empirical evidence at the firm level for Europe

Hall B H, Moncada-Paternò-Castello P, Montresor S, Vezzani A (2015). Financing constraints, R&D investments and innovative performances: new empirical evidence at the firm level for Europe. *Economics of Innovation and New Technology*.

- Financing constraints affect the level of R&D investment by European firms negatively, especially if they are more technology intensive and/or smaller.
- Uncertainty in the macroeconomic environment and the availability of bank lending which has been constrained by the financial crisis affect R&D investments negatively.
- Higher quality firms (proxied as higher TFP, exporting and more technology oriented) are able to maintain their activities and productivity in the presence of economic downturns.
- Financial constraints are the most important barriers, although an inability to find qualified personnel and information about innovation also form obstacles for the more productive firms.

The relationship between financing constraints, investments in research and development (R&D) and innovative performances has recently attracted renewed attention in the aftermath of a financial crisis that has led to problems of access to the credit on which innovation activities crucially rely. In spite of past developments in the theoretical analysis and in the data and methodologies for empirical investigation, some issues have remained unexplored to date. This paper reviews the contribution of selected papers, which provide new conceptualisations and empirical evidence at the firm level for Europe. Most previous research results, which were mainly based on extending models of financing constraints and physical investments to R&D investments, are confirmed, while new insights about this relationship are uncovered, in terms of the structural characteristics of the constrained firms, of the industries in which they operate, of their innovative activities and of the innovation outcomes they achieve.

## 5. Acquisitions of start-ups by incumbent businesses: A market selection process of “high-quality” entrants?

Andersson M, Xiao J (2015). Acquisitions of start-ups by incumbent businesses: A market selection process of “high-quality” entrants? *Research Policy* 45(1):272-290.

- The paper analyzes the frequency and nature by which new firms are acquired by established businesses.
- Acquisitions primarily concern new technology-based firms in market contexts where entry costs are large, access to finance is important and incumbents have complementary assets and resources.
- Spin-offs with strong technological profiles, weak internal financial resources, which operate in hightech sectors, are more likely to be acquired.

The paper analyzes the frequency and nature by which new firms are acquired by established businesses. Acquisitions are often considered to reflect a technology transfer process and to also constitute one way in which a “symbiosis” between new technology-based firms (NTBFs) and established businesses is realized. Using a micro-level dataset for Sweden in which the authors follow new entrants up to 18 years after entry, the paper shows that acquisitions of recent start-ups are rare and restricted to a small group of entrants with defining characteristics. Estimates from competing risks models show that acquired start-ups, in particular by multinational enterprises (MNEs), stand out from entrants that either remain independent or exit by being much more likely to be spin-offs operating in high-tech sectors, having strong technological competence, and having weak internal financial resources. The overall findings of the study support the argument that acquisitions primarily concern NTBFs in market contexts where entry costs are large, access to finance is important and incumbents have valuable complementary capabilities and resources.

## 6. Technological diversification, core-technology competence, and firm growth

Kim J, Lee C-Y, Cho Y (2015). Technological diversification, core-technology competence, and firm growth. *Research Policy* 45(1):113-124.

- This paper investigates the relationship between technological diversification and firm growth and the moderating role of core-technology competence in the relationship.
- Technological diversification has an inverted U-shaped relationship with firm growth.
- Core-technology competence moderates the relationship, by attenuating the harmful effect of excessive technological diversification.
- In case of unrelated technological diversification, the inverted U-shaped relationship weakens substantially for firms with high core-technology competence.

This paper investigates, using a unique panel dataset of Korean manufacturing firms, the relationship between technological diversification and firm growth and the conditioning role of firm-specific core-technology competence in the relationship. First, the relationship is inverted U-shaped regardless of the type of technological diversification, implying that both insufficient and excessive technological diversifications are harmful for firm growth. Second, the level of competence in the field of core technology conditions the relationship by attenuating the harmful effect of excessive technological diversification. Furthermore, in case of unrelated technological diversification, the inverted U-shaped relationship weakens substantially for firms with high core-technology competence. These results suggest that sufficient core-technology competence is needed for firms to effectively manage and utilize technological diversification, particularly unrelated one, for their growth.

## 7. Science and Technology Parks and cooperation for innovation: Empirical evidence from Spain

Vásquez-Urriago A R, Barge-Gilb A, Ricoa A M (2015). Science and Technology Parks and cooperation for innovation: Empirical evidence from Spain. *Research Policy* 45(1): 137-147.

- Science and Technology Parks (STPs) are one of the most important regional innovation policy initiatives.
- The paper extends previous literature by analyzing how STPs influence the results of cooperation of on park firms.
- Location in a STP increases likelihood of cooperation and the intangible results achieved.
- This effect is driven by the more diverse relationship established by on park firms, compared to non-park firms.

Science and Technology Parks (STPs) are one of the most important innovation policy initiatives. Previous studies show that location in a park promotes cooperation for innovation, but do not investigate whether this cooperation produces better results. The paper extends this literature by analyzing the effect of location on an STP on the results of cooperation for innovation and the mechanism facilitating this effect. The study relies on a much larger sample of firms and STPs than previous studies, and, where necessary, accounts for selection bias and endogeneity. The results show that location in an STP increases the likelihood of cooperation for innovation, and the intangible benefits of cooperation with the main innovation partner, due mainly to a more diverse relationship.

## 8. Detecting the emergence of technologies and the evolution and co-development trajectories in science (DETECTS): a 'burst' analysis-based approach

Dernis H, Squicciarini M, de Pinho R (2015). Detecting the emergence of technologies and the evolution and co-development trajectories in science (DETECTS): a 'burst' analysis-based approach. *The Journal of Technology Transfer*. p.1-33

- This paper aims to detect the emergence of science and technology fields and to characterise science and technology trajectories.
- It proposes a new data mining approach, called 'DETECTS', for the identification of those research and innovation activities whose intensity increases sharply compared to previous levels and to other developments.
- This approach also allows monitoring the extent to which field and topic-specific activities further accelerate, stabilise or abate, and the time it takes for such dynamics to unfold.
- Results suggest that in some focal technology fields considered, the acceleration in the development of science seems to closely follow the acceleration in the development of technologies, and not vice versa.

This work aims to detect the emergence of science and technology fields and to characterise science and technology trajectories. It proposes a new data mining approach, called 'DETECTS', for the identification of those research and innovative activities whose intensity increases sharply compared to previous levels and to other developments. This approach also allows monitoring the extent to which field and topic-specific activities further accelerate, stabilise or abate, and the time it takes for such dynamics to unfold. By applying the 'DETECTS' methodology on data from scientific publications and patents, this work sheds light on: the structure, articulation and relevance of the most important scientific and technological developments occurred during the period 1990–2011; the extent to which new fields arise from the cross-fertilisation of different technologies; the way in which advancements in science relate to technological progress; and the areas where future developments are likely to occur in the short and medium term. Results further suggest, somewhat unexpectedly, that in some focal technology fields considered, the acceleration in the development of science seems to closely follow the acceleration in the development of technologies, and not vice versa.

## 9. China's R&D explosion—Analyzing productivity effects across ownership types and over time

Boeing P, Mueller E, Sandner P (2015). China's R&D explosion—Analyzing productivity effects across ownership types and over time. *Research Policy*. 45(1):159-176

- This paper analyses the influence of R&D activities on TFP of Chinese firms across ownership type and over time.
- Privately owned enterprises benefit increasingly more from R&D than minority and majority state-owned enterprises.
- Increasing size of patent stocks is related to decreasing or vanishing effect on TFP.
- The study finds so far no positive productivity effects from research cooperations with other institutions.

In the past years, Chinese firms increased their spending on R&D substantially and worked on achieving a higher quality level of R&D. The paper analyzes whether different R&D activities show a positive influence on total factor productivity (TFP) for firms of different ownership types and across two time periods. The panel dataset with annual information allows the authors to study listed firms over the two time periods 2001–2006 and 2007–2011. Privately owned enterprises (POEs) not only obtain higher returns from own R&D than majority and minority state-owned enterprises (SOEs), they are also able to increase their leading position. Overall strong increases in the size of patent stocks are related to a decreasingly positive or even vanishing influence on TFP. POEs not only produce R&D of the highest quality but are also the only ownership type profiting from higher quality. Up to now research collaborations allow almost no benefit with the only exception stemming from domestic collaborations with individuals. The analysis depicts strengths

but also weaknesses of the corporate sector in China. The authors derive implications for the further development of economic policies.

## 10. The effect of patent litigation and patent assertion entities on entrepreneurial activity

Kiebzak S, Rafert G, Tucker C E (2015). The effect of patent litigation and patent assertion entities on entrepreneurial activity. *Research Policy* 45(1)218-231.

- This paper investigates the relationship between levels of patent litigation and venture capital investments in the U.S.
- The authors find an inverted U-shaped relation between patent litigation and VC investment: VC investment initially increases with the number of litigated patents but after a certain point it decreases.
- This appears strongest for technology patents, and negligible for products such as pharmaceuticals.
- Litigation by frequent patent litigators is associated with decreased VC investment with no positive effects initially.

This paper empirically investigates the statistical relationship between levels of patent litigation and venture capital investments in the U.S. The authors find that VC investment, a major funding source for entrepreneurial activity, initially increases with the number of litigated patents. However, there is a “tipping point” where further increases in the number of patents litigated are associated with decreased VC investment, which suggests an inverted U-shaped relation between patent litigation and VC investment. This appears strongest for technology patents, and negligible for products such as pharmaceuticals. Strikingly, the authors find evidence that litigation by frequent patent litigators, a proxy for litigation by patent assertion entities, is directly associated with decreased VC investment, with no positive effects initially.

## 11. Do inventors talk to strangers? On proximity and collaborative knowledge creation

Crescenzi R, Nathan M, Rodríguez-Pose A (2015). Do inventors talk to strangers? On proximity and collaborative knowledge creation. *Research Policy*. 45(1)177-194.

- Innovation is an increasingly collaborative activity: this paper explores the characteristics of the collaborations between inventors.
- Organisational proximity is a key feature of co-patenting teams together with cultural/ethnic diversity and ‘unconstrained’ social networks.
- Geographic proximity is linked to co-patenting only when it interacts with other proximities.
- Innovation policies should, rather than focus on spatial clustering, facilitate the formation of open and diverse networks.

This paper examines the characteristics of the collaborations between inventors in the United Kingdom (UK) by looking at what types of proximities – geographic, organisational, cognitive, social, and cultural–ethnic – between inventors are prevalent in partnerships that ultimately lead to technological progress. Using a new panel of UK inventors this paper provides an analysis of associations between these ‘proximities’ and co-patenting. The results show that while collaboration within firms, research centres and universities remains crucial, external networks of inventors are key feature of innovation teams. The analysis shows that external networks are highly dependent on previous social connections, but are generally unconstrained by cultural or cognitive factors. Geographical proximity is also weakly linked with external networks. The results suggest that innovation policies should, rather than focus on spatial clustering, facilitate the formation of open and diverse networks of inventors.