State of the Art Review

Public University Policy and R&D Success

Erik E. Lehmann
University of Augsburg
Erik.lehmann@wiwi.uni-augsburg.de

SOTA Review No 12: November 2018

Today, public university policy is widely accepted as one of the most adopted approaches to spur innovativeness, competitiveness, and growth in a knowledge-based economy. Despite the popularity of public university policy in academia and politics, solid evidence is scarce. Although there is increasing experience in designing public university policy to spur R&D activities and success, little is known about whether such policies actually work. What does the evidence suggest about the relationship between public spending on generating public knowledge spillovers and R&D outcomes? Is public university sponsorship overall beneficial?

While plenty of studies analyzing public university sponsorship suggest positive benefits, with the strongest effects arising from the locally bounded knowledge spillover effects, some recently published studies are more skeptical about the overall beneficial effects.

Background

Public university policy is rooted in the economic growth literature (Romer, 1990) arguing that knowledge and human capital are the key elements to foster competitiveness and economic growth. This year's (2018) Nobel Prize winner, Paul M. Romer, argued that economic growth is endogenously shaped by internal R&D investments and exogenous knowledge spillovers: knowledge created by one firm or organization can be also used by other firms, without bearing the full costs of creating the knowledge. This constitutes knowledge as a public good, characterized by both non-excludability and non-rivalry, leading to a market failure, i.e. inadequate incentives for private investment in R&D (Arrow, 1962). Universities represent privileged entities and are sources to generate new knowledge and ideas and where to find human capital ready to transfer the knowledge to the industry. University spillovers are externalities that are commercialized by firms (established firms or new start-ups), for which the university is the source of the spillover but is not fully compensated. Public university policy interventions to spur R&D activities are thus justified by the existence of market failure from the public good or spillover nature of basic R&D.

The knowledge generated in universities and research centres is classified as either tacit or codified (Kogut and Zander, 1992). Tacit knowledge is difficult to write down in such a way that it is meaningful and readily understood. By contrast, stand-alone codified knowledge can be written down such as a formula and disseminated via academic journals. While codified knowledge is more akin to information, tacit knowledge involves more than what can be codified and written explicitly. A key characteristic of knowledge is its tacit nature and the ambiguities inherent in the tacit nature of knowledge can be overcome only when communication takes place in face-to-face situations. Tacit knowledge needs communication as well as reciprocity, all of which may be ineffective or infeasible over longer distances, leading to geographic agglomeration and clustering effects around the source of tacit knowledge spillovers, like public universities. This has spurred interest in place-based public university policies facilitating innovation and competitiveness, either by revitalizing lagging and disadvantaged communities or picking and promoting outstanding and promising regions by subsidizing the local universities (Autio and Ranniko, 2016).

According to this literature, there are at least three aspects shaping knowledge spillovers by public university policy (Acs et al. 2013):

- the first involves the extent of knowledge generated or produced,
- the second involves its propensity to spill over and
- third encompasses the capacity to absorb the knowledge spillovers to generate marketable goods and services

What does the evidence suggest about the relationship between public university policy and R&D success?

Evidence

There have been relatively few studies analyzing the direct relationship between public university policy and local performance. Lehmann (2015) provides a survey on universities and local competitiveness in general. Table 1 lists studies using treatment-of-the-treated and difference-in-difference estimations, identifying a positive relationship between knowledge spillovers and some measures of local R&D success for Germany, but also the adverse effect of an increase in the economic inequality caused by public university policy (Table 1).

In terms of the **first** aspect, some regions are rich in in knowledge based on R&D investments, human capital and university research, while other places exhibit considerably lower investment in knowledge. This literature draws heavily on the extent of knowledge generated by subsidizing public universities, analyzing the relationship between monetary spending and university performance measures, like publications, citations or patents. While an overwhelming portion of this literature confirms the general positive relationship (see Lehmann, 2015 for an overview), there is mixed evidence about the impact and success of the different kinds of spillovers. In the Anglo-Saxon countries, positive effects of academic research could only be confirmed for excellent and outstanding universities and ‘star scientists’ (Acs et al, 1992). The results concerning patents, the most prominent and discussed spillover mechanisms, are also mixed (Zahringer et al. 2017).

The **second** aspect, the propensity to spill over, is the mechanism of the knowledge filter. Knowledge created in academia doesn't spill over automatically, and not all knowledge created could be commercialized. R&D success of public university policy depends on the ability to penetrate the knowledge filter, the barriers inhibiting the conversion of knowledge produced into commercialized knowledge (Lehmann, 2015). Important vehicles to pass the knowledge filter are academic spin-offs (Meoli & Vismara, 2013), the mobility of graduates (Braunerjhelm et al. 2018) or new firm creation (Audretsch et al. 2005). Empirical results show that the knowledge filter is 'thin' when new ideas and innovations flow freely between academia and industry, and 'thick', when knowledge cannot directly flow to the local industry, like strong property rights of university patents, which hinder the free flow (Acs et al. 2013).

Table 1: Public university policy

Study	Data	Methodology	R&D Measures	Principal empirical results:
Audretsch & Lehmann (2005a)	Total of 150 labor market regions, IPO firms (1996-2005); Technical Universities vs. general universities	OLS regression of firm growth	Focus on R&D and knowledge intensive fields (engineering, ICT, biotechnology), new venture,	Only moderate effects; public university policy does not make a difference, at least not in terms of influencing the performance of knowledge-based startup policy.
Audretsch & Lehmann (2005b)	Total of 150 German labor market regions, IPO firms (1996-2005), all public universities	Probit regressions, Poisson regressions,	Human capital (tacit) and research (codified) in the natural and social sciences	Firm location depends on the kind of sciences ; tacit knowledge matters for agglomeration effects. Public university policy stimulates the production of tacit knowledge.
Audretsch, Lehmann & Warning (2005)	Total of 150 German labor market regions, IPO firms (1996-2005), all public universities	Quantile regressions	Academic research and human capital (natural science and social sciences).	Regional clustering effects of newly founded high-tech firms strongly depends on the kind of spillover mechanisms, in particular graduates in the natural sciences.
Lehmann & Menter (2016)	Total of 150 German metropolitan areas and public universities, 1998-2012.	Balanced panel, treatment-of-the treated, difference-in-difference estimations	University-industry collaboration, absorptive capacity	Active public policy fosters regional growth (GDP); Positive effects requires regional absorptive capacity.
Menter, Lehmann & Klarl (2018)	German public universities (1998-2012), effect of the public 'excellence initiative'	Balanced panel regression, DoD Estimations	Publications, citations	Confirms the 'picking the winner' effect (selection of the best universities), no significant ex-post effect compared to control group.
Lehmann & Menter (2018)	German public universities (1998-2012), effect of the public 'excellence initiative'	Balanced panel regression, DoD Estimations,	Academic research, public and private funding of universities, university-industry collaboration	Rejects the hypothesis that 'picking the winners' will lead to positive spillovers to neighbouring regions; picking the winners leads to regional inequality and adverse effects.

The relation between public university policy and R&D success strongly depends on the **third aspect**, the absorptive capacity. According to Cohen & Levinthal (1989), firms have to invest in R&D capacity to adapt new technologies and ideas to absorb the knowledge that spills over from universities (among others). Investment in firm specific R&D and knowledge spillovers from universities are thus complements, expressed by the knowledge production function. Public university policy to promote knowledge spillovers and R&D success in the industry depends on the absorptive capacity of firms and regions (Lehmann & Menter, 2016, 2018).

Summary and evidence gaps

There is ample empirical evidence that public university policy leads to (regional) R&D success and thus econmic growth and competitiveness (see table 2).

Table 2: University Policy and R&D success

Study	Data	Methodology	R&D Measures	Principal empirical results:
Kenney & Patton (2011)	census of technology-based university spin-offs from six universities; inventor ownership system (Anglo-Saxon Countries)	Case study approach,	Academic spin-offs in R&D intensive sectors	Governments seeking to encourage university invention commercialization and entrepreneurship should experiment with an inventor ownership system.
Bonaccorsi et al (2013)	new firm creation in Italian provinces (i.e., at the NUTS3 level),	negative binomial regression models, for each industry category	new firm creation to the scientific specialization in basic sciences, applied sciences, engineering, social sciences and humanities of neighbouring universities.	Universities specialized in applied sciences and engineering have a broad positive effect in science-based manufacturing industries. Universities specialized in social sciences and humanities have no effect.
Meoli & Vismara (2013)	Through a longitudinal study of 559 spin-offs from 85 Italian universities from 1999 to 2013	OLS regressions	Academic spin-offs	Support from the parent university leads academics to create more technology spin-offs
Zahringer et al. (2017)	434 firms in the life science industry, 2007-2012, USA.	Tobit regressions	Patents, academic publications, citations	Articles published in journals with a higher impact factor lead to industrial innovation of higher quality, not science per se.
Baron et al. (2018)	Top US research universities; metropolitan areas. 1980-2010.	Descriptive statistics, correlation,	Top research universities (publications, citations, patents)	Establishment of a research university is not sufficient to transform a local economy.
Urbano et al. (2018)	Articles published since 1992-2016, Web of science database	Meta-Analysis	Research institutions, economic growth, entrepreneurship	Complex relationships between institutions and economic growth, useful for planning strategies and public policies.

The widely held perception, that high-tech clusters such as California's Silicon Valley owe much of their success to the neighbouring universities and that public policy fostering academic research and education could spur R&D success and economic growth, is a myth. The empirical results demonstrate that top research universities are not sufficient for regional economic prosperity and cast doubt on the utility of a one-size-fits-all approach.

Consistent linkages are found between academic knowledge spillovers and entrepreneurship, via academic spin-offs, mobility of graduates and new firm creation by students and graduates, and intensive university-industry relations. The results reflect that publicly funded research is associated with a higher degree of spillovers, but that R&D success strongly depends on the absorbative capacity, i.e. the R&D intensity of the local economy. This emphasizes the complimentarity between public university policy and investment in the business sector (Veugelers & Del Rey, 2014).

Recent studies for Germany demonstrate adverse effects of public university policy on neighbouring regions. Policy makers almost justify the retaining or picking the winners approach (Autio & Ranniko, 2016) by positive R&D effects spilling over from the funded areas to the neighbouring regions. Recent evidence shows that the opposite holds: neighbouring regions are flushed and underperform compared to disadvantaged regions which are not in close proximity to 'excellent' universities and clusters (Lehmann and Menter, 2018).

Sources

Acs, Z., Audretsch, D. B. & Lehmann, E. E. (2013). The Knowledge Spillover Theory of Entrepreneurship, *Small Business Economics*, **41(4), 757-774**.

Arrow, J. (1962). The economic implications of learning by doing, Review of Economic Studies, **29(3): 155-173.**

Audretsch, D. B., & Lehmann, E. E. (2005). Does the knowledge spillover theory of entrepreneurship hold for regions? *Research Policy*, **34(8): 1191–1202**.

Audretsch, D. B., Lehmann, E. E., Meoli, M. & Vismara, S. (2014). *University Evolution, Entrepreneurial Activity and Regional Competitivess* (eds)., Heidelberg/New York: Springer.

Audretsch, D. B., Lehmann, E. E., & Warning, S. (2005). University spillovers and new firm location, *Research Policy*, **34(7):1113–1122**.

Autio, E. & Ranniko, H. (2016). Retaining winners: Can Policy boost high-groth entrepreneurship? *Research Policy*, **45(1): 42-55**.

Baron, E. J., Kantor, S. & Whalley (2018). Extending the Reach of Research Universities. The Hamilton Project: Brooking Institutes, September 2018.

Bonaccorsi, A., Colombo, M. G., Guerini, M., & Rossi Lamastra, C. (2014). University specialization and new firm creation across industries, *Small Business Economics*, **41(4):837-863**.

Braunerhjelm, P., Ding, D. & Thulin, P. (2918). The knowledge spillover theory of intrapreneurship, *Small Business Economics***, 51(1): 1-30.**

Kenney, M. & Patton, D. (2011). Does Inventor Ownership Encourage University Research-Dereived Entrepreurship? A Six-University Comparison, *Research Policy*, **40(8): 1100-1112**.

Kenney, M. (2014). Commerzialization or Engagement. Which is more of significance for regional economics?, in: Audretsch, Link & Walshok, *The Oxford*

Handbook of Regional Competitiveness, chapter 12, Oxford/New York: Oxford University Press, **255-267**.

Lehmann, E. E. (2014). The Role of Universities in local and regional competitiveness, in: Audretsch, Link & Walshok, *The Oxford Handbook of Regional Competitiveness*, chapter 10, Oxford/New York: Oxford University Press, **211-236**.

Lehmann, E. E. & Menther, M. (2018), Public cluster policy and neighboring regions: beggar-thy-neighbor?, *Economics of Innovation and New Technology*, **27(5/6): 420-437**.

Lehmann, E. E. & Menther, M. (2016). University-Industry Collaboration and Regional Wealth, *The Journal of Technology Transfer*, **41(6): 1284-1307**.

Menther, M., Lehmann, E. E. & Klarl, T. (2018). In search of excellence: a case study of the first excellence initiative of Germany, *Journal of Business Economics*, **88(9): 1105-1132**.

Meoli, M. & Vismara, S. (2016). University support and the creation of technology and non-technology academic spin-offs, *Small Business Economics*, **47(2): 345-362**.

Urbano, D., Aparicio, S. & Audretsch, D. (2018). Twenty-five years of research on institutions, entrepreneurship, and economic growth: what has been learned? Small Business Economics, **doi.org/10.1007/s11187-018-0038-0**

Veugelers, R. & Del Rey, E. (2014). The contribution of universities to innovation, (regional) growth and employment, *EENEE Analytical Report No. 18*, Brussels: European Comission.

Zahringer, K., Kolympiris, C. & Kalaitzandonakis, N. (2017). Academic knowledge quality differentials and the quality of firm innovation, *Industry and Innovation*, **26(5): 821-844**.

About the author

Erik E. Lehmann is the Professor of Management and Organization at the University of Augsburg and Co-Director of the Augsburg Center of Entrepreneurship. He is also Adjunct Professor at Indiana University Bloomington (USA) and Visiting Professor at University of Bergamo (Italy). His research is focused on the links between entrepreneurship, corporate government, innovation policy, economic development and regional competitiveness. He is co-author of 'The Seven Secrets of Germany', and 'Entrepreneurship and Economic Growth', both published by Oxford University Press, and co-editor of 'The Routledge Companion to the Makers of Modern Entrepreneurship'. He is a member of the editoriol board of Small Business economics. He can be contacted at: erik.lehmann@wiwi.uni-augsburg.de

Other SOTA Reviews are available on the ERC web site www.enterpriseresearch.ac.uk. The views expressed this review represent those of the authors and are not necessarily those of the ERC or its funders.

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

Department for Business, Energy & Industrial Strategy

BRITISH BUSINESS BANK

Innovate UK Technology Strategy Board

Intellectual Property Office