AUA Working Paper Series No. 2014-5
July 2014

Research Funding and Academic Output: The Case of Agricultural University of Athens

Kyriakos Drivas
kdrivas@aua.gr

Athanasios T. Balafoutis
abalafoutis@aua.gr

Stelios Rozakis
rozakis@aua.gr

Agricultural **U**niversity of **A**thens ·
Department of Agricultural Economics
& Rural Development · http://www.aoa.aua.gr

Research Funding and Academic Output: The Case of Agricultural University of Athens

Kyriakos Drivas, Athanasios T. Balafoutis, Stelios Rozakis

Department of Agricultural Economics & Rural Development.
Agricultural University Of Athens,
Iera Odos 75, Athens 11855, Greece

Abstract

This paper uses detailed data on funding information and research output from Agricultural University of Athens to examine how each type of funding source is related to the quantity and quality of academic research output. Of special interest are the corporate sponsors, the Greek government and European Union funding. We find that after controlling for unobserved heterogeneity from each research lab, all types of research sponsors are similarly related to both the count of publications and citations. Further, we find that research labs that have filed for at least one patent application, produce on average more publications and citations and receive more funding both from corporate and public sponsors.

Keywords: research sponsor, corporate funding, government sponsor, European Union funding, publications, patents.

JEL Classification: O32, O33, O34

1. Introduction

Innovation has been the key driver of agricultural productivity (Johnson 1997). Throughout history, technological advancements have drastically increased the rate of agricultural production and as a result social welfare.[1] As such the returns to Research and Development (R&D) are one of the most heavily studied topics in the agricultural economics literature. The overwhelming majority of this literature has found that the returns are substantially positive (see Alston 2000 for a meta-analysis).

The role of the universities in agricultural innovation has not gone unnoticed. Universities have played a significant role in the private sector's R&D activity (Jaffe, 1989; Adams, 1990; Mansfield, 1991). [2] However, the ongoing involvement of universities in public-private partnerships has been met with skepticism on the potential dangers it may hinder. Universities' missions are to educate students by providing them the necessary skills and advance the frontiers of science. Skeptics have argued that the latter mission is in jeopardy when the private sector finances university research (Blumenthal et al 2007; Washburn 2005).

The empirical evidence to this debate has been mixed. Guena (1997) found for UK universities that their dependence in industry funding can result in reduced academic output. However, Banal-Estanol (2008), studying UK engineer academics, found significant positive relationship between industry funding and publication output when the amount of industry funding is small. Manjarrés-Henríquez et al (2009) reached to similar conclusion when examining two Spanish universities. With respect to German universities, Hottenrott and Thorwarth (2011) found that industry funding leads to reduced quantity and quality of research output but Hottenrott and Lawson (2013) refined these finding at the research lab level and show that there is variation by the type of industry sponsor.

We add to the above debate by examining a country, namely Greece, which has less experience in university-industry collaborations than northern European countries and the US. Further, we specifically focus on agricultural-related disciplines and explore how each type of research funding is associated with academic output. From the above discussion, of particular interest is the comparison between public

[1] Two examples include are the research and development of wheat varieties in Mexico and rice at the International Rice Research Institute (Wright 2012).
[2] Recent case studies have found a positive impact of university research on regional innovation activity (Acosta et al 2009; Carree et al 2012).

and private sector funding. We bring evidence from 38 research labs of the Agricultural University of Athens – the largest agricultural university in Greece.[3] By pulling data from a wide array of sources we estimate the relationship between the type of research funding and research output as that measured by publications and citations. An additional novelty of the dataset is that we can distinguish across three types of public funding; government funding, European funding that is handled by Greek agencies and direct European Union (mostly through the Framework Programmes) funding. To our knowledge, this is the first paper that distinguishes public funding in such a detailed way.

An additional channel through universities may distort their research agenda is through the increased tendency of faculty to seek entrepreneurial activities instead of scientific-oriented ones (Dasgupta and David 1994). Scholars have approached this topic by examining the propensity of faculty to patent and publish. While publishing in scientific journals is an indication of research output, patenting may be more related to business oriented activities by the faculty (Thursby et al 2007). We contribute to this debate by also examining the patent application profiles for research labs. We find that research labs that have filed for at least one patent application, they produce on average more publications and receive more research funding from almost all types of sponsors.

Our paper generally relates to the literature that is concerned with a decline of university research due to public-private partnerships. [4] Specifically, scholars are concerned with universities sacrificing research output due to increased industry funding at (Rai and Eisenberg 2003; Campbell et al. 2002; Blumenthal et al. 1996) and/or to pursue commercialization activities (Kennedy 2000; Dasgupta and David 1994) such as patenting and licensing. We contribute to this literature by examining in depth the research labs of one university. An additional feature of this project is that it examines a medium size university in a country where these issues may be augmented due to the inexperience of institutions to deal with these issues.

---

[3] This university is also a research-oriented university. According to the 2013 National Taiwan University Ranking, Agricultural University of Athens was ranked 104th university in the world in Agricultural Sciences.

[4] We should note that the other major concern of university-industry collaborations is the exclusionary control over the academic research findings stemming from industry funding (Washburn 2005). This concern has received considerable attention in the literature after a series of high-profile and large amount of research grants of multinational corporations to academic institutions (Press and Washburn 2000; Washburn 2010). This issue however is not the focus of this paper.

Finally, by examining an agricultural university, this paper also relates to the literature that examines the role of universities in agricultural or agricultural-related innovation. This literature has found that universities indeed contribute positively to innovation and overall agricultural productivity (Foltz 2003). In a case study of nanobiotechnology, Weber and Xia (2011) found that universities have played a critical role in advances in this technological area. However, the implications of agricultural universities' industry support and increased commercialization are less studied especially outside the US.

The next section describes the data construction. The following section discusses the descriptive findings and the regression analysis. Finally, the paper concludes.

2. Data Construction

The institution that is examined is the Agricultural University of Athens (AUA). AUA has 6 Departments and each department includes several research labs. Each faculty member belongs to a research lab. While the course curriculum takes place at the department level, the research takes place at the lab level. The University has 42 research labs overall. However, for the purposes of this study, we exclude four labs that had only one faculty during our time period.[5] Therefore, for the remainder of the paper we focus on the 38 research labs.[6]

There were several steps in the process of retrieving and collecting the data. As a first step, for each faculty member, the information on their publications was collected. The publications were collected from www.scopus.com for two reasons. First of all, Scopus has an id number for each author; therefore, by retrieving the id numbers we were able to collect all the papers corresponding to each faculty member. Whenever the id number was not unique (less than ten percent of the case) we downloaded all the id numbers for each author. Second, Scopus is the most comprehensive database of scientific publications; in a case study of researchers in medical schools, Kazakis et al (2014) found that for more 90% of the authors, Scopus had all their publications. In addition, we collected for each publication the number of citations it received until 2013.

[5] Results are qualitatively similar if we include these four labs in our analysis.
[6] Table A1 of the appendix shows the names of the research labs and the department that each belongs to.

A challenge that arose was that as we collected the faculty members from the AUA's directory, the retired faculty was not included in the directory. To retrieve the active faculty, but as of date of extraction retired, during our study period (2002-2013) we communicated with each department and collected information on the retired faculty and the research lab they belonged to. Afterwards, we retrieved the publication information for them as well. Overall, we acquired information on 208 faculty members, 48 of which were retired as of the end of 2013.

The second step was to retrieve information on research grants. This information was extracted from the AUA Research Committee. We collected for each research lab all the research grants, their start and end dates, the amount and the type of funder. After a cursory review of each type of funder we bundled them in one of the following categories:

- GOV which is funding from the government or a local government authority (for instance municipalities);
- GOVEU which is funding that is handled by a government authority (for instance the General Secretariat for Research and Technology) but are co-financed by the European Union. In most of these grants, the EU money account for more than 75% of the total budget;
- EU which is the funding that that comes directly from the European Union from competitive research programs. The largest majority of these research money stem from the Framework Programmes;
- PRIV which is the funding that comes from private sponsors;
- UNCLASS which is funding that did not match any of the above categories.

This distinction, in addition to allowing us to compare public and private funding, also facilitate the comparison of the three major types of public funding which are available not only to Greek universities but also to European universities.

The final step was to collect all the patents where the inventor was a faculty member. We performed a manual search of all 208 names at espacenet.[7] Espacenet is hosted by the European Patent Office and contains information of patents and patent applications for patent offices of more than 90 countries. In its search engine, we

[7] http://worldwide.espacenet.com/advancedSearch?locale=en_EP

manually searched for each name from the AUA database. In cases where we found a match, we further cross-checked if the inventor had disclosed a Greek address and the technology field of the patent was similar to his/her area of specialization. After this exhaustive matching we found 25 patent applications invented by AUA faculty.

3. Empirical Findings

3.1. Relationship between Type of Funding and Research Output

3.1.1. Descriptive Analysis

Table 1 shows the summary statistics for the variables that were collected and constructed. The average number of publications per year per research lab is 6.9. To standardize the importance of publications we further collected the number of citations per publication. Each research lab has obtained 89.4 citations on average per year. Patent applications per year are naturally small; there are 0.05 patent applications per year per research lab.

The next five variables display the amount of research money by type of sponsor. The year we consider for these variables is the award year of the research grant. The funding from the European Union either directly (EU), or indirectly through the Greek government (GOVEU), accounts for the majority of the research funding. Indicatively, per year they account in total for 111 thousand Euros when the total inflow of research money is approximately (by adding up all five types) 157 thousand; in other words EU and GOVEU account on average for 70% of total research funding. Via similar calculations, GOV accounts for 12.5% and PRIV for 15.3%. The remainder is attributed to UNCLASS. Given that UNCLASS is a very small portion of total research funding, we exclude it in the rest of the analysis. To draw a comparison with US universities, it is noteworthy that the federal government accounts for approximately 60% of academic research and state and local governments for approximately 7% (National Science Board 2012). Therefore, the share of public support in Greece appears to be higher than the share of public support in the US. However, the industry in the US accounts for merely 6% of funding to universities while the rest of university funding comes from own sources and non-profit organizations. Hence, we observe that a lack of public funding may be complemented by private funding. This finding merits further examination as to analyze whether each type of funding is differentially related to publication output.

The following five variables display again the amount of research money by type of sponsor but smoothing out the amount of money over the years that each research grant takes place. While the previous five variables assign the entire amount of each research grant in the award year, these variables distribute the amount evenly to the years that the research grant takes place. For the remainder of the paper we will be using these variables as they can more parsimoniously capture the relationship between funding and academic output.

Figure 1 shows the total number of publications per year. Overall, we observe a steady upward trend in the number of publications. Before 2005, the number of publications was below 240 while after 2005, it is well above that number and occasionally closer to 300 publications. Figure 2 shows the total amount of research funds by type of sponsor per year and indicates that the three public funding categories (GOV, GOVEU and EU) showed increased rates after 2010 (start of economic crisis in Greece), as regular state funding for the universities was decreased by almost 50%. At the same time, private funding has been more or less stable, showing that private interests require university expertise regardless of the economic climate. Particularly, the dramatic increase of GOVEU in the final years of the sample was impressive and attributed to large scale competitive research projects that were awarded to research groups of AUA in collaboration with other universities and private companies from the General Secretariat of Research and Technology and other research directories of the Ministry of Education. The second observation is that PRIV and EU research funds experience a steady upward trend over the sample period. Conversely, the funding by GOVEU and GOV has greater variation; this variation is probably supply driven and shows that while PRIV and EU funding may be less sensitive to the economic cycles, GOV and GOVEU are more sensitive. While for GOV, this is intuitive for GOVEU it might be less intuitive. There can be two reasons why this sensitive pattern is observed. First, GOVEU funds need to have a small participation from the Greek government; if they do not, then they cannot be manifested to open calls for researchers. Second, as the study by Grant et al (2011) showed, the Greek government faces serious institutional and organizational challenges in absorbing EU money.

Figure 3 explores the relationship between each type of funding and publication output. As funding may take years to manifest to research output we consider publications with a two year lag. For the remainder of the analysis, we standardize for each research lab their publications and funding by the number of faculty. The figure shows that for EU, GOVEU and PRIV funding there is a somewhat positive relationship with publication output; the correlation coefficients are 0.35, 0.16 and 0.32 respectively and significantly different from zero (Table 2). However, the relationship between GOV funding does not appear to have a robust relationship with publication output. The correlation is -0.08 and not statistically different from zero.

A somewhat different picture emerges in Figure 4 where instead of considering publications per number of faculty for each research lab, we consider number of citations per number of faculty for each research lab. The first difference is the dramatic decrease in correlation between PRIV and citations and the second is the less dramatic, but still significant, decrease between EU and citations. The above results show that while there is a somewhat positive relationship between EU, GOV-EU, PRIV and publication output, this relationship is not robust and decreases significantly for EU and PRIV when instead of examining the quantity of scientific output, we examine its impact via citations.

3.1.2. Regression Analysis

To explore in more detail these relations, we perform a regression analysis by controlling for all the types of funding simultaneously. Our model is:

$$ln(Publications_{i,t+2}) = \beta_0 + \beta_1 ln(EU_{i,t}) + \beta_2\, ln(GOV_{i,t}) + \beta_3 ln(GOVEU_{i,t}) + \beta_4 ln(PRIV_{i,t}) + \beta_5 Lab_i + \beta_6 Year_t + \varepsilon_{it}$$

where $Publications_{i,t+2}$ is the number of publications of research lab *i* at year *t+2* per number of faculty at lab *i*. $EU_{i,t}$ is the amount of EU funding to lab *i* at year *t* divided by the number of faculty. Similarly for $GOV_{i,t}$, $GOVEU_{i,t}$ and $PRIV_{i,t}$. Lab_i is lab fixed effects and $Year_t$ are year fixed effects. We include lab fixed effects to account for unobserved heterogeneity within each research lab. To examine the relationship with citations, we re-run the above regression by replacing $Publications_{i,t+2}$ with $Cites_{i,t+2}$.

Table 3 displays the results. The first two Columns do not include lab fixed effects while Columns 3 and 4 do. Given that all variables are in logs, the coefficients can be interpreted as elasticities. For instance a 100% increase of EU funding is associated with 0.07% increase in publications (Column 1). By and large the coefficients of each type of funding do not seem to be related with either publications or citations. This finding can be interpreted in the following two ways. First, we observe the scientific conduct of each lab at equilibrium and therefore funding has already been pre-determined. Second, related to the above, labs perform their research consistently throughout the years and even though they are always in pursuit of research money, this research money does not seem to influence their over-arching research agenda. In any case however, these findings imply that there are no significant differences between public and industry research support. While the results need to be interpreted cautiously in light of significant policy initiatives in Greece to promote university-industry collaborations, they show that if handled appropriately, they will not negatively influence either the quantity or quality of the research output.

3.2. Role of Patent Filing Propensity

This section examines whether research labs that have pursued patenting are more or less productive in research activities. Table 4 shows that merely 7 research labs have filed for at least one patent application. If we were to exclude the research labs from the Department of Agricultural and Rural Development (AGECON), as they are less likely to have patentable output, this constitutes a 20.5% of labs that have pursued at least one patent application. Figure 5 shows the difference in publications and citations per faculty for the labs with at least one patent application and the labs without (excluding the labs from the AGECON department). Labs with at least one patent application appear to outperform the labs without in both of these two metrics. Table 5 examines the differences in research funds in addition to research output. With the notable exception of GOV, labs with at least one application receive more money from all types of research sponsors.

The above findings appear to be consistent with the literature which primarily has focused in the US as scholars have found a positive to no relationship between patenting and publications; see Foltz et al (2007). Further, Thursrby et al (2007) show that a faculty’s career that is spread between basic and applied research is likely to be more productive than a career that is single-dimensional. For the UK, Lawson (2013) also found that industry support increases the quality of innovation output; similarly Wright et al (2014) found for the case of University of California that industry funded inventions are more likely to be licensed and their associate patents more cited than their federally funded counterparts. The results here give insights on the concerns that have been raised that increased commercialization of universities may lead to distortion of university research agenda (Dasgupta and David 1994).

The necessary caveat here is that for this level of commercialization propensity by the research labs, we observe an also increased publication propensity and research funding propensity. However, given the intense policy debate in Greece for supporting university-industry collaborations, we should note that such a policy direction should be accompanied by the appropriate framework under which these collaborations should function so that they will yield the optimal results both for the industry and university partners.

3.3. Analysis at the Faculty Level

We should note that initially we considered of performing the entire analysis at the faculty level instead of the lab level. However, given that we observe a limited number of years, we would not be able to capture the entire career trajectory of each faculty level. Indeed, studies that have focused at the faculty level have had information for then entire lifecycle of a faculty's research activity; see Azoulay et al (2010, 2011). Instead, studies that had a limited number of years opted for an analysis at a more aggregate level such as the research lab; see Hottenrott and Lawson (2013). In any case, we performed a similar analysis for the active faculty for the available years and results are available upon request.

4. Conclusion

This paper has examined the relationship between the research support and scientific output by distinguishing across types of sponsors. While universities play a critical role in the innovation system, concerns have been raised that the continuing interaction between industry and academia can impede the university's mission. The overwhelming research has focused on countries with significant experience in public-private collaborations and has found mixed results of how the type of research funding may be related to the quantity and quality of research output. We examine these relationships in a smaller country, namely Greece, where recent policy initiatives are directed towards enhanced university-industry collaborations and specifically in agricultural-related sciences. Further, we distinguish public funding that either stems from the Greek government, the European Union but handled by

Greek agencies or finally the European Union directly. This is an important distinction when examining European universities as more or less they all face these types of public sponsors.

With the data at hand, we find that the type of research sponsorship does not seem to be associated with the quantity or quality of the research output, as that approached by scientific publications and their citations respectively. While these results should be interpreted cautiously, they depict that if the appropriate institutional structure is in place then there is industry funding may not lead to a decrease of academic research output.

Further, we showed that research labs that are more commercially-oriented, as that depicted by their patent application propensity, are on average more productive and receive more research funding both from public sponsors and industry sponsors. These results should also be interpreted cautiously but imply that a right mix of scientific research and entrepreneurial activity may maximize a research lab's scientific productivity.

References

Acosta, M., D. Coronado, M. D. Leon, and M. A. Martinez. "Production of university technological knowledge in European regions: Evidence from patent data." *Regional Studies* 43, no. 9(2009): 1167-1181.

Adams, J. "Fundamental Stocks of Knowledge and Productivity Growth." *Journal of Political Economy* 98(1990): 673-702.

Alston, J. M., M. C. Marra, P. G. Pardey, and T. J. Wyatt. "Research Returns Redux: a Meta-Analysis of the Returns to Agricultural R&D." *Australian Journal of Agricultural and Resource Economics* 44, no. 2(2000): 185-215.

Azoulay, P., J. S. Graff Zivin, and G. Manso. "Incentives and Creativity: Evidence from the Academic Life Sciences." *Rand Journal of Economics* 42, no. 3(2011): 527-554.

Azoulay, P., J. S. Graff Zivin, and J. Wang. "Superstar Extinction." *Quarterly Journal of Economics* 125, no. 2(2010): 549-589.

Banal-Estanol, Albert, Mireia Jofre-Bonet, and Cornelia Meissner. "The impact of industry collaboration on research: Evidence from engineering academics in the UK." (2008).

Blumenthal, D., E. Campbell, N. Causino, and K.S. Louis. 1997. "Participation of Life-Science Faculty in Research Relationships with Industry." *New England Journal of Medicine* 335:1734–39.

Campbell, E., B. Clarridge, M. Gokhale, L. Birenbaum, S. Hilgartner, N. Holtzman, and D. Blumenthal. 2002. “Data Withholding in Academic Genetics.” *Journal of the American Medical Association* 287(4):473–80.

Carree, M., A. Della Malva, and E. Santarelli. "The contribution of universities to growth: Empirical evidence for Italy." *Journal of Technology Transfer* 39, no. 3(2012): 393-414.

Dasgupta, P., and P. A. David. "Toward a New Economics of Science." *Research Policy* 23, no. 5(1994): 487-521.

Foltz, J. D., B. L. Barham, and K. Kim. "Synergies or Trade-offs in University Life Sciences Research." *American Journal of Agricultural Economics* 89, no. 2(2007): 353-367.

Foltz, J. D., K. Kim, and B. Barham. "A Dynamic Analysis of University Agricultural Biotechnology Patent Production." *American Journal of Agricultural Economics* 85, no. 1(2003): 187-197.

Grant, J., Ling, T., Potoglou, D., & Culley, D. M. (2011). A rapid review of the Greek research and development system. *RAND Europe, Documented Briefing*.

Geuna, Aldo. "Allocation of funds and research output: the case of UK universities." *Revue d'économie industrielle* 79.1 (1997): 143-162.

Hottenrott, Hanna, and Susanne Thorwarth. "Industry funding of university research and scientific productivity." *Kyklos* 64.4 (2011): 534-555.

Hottenrott, H., and C. Lawson. "Research grants, sources of ideas and the effects on academic research." *Economics of Innovation and New Technology* 23, no. 2(2013): 109-133.

Jaffe, A. "Real Effects of Academic Research." *American Economic Review* 79(1989): 957-970.

Johnson, D. G. "Agriculture and the Wealth of Nations." *American Economic Review* 87, no. 2(1997): 1-12.

Kazakis, N. A., Diamantidis, A. D., Fragidis, L. L., & Lazarides, M. K. "Evaluating the research performance of the Greek medical schools using bibliometrics." *Scientometrics* 98.2 (2014): 1367-1384.

Kennedy, D. 2000. “Science and Secrecy.” *Science* 289: 724.

Lawson, Cornelia. "Academic patenting: the importance of industry support." *The Journal of Technology Transfer* 38.4 (2013): 509-535.

Lawson, Cornelia. "Academic patenting: the importance of industry support." *The Journal of Technology Transfer* 38.4 (2013): 509-535.

Manjarrés-Henríquez, L., Gutiérrez-Gracia, A., Carrión-García, A., & Vega-Jurado, J. (2009). The effects of university–industry relationships and academic research on scientific performance: Synergy or substitution?. *Research in Higher Education*, *50*(8), 795-811.

Mansfield, E. "Academic Research and Industrial Innovation." *Research Policy* 20(1991): 1-12.

National Science Board. "Science and Engineering Indicators 2012." *Arlington, VA: National Science Foundation (NSB 12-01).* (2012).

Press, E., and J. Washburn. "The Kept University." *The Atlantic Online* (2000).

Rai, A., and R. Eisenberg. 2003. “Bayh-Dole Reform and the Progress of Biomedicine.” *Law and Contemporary Problems* 66(1):289–315.

Thursby, M., J. Thursby, and S. Gupta-Mukherjee. "Are there real effects of licensing on academic research? A life cycle view." *Journal of Economic Behavior & Organization* 63, no. 4(2007): 577-598.

Washburn, J. *University, Inc.: The Corporate Corruption of Higher Education*, 2005.

Washburn, J. "Big Oil Goes to College." *Center for American Progress* (2010).

Weber, W. L., and Y. Xia. "The Productivity of Nanobiotechnology Research and Education in U.S. Universities." *American Journal of Agricultural Economics* 93, no. 4(2011): 1151-1167.

Wright, B. D., K. Drivas, Z. Lei, and S. A. Merrill. "Technology Transfer: Industry-funded Academic Inventions Boost Innovation." *Nature* 507, no. 7492(2014): 297-299.

Table 1.Summary statistics of variables of interest.

Variable	Obs	Mean	Std. Dev.	Min	Max
Publications	468	6.861111	5.263094	0	25
Cites	468	89.4188	122.7616	0	781
Patent Applications	468	0.053419	0.298693	0	3
EU (ByAwardYear)	468	55079.77	195593.3	0	2953700
GOV (ByAwardYear)	468	19776.6	90417.34	0	1292373
GOVEU (ByAwardYear)	468	56174.05	162194.6	0	1535014
PRIV (ByAwardYear)	468	24205.26	62447.79	0	500000
UNCLA (ByAwardYear)	468	1828.938	16331.49	0	205600
EU	468	44607.59	88217.03	0	642790
GOV	468	18165.6	46326.66	0	403753.3
GOVRTD	468	43732.58	79465.98	0	556341.3
PRIV	468	21723.58	34338.73	0	244900.6
UNCLA	468	1468.536	10242.13	0	102800

Table 2. Pairwise correlations across variables of interest.

	Publications	Citations	EU	GOV	GOVRTD	PRIV
Publications	1					
Citations	0.6439*	1				
EU	0.3504*	0.1878*	1			
GOV	-0.0815	-0.0002	0.1967*	1		
GOVEU	0.1625*	0.2084*	0.0911*	0.0194	1	
PRIV	0.3199*	0.0373	0.1934*	0.2568*	0.2108*	1

Notes: * displays significance at the 10% level.

Table 3. Regression results.

VARIABLES	(1) lnPubs	(2) lnCites
lnEU	-0.000722	0.00553
	(0.00570)	(0.0150)
lnGOV	-0.00697	0.00386
	(0.00476)	(0.0129)
lnGOVEU	-0.00467	-0.0204
	(0.00619)	(0.0186)
lnPRIV	-0.000549	-0.0220
	(0.00714)	(0.0165)
Constant	0.823***	2.503***
	(0.0923)	(0.240)
Lab Fixed Effects	YES	YES
Year Fixed Effects	YES	YES
Observations	390	390
R-squared	0.682	0.743

Notes. The regressions are estimated via Ordinary Least Squares. Standard errors are clustered at the lab level. *** p<0.01, ** p<0.05, * p<0.1

Table 4. Frequency of patent applications per research lab.

Research Lab	Number of Patent Applications
ANIM---Nutritional Physiology and Feeding	1
BIO---Enzyme Technology	4
CROP---General and Agricultural Microbiology	3
FOOD---Dairy Research	1
FOOD---General Chemistry	9
NAT---Agricultural Engineering	5
NAT---Soil Science & Agricultural Chemistry	2

Table 5. Compare variables of interest between research labs with and without patent applications.

	Labs w/o Patent Application	Labs with At Least One Application	P-Value
Publications	1.18	1.68	0
	(1.04)	(1.14)	
Cites	14.48	20.94	0.05
	(24.89)	(21.62)	
EU	6393.30	10389.52	0.05
	(17706.49)	(11045.71)	
GOV	2790.73	2731.92	0.95
	(7456.63)	(6643.99)	
GOVEU	7235.74	12587.58	0.03
	(16443.90)	(28402.85)	
PRIV	3709.01	5499.19	0.03
	(6950.50)	(6617.14)	

Figure 1. Total number of publications per year.

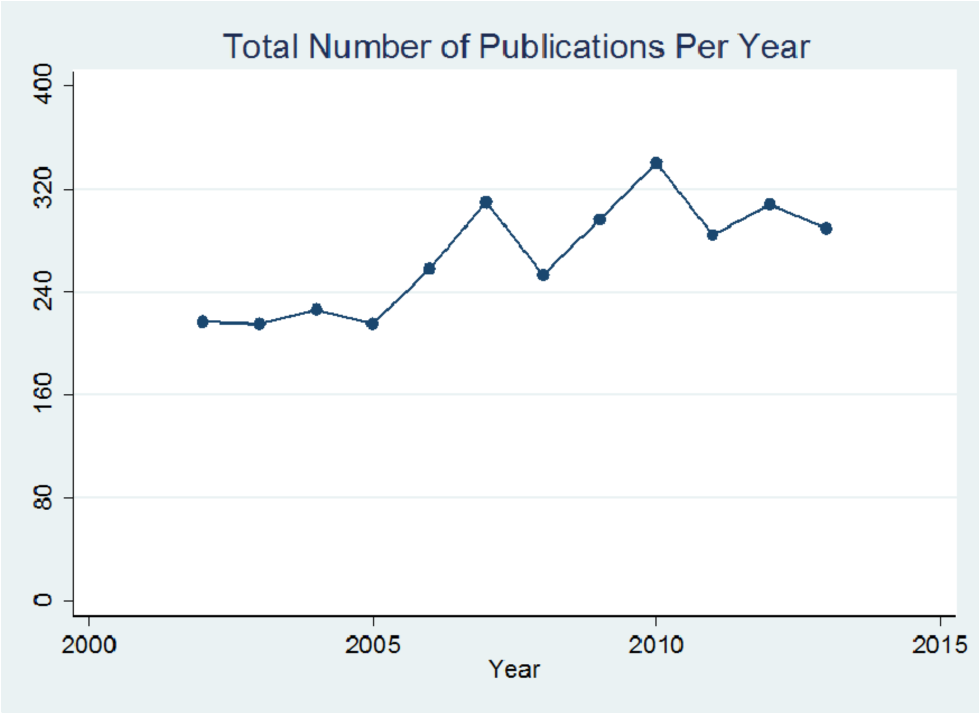

Figure 2. Total amount of research funding by sponsor.

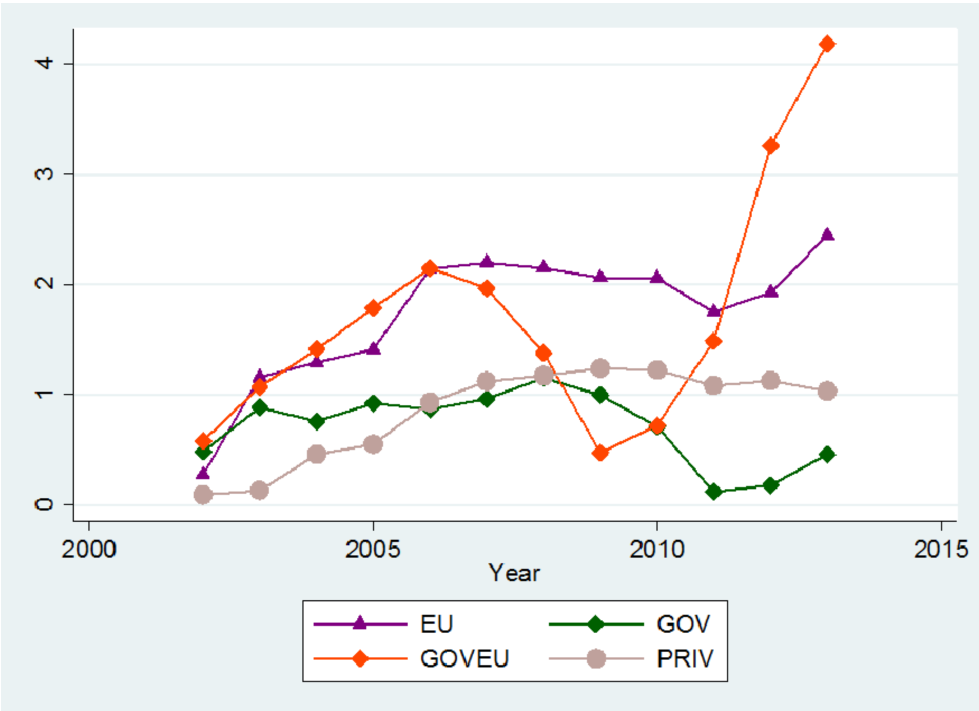

Figure 3. Scatter plot. Publications in relation to each type of research sponsors.

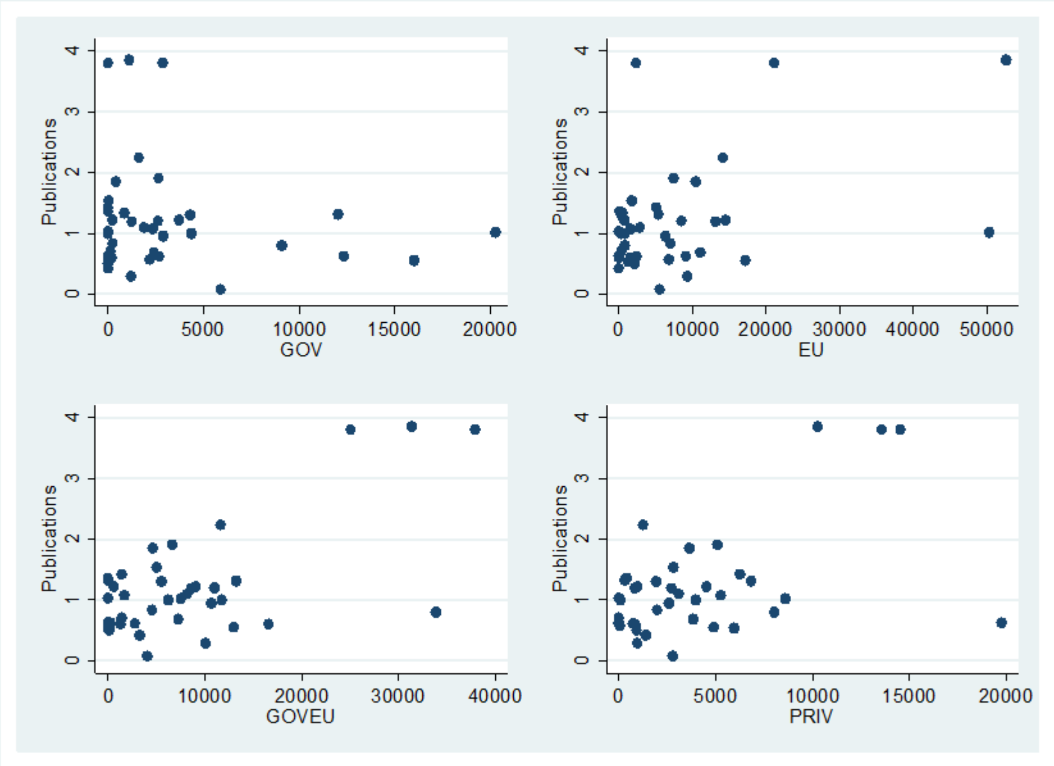

Figure 4. Scatter plot. Citations in relation to each type of research sponsors

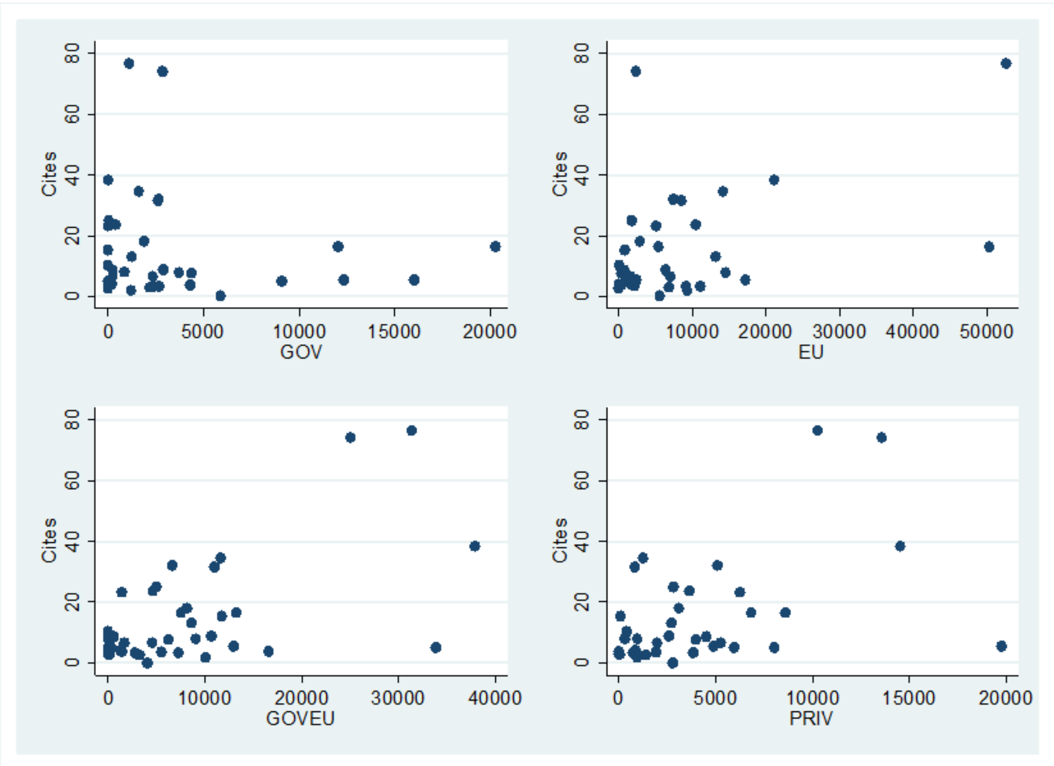

Figure 5. Compare publications and citations for labs with and without patent applications.

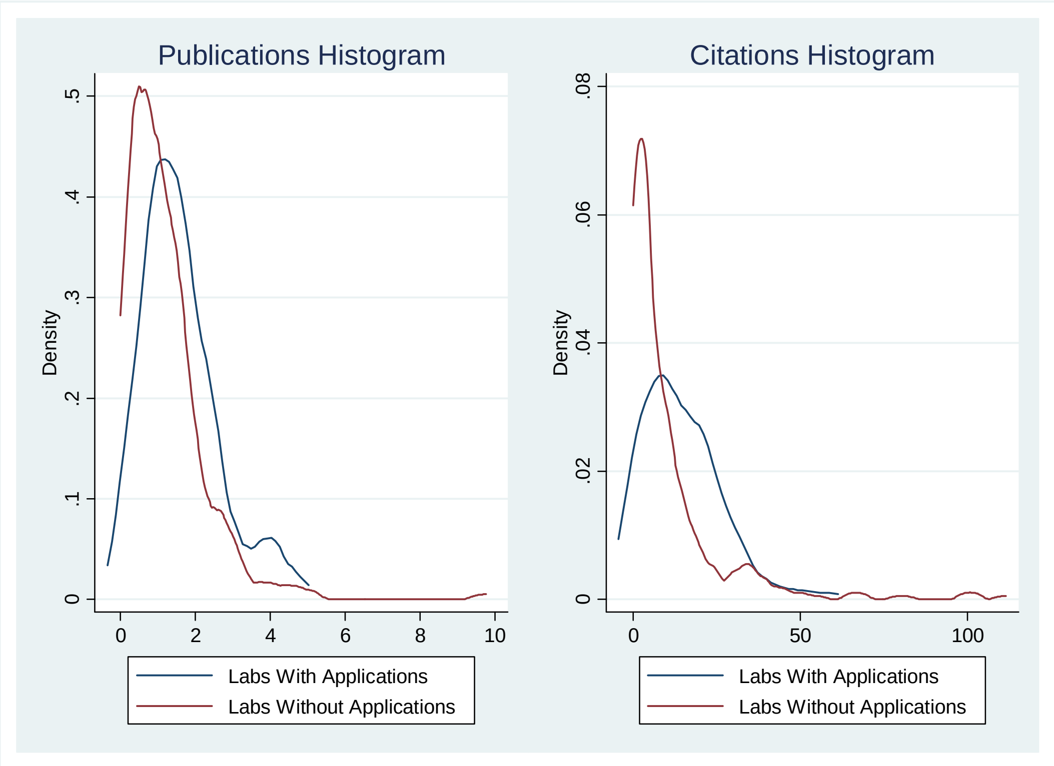

Table A1. Research lab names

Laboratory
AGECON---Agribusiness Management
AGECON---Agricultural Extension, Agricultural Systems & Rural Sociology
AGECON---Informatics
AGECON---Political Economy and European Integration
AGECON---Rural Economic Development
ANIM---Anatomy and Physiology of Farm Animals
ANIM---General and Special Animal
ANIM---Nutritional Physiology and Feeding
BIO---Enzyme Technology
BIO---Genetics
BIO---Molecular Biology
BIO---Physics
CROP---Agricultural Zoology and Entomology
CROP---Agriculture
CROP---Arboriculture
CROP---Ecology and Environmental Science
CROP---Electron Microscopy
CROP---Floriculture and Landscape Architecture
CROP---General and Agricultural Meteorology
CROP---General and Agricultural Microbiology
CROP---Pesticide Science
CROP---Phytopathology
CROP---Plant Breeding and Biometry
CROP---Plant Physiology and Morphology
CROP---Systematic Botany
CROP---Vegetable Production
CROP---Viticulture
FOOD---Dairy Research
FOOD---Food Chemistry and Analysis
FOOD---Food Microbiology and Biotechnology
FOOD---Food Process Engineering, Processing and Preservation of Agricultural Products
FOOD---Food Quality Control and Hygiene
FOOD---General Chemistry
NAT---Agricultural Constructions
NAT---Agricultural Engineering
NAT---Hydraulic Agriculture
NAT---Mathematics and Theoretical Mechanics
NAT---Mineralogy and Geology
NAT---Soil Science & Agricultural Chemistry

The abbreviation before the Laboratory name stands for the department the laboratory belongs to. AGECON refers to Agricultural Economics & Rural Development; CROP to Crop Science; ANIM to Animal Science and Aquaculture; BIO to Agricultural Biotechnology; FOOD to Food Science & Technology; NAT to Natural Resources Management & Agricultural Engineering.