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- ***Conference themes***

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- ***Keywords***: Researcher impact, research collaboration, Public-private R&D collaborations; Government-universities-industries research co-funding; research policy evaluation

- **Title**

Research funding in the «triple helix» era: does funding source determine researchers impact and to what extent? Empirical evidence from health research disciplines in Canada (2001-2008)

- **Abstract**

In order to maximize their individual productivity and their international visibility, academic researchers must compete for grants and resources. If they have to publish, they also have to struggle for funding, coming not only from conventional funding councils (federal government), but also from the private sector (firms, private organisations, etc.) and local government initiatives (provincial and regional councils, etc.). In the "triple helix" era, researchers have to diversify their funders and behave consequently in order to optimise their extrants and outcomes, as funder requirements anticipate.

Our article seeks to identify the factors that determine researcher productivity in the health research fields, in 6 universities in Canada from 2001 to 2008. The main hypothesis is that productivity in scientific research is significantly influenced by the amount and origin of the funding sources invested to support scientific research performance. Individual publications in referred journals (number of publications, fractioned publications, citations, impacts, h-index) were used as surrogates for research productivity. Based on a sample of 2070 researchers and time series data (2001-2008), our results suggest sharply diminishing returns of grants dedicated

to research. We find that age, gender, size and language (Francophone versus Anglophone) of university instruction, funding councils, grants and provincial government funding significantly affect researcher productivity and collaborations.

Theory. Despite this ongoing funding effort required by research in the health sector, researcher contribution to the advancement of knowledge is rather unpredictable and uncertain (Carayol & Matt, 2006; Adams & Griliches, 1996, 1998; Mortimore, 1999). It raises certain questions about the determinants of researcher productivity and the impact of their scientific publications (Edwards, 2000). It is postulated that the funding sources do not all necessarily have the same effect on researcher productivity and on the impact of the scientific articles produced. Due to the significant amount of funding for university research, funding organisations, like other public organisations, have been exposed to the demands of optimising resources, leading to adjustments in their allocation strategies and criteria for university research funding based on researcher performance. In this context, the relationship between the inputs and outputs of subsidized research (scientific publications and associated impact) emerges as a strategic issue for public decisions having an impact on innovation and the development of competencies. Our paper focuses on the relationship between research inputs (grants, contracts, different funding sources, etc.) and research outputs (productivity, citation, impact, etc.) (Carayol & Matt, 2006; Bozeman & Gaughan, 2007; Abramo, D'Angelo & Caprasecca, 2009; Marinova & Newman, 2008; Defazio, Lockett & Wright, 2009). A two-phased approach has been used for empirical analysis. The first is concerned with the origin and size of the effects of total funding on productivity in research. The second looks at the effects attributable to funding from funding grants from the different levels of government and to funding from the private sector (corporations, foundations, etc.).

Economic theory has greatly inspired the measurement of the productivity of scientific research, especially through econometric models relating, at the macroeconomic level, the outputs

of university research to their outcomes on economic growth and the improvement of societal well-being (health, wealth, standard of living, etc.). We have taken our inspiration from the works of Adams and Griliches (1996/1998) that equated the productivity of scientific research, using the production functions known in economics and whose logarithmic specification can estimate the elasticity coefficients of the outputs of scientific production, to input variation, in particular, financial capital (grant, funding, etc.), human capital (researcher's qualifications, age, gender, status, etc.) and any other asset linked to the attributes of the research disciplines or research organisations (research groups, laboratories, departments, etc.). From linear regression techniques, the evaluators are then also able to estimate the returns to scale of the inputs with regard to the analysed outputs (Adams & Griliches, 1998).

The evaluation of science policies sheds light on the performance, adequacy and value of public support for scientific research and innovation (Marinova & Newman, 2008; Hicks, Tomizawa, Saitoh & Kobayashi, 2004; Abramo et al., 2009; Geuna & Martin, 2003). Using substantiating evidence, several governments have implemented evaluation mechanisms to assess the effects and outcomes of publicly funded scientific research. Program evaluation offers the possibility of formalizing the links between inputs, outputs and impact (or outcomes). The literature dealing with productivity in research has highlighted many of its determinants. These can be put into at least three categories: researchers' individual attributes, funding attributes and the organisational attributes of the research context. Funding attributes are at the core of much empirical research (Carayol & Matt, 2006; Adams & Griliches, 1996-1998). This research shows us that productivity in research would be heavily influenced by strategies and priorities linked to the granting of financial incentives by research funders (Auranen & Niemine, 2010; Fender, Taylor & Burke, 2006). The type of funding (research funded by grants vs. research sponsored by the public or private sector) would have different effects on researcher productivity. The most productive researchers would be those who implement coincidentally merit-based funded

research (through grants) and contracted research sponsored by private and public partners (Bozeman & Gaughan, 2007).

Data. The statistical analyses conducted in this research use two categories of data. The data on funding come from administrative and statistical files declared by the universities (university research funding, whatever its source) at the request of the Quebec Ministry of Education. The bibliometric data are extracted from Web of Science (WoS -Thomson Reuter) that indexes the articles from more than 11,000 scientific journals.

Results. The results of the statistical analyses are presented with commentary below, following a two-phased approach. First, the effects of total aggregate funding are examined, and then the effects of funding from each of the sources studied (research funding councils, federal or provincial government, private sector). Our results suggest that aggregate funding is a determinant of research productivity indicators for researchers in education. The regression coefficients linked to the variable measuring overall funding per researcher are all positive and statistically significant, therefore confirming the importance of the effects of funding on research productivity. The regression coefficient varies from 0.17 to 0.32. This coefficient constitutes a measure of elasticity (relative variation of outputs following a relative variation of inputs). Our results suggest, for example, that a 10% increase in funding to researchers generates a 3% increase in the volume of publications produced, an approximate 2% increase in the mean h-index, in the fractioned number of publications and in the number of citations, and finally a 1% increase in the mean impact factor. Certain individual attributes used also influence researchers' productivity. Our analyses suggest that productivity tends to decrease with age. In other words, other things being equal, the younger the researchers, the more they produce. Furthermore, the gender of the researcher does not seem to significantly influence the productivity variables. The results obtained also suggest that university institutional attributes influence productivity in health research. Other things being equal, researchers working in Anglophone universities (McGill,

Concordia) tend to produce more articles (indexed in the databases used), to be cited more often and to benefit from a higher impact factor.

Wishing to analyse further the effects of funding on research productivity, we have decomposed the total funding by using four funding categories: academic funding from funding councils, sponsored research funded by the federal government, sponsored research funded by the provincial government, and funding from corporations and not-for-profit organisations (sponsorship, in particular). Our results suggest that academic funding from funding councils and grants exercises a positive and statistically significant impact on almost all researcher productivity indicators. Our results also suggest that both private sector and provincial funding is significantly impacting health research productivity, mainly in terms of number of publications and collaboration. The results related to the other control variables suggest that age is a significant determinant of researcher productivity. Our results indicate that the publication of articles is associated with gender; specifically men are related to a higher level of productivity than women (with a logarithmic transformation). This result is consistent with Hesli & Lee (2011) who found that the publication of articles is gender-related, with more published articles for male researchers than for female ones.

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