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PUBLIC FUNDING OF RESEARCH IN THE SOCIAL SCIENCES: ARE CANADIAN ACADEMICS DISCOURAGED?

Marco Cozzi
Department of Economics, University of Victoria
Victoria, B.C., Canada V8W 2Y2

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Abstract

I use Social Sciences and Humanities Research Council data to analyze some of the elements shaping the decision of Canadian researchers to apply for public research grants. Relying on both time series and panel data methods, I find that researchers show some degree of forward looking behavior and an aversion to the instability of the funding likelihood (hence, to the uncertainty in the policy environment). In particular, the volatility of the funding probability deters researchers from submitting proposals. I then speculate on the possible consequences of the current funding scheme and on the chances for some recent worrisome trends to revert in the near future.

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JEL Classifications: H50, I23, I28.

Author Contact:
Marco Cozzi, Dept. of Economics, University of Victoria, P.O. Box 1700, STN CSC, Victoria, B.C., Canada V8W 2Y2; E-mail: mcozzi@uvic.ca; Voice: (250) 721-6535; FAX: (250) 721-6214

Public Funding of Research in the Social Sciences: Are Canadian Academics Discouraged?

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I use Social Sciences and Humanities Research Council data to analyze some of the elements shaping the decision of Canadian researchers to apply for public research grants. Relying on both time series and panel data methods, I find that researchers show some degree of forward looking behavior and an aversion to the instability of the funding likelihood (hence, to the uncertainty in the policy environment). In particular, the volatility of the funding probability deters researchers from submitting proposals. I then speculate on the possible consequences of the current funding scheme and on the chances for some recent worrisome trends to revert in the near future.

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Contact details: *Department of Economics, University of Victoria, 3800 Finnerty Road, Victoria, BC V8P 5C2, Canada. Tel: 1-250-721-6535, Fax: 1-250-721-6214, E-mail:* mcozzi@uvic.ca

1 Introduction

Research in the Social Sciences is typically carried out at post-secondary educational institutions. In Canada, academic researchers primarily seek funding by submitting proposals to the Social Sciences and Humanities Research Council (SSHRC), a federal agency founded in 1977.[1] SSHRC currently runs a number of initiatives: Insight, Talent, and Connection. Jointly with NSERC and CIHR, it also runs the Canada First Research Excellence Fund (CFREF), a recent and fairly small scheme that was established in 2015. The 2017-18 budget shows that $176.7 million (45.4%) was devoted to the Insight initiative, $169.0 million (43.6%) to the Talent initiative, $29.6 million (7.6%) to the Connection initiative, and $12.9 million (3.3%) to the CFREF initiative. In this paper I am going to focus on the Insight programs, which were introduced in 2012 as part of a major re-design in the structure of the SSHRC grants, and on their predecessors, the Standard Research Grants.[2] These schemes are important in terms of overall funding and are the principal way of financing basic research by both experienced and emerging scholars at Canadian institutions. Among many undertakings, social scientists participate in the debate for the design of key policies, yet the research funding they receive currently accounts for only 0.046% of Canadian public expenditure. This article studies the determinants of the number of grant proposals submitted to SSHRC, it describes some empirical evidence and suggests some avenues that might lead Canadian scholars to increase their efforts in this domain.

1.1 Institutional Background

Quoting from SSHRC's website, the Insight program's goal is: "to build knowledge and understanding about people, societies and the world by supporting research excellence in all subject areas eligible for funding from SSHRC".[3,4] Arguably, these objectives are very broad and loosely defined, which perhaps is an intrinsic and unavoidable feature of public programs aimed at funding a wide array of fields and approaches to research. However, this level of generality makes long term assessment an extremely challenging task. As a consequence, it is hard to know if and when it would be desirable to undertake changes in funding initiatives.

[1] The other two federal funding agencies are the Natural Sciences and Engineering Research Council (NSERC), whose mission is fostering discovery and innovation in natural sciences and engineering, and the Canadian Institutes of Health Research (CIHR), whose mission pertains discoveries and innovations that strengthen Canada's health care system and improve the health of Canadians. Researchers might also have access to provincial funding, depending on the location of the institution they are based at. In the Social Sciences provincial funding has not been offered regularly, with the exception of Québec and their Fonds de Recherche du Québec Société et Culture (FRQSC).

[2] For brevity's sake, I am going to refer to either as the SSHRC research grants.

[3] The disciplines pertaining to SSHRC are: Anthropology, Archaeology, Archival Science, Classics/Classical and Dead Languages, Communications and Media Studies, Criminology, Demography, Economics, Education, Fine Arts, Folklore, Geography, History, Industrial Relations, Interdisciplinary Studies, Law, Library and Information Science, Linguistics, Literature and Modern Languages, Management/Business/Administrative Studies, Mediaeval Studies, Philosophy, Political Science, Psychology, Religious Studies, Social Work, Sociology, Urban and Regional Studies/Environmental Studies.

[4] The Talent program's goal is: "to support students and postdoctoral researchers in order to develop the next generation of researchers and leaders across society, both within academia and across the public, private and not-for-profit sectors". The Connection program's goal is: "to realize the potential of social sciences and humanities research for intellectual, cultural, social and economic influence, benefit and impact on and beyond the campus by supporting specific activities and tools that facilitate the flow and exchange of research knowledge".

The Insight initiative replaced the Standard Research Grants (SRG) in 2012. A major innovation was the creation of two separate competitions: the Insight Grants (IG) and the Insight Development Grants (IDG). These initiatives have separate deadlines, budgets, and adjudication committees. IG proposals are typically due in mid October, while IDG ones in early February. The related guidelines on how to allocate the overall resources between the two schemes are not disclosed.[5] Researchers affiliated with eligible Canadian post-secondary institutions cannot submit proposals to both competitions in the same calendar year, while they can do so in two consecutive years (provided they submit substantially different proposals). Projects that do not get funded can be re-submitted in a future competition of the same type. In particular, some proposals are recommended for funding, but do not receive any because SSHRC runs out of resources.

The IDG are designed to support preliminary research ideas, rather than full-fledged research agendas. These grants allow for a maximum of $\$75,000$ of funding over two years, and 50% of the total available resources are reserved to fund proposals submitted by emerging scholars (i.e., new researchers, within 6 years of obtaining their Ph.D.'s).[6]

The IG are designed to support research excellence, meant to be achieved with a structured and articulate research agenda. In their latest incarnation, depending on the project size, applicants can choose between two funding streams. One stream of these grants allows for a maximum of $\$100,000$ of funding over five years, while the other stream between $\$100,000$ and $\$400,000$ of funding over the same time horizon.

As for the evaluation of the submitted projects, the IG applications are first assessed by external reviewers, usually with three referees per proposal. Subsequently a designated (field-specific) adjudication committee ranks all the proposals and decides which ones should be funded. The IDG applications are not assessed by external reviewers, and the funding decisions are made entirely by the (field-specific) adjudication committees. There are strict rules concerning conflicts of interest (potential and objective), which must be declared by the committee members. Any affected proposal is then assessed only by members without a conflict of interest. Both the external reviewers and the adjudication committees must follow specific criteria developed by SSHRC to assess various dimensions of both the proposal and the applicant(s). These are grouped in the Challenge, Feasibility, and Capability areas.

The superseded SRG shared many features with the present-day IG. The SRG was designed to support research programs and develop excellence in those research activities. In their last round these grants allowed for a maximum of $\$250,000$ of funding over three years, but this limit changed considerably over time. The proposals submitted by new and regular scholars were scored using different criteria. To the best of my knowledge, the SRG allowed for a broader category of eligible expenses. In particular, in the year 2000 the so-called Research Time Stipend (RTS) was introduced, which was in place until 2010. The RTS allowed researchers to buy-out some of their teaching duties.

[5] The detailed rules of the three grant schemes can be found in SSHRC (2018a).

[6] Whenever the funds are not spent in full at the natural end of the grant, SSHRC has an automatic one-year extension in place. If the funds are not spent by then, usually the managing institutions retain the outstanding balance, which can be used to fund their general research costs.

1.2 Related Literature

In the literature, there is an extensive body of work addressing the most fundamental question of whether public research funding increases university research output. There appears to be consensus on the broad answer, namely more resources do make researchers more productive.[7] Using U.S. data, Adams and Griliches (1998) and Payne and Siow (2003) find that Federal funding positively affects the number of publications. However, there is some evidence of diminishing returns at the researcher/institution level. Not only public funding, but also private endowments can be used to finance research, and Whalley and Hicks (2014) use an instrumental variable analysis that confirms that total research spending has a substantial and positive effect on the number of papers produced. However, they do not find the same effect on the impact of these contributions: more generous funding does not seem to facilitate breakthroughs.

For Canada, both Fortin and Currie (2013) and Murray et al. (2016) use NSERC data. The former show that impact measures of the researchers' output are weakly correlated with more generous funding, while the latter detect negative biases (at the stage of the evaluation of the proposals) against researchers working at smaller institutions. On the basis of their results, both contributions make the case for public funding strategies that favor diversity, rather than excellence.

A limitation of most contributions in the literature is the lack of experimental data. Some authors have tried to overcome this shortcoming by using a structural approach, tackling the selection and simultaneity issues with an explicit model. This is the method proposed by Arora, David and Gambardella (1998), that rely on Italian biotechnology grant applications, and find an average elasticity of research output with respect to funding of 0.6 (doubling the resources given to a researcher increases their output by 60%). Others have exploited the characteristics of the institutional frameworks to implement program evaluation techniques, as advocated by Jaffe (2002). In this vein, Chudnovsky et al. (2008) exploit the exogenous variation in the availability of funding in Argentina to use both a difference-in-differences estimator and a propensity score matching one. In this setting they find a positive effect of funding on productivity, which is particularly strong for junior researchers.

One notable exception to the effectiveness of public funding is found by Jacob and Lefgren (2011). Using NIH data, their estimates show that receiving approximately $1.7 million of USD (the average value of a NIH research grant) leads to only a 7% increase in output, namely one additional publication over the next five years. An explanation that the authors have put forward for their result is that the researchers that are just below the NIH funding threshold (the main source of identification in their regression discontinuity design) are able to secure funding from other sources.

Two other papers that exploit a regression discontinuity approach to estimate the causal effect of research funding on research output are Benavente et al. (2012), that relies on data from Chile, and Gush et al. (2018), that relies on data from New Zealand. They both find positive effects of funding on productivity.

Mongeon et al. (2016) argue that a concentration of research funds leads to decreasing marginal returns. Their findings also clash with the notion that larger grants lead to groundbreaking discoveries. Given the evidence on decreasing returns of research inputs, a less concentrated allocation of funds might be desirable.

[7] For comprehensive surveys on the economics of science see Stephan (1996), Antonelli, Franzoni and Geuna (2011) and Stephan (2012).

In the literature, there is a crucial debate on the pro's and con's of different funding modes, illustrated by Stephan (2012). Azoulay, Graff Zivin and Manso (2011) assess the merits of not penalizing early failures too heavily, exploiting data from the life sciences. In particular, they compare the output of researchers that are funded by the NIH (which is unforgiving of early failures) with that of researchers that are funded by the HHMI (a medical institute focused on long-run outcomes). They find that HHMI researchers produce more high-impact articles compared to similar NIH-funded investigators. Wang, Lee and Walsh (2018) study how competitive and block funding affect a measure of research novelty. Using data from Japan, they find mixed results: competitive funding seems to foster the creativity of senior scholars, while block funding seems to achieve a similar outcome for less established (junior and female) researchers.

Finally, Lane (2010), Hicks (2011) and Hicks et al. (2015) are some of the most influential contributions in the field of Science metrics. These authors have argued that accurately measuring research output is of paramount importance, particularly in assessing the relative performance of different funding practices.

While Gordon (2016) already reported and interpreted some of the trends that I will discuss in this article, in the literature there is limited work on the incentives for researchers to apply for public funding. My paper contributes to this debate. On the basis of both descriptive and regression analysis, I speculate that Canadian researchers submitting fewer grant proposals than in the past is partially due to the perceived instability of the funding opportunities. After the SSHRC reform, researchers have been trying to learn the new environment, but in the face of too uncertain a return, many stopped undertaking a costly action. Drawing a parallel from labor economics, I will refer to this circumstance as discouraged researchers.

The rest of the paper is organized as follows. Section 2 presents a preliminary descriptive analysis, documents some facts, and discusses some exploratory time series estimates. Section 3 contains a thorough panel data analysis, using methods for a limited dependent variable. Section 4 offers a discussion of the main results, while Section 5 concludes. Three appendices include further details on the empirical methods used (Appendix A), on the panel dataset compiled for the econometric analysis (Appendix B), and on some robustness checks (Appendix C).

2 Preliminary Time Series Evidence

In this section I document some facts related to the SSHRC research grants over the 1995-2017 period. I start by focusing on the aggregate SSHRC outcomes for all disciplines. Because of some noteworthy differences, I then move to present separately evidence for the field of Economics. For both groups, I also present and discuss the results of some exploratory time series analysis.[8] In the graphs, the vertical lines represent the implementation of the 2012 SSHRC grants reform, which introduced the Insight initiatives as the new framework for administering and funding research grants.[9]

[8] All pecuniary series are adjusted for inflation using the CPI index, with 2002 as the base year.

[9] To ensure comparability between the Standard Research Grants and the Insight initiatives, for the latter I added up the proposals submitted to, and funded by, both Insight schemes.

2.1 Grant Proposals and Funding Trends for the SSHRC Disciplines

[Figure 1 about here]

Figure (1) shows four different plots displaying the aggregate trends of all SSHRC disciplines. The first panel depicts the time series of the overall grant proposals submitted, together with the overall number of projects funded. Several patterns emerge. First, both series have trended upward, with both the proposals and the projects funded more than doubling at their peaks in 2011. The series for the number of proposals shows a remarkable growth from 2000 until 2011, and since then it has behaved more erratically. This recent instability might be explained by: a) an anticipation effect, with researchers submitting more proposals than normal in 2011, because of the imminent radical changes in the SSHRC initiatives that were announced (making it more difficult to predict the future environment), b) a sequential downward updating on the expected value of a grant, arising from a more accurate understanding of the new system. The series for the number of projects funded has fairly different dynamics. In particular, after the sudden fall in 2012, it decreased slowly until 2015, and only more recently it partially reversed this trend. The second panel depicts the funding (requested and granted) in million of real Canadian dollars (CAD). In the first twenty years of the sample, Canadian researchers in the Social Sciences almost tripled their requests in terms of research funds, which reached 400.6 million in 2014. The total funds actually granted have been increasing by a similar factor, with some significant differences. In particular, the latter has decreased between 2004 and 2011, only regaining its 2004 value in 2012. As argued by Gordon (2016), this suggests that there was a period during which SSHRC was in a position to accommodate systematic larger budget requests, a tendency that eventually stopped (possibly because of a changing political climate, and/or because the fast growth in the budgets was deemed unsustainable). The third panel depicts two series related to the grants' success rates. The solid line can be interpreted as the unconditional (ex-post) probability of a proposal being funded, while the dashed line as the share of the total requested funding that was actually paid out. Also in this plot there are some remarkable trends. The probability of success has been changing wildly, with a range of 19.7 percentage points. In some years researchers faced a probability of being successful in excess of 42%, while more recently the corresponding figures have been below 24%. Although the decline in the proposals' success rates started in the late 1990's, the changes in the SSHRC initiatives have had an unprecedented negative effect, with a cumulated fall of 13.5 percentage points in the first two rounds of the new competitions. Historically, the funding success rate has co-moved with the proposals success rate. The only major difference between the two is observed again in the years following the reform. The fourth panel displays the average funding per project. The solid line depicts the average amount of grant dollars requested per proposal, while the dashed line is the average amount paid out per successful proposal. These series also changed drastically over time, suggesting some strategic behavior by the researchers and a change in standards applied by SSHRC. In real terms, from its trough to its peak, the amount requested per project increased by 55.2%, from $\$78,901$ to $\$122,423$, with a sudden acceleration after 2011. Perhaps, what is even more spectacular is the narrowing down of the gap between the two series. This suggests that SSHRC, as far as funding decisions are concerned, has operated relying on both the extensive and the intensive margins, with the related mix

changing over time. In particular, the 2012 reform brought about another change: fewer projects were funded overall, but the researchers started obtaining virtually the full amount of their proposed budgets. This new regime has also been discussed by Gordon (2016), who emphasized how this might be due to a strategic element. Different committees did not have an incentive to cut the proposed budgets, because the savings made were not retained in the same field. Given the historical values, it is plausible that until the reform took place researchers were expecting a substantial reduction in their proposed costs, with this downward adjustment intensifying after 2004. However, following the reform, the requested and actual funding almost converged. The increase in the requested funds could be due to a combination of a genuine underlying increase in the cost of doing research (e.g., because of expensive specialized equipment, or a paradigm shift towards pricey experiments and data collection endeavours) and an attempt to undo the expected trimming of the budgets.

Taken together, these plots suggest that Canadian researchers in the Social Sciences have been facing quite a turbulent environment, with drastic changes in both the likelihood of being funded and the amount of funding received.

In many respects, the Canadian experience is not unique. Stephan (2012) documents that also in the U.S. system the National Science Foundation (National Institute of Health) had anywhere between 20% and 37% (10% and 40%) of funded research proposals. Furthermore, in the early 2000's the NSF increased the average grant size by 41%, with the side effect of plummeting success rates. Given the different nature of the two systems, though, in the U.S. the number of applications (both overall and per applicant) increased. As argued above, this has not been the case for Canada. Conceivably, since Canadian post-secondary institutions typically do not rely on "soft money" to pay for their faculties' salaries (e.g., the summer support is guaranteed, as standard contracts for faculty members pay a salary for 12 months) Canadian researchers did not face an immediate and substantial cost of reduced research funding, with a number of researchers abandoning the routine of crafting grant proposals. In the face of a deteriorating likelihood of success, Canadian researchers in the Social Sciences started seeking less public funding for their research, which, especially for tenured faculties, can be less salient for their future careers and economic outcomes.

2.1.1 Exploratory Regression Analysis

In order to get a better understanding of what drives the number of proposals submitted to SSHRC, I start by considering a simple time series framework. The most general specification is included in the following equation (1):

$$\begin{aligned} proposals_t = \beta_0 + \beta_1 proposals_{t-1} + \beta_2 successrate_{t-1} + \beta_3 successrate_t \\ + \beta_4 successrate_{t+1} + \beta_5 cv\_successrate_{t-1} + \beta_6 cv\_cad_{t-1} + \epsilon_t. \end{aligned} \tag{1}$$

The dependent variable ($proposals_t$) is the aggregate number of research grant proposals submitted to SSHRC in a given fiscal year (t).[10] In terms of explanatory variables, notice the presence of: a) an autoregressive component

[10] Given the small sample size ($T = 20$ or $T = 19$, depending on the specification), the estimation results and the inference should be taken with caution. I also performed Dickey-Fuller tests for unit roots. In the all disciplines (Economics) sample, the

of order 1 ($proposals_{t-1}$), b) the success rate ($successrate_t$) with potentially a lag structure, and c) the rolling coefficients of variation (in the three-year window before period t) of the success rate ($cv\_successrate_{t-1}$) and the dollar amount received (cv_cad_{t-1}).[11]

[Table 1 about here]

Table 1 reports the estimation results of a set of simple OLS regressions, and each column represents a progressively richer model.

The first column suggests that the number of proposals submitted in the previous year can positively affect the current number of proposals. This might be due to temporary improvements in institutional services that make putting together an application less costly. However, the statistical significance is lost in more general specifications. The lag of the success rate has always a negative sign, possibly exacerbating the mechanical effect of multiple years of funding. A year with an exceptionally high success rate might be followed by a decline in the applications, because of the decreased need to secure funding immediately. The two sets of remaining explanatory variables are of particular interest. One set refers to proxies for the instability of the environment, represented by the conditional volatility of the success rate and of the funding received. Although both parameters are imprecisely estimated, the former channel seems to deter researchers from applying. Turbulent periods, especially in terms of the perceived probability of getting funded, can negatively affect the number of submitted proposals. The volatility of the funds actually received seems to be less important: arguably, researchers can adjust the cost of the project (e.g., by attending fewer conferences), provided that some funding is obtained. The other set of variables consists of the contemporaneous and future expected success rates.[12] It attempts to capture whether researchers display forward looking behavior. The rationale behind including the future success rate is that researchers have an appreciation of the quality of their prospective proposals, eventually submitting them only when they will be deemed ready for external scrutiny. The negative coefficient on the future success rate seems to suggest that this delaying effect is at play. If a researcher (correctly) believes that the probability of getting funded will increase in the future (say because of an announced expansion in the SSHRC budget, or additional time spent polishing an incomplete application) this will have a negative effect on the current number of proposals. The negative, albeit imprecise, estimate on the contemporaneous success rate is harder to interpret, but it might be suggesting the presence of a strong self-selection mechanism.

Dickey-Fuller test with a drift term rejects the null hypothesis of a unit root at the 10.2% (5.4%) for the proposals variable, and at the 4.4% (2.5%) level for the success rate. Finally, ϵ_t stands for the error term, and the β_j's, $j = 0, ..., 6$, are parameters to be estimated.

[11] I use a three-year window as, in the on-line reports, usually SSHRC lists the statistics of the last three rounds of that initiative. I also experimented with a five-year window, and the results were similar, at the cost of losing even more observations.

[12] For the variable $successrate_{t+1}$, lacking data on expectations, I simply replace them with the realized values, which can be interpreted as a form of rational expectations.

2.2 Public Funding of Research in the "Dismal Science": Are Canadian Economists Discouraged?

In this subsection I focus on a specific SSHRC discipline, Economics, whose core is fittingly concerned with studying the allocation of scarce resources.[13] Figure (2) re-proposes the same plots depicted in Figure (1), now with data only for Economics, while the first two panels in Figure (3) provide a direct comparison of the trends for Economics vs. all other SSHRC disciplines (excluding Economics, and labeled as Non-Economics).

[Figures 2 and 3 about here]

Figure (2) shows that for Economics we might be witnessing the unfolding of two lost decades. The number of applications is virtually back to its 1995 value, and in the 2013-2015 period the number of funded proposals was even below its 1995 value (with a mere 49 projects funded in 2014). Differently from the Non-Economics group, a sizable fall in applications was observed in the year before the reform, while in 2012 the number of proposals increased. The swings in the success rates have been even more pronounced, with a range of 23.4 percentage points. For Economics, the rise in budgets seems to pre-date the one for the Non-Economics group. In real terms, from its trough in 1997 to its peak in 2009, the amount requested per project increased by 64.3%, from $\$57,254$ to $\$94,056$, with a jagged behavior starting already in the mid 2000's. The funding plot shows that the two series have intersected. This means that not only did the practice of trimming the budgets change, but also some selection has been at play: recently, the proposals with larger budgets have been granted funding.

At a glance the trends between Economics and Non-Economics appear to be quite similar, but a few discrepancies are worth pointing out. In the first panel of Figure (3) it is possible to detect two main differences: a) the recent drop in the number of applications is more pronounced for Economics, with signs of an acceleration of the phenomenon; b) Economics researchers displayed a pattern of declining proposals already at the beginning of the sample, with the number of applications plummeting in just four years. An uncontroversial fact is that in recent years the number of applications has fallen at a remarkable rate. In 2017, the figure for Economics reveals that only 145 applications were submitted, which represents a 28.6% decrease from the peak of the series in 2014, when 203 applications were received. The corresponding figure for all other SSHRC disciplines is a 15.1% decrease between 2014 and 2017, and a 18.8% decrease from the peak of the series in 2011. The second panel shows that starting in second half of the 1990's, both the Economics and Non-Economics groups enjoyed an increase in the number of projects funded. However, this pattern changed quite abruptly for Economics, with the long run trend in the last decade now being a decrease.

In terms of descriptive analysis, some Economics series are somewhat less volatile: the coefficient of variation for the Economics proposals (funded proposals) is 0.201 (0.199), while the same statistic is 0.273 (0.236) for all other disciplines. This result might be counterintuitive, as the non-Economics series is an aggregate one, hence it is implicitly "averaging out" a spectrum of potentially different behaviors. This suggests that there is a sizable amount of correlation among the SSHRC disciplines.

[13] For a comparison with the U.S. system, see Arora and Gambardella (2005), who exploit NSF data on all applications in Economics during the 1985-1990 period.

2.2.1 Exploratory Regression Analysis for Economics

Table 2 reports the results of the same time series regressions considered above, now estimated on the Economics sample.

[Table 2 about here]

Overall, the results are in line with what was found above for the SSHRC disciplines as a whole. Notable differences are: a) the explanatory power is uniformly lower, yet still high, b) the negative sign on the past success rate appears to be more robust, while the current success rate does not seem to play a role, c) the negative sign on the success rate volatility is more precisely estimated, while the funding volatility has a consistently positive sign.

2.3 Taking Stock

The results draw a bleak picture, with some disciplines (e.g., Economics) experiencing eroding opportunities to undertake appropriately funded research. Some further broad observations can help understanding the current environment for Canadian researchers in the Social Sciences.

In real (nominal) terms, the growth rate of Canadian GDP in the 1995-2017 period has been 70.7% (158.8%), the growth rate of SSHRC funds devoted to research grants was 158.3% (284.5%), while the growth rate of SSHRC funds devoted to Economics research grants was only 62.5% (141.9%). It is kind of ironic that in the land of sophisticated bargaining theorists (see e.g., Hosios (1990), Osborne and Rubinstein (1990), and Shi (1995)) the Economics discipline as a whole has not managed to hold its ground in terms of the public funding allocation for academic research.

The third panel in Figure (3) plots the Herfindahl concentration index for the SSHRC grants, computed with the panel dataset that will be introduced in the next section. The index is quite volatile, ranging from 0.0456 to 0.0533. For the first ten years of the sample, the index showed a declining trend, which eventually reverted. Compared to the value of the index observed in many industries, the Canadian SSHRC grants do not seem to be overly concentrated. However, it is not obvious which sectors might represent a valid benchmark.

The last panel in Figure (3) shows the trends for the number of faculties and student enrollment. These data are aggregate, namely they also include students and faculties in disciplines that are outside SSHRC's scope. However, the relative importance of the SSHRC disciplines has stayed virtually constant, as in 1997 and 2007 (the two years with the relevant data) they accounted for 67.7% and 67.3% of the degrees granted by Canadian universities, respectively.[14] Applying an adjustment to these figures would not affect the trend. The Students/Teacher ratio has risen from 36.4 in 1992 to 44.6 in 2016, a 22.5% increase. It seems fair to conjecture that this has implied increasing demands in terms of teaching duties and student supervision. Also this dimension does not seem to have created more chances to generate research output at a steady pace.

[14] Statistics Canada, CANSIM table 477-0014.

[Figure 4 about here]

Figure (4) displays two more plots related to the dynamics of faculties at Canadian post-secondary institutions. The first panel plots the full-time teaching staff for a much longer period, from 1970 to 2015. Four phases can be identified. In the first one, from 1970 until 1992, the number of faculties was growing at a fairly constant rate. For the next six years a contraction was observed, but the number of faculties started growing quickly again at the beginning of the new millennium. The more recent tendency is difficult to interpret, as there are no data available for the 2011-2015 period. However, the two data-points for 2010 and 2016 imply a virtually flat series.

The previous series can be disaggregated into four components, which are plotted in the second panel, each representing the dynamics of a specific faculty rank. Following the onset of the great recession, a phenomenon has been observed for the first time: assistant professors positions are possibly substituted with less stable forms of academic employment, which rarely have a remuneration for research output. Although these less conventional contractual forms have always been present, and with non trivial numbers, for the first time it has been observed that the series for assistant professors and the one for other ranks moved in opposite directions. The assistant professors series is the most volatile, and seems to be pro-cyclical. From 1998 to 2007 this series grew at a steady pace. With a lag, after the tenure track period, a similar pattern is observed for the associate professors, but it still does not seem to be the case for the full professors. In the first part of the sample, the series for full professors and associate professors were growing at a high rate. They then both plateaued. More recently, it seems that the number of associate professors has been abnormally large. An interpretation is that these academics are facing more obstacles in getting promoted to full professors. It is possible that the talent of this pool of scholars is lower than the previous cohorts. Alternatively, these professors might have faced a fiercer competition in the publication process, increased teaching, supervision, and administrative duties, and —going back to the main argument— comparatively less public resources to fund their research projects.

Given the data limitations, the analysis reported in this section can only be interpreted as suggestive of plausible trends, behaviors and outcomes. More reliable insights can be obtained from a richer panel dataset and the related analysis, which is presented in the next section.[15]

[15] Although straightforward to compile, I did not consider a panel dataset consisting of all the separate time series by discipline. Even though the time series dimension is quite long, there are only 26 (correlated, as noted above) disciplines, causing problems for the typical and desirable assumption of random sampling in the cross sectional dimension. Furthermore, I tried to implement a difference-in-differences approach, using the NSERC disciplines as the control group. Irrespective of the possible concerns about the tenability of the parallel trend and common support assumptions, such an analysis is not feasible because of data limitations. During the 2009-2017 period, NSERC published the same data as SSHRC on their own competition results only in one year. In particular, the success rates by discipline have been published, while the number of proposals has not (and cannot be re-constructed with the available information).

3 Panel Data Analysis

In order to study the grant proposals decisions, and how they respond to incentives, ideally one would need data at the researcher level. These data are not publicly available, because of evident confidentiality concerns.[16] Instead, I compiled data from 15 annual SSHRC reports, detailing the competition statistics for the post-secondary institutions participating in a specific round of the SRG initiative. In the sample, a unit of observation is a post-secondary institution that applied for at least one research grant in the 1997-2011 period.[17]

One of the main advantages of using panel data is the availability of estimators that control for time-invariant unobserved heterogeneity. Adams and Griliches (1998) and Payne and Siow (2003) show the importance of doing so in their U.S. data. Also for the Canadian case it is hard to know whether the unobservable characteristics of the post-secondary institutions have been changing over time. Some indirect, and by all means imperfect, evidence is related to the ranking of these institutions. Although the relative academic standing and prestige of some institutions did evolve in the sample period, there were no drastic changes in terms of entry and exit from this market.[18]

This panel dataset provides another advantage, as it includes a larger number of observables. In particular, since I keep track of the same academic institutions for several years, I can construct variables capturing the cumulated histories deriving from past outcomes. In a learning set-up, these can be interpreted as proxies for the uncertain research talent, that also the academic institutions are conceivably trying to assess. They are meant to approximate a researcher's ability, while they are in the process of learning their academic type.

The number of proposals is a count variable, hence I rely on a panel data generalization of Poisson regression, controlling for unobserved heterogeneity with either Random or Fixed Effects. In general, the econometric model takes the following form:

$$\begin{aligned} log\left(\mathbb{E}[proposals_{i,t}|\mathbf{X}_{i,t}]\right) = \beta_0 + \beta_1 proposals_{i,t-1} + \beta_2 successrate_{i,t-1} + \beta_3 successrate_{i,t} + \beta_4 successrate_{i,t+1} \\ + \beta_5 tot\_propfunded_{i,t-1} + \beta_6 tot\_cad_{i,t-1} + \beta_7 tot\_proposals_{i,t-1} + \beta_8 proposalsfunded_{i,t-1} + \beta_9 cad_{i,t-1} \\ + \beta_{10} cv\_successrate_{i,t-1} + \beta_{11} cv\_cad_{i,t-1} + \eta_i. \end{aligned} \tag{2}$$

[16] SSHRC maintains a researchers' database that is publicly available. However, this contains information only on the projects that were granted funding in one of their initiatives, which is clearly a selected sample. For a discussion on the possible effects of selectivity biases see Arora and Gambardella (2005).

[17] There are reports available also for the years 1995 and 1996. However, some observables (such as the number of researchers) are not reported, hence I dropped them. Starting from the 2014 fiscal year the total number of applications is no longer reported (only the success rate is). This has the problematic consequence that it is not possible to reconstruct the number of applications for the institutions that do not get funded. For this reason, I dropped all the waves after 2013. Finally, after 2011 SSHRC implemented a major reform to the structure and nature of their initiatives. I decided to drop the years 2012 and 2013, to consider only the standard research grant regime. Aggregating the IG and IDG for only two years does not seem reasonable, as it would only provide an assessment of the short term response, which the time series data showed to be potentially different from the long term one. More detailed sample selection criteria and the full list of institutions in the dataset are reported in Appendix B.

[18] A notable exception is represented by the Ontario Institute of Technology, which was founded in 2002. Since then it has been quite active in its research endeavors, applying for and receiving a number of grants.

The dependent variable ($proposals_{i,t}$) is the number of research grant proposals submitted to SSHRC in a given fiscal year (t) by an academic institution (i).[19] There are up to 145 such institutions.

[Table 3 about here]

The regression results are included in Table 3. The first four columns report the estimates for the Random Effects specification, of increasingly richer models. The fifth column reports the estimates for the Fixed Effects specification of the most complete model.[20] It is reassuring to find that overall the results of the time series regressions are in line with the panel data estimates. In particular, researchers in the Social Sciences are dissuaded from applying for research grants when the likelihood of obtaining a grant has been more volatile than usual. Not only the instability of the success rate seems to matter, but in this sample also the instability of the funds received seems to have a negative impact. Controlling for individual effects shows that researchers appear to be forward looking, but the related mechanism might be somewhat different from the one described above. The sign on the current success rate is positive: researchers correctly believing that they can craft a strong proposal are indeed preparing and submitting those proposals, which eventually get funded at a higher rate. The sign on the future success rate is now positive, which is hard to reconcile with the time series evidence. As with the time series analysis, the proposals show a positive autocorrelation, and in the most general models depend negatively on the past success rate. Notice also how the number of proposals submitted and the dollar amount of SSHRC grants received in the previous year affect negatively the current number of proposals. The estimate associated with the cumulative number of proposals that received funding in the past is positive. This seems to be consistent with the notion that also the academic institutions are trying to learn their type. Alternatively, the institutions that were lucky in the past have more funds available to help researchers to develop competitive proposals.[21]

[19] The (i,t) indexes refer to the cross-sectional and time series dimensions of the panel dataset, respectively. $\mathbf{X}_{i,t}$ is the vector of regressors and $\mathbb{E}$ is the conditional expectation operator. Variables whose names display the *tot* prefix stand for running totals at the academic institution level. For instance, $tot\_propfunded_{i,t-1}$ stands for the cumulative number of proposals that received funding up to fiscal year $t-1$. Similarly, $tot\_cad_{i,t-1}$ stands for the cumulative dollar value of grants received and $tot\_proposals_{i,t-1}$ the cumulative number of proposals submitted. η_i stands for the unobservable (time-invariant) individual effect. Time dummies are included to control for aggregate changes, as well as geographical dummy variables (when identified).

[20] The Random Effects are assumed to follow a gamma distribution, and the null hypothesis of absence of random effects is always rejected at the 1% level. The Conditional Fixed Effects estimator has fewer observations because, for some institutions, the dependent variable does not vary over time (hence, it does not contribute to the likelihood function).

[21] I also performed a robustness analysis, which is included in Appendix C. In particular, since the panel data models are dynamic and have a time-invariant component in the error term, the estimate for the AR(1) component can be severely biased. I then implemented a system GMM procedure. Apart from the persistence parameter, which was biased downward in the Poisson regressions, the other results appear to be robust. Moreover, since in each year there are several institutions that do not submit any proposals, the dependent variable has a spike at zero, and we are in a case of left-censoring. I then relied on a panel data version of a Tobit estimator (with Random Effects), and the results are quite similar.

4 Discussion

The estimates in the pre-Insight reform period can be used to shed some light also on the more recent trends. The drastic fall in the funding success rate has been followed by a persistent decline in the number of applications. The regression results show that researchers in the Social Sciences, and Economists possibly to a larger degree, dislike such large fluctuations. If the subjective probability of getting funded, conditional on a number of characteristics (including an individual unobservable component), is perceived to be too low, the fixed costs of preparing a research grant proposal become too large relative to the expected gains. Whether this downward trend will change is yet to be seen. Possibly concerned about the falling number of applications received after their program changes, and in an attempt to increase the success rates, SSHRC seems to have undertaken some further formal and informal changes in the latest rounds of their research grants initiatives (e.g., the creation of two funding streams for the IG scheme, and, as documented by Gordon (2016), a more aggressive trimming of the proposed budgets).

An assessment on whether the current situation can be improved begs the question of what is the objective that SSHRC is trying to achieve. I believe that it can be argued that SSHRC's goal is to maximize the research quality being conducted in every discipline under their umbrella.[22]

It goes without saying that it would be inefficient for a number of researchers to scribble down bogus applications, just to inflate the number of proposals. As a matter of fact, SSHRC is preventing this from happening by imposing a fixed cost, namely by asking researchers to complete demanding tasks in the preparation of the proposals (e.g., the infamous —yet useful from the perspective of the adjudication committees— Canadian Common CV). Unfortunately, it is virtually impossible to know what is the optimal number of applications. The screening costs in terms of organizing adjudication committees and finding reviewers willing to donate their time are important elements that go in the direction of a limited pool of applicants. However, one simple metric tends to suggest that some efficiency gains might be achieved, for example by reallocating some funds. For instance, the current number of applications in Economics seats below its corresponding figure in 1995, and the funded proposals increased mildly. Either two decades ago this field's efforts in generating proposals were grossly sub-optimal, with an excessive number of applications being submitted, or the current figures are worrisome. In the meantime, academic departments have typically grown in size, and the student population has risen dramatically (from 1.35 million in 1992 to 2.04 million in 2015). Yet only $1,002$ proposals received funding by SSHRC in 2017. To put this figure in perspective, the number of potential researchers in the Social Sciences can be estimated by summing the number of full-time faculties (full, associate and assistant professors), and multiplying this figure by 67% (the share of students obtaining degrees in the SSHRC disciplines). In 2016 this figure was $27,501$. The total number of Principal Investigators and Co-investigators winning a grant in 2016 is estimated to be $1,994$.[23] Assuming that the average duration of a grant is 3 years, this means that 21.6% of academics received some form of SSHRC funding in 2016.

[22] The explicit goals and objectives of the Insight program can be found in SSHRC (2018b).

[23] This estimates excludes the collaborators, as their expenses cannot be directly financed, and they are not restricted to be affiliated with a Canadian institution. It is likely to be an upper bound, as some researchers received funding in multiple projects.

5 Conclusions

In this paper I provided some empirical evidence on the determinants of the decision to apply for public research grants. Using data on Canadian researchers in the Social Sciences, I documented a number of facts, with an emphasis on the steep decline in the number of grant applications submitted to SSHRC in their most recent competitions. I argued that this can be explained by the researchers' aversion to the instability of the likelihood of funding. In particular, even controlling for unobserved heterogeneity (i.e., the talent in research), I found that the volatility of the funding probability deters researchers from submitting grant proposals.

As noted by Xie (2014), inequality is an intrinsic and perhaps unavoidable trait of Science. Arguably, only the most talented and motivated students are given an opportunity to enroll in graduate programs. In turn, only a subset of them manages to eventually land academic jobs and to build long-lasting careers as researchers. Competition is a defining feature of this process. Similarly, the publishing "industry" dealing with scientific literature is based on an unforgiving peer-reviewing system, with acceptance rates of 5% or less for the most prominent journals, as reported by Card and DellaVigna (2013). With a plummeting number of grant proposals submitted to SSHRC, in Canada the level of competition is declining, which coupled with stagnating resources, may hurt the quality of the research produced by Canadian scholars.

In the absence of direct financial gains, experienced academics need to face appropriate incentives to find crafting strong grant proposals worthwhile. A possibility could be to allow for less restrictive rules in terms of eligible equipment and indirect costs (e.g., allowing for the so-called overhead costs, leading to an increased opportunity for the post-secondary institutions to have a flexible, and merit-based, component of salaries) and to bring back teaching buy-outs as an eligible expense. The findings in Stephan (2012) show that it has become less frequent for Ph.D. graduates to gain employment as researchers. Teaching now represents a more common "fall-back" option; however, graduate students typically lack training and exposure to the creation and delivery of course content. Not only do teaching buy-outs free up the Principal Investigators' schedule, giving them a chance to focus on their research projects (possibly counteracting the onset of decreasing returns), but also they create the need for temporary teaching positions, that can often be competently filled by passionate graduate students. Currently, two of SSHRC's priorities are the funding and training of graduate students. These goals are achieved directly, with the Talent program (whose budget is almost as large as the Insight one) and indirectly, with the Insight program and the Research Assistant positions (which are favored and encouraged by SSHRC's funding rules) created by the Principal Investigators. This begs the question of whether the two channels lead to a duplication of funding for students. Although admittedly controversial, a partial solution to the limited funding opportunities for researchers could be to transfer some resources from the Talent program to the Insight one. One justification for this proposal is contained in Chandler (2018): using a regression discontinuity approach, he finds that generous SSHRC scholarships can be ineffective.

It seems rather perverse to give graduate students rich SSHRC scholarships (often topped up by provincial financial aid, such as the Ontario Graduate Scholarships), trying to maximize the quality of their research training, eventually discouraging them upon becoming professional researchers. In the early stages of academic life there is a lot of uncertainty on both the students' research potential and their long-term career plans,

while junior scholars tend to have a proven record. Giving researchers in the making training opportunities is undoubtedly important. However, providing incentives for both established and junior researchers to submit proposals to create the best circumstances for these opportunities to arise is equally important. Perhaps, the recent announcements of more generous funding for research go in this direction, Shen (2018). However, if the political climate were to change, the issue of the optimal mix of programs in the SSHRC portfolio will stay relevant.

Although it is possible to argue that lower chances of obtaining public funds might have already led to a decline in the volume of high quality research being conducted, currently it is not possible to assess whether this phenomenon is indeed taking place, and what the costs for society might be.

To conclude with, it is apparent that the academic world has been evolving substantially. The size and scope of post-secondary institutions have greatly changed, and so has the way research is undertaken. It goes without saying that reforms to the way research is funded are to be expected (and ideally encouraged) by the research community. I believe that this paper shows that public institutions funding academic research should announce their policies and intended goals well in advance, in order to make the environment as predictable as possible. However, at the stage of the implementation of a policy reform, the objective of fostering competition can suffer from a sample selection issue. If researchers with promising ideas become discouraged because they perceive a low probability of obtaining funding, they are not going to put together a grant proposal. These are valid concerns, especially for scholars affiliated with non-top ranking post-secondary institutions, whose graduate programs might be limited in size and scope. Preparing a grant proposal is by no means a low cost endeavour, which might not be worthwhile if the main benefit is hiring graduate students that might not even specialize in the PI's field. Unless these latent projects, in terms of quality and impact, all fall below the level of the marginally funded projects, there will be an efficiency loss. Perhaps, in transitional periods, guaranteeing a minimum number of funded proposals, irrespective of the number of applications, might circumvent some of these problems. Given how drastic the recent trends have been, a switch in expectations might take an extended period of time to take place.

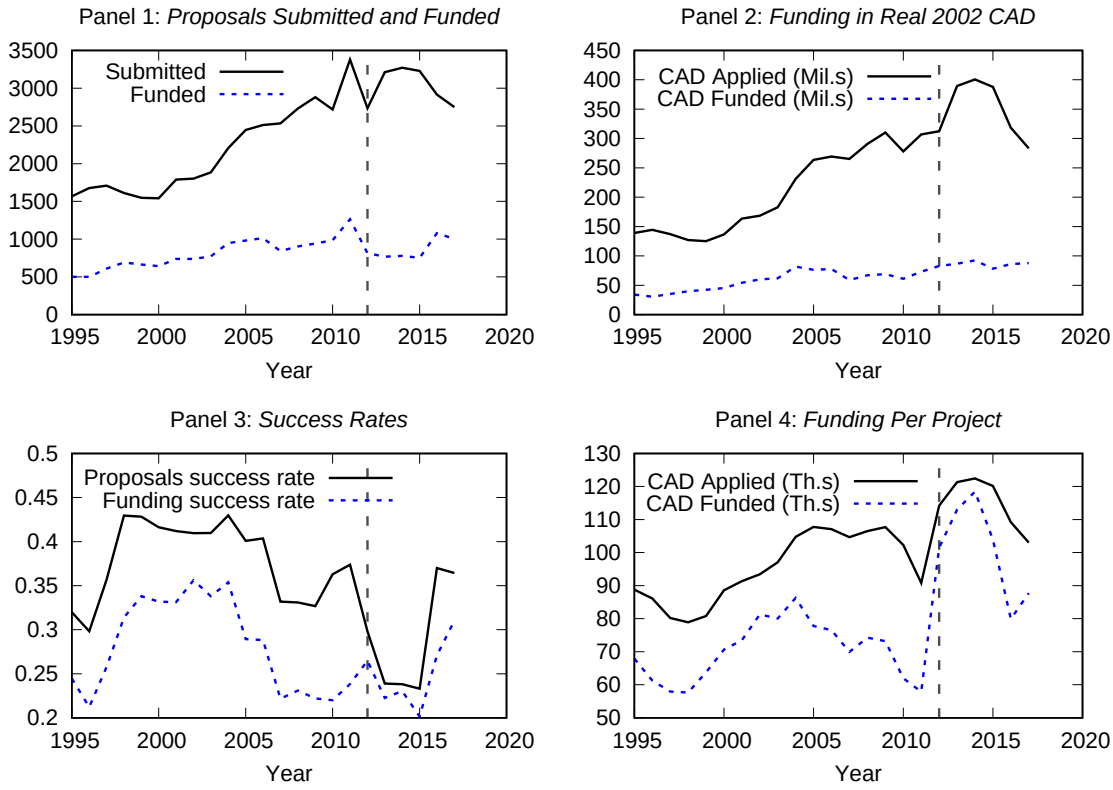

Figure 1: Trends for All SSHRC Disciplines, 1995-2017. The vertical lines represent the implementation of the 2012 SSHRC grants reform. Source: Author's calculations from SSHRC yearly reports.

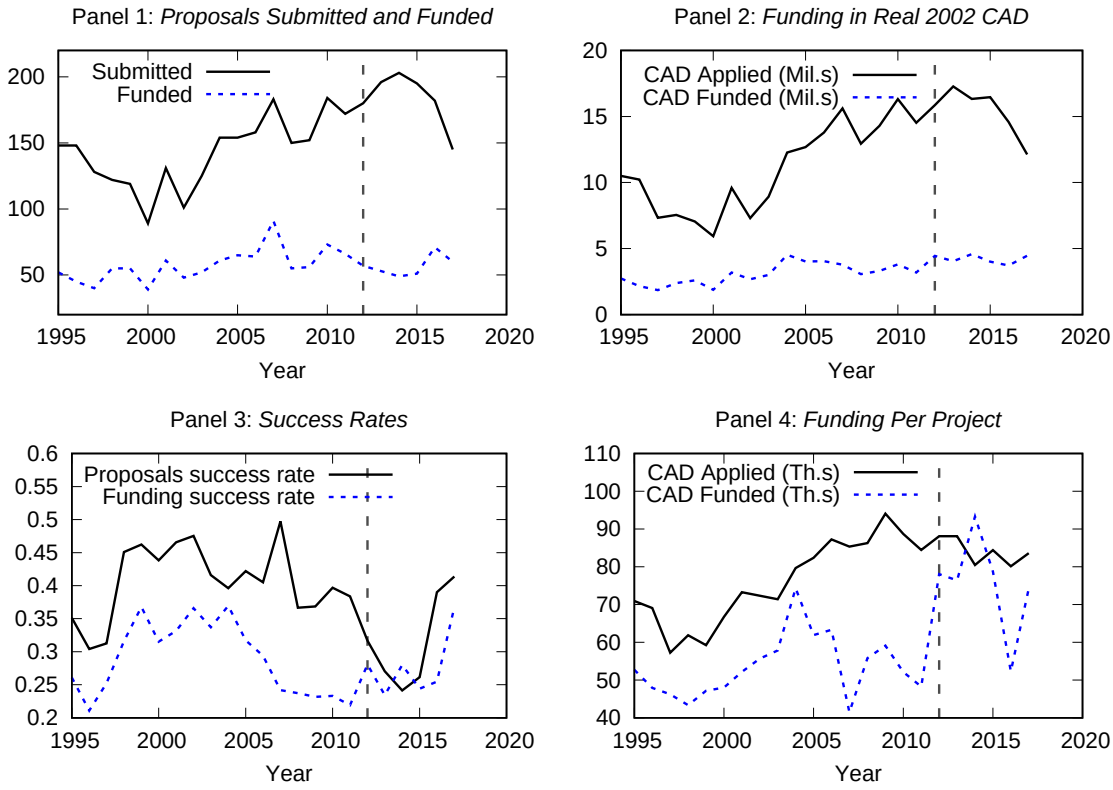

Figure 2: Trends for Economics Discipline, 1995-2017. The vertical lines represent the implementation of the 2012 SSHRC grants reform. Source: Author's calculations from SSHRC yearly reports.

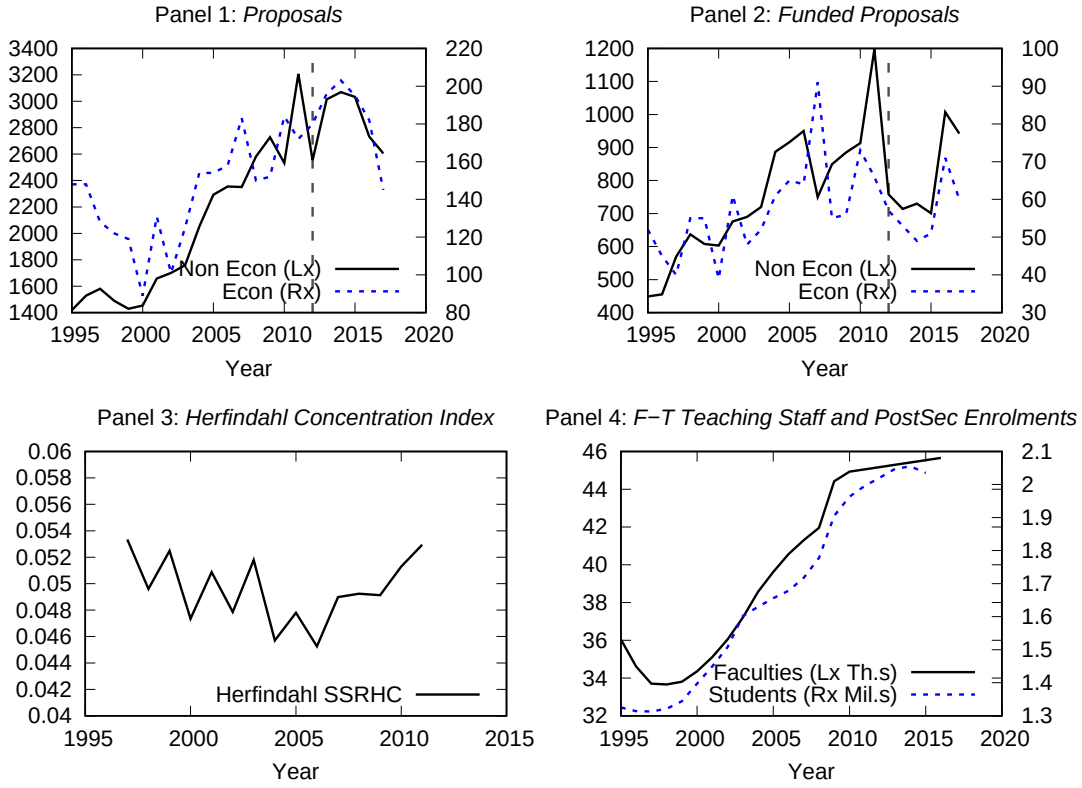

Figure 3: Trends for Economics Vs. All other SSHRC Disciplines, 1995-2017. The vertical lines represent the implementation of the 2012 SSHRC grants reform. Source: Author's calculations from SSHRC yearly reports and CANSIM data, series V53451372 and V79657395. For the Faculties series, the years from 2011 to 2015 are missing and are filled with a linear interpolation of the 2010 and 2016 data. The Herfindahl concentration index can only be computed for all SSHRC Disciplines.

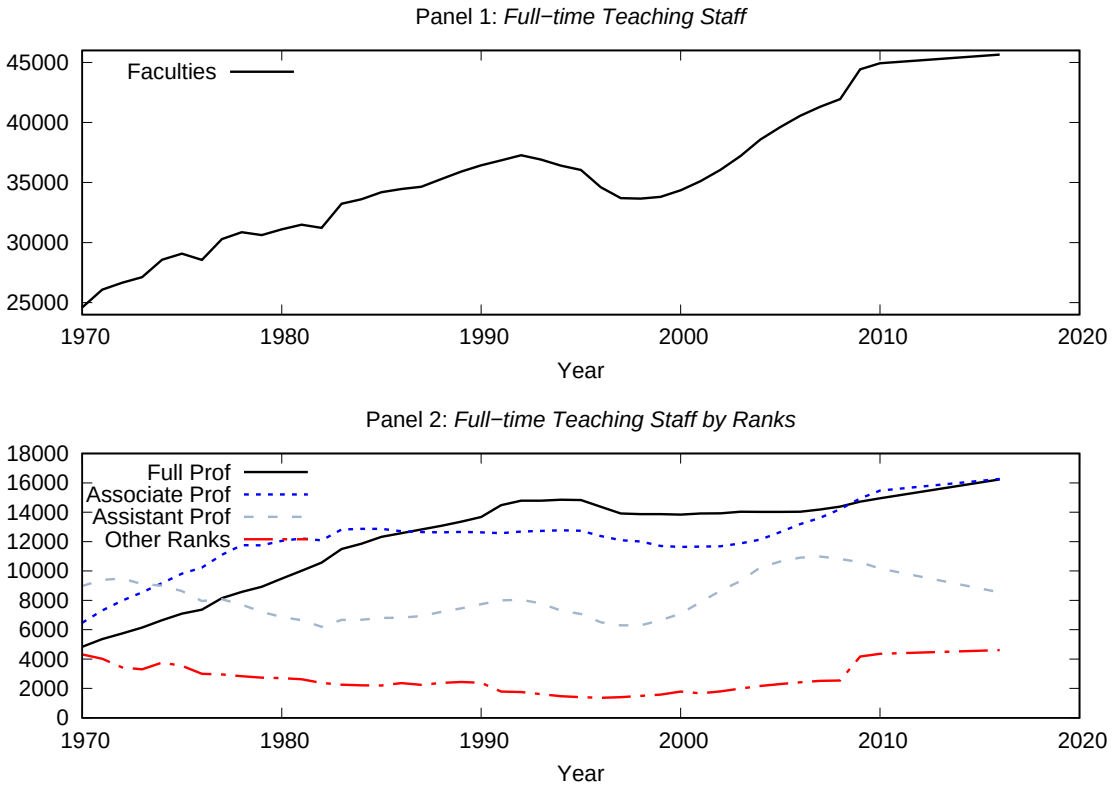

Figure 4: Trends for Full-Time Teaching Staff, 1970-2015. Source: Author's calculations from CANSIM data, series V53451372, V53451375, V53451378, V53451381, V53451384, V53451387. The years from 2011 to 2015 are missing and are filled with a linear interpolation of the 2010 and 2016 data.

	(1)	(2)	(3)	(4)
$proposals_{t-1}$	0.794	0.791	0.458	0.267
	(0.157)	(0.158)	(0.401)	(0.476)
$successrate_{t-1}$	-934.0	-475.6	-2302.6	-2588.5
	(1510.9)	(1569.8)	(2782.3)	(2849.9)
$successrate_{t+1}$			-3521.2	-4056.1
			(3593.0)	(3714.0)
$successrate_t$				-2076.7
				(2677.7)
$cv\_successrate_{t-1}$		-854.3	-996.7	-1556.4
		(1002.6)	(1355.0)	(1554.0)
cv_cad_{t-1}		1333.5	-338.3	-1140.9
		(965.3)	(1975.4)	(2257.6)
$constant$	888.3	669.9	3555.8	5171.8
	(873.6)	(899.6)	(3276.9)	(3926.8)
T	20	20	19	19
R^2	0.810	0.832	0.843	0.851

Table 1: Time series regressions for the period t number of grant applications $proposals_t$ in all SSHRC disciplines, 1995-2017. $cv\_x_{t_1}$ stands for the rolling coefficient of variation of the explanatory variable x in the 3-year window before period t. Standard errors in parentheses.

	(1)	(2)	(3)	(4)
$proposals_{t-1}$	0.537	0.398	0.307	0.308
	(0.181)	(0.200)	(0.210)	(0.223)
$successrate_{t-1}$	-151.8	-164.3	-154.7	-154.9
	(81.32)	(75.22)	(74.35)	(83.91)
$successrate_{t+1}$			-108.5	-108.9
			(81.75)	(95.20)
$successrate_t$				0.985
				(114.8)
$cv\_successrate_{t-1}$		-139.2	-98.05	-97.92
		(65.53)	(69.62)	(74.10)
cv_cad_{t-1}		123.7	103.4	103.6
		(76.88)	(82.17)	(88.46)
$constant$	130.8	156.0	207.5	207.2
	(53.63)	(51.09)	(70.33)	(77.94)
T	20	20	19	19
R^2	0.647	0.736	0.784	0.784

Table 2: Time series regressions for the period t number of grant applications $proposals_t$ in Economics, 1995-2017. $cv\_x_{t_1}$ stands for the rolling coefficient of variation of the explanatory variable x in the 3-year window before period t. Standard errors in parentheses.

	(1)	(2)	(3)	(4)	(5)
$proposals_{i,t-1}$	0.00964	0.0102	0.0110	0.00991	0.00927
	(0.000797)	(0.000801)	(0.000887)	(0.00101)	(0.00102)
$successrate_{i,t-1}$	0.0657	0.105	0.133	-0.144	-0.172
	(0.0777)	(0.0781)	(0.0819)	(0.0928)	(0.0943)
$successrate_{i,t}$		0.492	0.496	0.327	0.261
		(0.0639)	(0.0675)	(0.0764)	(0.0768)
$successrate_{i,t+1}$			0.259	0.149	0.0907
			(0.0697)	(0.0778)	(0.0782)
$cv\_successrate_{i,t-1}$				-0.122	-0.0945
				(0.0594)	(0.0595)
$cv\_cad_{i,t-1}$				-0.108	-0.0883
				(0.0534)	(0.0535)
$tot\_propfunded_{i,t-1}$	0.00125	0.00152	0.00216	0.00126	0.000960
	(0.000696)	(0.000697)	(0.000781)	(0.000890)	(0.000893)
$tot\_cad_{i,t-1}$	-1.12e-08	-1.08e-08	-1.07e-08	-6.79e-10	2.71e-09
	(6.66e-09)	(6.67e-09)	(7.28e-09)	(8.35e-09)	(8.37e-09)
$tot\_proposals_{i,t-1}$	-0.000466	-0.000652	-0.00107	-0.00103	-0.00100
	(0.000184)	(0.000186)	(0.000222)	(0.000255)	(0.000257)
$proposalsfunded_{i,t-1}$	-0.00433	-0.00531	-0.00727	-0.00589	-0.00633
	(0.00237)	(0.00237)	(0.00262)	(0.00278)	(0.00279)
$cad_{i,t-1}$	-3.66e-08	-3.22e-08	-1.44e-08	-1.27e-08	-8.64e-09
	(1.99e-08)	(1.99e-08)	(2.17e-08)	(2.25e-08)	(2.25e-08)
Time Dummies	Yes	Yes	Yes	Yes	Yes
Province Dummies	Yes	Yes	Yes	Yes	No
N	2021	2021	1876	961	938

Table 3: Random Effect Poisson Panel data regressions for the number of grant applications ($proposals_{i,t}$), 1997-2011. cv_x_{i,t_1} stands for the rolling coefficient of variation of the explanatory variable x in the 3-year window before period t. $tot\_x_{i,t}$ stands for the running total at the post-secondary institution level up to period t. Standard errors in parentheses.

References

Adams, J., and Griliches, Z. (1998). "Research Productivity in a System of Universities," *Annales d'Économie et de Statistique*, Vol. 49-50, 127-162.

Antonelli, C., Franzoni, C., and Geuna, A. (2011). "The Organization, Economics, and Policy of Scientific Research: What we do Know and What we Don't Know - an Agenda for Research," *Industrial and Corporate Change*, Vol. 20, 201-213.

Arora, A., David, P., and Gambardella, A. (1998). "Reputation and Competence in Publicly Funded Science: Estimating the Effects on Research Group Productivity," *Annales d'Économie et de Statistique*, Vol. 49-50, 163-198.

Arora, A., and Gambardella, A. (2005). "The Impact of NSF Support for Basic Research in Economics," *Annales d'Économie et de Statistique*, Vol. 79-80, 91-117.

Azoulay, P., Graff Zivin, J., and Manso, G. (2011). "Incentives and Creativity: Evidence from the Academic Life Sciences," *RAND Journal of Economics*, Vol. 42, 527-554.

Benavente, J., Crespi, G., Garone, L., and Maffioli, A. (2012). "The Impact of National Research Funds: A Regression Discontinuity Approach to the Chilean FONDECYT," *Research Policy*, Vol. 41, 1461-1475.

Card, D., and DellaVigna, S. (2013). "Nine Facts about Top Journals in Economics," *Journal of Economic Literature*, Vol. 51, 144-161.

Chandler, V. (2018). "Short and Long-term Impacts of an Increase in Graduate Funding," *Economics of Education Review*, Vol. 62, 104-112.

Chudnovsky, D., Lopez, A., Rossi, M., and Ubfal, D. (2008). "Money for Science? the Impact of Research Grants on Academic Output," *Fiscal Studies*, Vol. 29, 75-87.

Fortin, J.-M., and Currie, D. (2013). "Big Science vs. Little Science: How Scientific Impact Scales with Funding," *PloS ONE*, Vol. 8, e65263.

Gordon, S. (2016). "The economics of SSHRC research grants (Parts I-IV)," *Worthwhile Canadian Initiative - Blog*, Aug. 9^{th}-12^{th}, retrieved on-line at (accessed 14 October):
`http://worthwhile.typepad.com/worthwhile_canadian_initi/2016/08/sshrc1.html`

Gush, J., Jaffe, A., Larsen, V., and Laws, A. (2018). "The Effect of Public Funding on Research Output: the New Zealand Marsden Fund," *New Zealand Economic Papers*, Vol. 52, 1-22.

Hicks, D. (2011). "Performance-based University Research Funding Systems," *Research Policy*, Vol. 41, 251-261.

Hicks, D., Wouters, P., Waltman, L., De Rijcke, S. and Rafols, I. (2015). "Bibliometrics: The Leiden Manifesto for research metrics," *Nature*, Vol. 520, 429.

Hosios, A. (1990). "On the Efficiency of Matching and Related Models of Search and Unemployment," *The Review of Economic Studies*, Vol. 57, 279-298.

Jacob, B., and Lefgren, L. (2011). "The Impact of Research Grant Funding on Scientific Productivity," *Journal of Public Economics*, Vol. 95, 1168-1177.

Jaffe, A. (2002). "Building Programme Evaluation into the Design of Public Research-support Programmes," *Oxford Review of Economic Policy*, Vol. 18, 22-34.

Lane, J. (2010). "Let's Make Science Metrics more Scientific," *Nature*, Vol. 464, 488-489.

Mongeon, P., Brodeur, C., Beaudry, C., and Lariviere, V. (2016). "Concentration of Research Funding Leads to Decreasing Marginal Returns," *Research Evaluation*, Vol. 25, 396-404.

Murray, D., Morris, D., Lavoie, C., Leavitt, P., MacIsaac, H., Masson, M., and Villard, M.-A. (2016). "Bias in Research Grant Evaluation Has Dire Consequences for Small Universities," *PloS ONE*, Vol. 16, e0155876.

Osborne, M., and Rubinstein, A. (1990). Bargaining and Markets, Academic Press, San Diego, CA.

Payne, A., and Siow, A. (2003). "Does Federal Research Funding Increase University Research Output?," *The B.E. Journal of Economic Analysis & Policy*, Vol. 3, Article 1.

Shen, A. (2018). "Budget 2018 gives a major boost to fundamental research in Canada," *University Affairs*, Feb. 28^{th}, retrieved on-line at (accessed 14 October):
https://www.universityaffairs.ca/news/news-article/budget-2018-gives-major-boost-fundamental-research-canada/

Shi, S. (1995). "Money and Prices: A Model of Search and Bargaining," *Journal of Economic Theory*, Vol. 67, 467-496.

Social Sciences and Humanities Research Council. (2018a). SSHRC grant rules can be retrieved on-line at (accessed 14 October):
https://webapps.nserc.ca/SSHRC/Instructions-Help/stdinstr_e.htm
http://www.sshrc-crsh.gc.ca/funding-financement/programs-programmes/insight_development_grants-subventions_de_developpement_savoir-eng.aspx
http://www.sshrc-crsh.gc.ca/funding-financement/umbrella_programs-programme_cadre/insight-savoir-eng.aspx

Social Sciences and Humanities Research Council. (2018b). Insight grants objectives can be retrieved on-line at (accessed 14 October):
http://www.sshrc-crsh.gc.ca/funding-financement/umbrella_programs-programme_cadre/insight-savoir-eng.aspx#a3

Stephan, P. (1996). "The Economics of Science," *Journal of Economic Literature*, Vol. 34, 1199-1235.

Stephan, P. (2012). How Economics Shapes Science, Harvard University Press, Cambridge, MA.

Wang, J., Lee, Y., Walsh, J. (2018). "Funding Model and Creativity in Science: Competitive versus Block Funding and Status Contingency Effects," *Research Policy*, Vol. 47, 1070-1083.

Whalley, A. and Hicks, J. (2014). "Spending Wisely? How Resources Affect Knowledge Production in Universities," *Economic Inquiry*, Vol. 52, 35-55.

Xie, Y. (2014). "'Undemocracy': Inequalities in Science," *Science*, Vol. 344, 809-810.

Appendix A - Data and Estimation

- The raw data on the SSHRC grants used in this paper can be downloaded from the following website:

  `http://www.sshrc-crsh.gc.ca/results-resultats/stats-statistiques/index-eng.aspx`

- The estimation was performed with STATA SE 15.1.

- The time series regressions are straightforward and use standard STATA built-in estimators and commands.

- The panel data regressions are somewhat more sophisticated, but still use STATA built-in estimators and commands. In particular:

  - since the number of proposals is a count variable, I relied on a panel data version of a poisson regression (with Random Effects or Fixed Effects). The typical STATA commands are:

    ```
    xi, noomit:  xtpoisson applications lapplications lsuccessrate ltotprojfund
     ltotawardamt ltotapplctns lprojectsfunded lawardedamount awardedamount_cv
                    successrate_cv i.year i.region, noconstant
    ```

    ```
    xi, noomit:  xtpoisson applications lapplications lsuccessrate ltotprojfund
     ltotawardamt ltotapplctns lprojectsfunded lawardedamount awardedamount_cv
                      successrate_cv i.year, noconstant fe
    ```

  - since in each year there is a substantial number of institutions that do not submit any proposals, the dependent variable has a spike at zero, and we are in a case of left-censoring. I relied on a panel data version of a Tobit estimator (with Random Effects) and the typical STATA command is:

    ```
    xi, noomit:  xttobit applications lapplications lsuccessrate ltotprojfund
    ltotawardamt ltotapplctns lprojectsfunded lawardedamount awardedamount_cv
                  successrate_cv i.year i.region, noconstant ll(0)
    ```

  - since the panel data models are dynamic and have a time-invariant component in the error term, the estimate for the AR(1) component can be severely biased. I then implemented a system GMM procedure and the typical STATA command is:

    ```
    xi:  xtdpdsys applications successrate lsuccessrate ltotprojfund ltotawardamt
     ltotapplctns lawardedamount awardedamount_cv successrate_cv i.year i.region
    ```

Appendix B - List of Academic Institutions

Id	*Institution*	*Id*	*Institution*
1	*Memorial*	31	*HEC Montréal*
2	*U Prince Edward Island*	32	*ENAP*
3	*Acadia*	33	*INRS*
4	*Cape Breton*	34	*Télé-université*
5	*Dalhousie*	35	*UQÀChicoutimi*
6	*King's College (Halifax)*	36	*UQÀHull*
7	*Mount Saint Vincent*	37	*UQÀMontréal*
8	*NS Agricultural College*	38	*UQÀRimouski*
9	*NS College of Art and Design*	39	*UQOutaouais*
10	*Saint Mary's*	40	*UQAbitibi-Témiscamingue*
11	*Sainte-Anne*	41	*UQTrois-Rivières*
12	*St. Francis Xavier*	42	*Sherbrooke*
13	*Atlantic Baptist College*	43	*Dawson College*
14	*Moncton*	44	*Marianopolis College*
15	*Mount Allison*	45	*Collège Valleyfield*
16	*New Brunswick*	46	*Vanier College*
17	*St. Thomas*	47	*Brock*
18	*Cégep de Maisonneuve*	48	*Carleton*
19	*Cégep Drummondville*	49	*Collège Dominicain*
20	*Cégep du Vieux Montréal*	50	*Confederation College*
21	*Cégep Édouard-Montpetit*	51	*Guelph*
22	*Collège John Abbott*	52	*Lakehead*
23	*Collège Lionel-Groulx*	53	*Laurentian*
24	*Collège Saint-Jean-sur-Richelieu*	54	*McMaster*
25	*Bishop's*	55	*Nipissing*
26	*Concordia*	56	*Ontario Bible College*
27	*Laval*	57	*OCAD University*
28	*McGill*	58	*Ontario Institute of Technology*
29	*Montréal*	59	*Ottawa*
30	*École Polytechnique de Montréal*	60	*Queen's*

Table: Units of Observation in the Panel Dataset

Id	*Institution*	*Id*	*Institution*
61	*Redeemer University College*	91	*Algonquin College of Applied Arts*
62	*Royal Military College*	92	*Canadian College of Naturopathic Medicine*
63	*Ryerson*	93	*Hearst University*
64	*Saint Paul*	94	*Humber College*
65	*Sault College of Applied A&T*	95	*Institute for Christian Studies*
66	*Sudbury U*	96	*McMaster Divinity College*
67	*Seneca College*	97	*Brandon*
68	*Sheridan Institute of TAL*	98	*Canadian Mennonite U*
69	*St. Michael's Hospital*	99	*Manitoba*
70	*Toronto*	100	*Université de Saint-Boniface*
71	*Pontifical Institute of Mediaeval Studies*	101	*Winnipeg*
72	*Trinity College (UoT)*	102	*Briercrest College and Seminary*
73	*St. Michael's College (UoT)*	103	*Regina*
74	*Victoria College (UoT)*	104	*Campion College*
75	*Wycliffe College (UoT)*	105	*Luther College Regina*
76	*Toronto School of Theology*	106	*Saskatchewan*
77	*Trent*	107	*St Thomas More Collegiate*
78	*Waterloo*	108	*Alberta*
79	*Renison College*	109	*Ambrose U/Canadian Bible College*
80	*St. Paul's United College*	110	*Athabasca*
81	*Saint Jerome's U*	111	*Augustana University College*
82	*Western Ontario*	112	*Calgary*
83	*Brescia University College*	113	*Concordia University Edmonton*
84	*Huron College*	114	*The King's University (Edmonton)*
85	*King's University College*	115	*Lethbridge U*
86	*Knox College*	116	*Taylor College and Seminary*
87	*Wilfrid Laurier*	117	*Grant MacEwan*
88	*Windsor*	118	*Medicine Hat College*
89	*York*	119	*Mount Royal University*
90	*Algoma University College*	120	*Southern Alberta Institute of Technology*

Table: Units of Observation in the Panel Dataset

Id	*Institution*
121	*Grande Prairie Regional*
122	*Lethbridge Community*
123	*Red Deer College*
124	*St. Mary's University College*
125	*U of British Columbia*
126	*Regent College*
127	*Fraser Valley U*
128	*Kwantlen Polytechnic University*
129	*Northern British Columbia*
130	*Northern Lights College*
131	*Okanagan College*
132	*Royal Roads U*
133	*Simon Fraser*
134	*Thompson Rivers*
135	*Trinity Western*
136	*Victoria*
137	*British Columbia Institute of Technology*
138	*Camosun College*
139	*Capilano University*
140	*Vancouver Island U*
141	*North Island College*
142	*Columbia Bible College*
143	*Emily Carr University of Art & Design*
144	*Vancouver School of Theology*
145	*Yukon College*

Table: Units of Observation in the Panel Dataset. Notes: a) Yukon is lumped together with Atlantic Canada in terms of geographical region. b) In the year 2000 the Research Time Stipend was introduced, which lasted until 2010: I consider the total requested and awarded (inclusive of the RTS). c) U of Michigan, Kalamazoo, Cambridge applied (most likely due to researchers that moved) but were dropped as they are outside Canada. d) Institutions that changed name were kept as the same institution (e.g., in 2005 University College of the Cariboo was renamed as Thompson Rivers University). e) The Technical University of British Columbia applied in 2002, but it was in operation only between 1999 and 2002 (it was dropped from the dataset). f) The First Nations University of Canada had a complicated history (it was put on probation and applied only in 2006, so it was dropped from the dataset). g) Tyndale UC applied only in 2011 (it was dropped from the dataset). h) The following institutions had their name listed in the SSHRC reports, but never applied in the sample period and were dropped in some regressions: Cégep du Vieux Montréal, Cégep Édouard-Montpetit, Confederation College, St. Michael's Hospital, Southern Alberta Institute of Technology.

Appendix C - Robustness

	(1) GMM	(2) Tobit
$proposals_{i,t-1}$	0.497	0.929
	(0.0249)	(0.0504)
$successrate_{i,t-1}$	-1.041	-2.687
	(0.768)	(1.223)
$successrate_{i,t}$	1.986	4.004
	(0.770)	(1.224)
$successrate_{i,t+1}$		1.370
		(1.298)
$cv\_successrate_{i,t-1}$		-1.526
		(1.366)
$cv\_cad_{i,t-1}$		-4.681
		(1.421)
$tot\_propfunded_{i,t-1}$	0.411	0.130
	(0.0431)	(0.0334)
$tot\_cad_{i,t-1}$	-0.00000245	-0.00000129
	(0.000000399)	(0.000000337)
$tot\_proposals_{i,t-1}$	-0.0719	-0.00338
	(0.00980)	(0.00916)
$proposalsfunded_{i,t-1}$		-0.374
		(0.144)
$cad_{i,t-1}$	0.000000529	0.00000399
	(0.000000600)	(0.00000136)
Time Dummies	Yes	Yes
Province Dummies	Yes	Yes
N	2021	961

Table 4: Panel data regressions for the number of grant applications ($proposals_{i,t}$), 1997-2011. cv_x_{i,t_1} stands for the rolling coefficient of variation of the explanatory variable x in the 3-year window before period t. $tot\_x_{i,t}$ stands for the running total at the post-secondary institution level up to period t. Standard errors in parentheses.