Retention of talented academic researchers:

Evidence from a government intervention

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Abstract: The Canada Research Chairs (CRC) program is designed primarily to retain academic talent in Canadian universities by providing targeted grants to outstanding researchers. Once awarded a Chair at her home university, a researcher's compensation increases by 6.3 percent on average, with a significant decline over CRC tenure. Furthermore, the chance of the researcher changing jobs does not decrease. Although universities report spending more than half of the grant on compensation, only a small portion of the grant can be accounted for as a compensation increase. This demonstrates the difficulty in designing government interventions to have an impact on academic retention.

Keywords: Compensation, retention, government intervention, academic research, Canada Research Chairs

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1 Introduction

In 2000, the Canadian government endowed the Canada Research Chairs (CRC) Program with $300 million per year to establish 2000 university research Chairs in order to "attract and retain excellent researchers in Canadian universities" (Picard-Aitken et al. 2010). Many other countries have also implemented programs specifically targeted at highly skilled university research personnel.[2] These programs are a response to the fear of brain drain fueled by the increased international competition for top talent and the greater mobility of highly qualified researchers. Rather than funding universities' general research budgets or specific research programs, this new wave of initiatives intends to target high-potential individuals (Ehrenberg et al. 2007).

Under the CRC Program, universities are allocated Chairs and choose who to nominate. Although the grant is tied to an individual, it is the university that receives the funds, and it can allocate them how it sees fit. Consistent with the CRC program's stated focus of attracting and retaining exceptional talent, universities report having used more than half (between 55 and 71 percent during our sample period) of the CRC funds to finance the salaries of chairholders (hereafter also referred to as nominees). This is exactly what one would expect universities to do if competition on salary is an important driver of mobility, as many have argued (Gibson and McKenzie 2011).

This paper presents evidence on the effects of CRC nomination on compensation, retention and attraction. Regarding retention, we estimate the impact of CRC nomination on compensation and mobility holding chairholder characteristics constant. Regarding attraction, we compare the

[2] The European Union, for example, launched in 2007 the European Research Council to fund outstanding researchers. This was in part to address the fear that bureaucratic European universities (Haeck and Verboven 2012) could not respond effectively to international competition. See Geuna (2001) for a broader discussion of research funding in European universities.

amount universities spend on the compensation of the CRC chairholders who move from abroad relative to Canadian CRC chairholders.

We construct a unique compensation dataset that covers, over an 11-year period, the senior CRC chairholders in British Columbia and Ontario and a large set of control individuals, whose compensation information is publicly available under provincial freedom of information laws. We observe the compensation of CRC chairholders before and after the Chair nomination, along with the compensation of control professors during the same period. For the sake of conciseness, we only discuss here the results for internally nominated chairholders, or internal chairholders hereafter. These individuals work at the same university before and after nomination and constitute the largest share of CRC chairholders. After controlling for a number of sources of unobserved heterogeneity, we find that the return to a Chair is around 6.3 percent. This figure does not change after a number of robustness checks. The compensation premium is not constant over time, however. On the fifth year after nomination it is only 40 percent of what it was on the first.

We complement the compensation dataset with the work history of all Ontario CRC chairholders before and after nomination. We also collect the work history of a control group composed of the scholars who act as referees for the CRC Program. These individuals are presumably facing the same trend in labour market opportunities as the CRC chairholders. We explain the events of accepting new jobs using a number of determinants of mobility and a treatment variable corresponding to CRC nomination. The chance of changing jobs does not decrease after CRC nomination. The finding that CRC nomination has no impact on retention is surprising given the earlier finding that nomination is associated with a compensation increase. This may be because the increase is small to start with and declines quickly with CRC tenure.

To further understand how universities have allocated the CRC grants, we compare the compensation of chairholders from abroad relative to Canadian chairholders. This comparison does not hold chairholder characteristics constant as the point is to understand university allocation choice. We find no difference in compensation. Universities do not spend more to attract nominees from outside Canada. It is true, however, that the compensation of the median senior CRC chairholder is about 18 percent higher than the salary of the median non-CRC full professor.

Stated as a fraction of the CRC grant, the compensation premium commanded by CRC chairholders is small. This is true if we compare compensation pre- and post-nomination, compensation of abroad and Canadian chairholders, or compensation of CRC chairholders and non-CRC professors. Our pass-through estimates find that chairholder compensation increases only account for five percent of CRC grant money. And we do not find any impact of nomination on retention. Section 6 argues that universities have used a very small fraction of CRC grant money to attract and retain talents. The section then goes on to investigate the possibility that universities have used the CRC grant money to increase faculty size.

The rest of the paper is organized as follows. The next section presents the CRC Program and describes our dataset. Section 3 outlines the empirical approach for the compensation study and section 4 presents the results. Section 5 presents the retention study and Section 6 discusses the broader implications of our results. The paper ends with a brief summary and some concluding remarks.

2 Institutional background and data

The information in this section is drawn from the CRC website (http://www.chairs-chaires.gc.ca/), evaluation reports, and in particular, the tenth year report (Picard-Aitken et al. 2010), and questions to CRC Program managers.[3]

2.1 Canada Research Chair Program

[3] See Fisher et al. (2006) for a discussion of the Canadian federal–provincial relationship in post-secondary education funding.

The Canada Research Chairs (CRC) Program was established by the federal government in 2000 with the main mandate "to attract and retain excellent researchers in Canadian Universities" (Picard-Aitken et al. 2010).[4] Between the years 2000 and 2005, 2000 CRC Chairs were allocated to two tiers. The senior tier comprises 1000 Chairs that are targeted to full professors (or associate professors within two years of promotion to full professor) who should be "outstanding researchers acknowledged by their peers as being world leaders in their fields." The junior tier covers emerging professors who have the potential to become leaders in their fields. Senior Chairs are awarded annual grants of $200,000 for a period of seven years, and are typically renewed when requested. Junior Chairs are awarded $100,000 for five years, renewable once. This study focuses on senior Chairs.

Once a university has received a Chair, it nominates a candidate to an independent committee of experts selected by the CRC Secretariat. The university then negotiates with the individual researchers a package that includes compensation, teaching release, and research support. A central feature of the program is that the government retains some control over the nomination process but universities administer the grants. Nominees can be internal (currently employed at the nominating institution) or external (employed elsewhere). Externals may come from within Canada or abroad. We use the notation **I** for internals, **CE** for Canadian externals, **AE** for abroad externals, and **E** for either type of external. Once a nomination is reviewed and accepted by the CRC Secretariat, the Chair is considered "filled." Figure 1 (see the solid line matched to the left axis) shows that most of the senior Chairs were filled by the mid-2000s.

The grants are paid into Chair-designated accounts administered by the universities. Each grant is earmarked to be spent on its respective chairholder. Universities can deploy the grants at

[4] The other three stated goals are closely related: (a) to improve universities' capacity for generating and applying new knowledge, (b) to strengthen the training of highly qualified personnel, and (c) to optimize the use of research resources through strategic planning.

their discretion to cover salary, benefits, research, and many other expenses of the chairholder, so it is possible that the funds have been used for very different purposes in various universities. In the first years of the program, there was no accounting on how universities were spending the funds and what goals they were pursuing. [5] Starting in 2002–2003, universities were required to provide administrative reports and statements of expenditure. According to these reports, the largest fraction of the program funds is allocated to chairholder salary. For the senior tier, this fraction increased from 55 percent in 2002–2003 to 71 percent in 2007–2008 (CRC Year in Review 2007–2008; Picard-Aitken et al. 2010). The next largest categories of CRC fund allocation were salaries to non-students, administrative costs, and salaries to students. Taken together, salary and administration costs account for the majority of the Chair funds (90 percent in 2002–2003 and 94 percent in 2007–2008).

2.2 Data

Using a variety of sources, we have compiled two distinct individual level datasets for the compensation and retention studies. Our compensation variable is defined by provincial Freedom of Information Laws (FIL): the British Columbia Financial Information Act and the Ontario Public Sector Salary Disclosure Act. Only FIL data is suitable to our study because the university census data of UCASS do not identify individual faculty members, which is necessary to tag CRC chairholders. FIL make publicly available the compensation data of public servants who earn above a given threshold. Since the major Canadian research universities are public, this data includes salaries of academics. In Ontario, the data is censored at $100,000. In other words, a public servant must earn over $100,000 for her compensation to be disclosed. In British Columbia, the censoring was set at $50,000 until 2002 and $75,000 after 2002.

[5] The third year review noted that some universities did not observe the program rules (Third Year Review of CRC Program, 2002, Section 4.6.3). In 2002, the CRC Secretariat asked universities to produce annual reports providing a statement of expenditure. In 2005, the Secretariat also required universities to provide a program result report for each Chairholder.

We focus on senior tier chairholders for several reasons. First, the compensation of senior CRC chairholders is more likely to be above the minimum threshold imposed by the FIL. Second, these individuals are also already well-established in their careers. One would expect that most of the salary changes due to career life cycle take place early in one's career. If so, the impact of Chair nomination on compensation should be easier to separate from career dynamic effects for senior than junior chairholders.

The compensation variable is broadly defined to include any form of salary, wages, bonuses, gratuities, taxable benefits, payment into trust or any form of income deferral in-kind benefit. [6] We supplement compensation data with information from university academic calendars to include individual level variables. Our resulting panel spans 11 years, from 2000 to 2010. For each year and each individual, we observe compensation, sex, academic field and rank, institution, administrative duties, and CRC status.[7]

[6] For the British Columbia observations, compensation corresponds to the reported remunerations, defined in the Financial Information Act as follows: "includes any form of salary, wages, bonuses, gratuities, taxable benefits, payment into trust or any form of income deferral paid by the corporation to the employee or on behalf of the employee during the fiscal year being reported upon, whether or not such remuneration is reported under the Income Tax Act (Canada)" (Financial information regulation). The BC data are reported annually for year end March 31. From Ontario observations, we construct the compensation variable as the sum of the reported salary paid and taxable benefits. Salary paid is defined in Ontario as excluding taxable benefits, which are reported separately. The definition of taxable benefits is identical to that of the Canada Revenue Agency, and includes allowances, free use of property or goods, along with reimbursements of personal expenses. The Ontario data are reported annually for each calendar year. British Columbia data were collected from the Consolidated Financial Statements Financial Information Act Report published annually by Simon Fraser University, the University of British Columbia, and the University of Victoria. Ontario data were collected from the Ontario Ministry of Finance website.

[7] We constructed an academic field variable covering the seven categories used by Statistics Canada in the annual University and College Academic Staff System (UCASS) survey. We grouped administrative duties into two categories: major and minor. Major corresponds to administrative duties at the faculty level (for example a researcher may hold the position of associate dean in a year we observe) while minor corresponds to administrative duties at the department level. We also observe academic rank. All individuals in our sample hold positions of either full professor or associate professor. This is consistent with the rules of the CRC Program that set a minimum rank to fill a senior tier Chair.

Internal nominees (I) typically receive the CRC between two financial years. To account for the fact that nomination occurs in the middle of an accounting year, we separately tag the transition years. This also eliminates the issue of having different accounting calendar years for British Columbia and Ontario. There is no transition variable for externals (CE or AE). We do not observe pre-Chair salary of AE individuals, and the salaries of the majority of CE individuals do not surpass censoring thresholds in either of the universities where they were employed in their transition years.

Table 1 presents summary statistics on the sample of professors used in the compensation study. The sample has 230 treatment individuals (CRC chairholders), which consist of 144 I chairholders, 16 CE chairholders, and 70 AE chairholders. Because the FIL compensation threshold is low in British Columbia, we have all the I, CE and AE chairholders. This is not the entire population of senior tier CRC in British Columbia because we have not collected the chairholders who moved from within Canada but from a province other than British Columbia or Ontario. The Ontario censoring, however, is binding. We only have data on 46 percent of Ontario senior tier internally nominated chairholders.

We have also collected information for 557 control individuals selected by matching observable characteristics: academic rank, department when possible and university and field otherwise, and year window. Moreover, we matched CE with individuals who moved universities. We selected two types of control individuals: movers, and non-movers. Movers were selected on the criteria of i) having moved universities between or within British Columbia and/or Ontario once over the course of our observed time period, and ii) having compensation observations above the censoring threshold both pre- and post-movement. We selected all the individuals who satisfied these two criteria. Non-movers were selected based on the observable characteristics of academic rank, field, institution, time window, and salary in the year 2000 when available.[8] Figure 2 plots the distribution of salary for treated and control on nomination year. The two distributions are similar. And indeed the Kolmogorov-Smirnov test of equality supports this, as we cannot reject the null hypothesis that the samples are drawn from the same distribution (p-value=0.443).

Treated and controls together result in 6747 individual-year observations. For I and CE, we observe compensation before and after CRC nomination. For AE, we can only observe compensation after CRC nomination, so cannot compute the compensation increase from nomination for these individuals. Figure 1 plots the activation path for the CE and AE in our sample (dash and dotted line matched to the right axis); it closely follows the activation path for the entire senior tier (solid line).

For the retention study, we used online bios and CVs, Google Scholar, and published works to collect the employment histories before and after nomination of all senior CRC chairholders in Ontario. A senior chairholder contract lasts seven years and can be renewed. We distinguish internal and external candidates and focus on the first CRC contract (the first seven years after nomination). There were 371 such CRC contracts (247 I and 124 E) in Ontario over the period 2000–2011.

The reader should keep in mind that the samples of CRC chairholders covered in the compensation and retention studies are different. The retention study covers only Ontario

[8] For each internal treatment individual, we selected up to four control individuals in the same field (in practice as well as the same department in most cases), institution, and of the same rank as the treatment individual. As all treatment individuals hold positions of either associate or full professor across all years we observe, this is also true of our control individuals. We were limited in the number of control individuals we could select from certain fields because of i) department size, and ii) Ontario censoring often was binding in low-paying fields. The final characteristic we selected was time. We ensured our control individuals for each treatment individual were present in the year before treatment, and remained at the university until the end of the time period we observed. We did this to avoid, as much as possible, selecting researchers at the end of their careers.

chairholders, but includes some that are not present in the compensation study due to the FIL censoring rule.

3. Compensation increase associated with Chair nomination: Identification issues

We are interested in measuring the increase in compensation that individual researchers experience after obtaining a CRC chair. We distinguish chairholders that are internal (I) and those that moved within or between British Columbia and Ontario (CE). While R^I denotes the percentage increase in compensation for internally nominated chairholders, matters are slightly more complicated in measuring the compensation increase for CE. A CE chairholder's compensation may change for at least three reasons. First, salaries depend on local labour market conditions (cost of living, attractiveness of the local area and so on). Second, changing universities typically triggers a contract renegotiation and salary update. Many moves are motivated by financial considerations and one would expect compensation to increase after a move (Ehrenberg, 2004). Third, a CRC nomination may be associated with an increase in compensation.

R^{CE} should include the third effect (because it is directly associated with nomination) and exclude the first effect (because the individual financial gain from nomination should be computed net of equilibrium compensating differentials across labour markets). Whether we should include the second effect is debatable. We should include it if the move would not have happened in the absence of the CRC Program. Otherwise, we should not. Since we do not know the answer to this question, we report both values of R^{CE} as the third effect alone and as the sum of the second and third effects. To keep the exposition short, we assume for now (without loss of generality) that R^{CE} is the sum of the last two effects.

We borrow the *treatment* terminology from the program-evaluation literature to explain how we estimate the values of R^I and R^{CE} (Angrist and Pischke 2009). Treatment in our application corresponds to CRC nomination. We observe the compensation of the CRC chairholders pre- and post-nomination. We also observe the compensation of controls (researchers who did not get a CRC) with similar observable characteristics as the CRC chairholders during the same period. The issue at hand is to construct a counter-factual of what post nomination salaries of CRC chairholders would have been in the absence of a CRC nomination. There are at least two main concerns. Firstly, the treated individuals (those who receive a CRC) may be different from the controls.[9] This could be the case, for example, if universities nominate scholars who earn more than other individuals, and if these differences are not captured by the individual level control variables. Secondly, CRC nomination may be correlated with variables that systematically vary over time. To deal with these two concerns, we estimate variants of the following class of models

$$Ln(s_{i,u,y}) = \beta_0 + X_i' \beta_1 + \Phi_Y + \Phi_U + \Phi_F + \Phi_I + CRC^{I}_{i,t} \beta_I + CRC^{CE}_{i,t} \beta_{CE} + M_{i,t} \beta_M + \varepsilon_{i,u,y} \quad (1)$$

where s is individual compensation and subscript i stands for individual, u for university, and y for year. The matrix X_i contains various control variables that vary across individuals: whether the individual is in a transition year between non-CRC to CRC,[10] is an associate professor, holds minor or major administrative responsibilities, and is female. Depending on the specification, we also include various combinations of the following sets of fixed effects: Φ_Y for year, Φ_U for universities, Φ_F for academic field, and Φ_I for individual. The variable $CRC^{I}_{i,t}$ ($CRC^{CE}_{i,t}$) is equal to one if internal (external) chairholder i holds a Chair throughout year t. The variable $M_{i,t}$ is equal to one if individual i is a control (never receives a CRC) who works at a different university throughout year t from that with which she entered our sample (individuals in our sample move universities at most once).

[9] A related concern for Ontario is due to the censoring associated with FIL. We do not observe the salary of individuals who earn less than $100K. Due to large salary inflation for the individuals in the sample, this constraint is more likely to hold early in the sample: the CRCs who are nominated early in the sample earn higher salaries relative to later CRCs.

[10] To account for the fact that nomination may occur in the middle of an accounting year, we separately tag the transition years for internal chairholders (see Appendix).

Including university fixed effects controls for differences in compensation across local labour markets. This is important to account for the compensation change of movers. As discussed above, it eliminates the first effect of CRC nomination. The inclusion of year fixed effects controls for time effects that are identical for the treated and controls and that could be correlated with the rollout of CRCs (e.g. salary inflation). The inclusion of individual fixed effects controls for individual heterogeneity and, in particular, for the fact that treated and control individuals may earn different amounts.[11]

Specification (1) is similar to a difference in difference approach: we control for selection on individual unobservable characteristics and for common time effects correlated with treatment. In addition, we include university fixed effects to eliminate the change in compensation associated with differences across local labour markets. The coefficient β_I estimates R^I, the percentage increase in compensation relative to what the individual would have earned by remaining in the same university. This assumes that her compensation would have changed in the same way as it did for the individuals who did not change treatment status that year. Similarly, β_{CE}-β_M measures the percentage increase in compensation relative to what the individual would have earned in the years following CRC nomination had she worked in her new university without a CRC. β_{CE} measures the percentage increase in compensation relative to what the individual would have earned in the years following CRC nomination had she worked in her previous university, net of the compensating differential across the two universities. $R^{CE} \in [\beta_{CE} - \beta_M , \beta_{CE}]$ since a CE may have moved even in the absence of the CRC Program (in which case $R^{CE} = \beta_{CE} - \beta_M$).

[11] The inclusion of individual fixed effects implies that we do not the use information of the individuals who appear in our sample only after CRC nomination due to FIL censoring.

Two assumptions discussed in the program-evaluation literature (Angrist and Pischke, 2009), are relevant to the interpretation of (β_I,β_{CE}) in our application as will become clear in the robustness section:

(A1) Common trend: CRC chairholders and controls experience the same compensation trend throughout the sample.

A1 says that the treated may differ from the controls only through unobserved additive constants. CRC chairholders may earn more than the controls each year, but they must experience the same compensation growth over time.

(A2) Constant treatment: The impact of CRC nomination is a once and for all percentage increase in compensation.

We initially present results assuming that A1 and A2 hold. We later relax these assumptions in a robustness section and demonstrate that even though these assumptions are violated, the economic implications of the results do not change.

4. Impact of Canada Research Chair nomination on salary: Results

Table 2 reports our main results. The seven columns have different sets of control variables to demonstrate how the different sources of unobserved heterogeneity influence the estimates of R^I and R^{CE}. Column 1 with only individual controls indicates a return of 17.4 percent. Adding year fixed effects reduces the estimate by about 4.7 percent. This is because CRC activation increases with time and salaries have also increased in our sample period. In fact, the year fixed effects are significant and imply an increase in compensation of 49 percent over the entire period or about 4.5 percent per year. In contrast, the consumer price index in Canada increased by 22 percent over the 11-year period, corresponding to a growth rate of 1.8 percent per year. Faculty salaries may increase faster than the consumer price index for a number of reasons including competitive pressures and personnel rules that pay for seniority (as in Haeck and Verboven 2012). In the rest of this paper we refer to the year effects as *salary inflation*.

Adding university or field fixed effects in columns 3 and 4 does not change the coefficient estimates of R^{I} and R^{CE} by much. Adding individual fixed effects in column 5, however, has a large impact on both R^{I} and R^{CE} that tells an interesting story. The estimate of R^{I} decreases by about half from 12.8 to 6.4 percent suggesting that CRC recipients tend to earn higher salaries to begin with. In contrast, the estimate of R^{CE} increases from 5.6 to 9.4 percent suggesting that CE Chairholders were underpaid prior to CRC nomination.[12] With the exception of R^{CE}, which falls to eight percent, the results do not change if we also add university fixed effects (column 6). This column corresponds to the fully saturated model; all sources of unobserved heterogeneity (time, field, university, and individual) are accounted for.[13]

Although Table 2 Column 6 controls for individual and year fixed effect, a concern is that it does not account for the fact that individuals may enter the sample at different stages of their careers. This could be a problem if earnings change systematically over one's career. To be sure, we control for life cycle effects using a variable equal to years since PhD graduation. We include this variable as a control (for the subsample of I chairholders and controls) in Table 2 Column 7. The coefficient estimate for R^{I} does not change.

[12] An alternative interpretation (assuming that movers are paid competitively before and after CRC nomination) is that the movers are less talented researchers. This interpretation, however, is in conflict with the impact of individual fixed effects on R^{I}. R^{I} should have increased and not decreased if CRC chairholders were less talented researchers.

[13]The results reported compute robust standard error clustered at the individual level (individual idiosyncratic shocks). We also tried to cluster at year-institution level (idiosyncratic institution transitory shocks) and significance levels did not change. Another concern regarding the computation of the standard errors is that a Professor's compensation could be serially correlated. This may overstate the significance of the coefficient estimates. We follow Bertrand et al. (2004) and recompute the standard errors using a block bootstrap approach. When we block bootstrap at the individual level, β_M and β_{CE} lose significance at conventional levels; however these coefficients are estimated with few observations. Significance of the main coefficient of interest, β_I, remains unchanged.

The main findings of Table 2 are summarized as follows: internal nominees experience a compensation increase of 6.3 percent, and nominees who moved within Canada an increase of eight percent. Individuals who move within Canada without a CRC experience a compensation increase of 6.3 percent. The impact of CRC nomination for CRC movers (CE) is between 1.7 percent (β_{CE}-β_M=8-6.3), assuming they would have moved anyway, and eight percent, assuming they would not have moved in the absence of the CRC Program. The individual control variables offer interesting benchmarks with which to compare the CRC impact. The 6.3 percent compensation increase associated with internal CRC nomination is of the same order of magnitude as doing major administrative duties or as changing universities without a CRC. It is about one and a half times the return of a promotion from associate to full professor, the increase associated with minor administrative duties, or one year of salary inflation. The results are striking. The impact of CRC nomination on compensation is surprisingly low and this holds both for I chairholders and for CE chairholders. We have done a number of robustness checks.[14] Next, we revisit assumptions A1 and A2.

4.1 Robustness: Common trend and constant treatment assumptions

Consider a generalized version of specification (1) with time trends for the three groups of interest—controls, chairholders pre-treatment and chairholders post-treatment (Angrist and Pischke 2009, 230–32). Due to data limitation we can implement this generalization only for internal chairholders, omitting the CRC chairholders who changed universities.[15]

$$Ln(s_{i,u,y}) = \beta_0 + X_i' \ \beta_1 + \Phi_Y + \Phi_I + CRC^I_{i,t} \ (\beta_I + yI_{i,b,y}\, \beta_b + yI_{i,a,y}\, \beta_a) + \varepsilon_{i,u,y} \qquad (2)$$

[14] For example, we have replicated the estimation for the subsamples of British Columbia and Ontario observations separately. In both cases, we find that CRC nomination has a highly significant (one percent) impact and the magnitude of the coefficients are similar (not reported).
[15] There are only 16 CE in our sample and the coefficient estimates for these individuals have high standard errors once we add time trends.

where $I_{i,b,y}$ is a dummy equal to one if year y occurs before individual i was nominated for a CRC and $I_{i,a,y}$ is a dummy equal to one if year y occurs after individual i was nominated for a CRC. The pre-treatment compensation growth trend is captured by β_b, and β_a captures a new trend for post-treatment observations which we label the CRC-tenure effect. Specification (2) includes year fixed effects for controls and treated. Thus, the trends β_b, and β_a are estimated off the time effects that equally impact all individuals. Under the common trend assumption, we would expect β_b=0. Under the constant treatment effect, we would expect β_a=0.

Table 3 presents the results of specification (2). Column 1 reproduces the results of Table 2, column 4 but excluding the CE chairholders and their associated controls, to check that the estimates of R^I are not affected by the change in sample. Column 2 includes a pre-treatment trend and a CRC-tenure effect. β_b is positive and significant at the one percent confidence level, indicating that CRC chairholders are moving on a higher compensation growth path relative to the controls. Over a five-year period, their compensation increases by 3.7 percent more than the controls. The impact of nomination decreases with CRC tenure; β_a is negative and significant at the one percent confidence level with the implication that the compensation decreases by 3.4 percentage points after five years of CRC nomination. Assumptions A1 and A2 are violated.

What are the implications for the estimate of the average CRC treatment effect? The average CRC tenure for internal chairholders in our sample is T^{CRC}=6.6 years (Table 1). The average treatment effect that matches the 6.3 percent figure for β_I in Table 2 (or column 1 in Table 3) is now $\beta_I + T^{CRC}\beta_a$=10.2-(6.6)*(.68)=5.7 percent. The average effect does not change by much relative to the 6.3 percent figure from Table 2, column 6. Although assumptions A1 and A2 are violated, the impact on the average treatment effect is of little economic significance for two reasons. First, assumptions A1 and A2 are not violated by a large magnitude relative to the estimated treatment effect. Second, the bias caused by the violation of A1 (positive growth for treatments) tends to be cancelled by the bias caused by the violation of A2 (negative trend post treatment).

Still, one should acknowledge that specification (2) better captures the dynamic changes in compensation for CRC chairholders. In fact, the average estimates presented in the previous section were concealing an interesting story: the impact of nomination on compensation decreases over tenure. Figure 3 illustrates this point. Figure 3a plots the compensation path for CRC chairholders and for our two sets of controls. Year zero is the nomination year and reference year for all three groups. The dashed line plots the compensation growth path for the controls used in Table 2 (non-CRC chairholders). The dotted line plots the compensation inflation for the controls used in Table 3, column 3 (the treated in absence of treatment). The CRC chairholders experience higher compensation growth over time (the dotted line grows faster than the dashed one). The solid line plots the compensation of CRC chairholders before and after nomination. As expected, the dotted and solid lines coincide before nomination. After five years, the CRC chairholders have already lost about half of the compensation increase from nomination. Two effects are at play. In the absence of nomination, the compensation of a treated individual would have increased by 3.7 percent more than the controls over five years. In addition, the chairholders grow on a slower growth path post-treatment than the controls. This is clear in Figure 3b, which plots the impact of CRC nomination over time (the difference between the solid and dotted line in Figure 3a). The CRC chairholders obtain a compensation increase (relative to the counterfactual of no nomination) of 14.2K upon nomination. After five years the difference is only 5.7K. That is, 60 percent of the initial compensation gains have been lost by the fifth year.

We now turn to our second robustness test. Specification (1) uses the control individuals to hold constant the influence of variables that are correlated with the timing of CRC activation. This is the standard approach when all treated individuals are treated together, as is common in many applications. One needs the controls to hold constant unobserved changes that may take place at the time of treatment. This is not the case in our application, however, because treatment was rolled out over time. In fact, Figure 1 shows that CRC activation slowly took place over the years 2000–2010. The treated can be used to control for time-fixed effects by simply keeping only the treated observations in specification (1). Doing this bypasses the need to assume that controls and treated share a common trend. This approach is valid if the unobserved time effects that are correlated with treatment are common to all treated. It leaves out, for example, the unlikely possibility that there are individual time effects correlated with treatment.

Table 3, column 3 presents the result of a specification similar to column 5 in Table 2, but with the sub-sample of observations that excludes the controls and externals. Doing so takes care of A1 (common trend) but not of A2 (constant treatment). The 8.4 percent estimate of R^I in Table 3, column 3 is slightly higher than the 6.3 percent figure found in Table 2, column 6. Again, we find that the violation of the common trend assumption does not have a large impact on our estimate of R^I. It is important to note that columns 2 and 3 in Table 3 report very similar estimates of R^I despite the fact that these two specifications use different control groups to hold constant unobserved time effects.

To sum up, the analysis so far has revealed two main findings: (a) CRC nominees get a modest increase in compensation following CRC nomination (6.3 for internals and an upper bound of eight percent for externals), and (b) this compensation increase decreases fairly rapidly with CRC tenure (the compensation premium in the fifth year is only 40 percent of what it was on the first).

4.2 Pass-through rates

We define the CRC pass-through rate as the fraction of the CRC grant that is given to researchers as an increase in compensation (including non-salary financial benefits)—see Busse et al. (2006).

The average compensation in our sample is $145K (Table 1). The 6.3 percent treatment figure for internals amounts to a 4.6 percent pass-through rate (.063*145K/200K). For movers the pass through rate is between 1.2 and 5.8 percent. These are very low pass-through rates. To put these numbers in perspective, the CRC Secretariat reports that nine percent of each Chair grant had been reported billed towards Chair-related administration costs at universities (Canada Research Chairs: Year in Review 2007-2008). The cost of the CRC Program associated with faculty compensation increase is about half the cost of administering the grants within universities (which excludes the federal administration costs borne by the CRC Secretariat). This low pass-through rate may be because CRC chairholders have little bargaining power over the CRC grants. Universities are free to nominate whom they want, and nominees are rarely denied by the expert reviewers. We revisit the issue in Section 7.

4.3 Robustness: Heterogeneity in treatment effects

We interact the CRC treatment variable with year, university, and field dummies to estimate interacted returns $\beta_{I,y}$, $\beta_{I,u}$, and $\beta_{I,f}$ respectively. We can do so only for the subset of internal chairholders. We reject the hypothesis that the university interaction effects are all equal to zero. The impact of a nomination ranges from zero to 13 percent across universities, and the difference between the top and bottom of this range is statistically significant at the one percent confidence level. This wide range is consistent with the fact that universities have discretion over the allocation of the CRC funds. Even if one takes the highest impact, however, this does not change our earlier conclusion that the role of financial incentives for retention is modest. We also interact the CRC treatment variable with a variable for comprehensive universities. These universities are typically smaller and are less involved in research. We find a higher impact of nomination on compensation. Comprehensive universities have to pay a higher premium to retain top scholars.

We also reject the joint hypothesis that the CRC impacts are the same for the six academic fields in our sample. The impact of nomination is zero for chairholders in Education and slightly lower than average for chairholders in Humanities. One interpretation is that the need for financial incentives for retention is less in these fields.

We also investigate whether the CRC return varies with time. We have shown in the previous section that the CRC return decreases with CRC tenure. In addition, the CRC return may have changed over time. This is because the grant entitlement remained constant at $200K during a period over which salaries may have increased at a rapid pace. But there are other reasons for why the CRC return may vary over time. For example, if competitive pressures matter and if the American academic market is attracting researchers working in Canada, as many have argued, one would expect the CRC return to increase with the ratio of American to Canadian academic salary. This ratio is driven to a large extent by the US/Canada exchange rate which experienced significant variations in our sample period.

We tried many possible specifications interacting the CRC dummy with a time trend, a CRC tenure variable and the US/Canada exchange rate. It turns out that CRC tenure is the variable that remains significant in various combinations. The other two variables (time interaction and exchange rate interaction) are significant alone but not when paired with CRC tenure. The fact that the US/Canada exchange rate does not influence the CRC return is interesting. Possibly, the threat of brain drain was not an issue during our sample period, or brain drain occurs early in one's career, in which case it may not be present in our sample. The results also indicate that the CRC return has not decreased over time. This is surprising because the real value of a CRC grant (deflated by an index of academic salary, for example) has greatly decreased over the period 2000–2010. These results, however, should be interpreted with caution because the variables are highly correlated.

4.3 Compensation comparisons of Canadian and abroad Canada Research Chairs

We compare the compensation of AE chairholders with the compensation of I and CE chairholders. The two groups of professors may have different experience and productivity that we do not hold constant. This is not an issue because the point is to compare the cost of internal and abroad CRCs. We estimate the following model:

$$Ln(s_{i,u,y}) = \beta_0 + X_i' \beta_1 + \Phi_Y + \Phi_U + \Phi_F + \Phi_I + CRC^{AE}{}_{i,t}\, \beta_{AE} + CRC^{CE}{}_{i,t}\, \beta_{CE} + \varepsilon_{i,u,y} \quad (3)$$

We use a subsample consisting of post-nomination observations for all CRCs. A dummy variable for abroad chairholders is shown as $CRC^{AE}{}_{i,t}$, while $CRC^{CE}{}_{i,t}$ is a dummy variable for Canadian external chairholders. All other variables are defined as in model (1). The parameter of interest, β_{AE}, measures the post-nomination compensation difference between abroad and internal CRC chairholders.

Table 4 reports the results. The estimates of β_{AE} are small, between -0.50 and 0.40 percent, and insignificant across all specifications (the p-values are between 0.73 and 0.96). These results show that chairholders recruited from abroad command the same salaries as internal chairholders already in Canada. It is not true that chairholders hired from outside Canada cost more than internal chairholders. Specification (3) does not hold constant unobserved researcher characteristics; It could be that abroad CRC chairholders command higher salaries after accounting for these differences. However, this does not change the point that universities do not spend more on chairholders from abroad.

Given that Table 4 compares post-nomination salaries, it is true that abroad chairholders are paid more (6.3 percent) than what internal chairholders earn prior to nomination. But this comparison is imperfect because chairholders from abroad have to change university. To account for this, recall that movers within Canada (with or without a CRC chair) experience an increase in compensation of 6.3 to 8.0 percent (coefficients β_{CE} and β_{M} in Table 3). Thus, a chairholders from abroad costs the same to universities as a chairholder who moves within Canada.

Another way to make the point is to look at the coefficient estimates of β_{CE} in Table 4. The coefficient estimates are small and insignificant at the five percent level in all specifications. (The coefficient estimate is marginally significant, but small, in the specification that does not include individual random effects). We conclude that universities spend the same amount on compensation for the three types of chairholders (I, CE, and AE).

To put these figures into perspective, we also compare the compensation of CRC chairholders with the salary of non-CRC professors. See Section 3 in the Appendix. If we focus on the median full professor in Ontario, universities pay CRC chairholders a compensation premium of about 18 percent relative to non-CRC full professors. This confirms the fact that CRC chairholders are not a random sample of all professors. Looking at absolute values, the compensation premium for CRC chairholders relative to the median Ontario professor is 24K. This represents only 12 percent of the CRC grant.

5. Impact of Canada Research Chair nomination on retention

Table 5, Panel A computes the Kaplan-Meier survival probabilities over the seven years of the CRC contract for I and E. The columns distinguish four types of termination risks that can cause a contract to end: the chairholder leaves for a new job, the chairholder terminates the contract but remains at the same university, the chairholder retires, and the chairholder dies. The Kaplan-Meier survival probabilities account for the right censoring at year 2011. If termination happens for reasons other than the risk under consideration, the event counts as right censoring.

The chance to complete the seven-year contract across all CRC spells is 88.4 percent. Most terminations are associated with moving to a new job. Externals have a slightly higher probability of terminating than internals and this is due to a marginally higher incidence of finding new jobs.

In the rest of this analysis, we focus on the event of *new jobs* because this addresses the issue of retention. Table 5, Panel B shows that the chance of finding a new job does not vary systematically over CRC tenure, and this holds both for I and E chairholders.

5.1 Empirical approach

We collect the employment histories for I and E chairholders before and after nomination. Denote $F_{i,t}$ a dummy variable that takes value one if professor i changes job in year t and zero if professor i stays in the same job. Our goal is to test whether professors are less likely to change jobs ($F_{i,t}$=0) after CRC nomination. We follow Arellano (2008) in that we treat the employment histories as a sequence of binary models. It is natural to do so in our application because job changes do not happen within academic years so there is no loss of information when looking at the events of new jobs year by year. Specifically, we estimate the following type of linear probability model

$$Pr(F_{i,t}=1|D_{i,t},X_{i,t}) = \beta_0 + \beta_1 D_{i,t} + \Phi_G + \Phi_Y + \beta_2 X_{i,t} \qquad (3)$$

where $D_{i,t}$ denotes a dummy that equals one if individual i holds a CRC Chair in year t; β_1 is the parameter of interest; Φ_G are dummies for whether individual i is an I, E or control; Φ_Y are year fixed effects (or a year trend); and $X_{i,t}$ is a set of control variables discussed later. The impact of nomination on retention, β_1, is estimated by comparing the incidence of job change before and after CRC nomination. We collect the event of job change for I and E chairholders over a window centered on the nomination year.[16]

As with the compensation study, we use two sets of control groups. One approach is to estimate model (3) only with CRC chairholders, leveraging the fact that the CRC Program was progressively rolled out over time. However, for robustness, we also collect a set of control professors as follows. Each CRC nomination is reviewed by peer reviewers. It is not unreasonable

[16] The size of the window may vary between CRC professors because some CRC spells are truncated in 2011. Formally, for CRC i denote N_i the year when i is nominated. We collect $F_{i,t}$ for CRC i during period $[N_i - L_i, N_i + L_i]$ where L_i=Min(7,2011-N_i).

to assume that these reviewers face a similar trend in career opportunities as the chairholders do. The CRC website lists all reviewers since the beginning of the CRC Program. We select all reviewers with an Ontario affiliation excluding those who have held a junior or senior CRC chair. There are 716 such individuals. We randomly draw individuals from this pool and keep them if they have a continuous employment history over the period 1995-2009, thus excluding those who graduate after 1995 and those who retire or die prior to 2009. We record the event of job change, $F_{i,t}$ as well as information on the control variables for I, E, and 95 controls. Table 5, Panel C presents summary statistics on the sample used to estimate model (3). We have 461 professors and the average employment history is 13.5 years adding up to 6.2K observations. Job changes, however, are rare. A job change ($F_{i,t}$ =1) happens for only 2.5 percent of the observations, and the chance of changing jobs differs slightly for I, E and controls. These numbers, however, do not account for the fact that the chance of changing jobs systematically varies over one's career. There may also exist cycles in academic labour markets.

5.2 Results

The results presented in Table 6 use a linear probability model to estimate model (3). The results do not change when we use a Probit or Logit model as shown in the last two columns. Our basic specification has three sets of controls. Dummies for treatment status (I, E, Control) control for the fact that internal, external and controls may have a different base level of turnover. Year dummies control for changes in the academic labour market that are correlated with time. Years since PhD graduation controls for changes in mobility that vary over the career cycle.[17] Column 1 shows our basic specification with these three sets of variables in addition to the dummy for CRC activation. The impact of nomination on the chance of changing jobs is small and insignificant. This result is very robust with the addition of control variables. For example, column two interacts treatment

[17] For those rare individuals who do not have a PhD or for whom we cannot find their PhD graduation year, we use instead the year of first publication recorded on Google Scholar.

with I to account for the fact that the retention effect could differ for internal and external chairholders, and column three adds random effects. The finding that the coefficient β_1 is small and insignificant also holds for a number of specifications not reported here for the sake of brevity.[18]

Moreover, the model delivers reasonable estimates for the control variables. The chance of changing jobs is about 3.2 percent per year for someone who just graduated and decreases over one's career at the rate of 1.3 percent for every 10 years from PhD graduation (Column 3). When we add a quadratic effect, we find that this decrease is reduced as the number of years from PhD graduation increases. The year fixed effects do not indicate a clear time trend. Adding a linear quadratic time trend reveals that mobility decreases in the first half of the sample and increases afterwards.

6 Discussion

The CRC program could have had various outcomes that can be ranked from most intended to least intended as follows: (a) The CRC budgets are spent to attract additional faculty members from abroad who would not have joined otherwise; (b) The CRC budgets are spent to retain faculty members who would have moved otherwise; (c) Universities use the budgets to attract new talents (other than the chairholders); (d) Universities spend the CRC budgets on other uses than faculty

[18] We replaced the year fixed effects with a linear quadratic time trend. We removed the controls from the sample and use only the pre-nomination observations to control for change in mobility correlated with time. We added a CRC tenure variable that captures the fact that the impact of nomination on retention may change over tenure. We added a job tenure variable for I that captures the fact that these chairholders have different job tenure when they are nominated. We added university dummies for the nine largest universities in Ontario to control for different academic labour markets. We added dummies for the three research councils in Canada to control for different mobility rates across broadly defined academic areas. In all specifications, the impact on the treatment dummy remains small and insignificant.

compensation; (e) University expenses do not change because the CRC budgets are matched by cuts in expenditures elsewhere.[19]

The fact that the majority of CRC chairholders were internally nominated (63 percent) rules out (a) as the main university response to the CRC grants. The salary and retention evidence presented earlier demonstrates that (b) does not play a large role either. We have tried to investigate whether response (c) took place: Do universities hire more professors (CRC and non-CRC) in response to receiving CRC grant money? The maximum possible CRC yearly transfer to universities is $300m. In 2004-2005, this represents about 9 percent of total university spending on professor salary. Thus, the CRC grants could have a significant impact on the number of faculty members. That is if universities spend the CRC grants to increase hiring budgets.

To investigate whether the CRC funds have an impact on university hiring we collected information on the number of Assistant, Associate and Full Professors in each of the 72 Canadian universities from the University College Academic Staff Survey. We ask whether exogenous variations across years in CRC grant activation have an impact on faculty counts. The idea is that random variations in activation generate fluctuations in university budgets that may have an impact on hiring. The results reported in the Appendix (Section 4) are interesting but not entirely conclusive: We find a small effect of CRC budgets on university hiring that is imprecisely estimated. This is because there is little exogenous variations in CRC grant transfer to work with.

Thus, we cannot reach definite conclusions on the role of response (c). It is also impossible to use university accounts to assess the role played by responses (d-e). Some background information on university accounting helps understand why. Universities, like most government organizations, operate under fund accounting (Ehrenberg et al. 2007). Accordingly, they have many different accounts, some of which are restricted in how funds can be expensed. Chair accounts are one

[19] Responses (d) and (e) have been labeled *crowding out* in the literature (Bergstrom et al. 1986; Andreoni and Bergstrom 1996; Wallsten 2000).

example of a restricted account. Non-Chair infrastructure costs, for example, cannot be expensed to a Chair account. In addition to restricted accounts, universities also have a large unrestricted general operating account to which the vast majority of academic salaries are expensed. Universities have much freedom to spend the CRC grants and can use them to pay an internal chairholder's entire compensation. A university can free money in its unrestricted general operating account by shifting a chairholder's compensation expenses from this account to the CRC grant. That compensation would have been spent even in the absence of the CRC Program. Thus the CRC grant money is fungible. This was most likely a concern. The CRC Secretariat has kept control of the CRC nomination process and started requiring universities to provide expenditure reports in 2002.

We do not deny that part of the CRC grants has been used to offer CRC chairholders more appealing packages, including research funding, student and research staff support, teaching release, start-up costs, and so on. But these expenses represent a small fraction of the CRC grant. Moreover, internal chairholders receive only 4.6 percent of the grant as a compensation increase, thus leaving between 50 percent and 66 percent of the CRC grants as allocated to pay the compensation of individuals who were already on the university payroll. This suggests that Federal research funding has replaced university research funding.[20] We do not argue either that responses (c) or (d) are necessarily a bad thing. Our point is that (a) and (b) have not been the primary result of the CRC Program, and that it is possible for universities to have funneled a large fraction of the CRC grants into their general budgets to be used for other initiatives than those intended by the CRC program.

7 Summary and concluding remarks

[20] A similar point can be made for E chairholders. Universities could nominate individuals who would have been hired from outside even in the absence of the CRC program. Whether substitution also happened for E as well is an open question.

The main goals of the CRC Program were to attract and retain excellent researchers in Canadian universities. This study presents three sets of results. (a) We find a modest role for salary being used as a retention instrument. The salary of internal chairholders increases by 6.3 percent on average after nomination and the compensation premium in the fifth year after nomination is only 40 percent of what it was in the first year. (b) Despite this salary increase, we find no impact of CRC nomination on retention. The chance of changing jobs does not decrease after CRC nomination. (c) We also compare the compensation of chairholders from abroad with Canadian ones. Universities do not spend more to attract external nominees relative to internal ones. It is true, however, that the compensation cost of the median senior chairholder is about 18 percent higher than the salary cost of the median full professor non-chairholder. Overall, we conclude that a small part of the CRC funds have been used to fund the compensation premium commanded by exceptional researchers.

What have universities done with the CRC grants? We cannot rule out the possibility that universities have used a large fraction of the Federal CRC grants to pay salaries that would otherwise have been paid from general budgets, thus freeing some of a university's general budget for other uses. This may be the efficient response if retention and attraction were not a relevant consideration. This raises a broader set of questions regarding the evaluation and design of government interventions, such as the CRC Program, that aim at attracting and retaining exceptional talent (Winston 1999). Does the current design of the CRC program maximize potential impact on attraction and retention? Is it possible to influence university decision-making, particularly in investments in research personnel, through the use of targeted funds? Should government subsidies for research excellence be awarded to universities, to researchers, or to some other third party?

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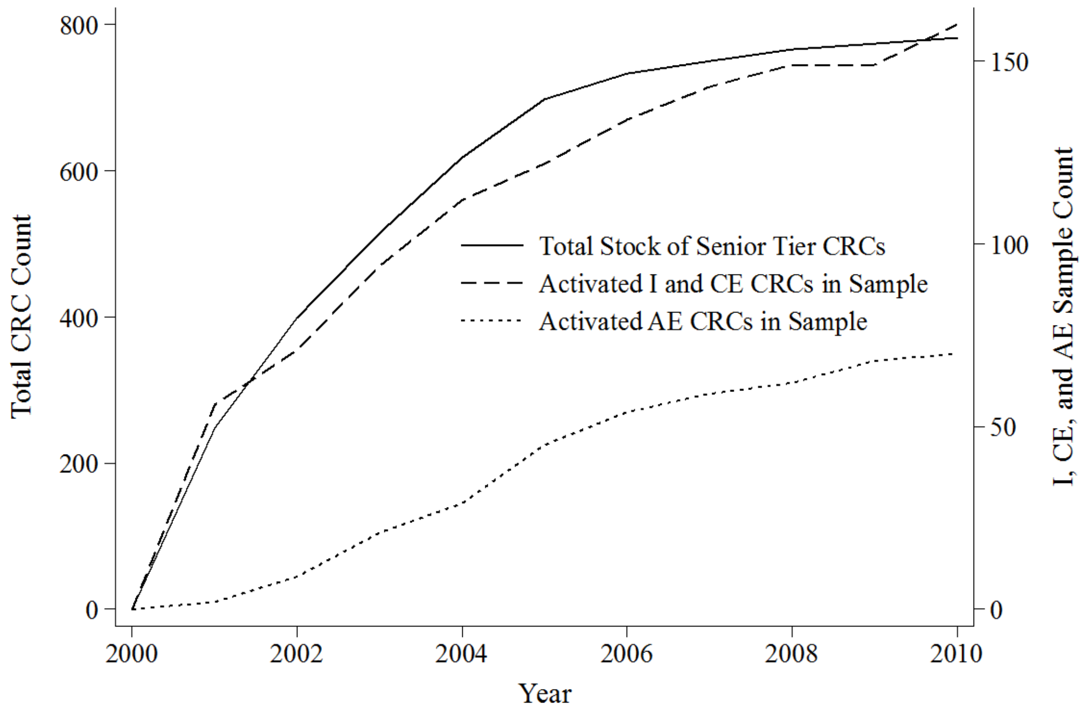
Figures and Tables

Figure1. Senior CRC tier activation path.



Left axis corresponds to solid line denoting total stock of senior tier CRCs. Right axis corresponds to dotted lines that denote senior tier CRC activation in our sample.

Figure 2: Distribution of salary of Control and Treatment in year 2000

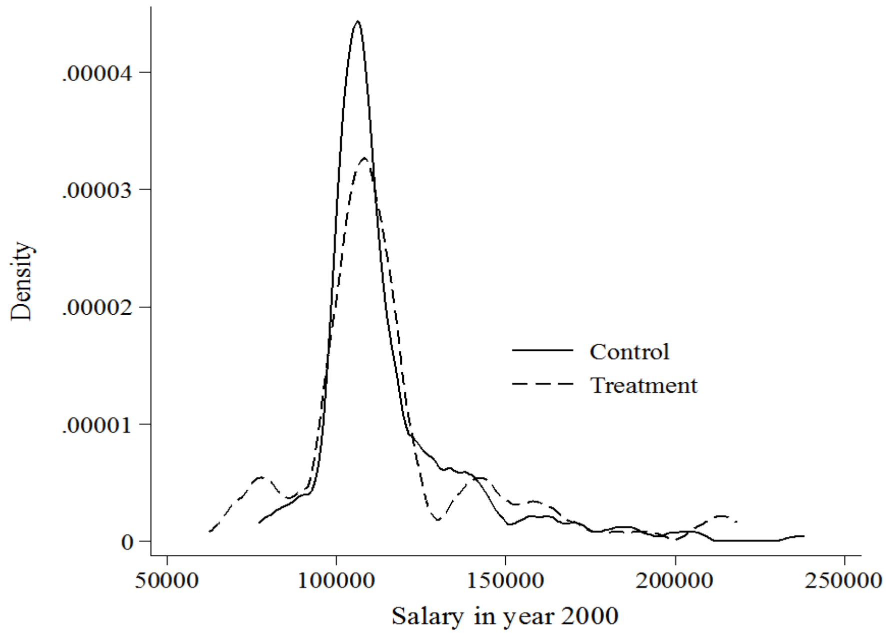


Figure 3a. Compensation path for CRC chairholders and controls.

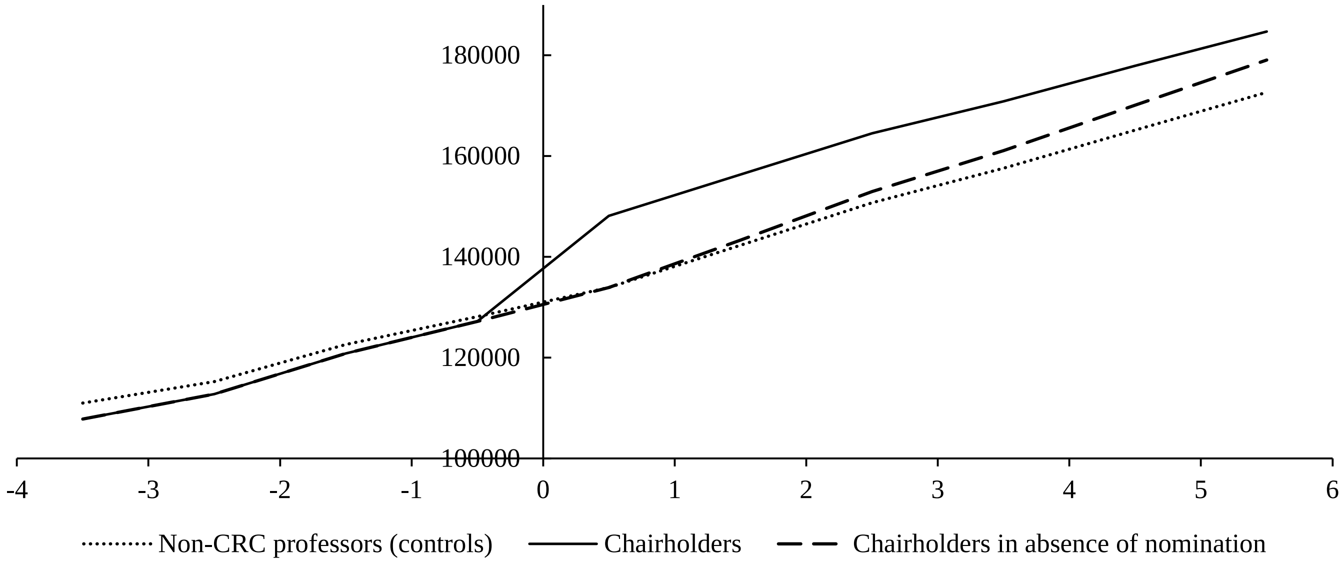
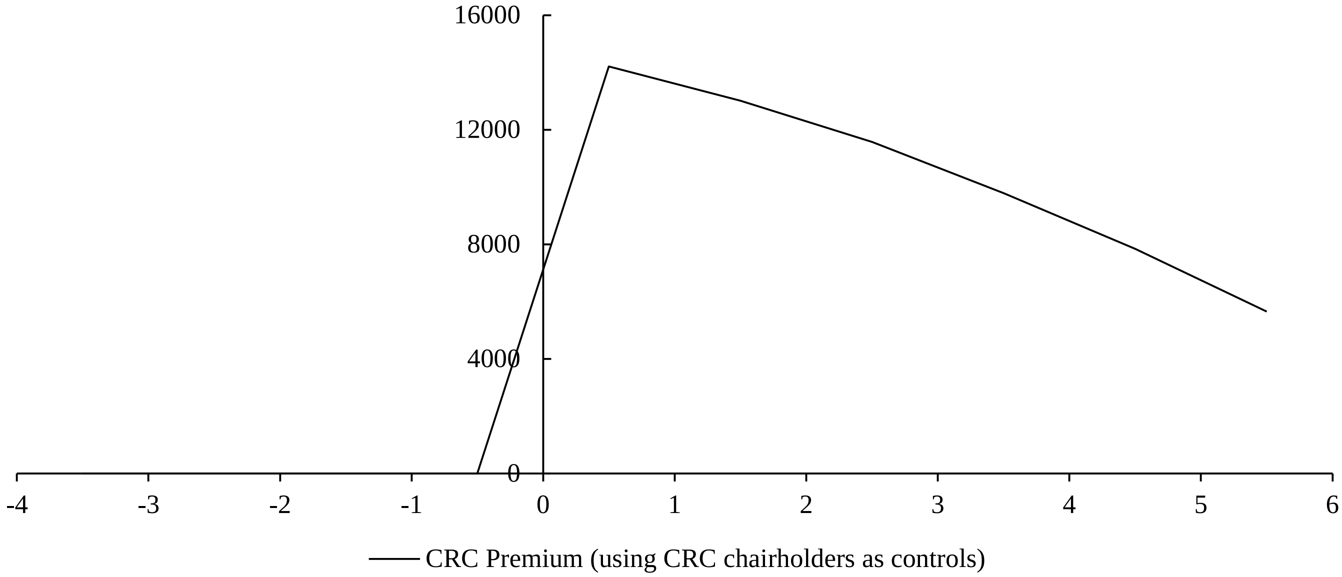


Figure 3b: CRC compensation premium.



Note: Figure 3a uses the coefficient estimates from Table 3, column 2 to construct the compensation path of chairholders, non-CRC professors (controls), and chairholders in absence of nomination. Figure 3b plots the difference between the solid and dashed lines in Figure 3a. In both cases, year 0 is CRC nomination (treatment)**.**

Table 1. Compensation sample descriptive statistics.

	Overall	Control	Treated			
			All	I	CE	AE
Individuals	787	557	230	144	16	70
Obs. Per Individual	8.6	8.8	8.1	9.4	7.9	5.5
Compensation Sample Average	145,094 (36311.1)	141,640 (35560.7)	154,115 (36708.4)	152,653 (38678.7)	140,920 (30322.3)	163,618 (28551.6)
Female %	16.0 (36.7)	16.3 (37.0)	15.3 (36.1)	13.9 (34.7)	43.8 (51.2)	11.6 (32.3)
Major admin. %	2.9 (16.9)	3.6 (18.6)	1.2 (10.8)	1.6 (12.4)	8.6 (9.3)	0.0
Minor admin. %	7.3 (25.9)	8.7 (28.2)	3.4 (18.1)	4.0 (19.6)	7.8 (26.9)	0.0
Average annual compensation growth rate %	5.7 (3.4)	5.8 (2.8)	5.6 (4.5)	6.0 (2.9)	7.0 (4.5)	4.4 (6.6)
Average years prior to treatment	N/A	N/A	1.6 (1.9)	2.3 (1.9)	2.8 (1.4)	0.0
Average CRC Tenure	N/A	N/A	6.2 (2.3)	6.6 (2.2)	5.3 (1.8)	5.5 (2.3)

Note: Numbers are averages over individuals for variables constant over time (e.g. female) and across the entire sample for time-varying variables (e.g. major/minor administration).

Table 2. Impact of CRC nomination on compensation: average effect.

	(1) Log (Compensation)	(2) Log (Compensation)	(3) Log (Compensation)	(4) Log (Compensation)
R^I (β_I)	0.1741***	0.1274***	0.1189***	0.1277***
	(0.000)	(0.000)	(0.000)	(0.000)
Transition	0.0085	0.0814***	0.0805***	0.0850***
	(0.610)	(0.000)	(0.000)	(0.000)
R^{CE} (β_{CE})	0.1389***	0.0680**	0.0880***	0.0559**
	(0.000)	(0.050)	(0.010)	(0.077)
β_M	0.1431***	0.0499	0.0683**	0.0316
	(0.000)	(0.152)	(0.033)	(0.374)
Associate	-0.1194***	-0.1267***	-0.0931***	-0.1335***
	(0.000)	(0.000)	(0.000)	(0.000)
Major	0.1271 ***	0.1197***	0.1403 ***	0.1167***
	(0.001)	(0.000)	(0.000)	(0.000)
Minor	0.0921***	0.0962***	0.0827***	0.0920 ***
	(0.000)	(0.000)	(0.000)	(0.000)
Female	-0.0148	-0.0292*	-0.0260	-0.0289
	(0.377)	(0.091)	(0.113)	(0.098)
Years since PhD	N/A	N/A	N/A	N/A
Year f.e.	No	Yes	Yes	Yes
University effects	No	No	Yes	No
Field f.e.	No	No	No	Yes
Individual f.e.	No	No	No	No
Constant	11.8170***	11.6341***	11.6555***	11.5629***
	(0.000)	(0.000)	(0.000)	(0.000)
R^2	0.1101	0.3702	0.4779	0.3967
Obsv.	6344	6344	6344	6344

Notes: Table reports results of specification (1) using the Ontario and BC salary sample of individuals. Sample includes controls, and I and E Chairs. P-values are reported in parentheses. P-values were calculated using robust standard errors clustered by individual. * significant at 10%; ** significant at 5%; *** significant at 1%.

	(5) Log (Compensation)	(6) Log (Compensation)	(7) Log (Compensation)
R^I (β_I)	0.0637*** (0.000)	0.0632*** (0.000)	0.0629*** (0.000)
Transition	0.0655*** (0.000)	0.0652*** (0.000)	0.0646*** (0.000)
R^{CE} (β_{CE})	0.0944** (0.026)	0.0797 ** (0.038)	N/A
β_M	0.0656** (0.023)	0.0626** (0.044)	N/A
Associate	-0.0516*** (0.001)	-0.0485*** (0.001)	-0.0494*** (0.004)
Major	0.0714*** (0.000)	0.0672*** (0.001)	0.0680*** (0.003)
Minor	0.0463*** (0.000)	0.0465*** (0.000)	0.0477*** (0.000)
Female	N/A	N/A	N/A
Years since PhD	N/A	N/A	-0.0058 (0.225)
Year f.e.	Yes	Yes	Yes
University effects	No	Yes	N/A
Field f.e.	N/A	N/A	N/A
Individual f.e.	Yes	Yes	Yes
Constant	11.56564*** (0.000)	11.5607*** (0.000)	11.6799*** (0.000)
R^2	0.3407	0.3741	0.2724
Obsv.	6344	6344	5418

Notes: Table reports results of specification (1) using the Ontario and BC salary sample of individuals. Sample includes controls, and I and E Chairs. P-values are reported in parentheses. P-values were calculated using robust standard errors clustered by individual. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3. Impact of CRC nomination on compensation: pre- and post-treatment trends.

	(1) Log (Compensation)	(2) Log (Compensation)	(3) Log (Compensation)
R^I (β_I)	0.0640*** (0.000)	0.1016*** (0.000)	0.0835*** (0.000)
Transition	0.0656*** (0.000)	0.0809*** (0.000)	0.0676*** (0.000)
Associate	-0.0448*** (0.006)	-0.0425*** (0.008)	-0.1120*** (0.001)
Major	0.0706*** (0.003)	0.0695*** (0.000)	-0.0325 (0.136)
Minor	0.0477*** (0.000)	0.0469*** (0.000)	0.0723*** (0.000)
Tenure CRC (β_a)	No	-0.0068*** (0.000)	No
Pre-Treatment Trend (β_b)	No	0.0074*** (0.002)	No
Year f.e.	Yes	Yes	Yes
Individual f.e.	Yes	Yes	Yes
Control Individuals	Yes	Yes	No
Constant	11.5684*** (0.000)	11.5676*** (0.000)	11.6075*** (0.000)
R^2	0.3429	0.3425	0.3907
Obsv.	5850	5850	1350

Notes: Table reports results of specification (2) using the Ontario and BC salary sample of individuals. Columns 1 and 2 report results of sample using controls and I Chairs. Column (3) reports results of sample using only I Chairs as controls. P-values were calculated using robust standard errors clustered by individual. Overall R^2 reported when individual fixed effects are used. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4. Salary of CE and AE relative to I.

	(1) Log (Compensation)	(2) Log (Compensation)	(3) Log (Compensation)	(4) Log (Compensation)	(5) Log (Compensation)
β_{AE}	-0.0050	0.0080	0.0017	-0.0011	0.0046
	(0.837)	(0.727)	(0.943)	(0.960)	(0.835)
β_{CE}	-0.0481	0.0020	-0.0626*	-0.0113	-0.0301
	(0.191)	(0.944)	(0.083)	(0.734)	(0.333)
Associate	-0.2620***	-0.2328***	-0.2557***	-0.0264	-0.0274
	(0.000)	(0.00)	(0.000)	(0.123)	(0.146)
Major	0.0436	0.0382	0.0131	-0.0326	-0.0335
	(0.776)	(0.713)	(0.930)	(0.215)	(0.208)
Minor	0.0924	0.0701	0.0825	0.0741***	0.0733***
	(0.130)	(0.102)	(0.151)	(0.000)	(0.000)
Female	-0.0297	-0.0408**	-0.0326	-0.0428	-0.0441*
	(0.205)	(0.047)	(0.214)	(0.048)	(0.056)
Year f.e.	Yes	Yes	Yes	Yes	Yes
University effects	No	Yes	No	Yes	Yes
Field f.e.	No	No	Yes	No	Yes
Individual r.e.	No	No	No	Yes	Yes
Constant	11.8181***	11.8265***	11.8140***	11.7492***	11.7435***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R^2	0.2285	0.3995	0.2485	0.3846	0.4036
Obsv.	1486	1486	1486	1486	1486

Notes: Table reports results of specification (3) using the Ontario and BC salary sample of individuals. Sample consists of chairholders post nomination only. P-values were calculated using robust standard errors clustered by individual. Overall R^2 reported when individual random effects are used. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 5. Retention sample descriptive statistics.[1]

Panel A: Kaplan-Meier survival probabilities broken by four termination risks.[2]

	New Job	Stay	Retired	Death	Total
Internals	92.9	99.1	100	97.2	89.4
Externals	88.3	97.6	100	100	86.3
Total	91.4	98.7	100	98.1	88.4

(1) Survival probabilities are multiplied by 100, broken down into four termination risks and independently computed for internal and external chairholders.

Panel B. Termination into a new job as a function of tenure.[3]

Tenure	Internal	External
1	0.0	1.6
2	1.2	3.3
3	1.7	1.8
4	0.9	0.9
5	0.5	2.0
6	2.0	1.1
7	1.1	1.4
Survival	92.9	88.3

(3) The numbers are termination probabilities multiplied by 100. The product of the complement of the termination probabilities over the seven years is equal to the Kaplan-Meier survival probabilities. (The two numbers on the last line are equal to the first two numbers reported in the first column in Panel A.)

Panel C. Retention sample used to estimate model (3).[4]

	Overall	Control	Treated All	I	E
Individuals	461	95	366	250	116
Obs. Per Individual	13.47	15	13.07	13.32	12.53
New Job Events $Pr(F_{i,t}=1)$	0.025	0.034	0.023	0.021	0.027

(4) Five I and E were dropped because we could not find their employment history.

(1) Panels A, B and C are based on the retention sample covering only Ontario individuals.

Table 6. Impact of CRC nomination on retention.

	(1) OLS F_{it}	(2) OLS F_{it}	(3) OLS F_{it}
D_{it}	0.0025 (0.694)	0.0081 (0.374)	0.0081 (0.374)
Years since PhD	-0.0013*** (0.000)	-0.0013*** (0.000)	-0.0013*** (0.000)
Control	0.0010 (0.765)	0.0048 (0.508)	0.0048 (0.508)
Internal	-0.0080 (0.106)	-0.0036 (0.608)	-0.0036 (0.608)
InteralxDit		-0.0084 (0.395)	-0.0084 (0.395)
Year f.e.	Yes	Yes	Yes
Individual r.e.	No	No	Yes
Constant	0.0354** (0.016)	0.0322** (0.034)	0.0322** (0.034)
R^2	0.0207	0.0208	0.0208
Obsv.	6208	6208	6208

Notes: Results using the retention sample covering only Ontario individuals. Overall R^2 reported when individual random effects are used. * significant at 10%; ** significant at 5%; *** significant at 1%

	(4) F_{it}		(5) F_{it}	
	Probit Coefficient	Marginal Effect	Logistic Coefficient	Marginal Effect
D_{it}	0.1780	0.010	0.4146	0.010
	(0.287)	(0.288)	(0.293)	(0.295)
Years since PhD	-0.0243***	-0.0014***	-0.0585***	-0.0015***
	(0.000)	(0.000)	(0.000)	(0.000)
Control	0.0397	0.0023	0.0991	0.0025
	(0.733)	(0.733)	(0.704)	(0.704)
Internal	-0.0337	-0.0019	-0.0786	-0.0020
	(0.765)	(0.765)	(0.757)	(0.757)
InteralxDit	-0.3337*	-0.0190	-0.8169*	-0.0204*
	(0.073)	(0.074)	(0.066)	(0.069)
Year f.e.	Yes		Yes	
Individual r.e.	No		No	
Constant	-5.2151		-16.5100	
	(0.978)		(0.982)	
Pseudo R^2	0.0755		0.0782	
Log Likelihood	-670.43		-669.91	
Obsv.	5993		5993	

Notes: Results using the retention sample covering only Ontario individuals. * significant at 10%; ** significant at 5%; *** significant at 1%

Appendix

Retention of talented academic researchers: Evidence from a government intervention

Pascal Courty and John Sim

This Appendix is constituted of three independent sections:

Section 1: Robustness Table for Retention results

Section 2: Salary comparisons between professors with and without Canada Research Chairs

Section 3: Impact of the CRC Programme on University Faculty Counts

Section 1: Robustness Table for Retention results[(1)]

	(1) F_{it}	(2) F_{it}	(3) F_{it}	(4) F_{it}	(5) F_{it}	(6) F_{it}	(7) F_{it}
D_{it}	0.0084	0.0142	0.0061	0.0082	0.0084	0.0023	0.0036
	(0.353)	(0.121)	(0.659)	(0.372)	(0.358)	(0.803)	(0.690)
Phd_time	-0.0013***	-0.0013***	-0.0013***	-0.0013***	-0.0013***	-0.0009***	-0.0008***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.002)
Control	0.0128*	0.0154**	0.0054	0.0050	0.0057		0.0029
	(0.091)	(0.042)	(0.461)	(0.503)	(0.433)		(0.694)
Internal	0.0002	0.0008	-0.0036	-0.0037	-0.0052	-0.0029	0.0233
	(0.974)	(0.915)	(0.613)	(0.615)	(0.465)	(0.672)	(0.003)
Internalxdit	-0.0102	-0.0117	-0.0147	-0.0084	-0.0084	-0.0092	0.0106
	(0.299)	(0.231)	(0.362)	(0.395)	(0.396)	(0.328)	(0.298)
Trend	-0.0021***	-0.0104***					
	(0.002)	(0.000)					
$(\text{Trend})^2$		0.0005***					
		(0.000)					
Year f.e.			Yes	Yes	Yes	Yes	Yes
University f.e				Yes			
Field f.e.					Yes		
CRC Tenure			0.0010				
			(0.711)				
Inernal CRC Tenure			0.0013				
			(0.678)				
Internal Job Tenure							-0.0028***
							(0.000)
Individual r.e							
Constant	0.0649***	0.0869***	0.0284*	0.0320*	0.0328**	0.0273*	0.025*
	(0.000)	(0.000)	(0.068)	(0.056)	(0.031)	(0.067)	(0.098)
R^2	0.0135	0.0163	0.0211	0.0212	0.0223	0.0160	0.0298
Obsv.	6208	6208	6208	6208	6208	4798	6208

(1) This table presents the results mentioned in footnote (15). “We replaced the year fixed effects with a linear quadratic time trend. We removed the controls from the sample and use only the pre-nomination observations to control for change in mobility correlated with time. We added a CRC tenure variable that captures the fact that the impact of nomination on retention may change over time. We added a job tenure variable for I that capture the fact that these chairholders have different job tenure when they are nominated. We added university dummies for the nine largest universities in Ontario to control for different academic labour markets. We added dummies for the three research councils in Canada to control for different mobility rates across broadly defined academic areas. In all specifications, the impact on the treatment dummy remains small and insignificant.”

Section 2: Salary comparisons between professors with and without Canada Research Chairs

This Section of the Appendix documents university spending: How much do universities spend on the salary of CRC chairholders relative to non-CRC professors? We cannot answer this question with our data because our controls are not a random subset of university professors. To make progress on the issue, we use the salary information reported in the University and College Academic Staff System (UCASS) database. We compare UCASS compensation for all full professors in Ontario and all full professors at the University of British Columbia (UBC), with the corresponding information for CRC chairholders.[21] This approach is not ideal but it is the best we can do to estimate the salary of CRC chairholders relative to non-CRC full professors. Because the data is aggregated across all academic fields, the exercise is to compare the salary of a random university full professor with the salary of a random CRC chairholder working in the same group of universities (Ontario) or at the same university (UBC). A shortcoming of this approach is that the UCASS sample includes the CRC chairholders. This should not be an issue, however, because senior chairholders represent only a very small fraction of all UCASS full professors (764 CRC chairholders against14K UCASS, or 5.4 percent). Another caveat worth keeping in mind is that due to the FIL censoring, our Ontario sample excludes some of the lower paid chairholders. As such, we consider our estimates of the CRC salary premium (for Ontario) an upper bound.

Keeping these points in mind, Table 1 reports compensation percentiles of post-nomination chairholders in our sample along with the salary percentiles from the UCASS census.[22] We do so for the year 2008–2009 because it is the year that has the largest number of activated CRC Chairs in our sample for which UCASS data is available. For the sake of conciseness, we discuss only the results for Ontario. CRC professors earn about $21–24K more than full professors. This corresponds to a percentage difference of 14 to 19 percent (column 3). If we focus on the median only, universities had to pay CRC Chairs a compensation premium of about 18 percent relative to non-CRC full professors. In contrast with the previous salary comparison (chairholders from abroad and from Canada), we now find a large difference in compensation. This confirms the presumption that CRC chairholders are different from non-CRC professors. The 18 percent figure is the compounded sum of a selection effect (prior to nomination, CRC chairholders are already amongst the highest paid full professors) and 6.3 percent due to CRC nomination. The contribution of the CRC Program to the CRC compensation premium is small.

Column 4 computes the CRC premium as a fraction of the CRC grant. The compensation premium for CRC chairholder corresponds to 11 to 12 percent of the CRC grant depending on which percentile one looks at (column 4). These low numbers are surprising given that universities declare having spent between 55 and 71 percent of the grant on chairholder salary.

[21] We could have also reported UCASS percentiles for Western Canada and the conclusions would not have changed. UCASS does not report salary percentiles for British Columbia on its own. Western Canada includes British Columbia, Alberta, Manitoba and Saskatchewan.

[22] Benefits are excluded from the UCASS salary variable but included in the CRC compensation variable. The measure of the CRC compensation premium relative to UCASS salary reported in Table 5 is an upper bound, but the bias is likely to be small. For Ontario, we have information on salary and benefits separately (see Appendix) and the benefits are a very small relative to the salary.

Table 1: Percentile comparisons of UCASS and CRC salary for the year 2008–2009.

Percentile	(1) UCASS Ontario	(2) CRC Ontario Sample	(3) Ontario Percentage difference	(4) Percentage of CRC Grant	(5) UCASS UBC	(6) CRC UBC Sample	(7) UBC Percentage difference	(8) Percentage of CRC Grant
10	115,350	136,799	18.6%	10.7%	116,400	152,499	31.0%	18.0%
50	138,450	162,808	17.6%	12.2%	143,475	177,280	23.6%	16.9%
90	175,525	199,945	13.9%	12.2%	207,225	244,887	18.2%	18.8%
Obsv.	4,701	131			882	51		

Notes: UCASS percentiles are reported for academics holding the position of full professor for the year 2008–2009. CRC percentiles are reported for Chairs in Ontario or UBC that are activated prior to 2009 and 2010, a restriction that excludes 22 Chairs.

Section 3: Impact of the CRC Programme on University Faculty Counts

Do universities hire more professors in response to receiving CRC grant money? The maximum possible CRC transfer to universities is $300m. In 2004-2005, this represents about 9 percent of total university spending on professor salary.[23] Thus, the CRC grants could have a significant impact on the number of faculty members. That is if universities spend the CRC grants to increase hiring budgets. But universities could also spend the grants on other items.[24] We investigate whether the CRC funds have an impact on university hiring.

3.1 Data, Descriptive Statistics, and Estimation Issues

We collected information on faculty count from the University College Academic Staff Survey (UCASS). We recorded the number of full time faculty (assistant, associate or full professor) in 67 universities over the period 1996-2008.[25] We also collected information on the CRC transfers to universities. The CRC funds are re-allocated across universities every other year based on each university's share of the past three years' tri-council research funding.[26] Because a university's research performance does not vary much over time, each university's allocation of the CRC allocations varies little over time. The CRC budgets are allocated to universities only when the chairs are filled. When this happens, we say that the chair is activated. We track all activated CRC chairs during 2000-2008. Activating a junior chair adds $100K to a university's budget. A senior chair adds $200K. As normalization, we measure activation in equivalent of junior chair. For example, if a university has activated 2 senior chairs and 3 junior chairs, we say that it has 7 junior equivalent chairs. In other words, the university has received $700K from the CRC program.

Table 1 presents summary statistics on our sample. There are 543 faculty members on average across the 67 universities with a maximum of 2691 and a minimum of 9. Universities receive on average the equivalent of 18.8 junior chairs ($1.88m) with a maximum of 381 and a minimum of 0. Figure 1 plots the growth over time in faculty count and CRC activation. As expected, CRC activation starts in year 2000 and plateaus shortly after 2005. Interestingly, this corresponds to a period of high growth in faculty count. But one has to be careful in interpreting these two trends. To start, faculty growth varies for reasons independent of CRC activation. For example, faculty count declined from 1992 to 1996 (not reported on the Figure), a period when the CRC programme did not exist. Faculty count also continues to grow beyond 2005 while CRC activation is stable. Moreover, measured in dollar value, the growth in faculty salary in 00-05 is much larger than the growth in CRC grant dollar.[27] Thus, it is important to control for time effects when looking at the impact of chair activation on faculty growth.

Another issue with interpreting these two variables is that CRC activation and faculty counts could be related through two different channels: (1) The CRC program rules dictate that CRC allocation depends on tri-council research funding which is related to faculty count. (2) Random variations in CRC activation could influence

[23] Not all chairs are activated at any given point in time. In 2013, for example, the CRC activated chairs amounted to a transfer of $250m to universities. The 9 percent figure, which is obtained using faculty salaries from UCASS (defined below), is approximate because UCASS report only median salaries not mean ones.

[24] University salary and benefits represents about sixty percent of total university expenses (UBC 2009 financial statement).

[25] The sample runs from the year 1996 to 2008 inclusive. The sample collected initially contained 72 universities participating in the CRC program. UCASS data was not available for 5 of the smallest universities participating in the CRC program. In total, 88 observations were dropped due to missing UCASS data.

[26] http://www.chairs-chaires.gc.ca/program-programme/allocation-attribution-eng.aspx

[27] Faculty count grew across all universities by 6,573 from year 99-00 to 07-08. Using median salaries in 04-05, this corresponds to an increase in faculty salary cost of $508m which is much greater than the maximum possible CRC grant transfer of $300m.

faculty hiring through changes in university budgets. We are interested in this later channel: Does CRC grants activation influences faculty hiring?

Formally, we denote faculty counts as F and activated grants A. Assume we can isolate random variations in CRC grant activation. We want to estimate the relation $F=\alpha_0+\alpha_A A$. The structural parameter of interest is α_A. We would expect $\alpha_A>0$ if universities respond to CRC grant activation by increasing faculty hiring and $\alpha_A=1$ if universities hire a new faculty member for each \$100K increase in CRC transfer. In practice, however, we face a reverse causality problem because faculty count is related to grant activation through the CRC allocation rule (first channel). To measure the second channel alone, we leverage variations in CRC activation over time that are due to random changes in university research performance and idiosyncratic shocks in the timing of activation at the university level. This approach is valid if the time variations in CRC budgets in a given university are not caused by faculty hiring policies. Consider the specification

$$F_{u,t} = \alpha_0 + \alpha_u I_u + \alpha_t I_t + \alpha_A A_{u,t} + \varepsilon_{u,t} \qquad (1)$$

where the sub-index t and u denote years and a universities respectively, I_u are university dummies, I_t are time dummies, and $\varepsilon_{t,u}$ is an error term. Larger universities have more chairs because they have more faculty members and do more research (first channel). University fixed effects control for the first channel if variations in chair activation over time in a given university are not due to change in faculty size. Section 4.3 presents a structural model that explains when this assumption is valid. Holding constant university fixed effects, activation varies for random reasons (e.g. random timing in activation). The error term captures random shocks to faculty count due, for example, to variations in hiring and retirement policies caused by changes in provincial economy, changes in faculty age structure, and so on...

3.2 Results

We estimate model (1) using ordinary least squares. Table 2 column 1 presents the results. The coefficient estimate for α_A is 0.81 and is not statistically different from zero (p-value .13). The economic interpretation is as follows: Universities increase faculty count by .81 for each increase of \$100K in CRC grant budget. Although the magnitude of the coefficient estimate is realistic, it is not precisely estimated.

The econometric model in Section 4.3 demonstrates that the estimate of α_A obtained by estimating specification (1) is unbiased only under the strong assumption that the hiring shocks are not correlated over time, that is, $Cov(\varepsilon_{t-n,u}, \varepsilon_{t,u})=0$ for n positive integer. Taking a first difference in (1), however, delivers an unbiased estimate under weaker assumption. Table 2 column 2 reports the results of estimating model (1) in first difference. The coefficient for α_A decreases to 0.06 and it is not statistically different from zero (p-value .93). For robustness concern, we drop the observations corresponding to across CRC funding cycle (year differences 00-99, 02-01, 04-03, 06-05, and 08-07). Channel one is shut down for the remaining observations because CRC grant allocation is constant within each CRC funding cycle. The variations in CRC allocation only comes from change in university allocation. The results do not change with a point estimate for α_A of .56.

Overall, the results indicate a weak and imprecise relation between CRC grant activation and faculty hiring. Across all specifications, we cannot reject the hypothesis that the estimate of α_A is statistically different from zero or from one. That is, we cannot reject the hypothesis that universities do not respond to CRC grant activation (α_A=0) and we cannot reject either the hypothesis that universities hire a new faculty member for every increase in \$100K in CRC grant (α_A=1).[28] The choice of α_A=1 is somewhat arbitrary but it makes the point that it is difficult to make definite statements on a university's hiring response to CRC grants. This is not entirely surprising. It is consistent with the interpretation that variations over time in CRC activation (in a given university) have a noisy influence on faculty counts. Thus, it is difficult to precisely estimate α_A.

3.3 Econometric Model

We outline a structural model of CRC grant allocation and activation. Denote allocated grants G. CRC activation, A, is a function of CRC grant allocation, G, and an error term that captures random delays in activating grants

$$A_{u,t} = \beta G_{u,t} + \eta_{u,t} \qquad (2)$$

where we would expect β to be lower than one, but close to one, if universities do not delay activating grants. In 2013, for example, only \$250m worth of grants was activated out of the \$300m available (β=.83). CRC grant allocation is a function of faculty count

$$G_{t,u} = \gamma F_{t-1,u} + \zeta_{t,u} \qquad (3)$$

where $\zeta_{t,u}$ captures random shocks in university research output. The parameter γ captures the conversion rate of current faculty count into grant allocation. It is reasonable to assume that the three error terms ($\varepsilon_{t,u}$, $\eta_{t,u}$, $\zeta_{t,u}$) are orthogonal. Plugging (3) into (2), we obtain

$$A_{t,u} = \beta\gamma F_{t-1,,u} + \beta\zeta_{t,u} + \eta_{t,u} \qquad (2')$$

We obtain $Cov(A_{t,u}, \varepsilon_{t,u}) = \beta\gamma Cov(F_{t-1,u}, \varepsilon_{t,u})$ and using equation (1) we write $Cov(A_{t,u}, \varepsilon_{t,u}) = \beta\gamma\alpha_A Cov(A_{t-1,u}, \varepsilon_{t,u}) + \beta\gamma Cov(\varepsilon_{t-1,u}, \varepsilon_{t,u})$ or after replacement

$$Cov(A_{t,u}, \varepsilon_{t,u}) = \beta\gamma\ Cov(\varepsilon_{t-1,u}, \varepsilon_{t,u}) + (\beta\gamma)^2\alpha_A Cov(\varepsilon_{t-2,u}, \varepsilon_{t,u}) + \ldots$$

Thus, $Cov(A_{t,u}, \varepsilon_{t,u}) = 0$ only if $Cov(\varepsilon_{t-n,u}, \varepsilon_{t,u}) = 0$ for n positive integer. This is a strong assumption. Faculty count may be correlated over time due to persistent shocks: changes in provincial university policies, enrollment trends and so on… Consider next a first-difference approach. Denote $\Delta X_{t,u} = X_{t,u} - X_{t-1,u}$ the first difference for variable X. We have

$$\Delta F_{t,u} = \alpha'_t + \alpha_A \Delta A_{t,u} + \Delta\varepsilon_{t,u} \qquad (1')$$

and $Cov(\Delta A_{t,u}, \Delta\varepsilon_{t,u}) = \beta\gamma\ Cov(\Delta F_{t-1,u}, \Delta\varepsilon_{t,u}) = \beta\gamma\alpha_A\ Cov(\Delta A_{t-1,u}, \Delta\varepsilon_{t,u}) + \beta\gamma\ Cov(\Delta\varepsilon_{t-1,u}, \Delta\varepsilon_{t,u})$ or after replacement

$$Cov(\Delta A_{t,u}, \Delta\varepsilon_{t,u}) = \beta\gamma\ Cov(\Delta\varepsilon_{t-1,u}, \Delta\varepsilon_{t,u}) + (\beta\gamma)^2\alpha_A Cov(\Delta\varepsilon_{t-2,u}, \Delta\varepsilon_{t,u}) + \ldots$$

We have $Cov(\Delta A_{t,u}, \Delta\varepsilon_{t,u}) = 0$ if the changes in faculty count across years are not correlated. This assumption is weaker than the assumption $Cov(\varepsilon_{t-n,u}, \varepsilon_{t,u}) = 0$.

[28] The lowest p-value for these two hypotheses tested using model (1) and (2) is .136.

Table 1: Descriptive Statistics

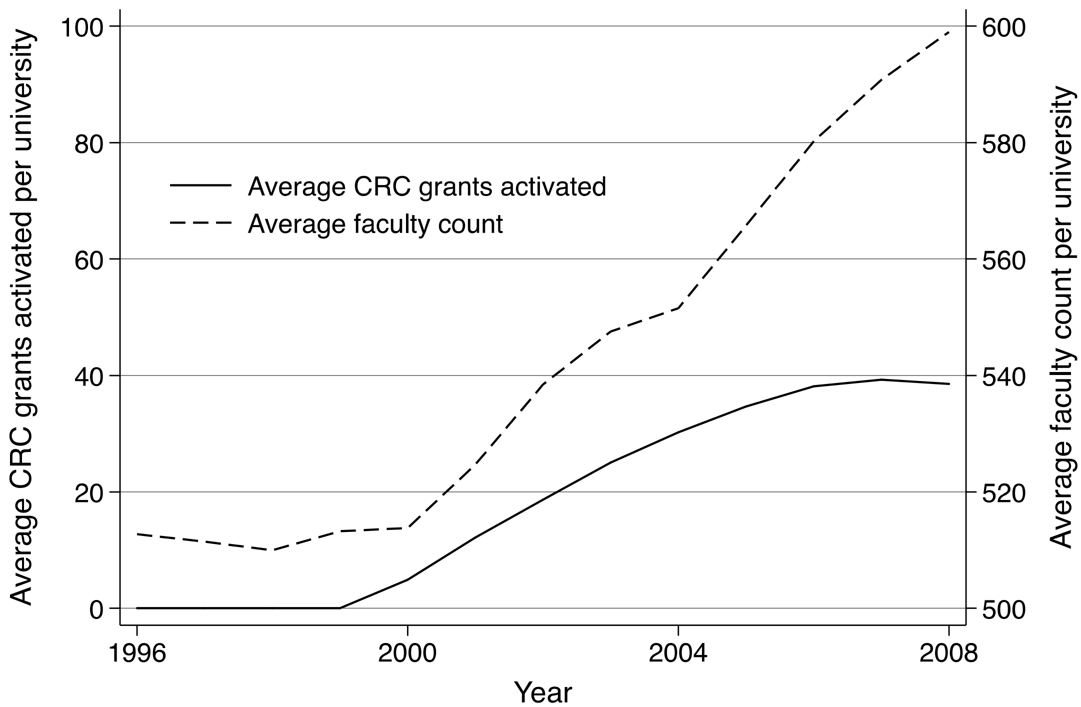
	Mean	S.dev	Min	Max	Total
Faculty Count	543.33	541.73	9	2691	
Chairholders	18.76	42.46	0	381	
Observations					848
Universities					67

Table 2: Impact of CRC Activation on Faculty Count

	(1) Faculty Count Level	(2) Faculty Count First Difference
Chairholders (α_A)	0.8103 (0.136)	0.0632 (0.930)
Year f.e.	Yes	Yes
University f.e.	Yes	Yes
Constant	505.6377*** (0.000)	-8.7871** (0.036)
R^2	0.2321	0.0869
Obsv.	848	780

Notes: P-values reported in parentheses were calculated using robust standard errors clustered by individual. * significant at 10%; ** significant at 5%; *** significant at 1%

Figure 1: CRC grant activated and Faculty count



Note: Average across universities of (a) number of CRC grants activated (left scale) and (b) faculty count (right scale).