

Courty, Pascal; Sim, John

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What is the cost of retaining and attracting exceptional talents? Evidence from the Canada Research Chair program

Pascal Courty
University of Victoria

John Sim
Queen's University

Department of Economics
Queen's University
94 University Avenue
Kingston, Ontario, Canada
K7L 3N6

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What is the cost of retaining and attracting exceptional talents?

Evidence from the Canada Research Chair program

Pascal Courty and John Sim¹

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Abstract: The compensation of a professor who is awarded an internal Canada Research Chair (CRC) increases by 6.3 percent on average in our sample. This gain is large initially but quickly erodes over CRC tenure. The gain is slightly larger for professors who change university to obtain a CRC Chair. Assuming that the CRC program has achieved its goal of attracting and retaining top talents, we infer that the compensation cost of doing so is modest. In addition, only a small fraction of the CRC grants have been passed through to professors as compensation increases. This is despite the fact that universities report spending more than half of the CRC grants on chairholder compensation.

Keywords: Compensation, brain drain, crowding out, Canada Research Chair

JEL: J3, I23

¹ Pascal Courty, Department of Economics, University of Victoria and CEPR, pcourty@uvic.ca. John Sim, Department of Economics, Queen's University, jsim@uvic.ca. This paper builds upon the Honors Essay, titled "Crowding-out in the Canada Research Chair program", that John Sim wrote under the supervision of Pascal Courty at the University of Victoria. We are grateful to Gerald Marschke for valuable discussions.

1-Introduction

In 2000, the government of Canada endowed the Canada Research Chairs program (CRC) with \$300 million per year to establish 2000 university research Chairs in order to attract and retain some of the world's top researchers. By 2008, all Chairs were filled. Many other countries have implemented policies 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 talents 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, each university is entitled to a fixed number of Chairs. A university proposes candidates who have to be approved by a CRC expert committee, and negotiates with individual researchers a package that includes compensation, teaching release, and research support. 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. A central feature of the program is that the government retains some control over the nomination process but universities administer the grants.

Universities report having used more than half of the CRC funds to finance the salary of the Chair recipients. In fact, this is exactly what one would expect universities to do if competition on salary is the main driver of mobility, as many have argued. Universities should target the high-risk individuals and pass on some of the CRC grant to increase researcher compensation.

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, 2010) could not respond effectively to international competition.

Such a strategy will work if financial incentives influence retention (Gibson and McKenzie, 2011). The CRC program, therefore, gives us a unique opportunity to understand the role for financial incentives in retaining top university personnel.

We estimate the impact of the CRC program on Chair recipients' salaries. We also compute the CRC compensation pass-through defined as the percentage of the CRC funds that are used to increase the Chair recipient's compensation. One would expect to find a large impact on compensation and a large pass-through if financial incentives matter and if universities faced external competitive pressure during the time of the CRC program.

We construct a unique dataset that covers, over an 11 year period, the senior CRC Chairs in British Columbia and Ontario and a large set of control individuals, whose compensation information is publicly available under provincial freedom of information laws. Since we observe the compensation of CRC nominees before and after the Chair nomination, along with the compensation of control professors during the same period, we use a difference in difference approach to estimate the return to CRC nomination.

After controlling for a number of sources of unobserved heterogeneity, captured by individual fixed effects and other control variables, we find that the return to a CRC is around 6.3 percent for those individuals who are internal nominees (they worked in the same university before and after nomination). This figure does not change after a number of robustness checks. We also look at the subgroup of individuals who moved from a university within Canada to fill Chair at a new university. For these individuals the CRC return is at most 8 percent, and this is after holding constant university fixed effects that control for local labor market and university characteristics, among other things.

To put these numbers into perspective, we also estimate the return of moving universities within Canada without a CRC Chair. We find a compensation increase of about 6.3 percent. The return of a CRC Chair is of approximately the same magnitude as the return to moving universities (without a CRC), and there is a small premium for moving across universities within Canada to fill a CRC. Stated as a fraction of the CRC grant, the compensation increase associated with CRC nomination corresponds to a pass-through rate somewhere between 4.6 and 5.8 percent.

Our estimates permit to draw two conclusions. First and most importantly, our figures suggest a modest role for financial incentives for retention. Although we do find statistically significant financial incentives for retention, the overall magnitude is small. If one assumes that the CRC funds were successful in achieving their retention and attraction goal, we can conclude that the financial compensation increase required to do so is small relative to the total CRC grant. The threat of international competition may not be as strong as what was thought.

Second, our estimates raise the question of what did universities do with the CRC funds. Because of the poor transparency on how funds are spent at the university level, it is not possible to give a definitive answer to this question. During our sample period, universities report having allocated between 55 and 71 percent of the CRC grant for nominee salary compensation. Our pass-through rate estimates say that actual compensation increases only account for 5 percent of the CRC grants. This leaves most of CRC grant money billed to chairholder compensation, or half of the CRC grant, unaccounted for as compensation increase. One cannot rule out the possibility that universities have transferred a large fraction of the grant to their general budget (Bergstrom et al. 1986, Andreoni and Bergstrom 1996, and Wallsten 2000).

The rest of the paper is organized as follows. The next section presents the CRC program and describes our dataset. Section 3 outlines our identification approach, and section 4 presents our results. Section 5 presents robustness analyses, and section 6 discusses 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-chaire.gc.ca/>), evaluation reports (Hickling, Arthurs, and Low 2002, Malatest and Associates 2004, CRC Year in Review 2007-08) 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

The Canada Research Chairs Program (CRC) was established by the federal government in 2000 with main mandate ‘to attract and retain excellent researchers in Canadian Universities’ (Picard-Aitken et al. 2010).⁴ Between 2000 and 2005, 2000 CRC Chairs were allocated to two tiers. The senior tier comprises 764 Chairs that are targeted to full professors (or associate within two years of promotion to full) 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 by the CRC

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

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, (b) to optimize the use of research resources through strategic planning.

of \$200,000 for a period of seven years, and are typically renewed when requested. Junior Chairs are awarded \$100,000 for five years.

Once a university has received a Chair, it has up to three years to fill it. To do so, a university must nominate researchers to an independent committee of experts selected by the CRC Secretariat. Nominees can be internal (currently employed at the nominating institution) or external (employed elsewhere). Once a nomination is reviewed and accepted by the CRC, the Chair is considered “filled”. Figure 1 (solid line matched to the left axis) shows that most of the senior Chairs were filled by the mid 00’s.

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 their discretion to cover salary, benefits, research, and many other expenses of the chairholder. 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 2002-03, 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. The share of the senior tiers grants that went to chairholders’ salaries increased from 55 percent in 2002-03 to 71 percent in 2007-08 (CRC Year in Review 2007-08, Picard-Aitken, et al. 2010). The next largest

⁵ The third year review (2002) noted that some universities did not observe the program rules (p.12, 2007-08 Evaluation Report). In 2002, the CRC Secretariat asked universities to produce annual reports providing a statement of expenditure. In 2005, it also required universities to provide a program result report for each chair holders. There are other mentions of poor accountability and transparency (e.g. Validation Study Report 2005-06 p. 30).

categories of CRC fund allocation were: salary to non-students, administrative costs, and salary to students. Taken together, salary and administration costs account for the majority of the Chair funds (90 percent in 2002-03 and 94 percent in 2007-08).

2-2 Data

We have compiled a unique individual level dataset using a variety of sources. Freedom of Information Laws (FIL) in British Columbia and Ontario make publicly available the compensation data of public servants who earn above a given threshold. Since the majority of Canadian universities (and certainly all 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 \$50,000 up to 2002 and \$75,000 after.

We focus on the senior CRC tier for two reasons. First, these individuals' compensation is more likely to be above the minimum threshold imposed by the FIL. Second and most importantly, these individuals are 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 CRCs.

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 benefits (see Appendix 1 for the construction of the compensation variable). 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.

Table 1 presents summary sample statistics. Our panel consists of 230 treatment individuals (CRC nominees). We have also collected information for 557 control individuals selected by matching observable characteristics. (Appendix 2 describes how we selected the controls.) Treated and controls sum to 6747 individual-year observations. Treatment individuals are split into 3 categories based on the researchers' work origin. The first two categories are internal nominee (I) and external nominee from British Columbia or Ontario (E). For these individuals, we observe compensation before and after CRC nomination and this information will be used in the core of our analysis. We have also collected information on nominees from outside of Canada (A for abroad). We cannot conduct our main analysis for these individual because we do not observe their compensation prior to nomination. We have 144 I nominees, 16 E nominees, and 70 A nominees. Because the FIL compensation threshold is low in British Columbia, we have all the I, E and A.⁶ The Ontario censoring, however, is binding. We only have data on 46 percent of Ontario senior tier internally nominated CRCs. Figure 1 plots the activation path for the E and A in our sample (dash and dotted line matched to the right axis). The activation path for the individual in our sample closely follows the activation path for the entire senior tier (solid line).

We grouped the academic field information into 7 categories following those used by Statistics Canada in the annual University and College Academic Staff System (UCASS) survey:

⁶ This is not the entire population of senior tier CRC in British Columbia because we have not collected the nominees who moved from within Canada but from a different province than British Columbia or Ontario.

Education, Humanities, Social Sciences, Agricultural & Biological Sciences, Engineering & Applied Sciences, Health Professions & Occupations, and Mathematics & Physical Sciences. We group 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 to the rules of the CRC that set a minimum rank to fill a senior tier Chair.

3-Compensation increase associated with CRC nomination: Identification issues

We are interested in measuring the increase in compensation that individual researchers experience after obtaining a CRC. We distinguish nominees that are internal (I) and those that moved within or between British Columbia and Ontario (E). R^I denotes the percentage increase in compensation from obtaining a CRC for a researcher who does not move university. R^I answers the question: How much have CRC internal nominees benefited from the program in compensation? If we assume that these CRC nominees would have left Canada had they not received a CRC, R^I also addresses the question: What is the financial cost of retaining researchers within Canada?

Matters are slightly more complicated for externals. A nominee's compensation may change for at least three reasons. First, salaries depend on local labor market conditions (cost of living, attractiveness of local area and so on). Second, moving 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^E should include the third

effect (directly associated to CRC) and exclude the first effect (because the individual financial gain from a CRC should be computed net of equilibrium compensating differentials across local labor 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^E : 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^E 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^E (Angrist and Pischke, 2009). See Busse et al. (2006) for an application similar to ours. Treatment in our application corresponds to CRC nomination. We observe the compensation of the CRC researchers pre and post nomination. We also observe the compensation of controls (researchers who did not get a CRC) with similar observable characteristics as the CRCs during the same period. The issue at hand is to construct a counterfactual of what post nomination salaries of CRC treated individuals 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 our controls.⁷ This could be the case, for example, if universities nominate only top scholars who typically earn more than other individuals, and if these differences are not captured by our individual-level control variables.

⁷ 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 dollars. Due to large salary inflation for the individuals in our sample, this constraint is more likely to hold early in the sample: the CRCs who are nominated early in our sample earn higher salaries relative to later CRCs.

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

$$\begin{aligned} \ln(s_{i,u,y}) = & \beta_0 + X_i' \beta_i + \Phi_Y + \Phi_U + \Phi_F + \Phi_I + \text{CRC}_{i,t}^I \beta_i + \text{CRC}_{i,t}^E \beta_e \\ & + M_{i,t} \beta_M + \varepsilon_{i,u,y} \end{aligned} \quad (1)$$

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,⁸ 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 universities, Φ_F for academic field, and Φ_I for individual. The variable $\text{CRC}_{i,t}^I$ ($\text{CRC}_{i,t}^E$) is equal to one if internal (external) nominee 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 than that with which she entered our sample (individuals in our sample move universities at most once). The parameter β_i measures the impact of CRC nomination for internals, β_e for external, and β_M the impact of moving universities without a CRC. Specification (1) recovers parameters R^I and R^E under two assumptions:

(A1) Common trend: CRC nominees 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 nominees may earn more than the controls each year, but they must experience

⁸ To account for the fact that nomination may occur in the middle of an accounting year we separately tag the transition years for internal nominees (See Appendix A).

the same compensation growth over time. A1 holds, for example, if most of changes in compensation growth take place early in the career.

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

If these two assumptions hold, a specification that includes Φ_Y , Φ_U , and Φ_I estimates our parameters of interest

$$R^I = \beta_i \quad \text{and} \quad R^E = \beta_e$$

keeping in mind that in general $R^E \in [\beta_e - \beta_m, \beta_e]$ since CRC movers may have moved even in the absence of the CRC program (in which case $R^E = \beta_e - \beta_m$), as discussed earlier. Including university fixed effects controls for differences in compensation across local labor 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.⁹

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 also include university fixed effect to eliminate the change in compensation associated with differences across local labor markets. β_i measures the percentage increase in compensation relative to what the individual would have earned by remaining in the same

⁹ The inclusion of individual fixed effect implies that we do not use information of the individuals who appear in our sample only after CRC nomination due to FIL censoring.

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, $\beta_e - \beta_m$ 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_e 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.

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

4-Results

Table 2 reports our main results. The six columns have different sets of controls to demonstrate how the different sources of unobserved heterogeneity influence the estimates of R^I and R^E . 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.¹⁰ In contrast the consumer price index in Canada has increased by 22 percent over the 11 year period, corresponding to a growth rate of 2 percent per year. Faculty salaries may increase faster than the consumer price index for a number of reasons. First, universities may follow personnel rules that pay for seniority (as in Haeck and Verboven, 2010).

¹⁰ $4.5 = \exp(.49/11) - 1$.

Second, Canadian faculty salaries may have increased in our sample period due to competitive pressure. 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 do not change the coefficient estimates of R^I and R^E by much. Adding individual fixed effects in column 5, however, has a large impact on both R^I and R^E 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^E increases from 5.6 to 9.4 percent suggesting that they were underpaid prior to CRC nomination.¹¹ With the exception of R^E , which falls to 8 percent, the results do not vary if we also add university fixed effects (Column 6). Since professors in our sample do not change fields, Column 6 corresponds to the fully saturated model. All sources of unobserved heterogeneity (time, field, university, and individual) are accounted for.

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 8 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 is between 1.7 percent ($\beta_c - \beta_m = 8 - 6.3$), assuming they would have moved anyway, and 8 percent, assuming they would not have moved in the absence of the CRC program.

The individual control variables offer interesting benchmarks to compare the CRC impact. Associate professors earn 5 percent less than full professors. Major administrative duties

¹¹ An alternative interpretation (assuming that movers were paid competitively before and after CRC nomination) is that the movers are less talented researcher. This interpretation, however, is in conflict with the impact of individual fixed effects on R^I . R^I should have increased not decreased if CRC nominees were less talented researchers.

increase compensation by 6.7 percent, and minor duties by about 4.7 percent. Thus, the 6.3 percent compensation increase associated with internal CRC nomination is of the same order of magnitude as doing major administrative duties (6.7 percent) or as moving universities without a CRC (6.3 percent). It is about one and a half times the return of a promotion from associate to full professor (4.7 percent), the increase associated with minor administrative duties (4.8 percent), or one year of salary inflation (4.5 percent).

The results are striking. The impact of CRC on compensation is surprisingly low and this holds both for internal nominees and for movers. Suppose we interpret the CRC compensation increase as the university response to the threat of international competition for talent. The results suggest that modest compensation increases are sufficient to match the threat associated with the international competition for researchers.

5- Robustness

We have done a number of robustness checks.¹² We report here only two extensions that offer new insights. We revisit assumptions (A1) and (A2). We also investigate whether the estimates of the impact of CRC on compensation vary across universities, fields, and years.

5-1 Common trend and constant treatment assumptions

Our interpretation rests on two key identifying assumptions: common trend and constant treatment. We follow two strategies to investigate the robustness of our results to (A1) and (A2). First, we investigate whether these two assumptions hold by comparing time trends of compensation of the three groups of interest---controls and CRC pre and post treatments (Angrist

¹² For example, we have replicated the estimation for the subsamples of British Columbia and Ontario observations taken independently. In both case, we find a highly significant (1 percent level) impact of a CRC and the magnitude of the coefficients are similar (not reported).

and Pischke, 2009, p. 230-32). The second approach is different. We argue that under reasonable assumptions we can estimate R^1 without the controls, leveraging the fact that treatment is rolled out over time.

We consider a generalized version of specification (1). Due to data limitation we can implement this generalization only for internal CRC, omitting the CRC nominees who moved universities.¹³

$$\text{Ln}(s_{i,u,y}) = \beta_0 + X_i' \beta_1 + \Phi_Y + \Phi_I + \text{CRC}_{i,t}^1 (\beta_i + yI_{i,b,y} \beta_b + yI_{i,a,y} \beta_a) + \varepsilon_{i,u,y} \quad (2)$$

where $I_{i,b,y}$ is a dummy equal to 1 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. β_b captures the pre-treatment compensation growth trend, and β_a a new trend for post-treatment observations which we label the CRC tenure effect. Under the common trend assumption, we would expect $\beta_b=0$. Under the constant treatment effect, we would expect $\beta_a=0$.

Table 3 presents the results of specification 2. Column 1 reproduces the results of Table 2 Column 4, but excluding the CRC movers, to check that the estimates of R^1 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 nominees are moving on a higher compensation growth path relative to the controls. Over a 5 year period, their compensation increases by 3.7 percent more than the controls. β_a is negative and significant at the one percent confidence level, indicating that the impact of a CRC decreases with CRC tenure. The compensation increase for CRC nominees decreases by 3.3 percent after 5 years of CRC nomination. Assumptions A1 and A2 are violated.

¹³ There are only 16 externals in our sample and the coefficient estimates for these individuals have high standard errors once we add time trends.

What are the implications for our estimate of the average CRC effect? The average CRC tenure for internal nominees in our sample is $T^{\text{CRC}}=6.6$ 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 $\beta_i + T^{\text{CRC}}\beta_a=10.1-(6.6)*(.66)=5.7$ 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 nominees. In fact, the average estimates presented in the previous section were concealing an interesting story. The impact of CRC on compensation decreases over tenure. Figure 2 illustrates this point. Figure 2a plots the compensation path for CRC nominees and for our two sets of controls. The nomination year is year zero. The dashed line plots the compensation growth path for our first controls used in Table 2 (non CRC nominees). The dotted line plots the compensation inflation for our second controls in Table 3 (the treated in absence of treatment). The CRC nominees experience higher compensation growth over time (the dotted line grows faster than the dashed one). The solid line plots the compensation of CRC nominees before and after nomination. As expected, the dotted and solid lines coincide before nomination. Note that the CRC and non-CRC lines are very close prior to nomination because both specifications include individual fixed effects.

After 5 years, the CRC nominees have already lost about half of the compensation return from a CRC 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, post-treatment, the treated grow a on a slower growth path than the non-CRC. The compensation increase after 5 years of treatment for a treated is $10.1 - 5 * (.66) = 6.8$ which is only 3 percent higher than what they would have earned in the absence of treatment.

This is clear in Figure 2b, which plots the impact of CRC nomination over time (difference between solid and dotted line on Figure 2a). The CRC nominees get a compensation increase (relative to CRC counterfactual of no nomination) of 14.2K upon nomination. After 5 years the difference is only 5.7K. That is, 60 percent of the initial compensation gains have already been lost by the fifth year. This happens because CRC nominees are on a positive trend (relative to non CRC) before nomination, and a negative trend (relative to non CRC) after nomination. Figure 2a clearly shows that the two trends roughly compensate each other when one computes the average treatment effect of CRC nomination.

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 simultaneously receive treatment, as is common in the literature. 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 time during the years 2000-2010.

Because CRC activation took place over time, we can use the treated to control for time fixed effects. In practice, we use specification (1) but leave out the controls and the external CRCs. Doing this, we bypass the need to assume that controls and treated share a common trend. This approach is valid if the only 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). Column 3 in Table 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 assumption one (common trend) but not of assumption 2 (constant treatment).

The estimate of R^1 in Table 3 column 3 is 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^1 . It is important to note that column 2 and 3 in Table 3 report very similar estimates of R^1 despite the fact that these two specifications use different control groups to hold constant unobserved time effects. If we add a tenure trend variable to Column 3, the coefficient on tenure trend is about double the one in Column 2 (R^1 is 6.8 and the post CRC trend is -0.0136, not reported). This post-treatment trend captures the loss after CRC nomination relative to what a CRC nominee would have earned in the absence of nomination. As expected, it is of the same order of magnitude as the difference between the pre- and post- treatment trends in column 2 (the slope of the solid line in Figure 2b).

5-2 Heterogeneity in treatment effects

We interact the CRC treatment variable with year, university, and field dummies to estimate interacted returns $\beta_{t,y}$, $\beta_{t,u}$, and $\beta_{t,f}$ respectively. We can do so only for the subset of internal nominees (I). We reject the hypothesis that the university interaction effects are all equal to zero. The impact of a CRC ranges from 0 to 13 percent across universities. Universities offer widely different compensation increases to their CRC nominees. 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 for 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. This may be because these universities are less focused on research.

We also reject the joint hypothesis that the CRC impacts are the same for the 6 academic fields in our sample. The impact of a CRC is zero for Chairs in education and slightly lower than average for Chairs in humanities. One interpretation is that the need for financial incentives for retention is smaller 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 dollars 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 US academic market is driving the brain drain, as many have argued, one would expect the CRC return to increase with the ratio of US to Canadian academic salary. This ratio is driven to a large extent by the US/Canada exchange rate in our sample period.

We tried many possible specifications interacting CRC with a time trend, a tenure variable and the US/Canada exchange rate. It turns out that 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 tenure. The fact that 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. The results also indicate that the return to CRC 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.

6 Discussion

To summarize, the analysis 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 8 percent for externals), (b) this compensation increase decreases fairly rapidly with CRC tenure (the compensation premium on the fifth year is only 40 percent of what it was on the first). We now address a broader set of questions regarding the CRC program.

What is the cost of the CRCs who join from abroad relative to Canadian CRCs?

The results so far have shown that the financial benefit associated with CRC nomination was relatively modest. One may conclude that a small fraction of the CRC funds were used to pay for the increase in faculty salaries. This conclusion, however, can be challenged on the following ground. Our analysis has considered only chairholders that were nominated either internally or from a university within Canada. Of all CRC nominees, 32 percent came from outside Canada (the figure is not available for the subset of senior CRC). It could be the case that nominees from abroad command much higher salaries than the CRCs represented in our sample. To address this issue, we estimate the following model to determine the compensation cost of CRCs from abroad relative to those internally nominated.

$$\ln(s_{i,u,y}) = \beta_0 + X_i' \beta_1 + \Phi_Y + \Phi_U + \Phi_F + \Phi_I + CRC_{i,t}^A \beta_A + CRC_{i,t}^E \beta_E + \varepsilon_{i,u,y} \quad (3)$$

The purpose is to investigate whether CRCs from abroad earn more than internal or external CRCs. Accordingly, we use a subsample consisting of observations post-nomination for all our CRCs. $CRC_{i,t}^A$ is a dummy variable for A(broad) chairholders, $CRC_{i,t}^E$ is a dummy variable for

external (E) chairholders. All other variables are defined as in model (1). The parameter of interest, β_A , measures the compensation difference between abroad and internal CRCs.

Table 4 reports the results. The estimates of β_A 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 Chairs already in Canada. It is not the case that CRC hired from outside Canada cost more than internal CRCs. This goes against the notion that there was a large cost of attracting talents from abroad.

Interestingly, we get similar results when comparing external chair holders to internal ones. The estimates of β_E are small and insignificant in all specifications but one that does not include individual random effects (even in that specification, the estimate is small and only marginally significant). We conclude that the compensation cost to universities is the same for the three types of chair holders (internal, external, and abroad).

What is the cost to universities of retaining CRC talents?

What about the cost of CRC professors relative to non-CRC professors? We cannot answer this question with our data because our controls are not a random subset of university professors but instead match the treated (CRC) in all observable dimensions including compensation on the year they enter the dataset (see Appendix 2). To make progress on the issue, we use the salary information reported University and College Academic Staff System (UCASS) database. We compare UCASS compensation for all full professors in Ontario and all full professors in UBC, with the corresponding information for CRC professors.¹⁴ This approach is not ideal but it is the

¹⁴ 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.

best we can do to estimate the cost of CRC relative to non-CRC full professors. Because the data is aggregated across all academic fields, the exercise is to compare the cost of a random university full professor with the cost of a random CRC professor working in the same group of universities (Ontario) or in the same university (UBC). A shortcoming of this approach is that the UCASS sample includes the CRC professors. This should not be an issue, however, because senior CRCs represent only a very small fraction of all UCASS full professors (764 CRC against 14K 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 low pay CRCs. As such, we consider our estimates of the CRC salary premium (for Ontario) an upper bound.

Keeping these points in mind, Table 5 reports compensation percentiles of post-nomination CRCs in our sample along with the salary percentiles from the UCASS census.¹⁵ We do so for year 2008-2009 because it is the year that has the largest number of activated CRCs 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 14-19 percent (Column 3). If we focus on the median only, universities had to pay CRC Chairs a compensation premium of about 17.6 percent relative to non-CRC full professors. This 17.6 percent figure is the compounded effect of 10.6 percent due to selection (prior to nomination, CRC nominees are already amongst the highest paid full

¹⁵ 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. Our conclusions are conservative, if anything. But the bias is likely to be small. For Ontario, we have information on salary and benefits separately (see Appendix) and the latter is a very small relative to the former.

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 professor corresponds to 11-12 percent of the CRC grant depending 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 Chair salary. We will return to this issue shortly. Before doing so, we make the point that universities have not used a large fraction of the CRC grant to finance the increase in compensation of CRC nominees upon nomination.

How much of the CRC grants have universities passed through to researchers as compensation?

We follow Busse et al. (2006) and define the CRC pass-through rate as the fraction of the CRC grant that was given to researchers as an increase in compensation (including non-salary financial benefits). The average compensation in our sample is 145K dollars (Table 1). Table 2 says that the compensation of internal nominees increased by 6.3 percent, while for movers (from Canadian universities) the increase is in the range of 1.7 to 8 percent (depending on whether one assumes movers would have –or not– moved in the absence the CRC program). The 6.3 percent figure amounts to a 4.6 percent pass-through rate ($.063 * 145K / 200K$). For movers the figure is in between 1.2 and 5.8 percent.

These are very low pass-through rates. To put these numbers in perspective, Malatest & Associates Ltd. report, in their commissioned third-year review, that 9 percent of each Chair grant had been reported billed towards Chair-related administration costs at universities. 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 nominees 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. In addition, the fact that the return to CRC decreases fairly rapidly over time suggests that researchers' bargaining power decreases with CRC tenure.

What do we learn about crowding-out?

The new findings are summarized as follows. The compensation cost of a CRC hired from abroad is the same as for a CRC hired from within Canada, internally or externally. CRC professors do not cost much more than non-CRC professors. The compensation difference corresponds to about 11-19 percent of the CRC grant. CRC professors do not receive a large compensation increase upon nomination (the compensation increase corresponds to 4.6-5.8 percent of the CRC grant).

How does one reconcile these findings with the fact that universities report having spent between 55 and 71 percent of Chair grants on chairholder salary expenses? A possibility is that universities have funneled a large fraction of this share of the CRC grants into their general budget; this is a response labeled crowding out in the literature (Bergstrom et al. 1986, Andreoni and Bergstrom 1996, and Wallsten 2000).

Some background information on university accounting helps understand how crowding out could take place in the CRC program. 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 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 fund to which the vast majority of academic salaries are expensed. Universities have much freedom to spend the CRC grants and can use them pay an internal chairholder's entire compensation. A university can free money in its unrestricted general revenue account by shifting a chairholder's compensation expenses from the unrestricted general revenue to the CRC grant. That compensation would have been spent even in the absence of the CRC grant. 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.

Without accurate accounting information, it is not possible to confirm or deny crowding out. We can, however, estimate the fraction of the CRC grant spent on chairholder salary that is not accounted for as compensation increase. Internal nominees receive only 4.6 percent of the grant as compensation increase. The figure for external nominees is 5.8 percent (upper bound). Given that 63 percent of CRC are internal, we obtain that universities have spent 5 percent of the grants on compensation increases. This leaves between 50 percent (55-5 in 02/03) and 66 percent (71-5 in 07/08) of the CRC grant unaccounted for. Universities may have used this share of the grant to pay the base salary of many professors whose positions would have been part of university payroll even in the absence of the CRC program. For these positions, federal research funding would have crowded out university research funding.

We do not deny that part of the CRC grants has been used to offer CRC nominees more appealing packages, including research funding, student and research staff support, teaching release, start-up cost, and so on. Our point is that crowding out could be a serious possibility and it is not possible to accurately measure its extent with the information provided under current CRC accounting. We do not argue either that crowding out would necessarily be a bad thing. It

could be that the \$200K grant was too large, at least for some chairholders, and the best way of spending the funds was to crowd out chairholder compensation.

7-Summary and concluding remarks

The CRC program was designed to attract and retain top university researchers. We estimate the impact of CRC nomination on chairholder compensation. We find that: (a) internal nominees get a 6.3 average compensation increase from CRC nomination, (b) the compensation premium on the fifth year after nomination is only 40 percent of what it was on the first. In addition, CRC nominees who change universities or come from abroad earn the same amount as Canadian CRCs. Finally, the compensation cost of the median senior tier CRC is about 18 percent higher than for the salary cost of the median full professor faculty member. Assuming that the CRC program has achieved its goal of attracting and retaining top talents, we conclude that the cost of doing so, measured in terms of compensation increase to nominees, or in terms of compensation premium relative to non-CRC full professors, is not very high.

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 talents (Winston, 1999). Does the current use of the CRC funds maximize potential impact on attraction, retention, and research productivity? Is it possible to influence university decision-making, and in particular 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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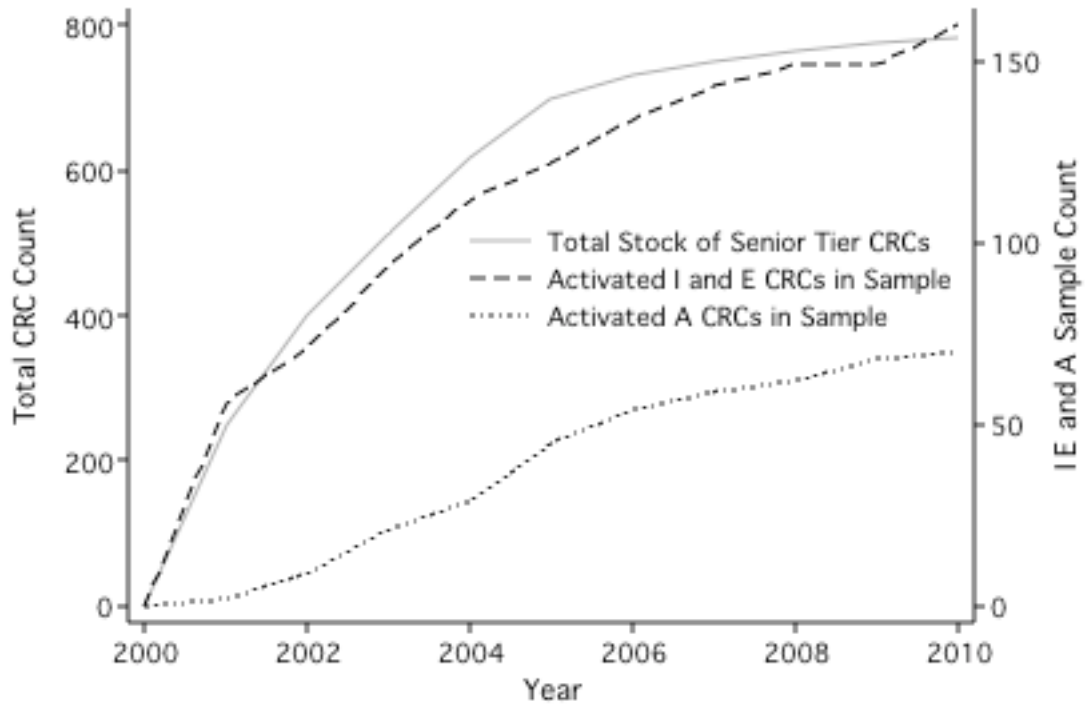
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Figures and Tables

Figure 1: Senior CRC tier activation path



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

Figure 2a: Compensation path for CRC nominee and control

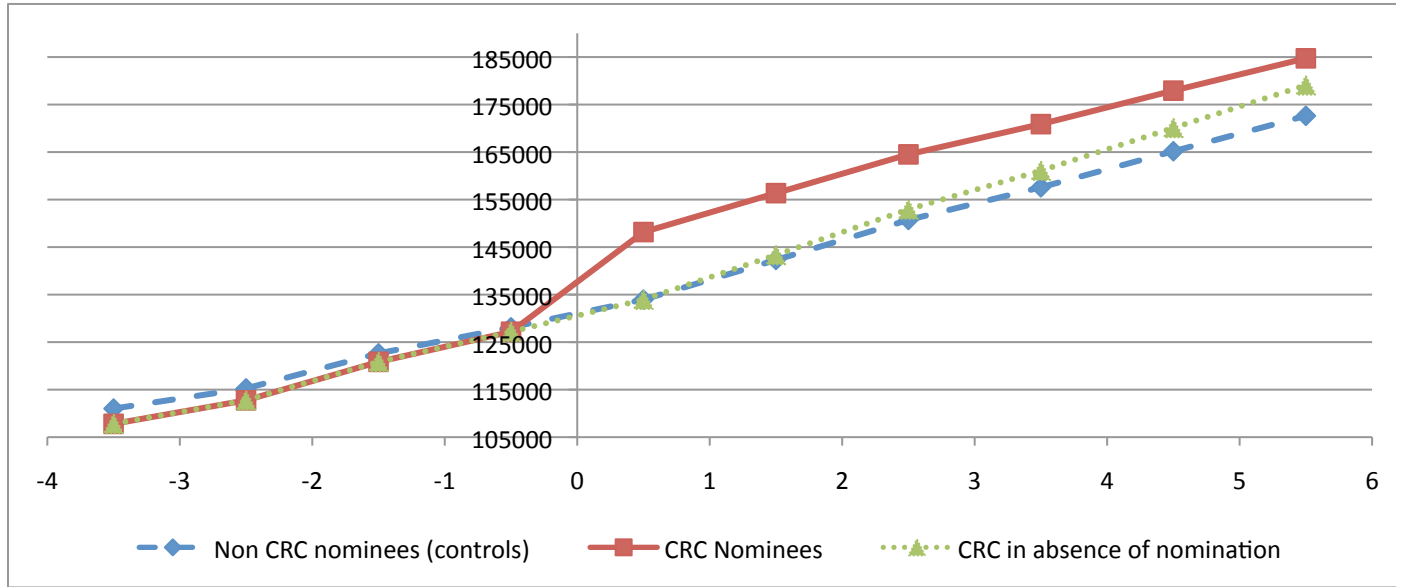
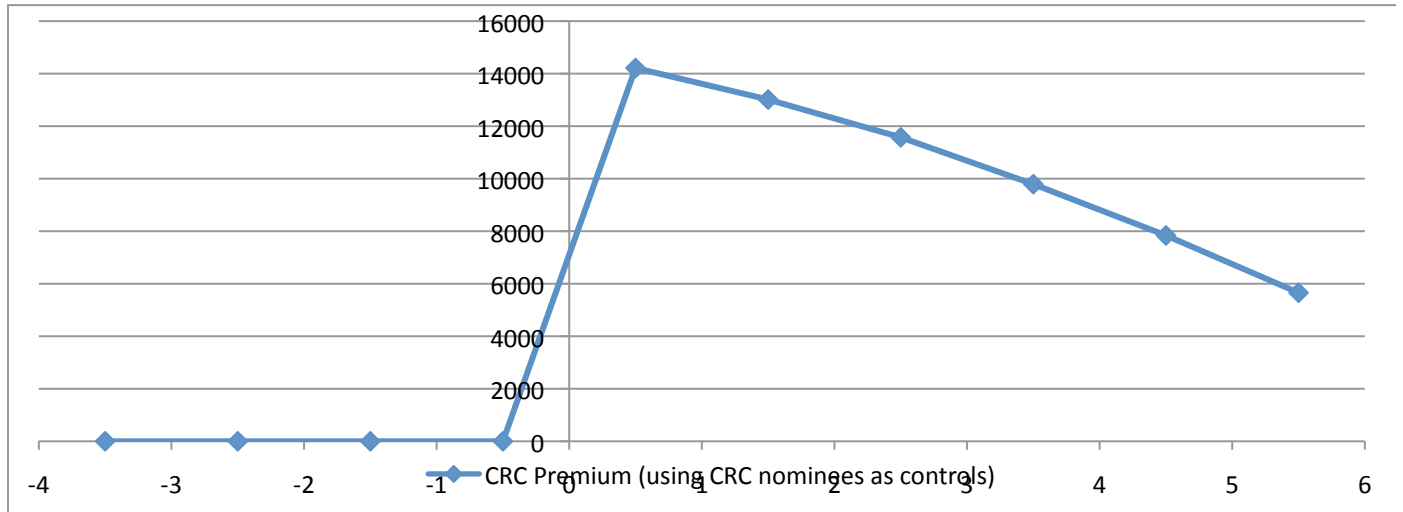


Figure 2b: CRC compensation premium



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

Table 1: Descriptive statistics

	Overall	Control	Treated All	I	E	A
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 admin).

Table 2: Impact of CRC nomination on Compensation: Average effect

	(1) Log (Compensation)	(2) Log (Compensation)	(3) Log (Compensation)	(4) Log (Compensation)	(5) Log (Compensation)	(6) Log (Compensation)
R ^I (β_i)	0.1741*** (0.000)	0.1274*** (0.000)	0.1189*** (0.000)	0.1277*** (0.000)	0.0637*** (0.000)	0.0632*** (0.000)
Transition	0.0085 (0.610)	0.0814*** (0.000)	0.0805*** (0.000)	0.0850*** (0.000)	0.0655*** (0.000)	0.0652*** (0.000)
R ^E (β_e)	0.1389*** (0.000)	0.0680** (0.050)	0.0880*** (0.010)	0.0559** (0.077)	0.0944** (0.026)	0.0797 ** (0.038)
β_m	0.1431*** (0.000)	0.0499 (0.152)	0.0683** (0.033)	0.0316 (0.374)	0.0656** (0.023)	0.0626** (0.044)
Associate	-0.1194*** (0.000)	-0.1267*** (0.000)	-0.0931 *** (0.000)	-0.1335*** (0.000)	-0.0516*** (0.001)	-0.0485*** (0.001)
Major	0.1271 *** (0.001)	0.1197*** (0.000)	0.1403 *** (0.000)	0.1167*** (0.000)	0.0714*** (0.000)	0.0672*** (0.001)
Minor	0.0921*** (0.000)	0.0962*** (0.000)	0.0827*** (0.000)	0.0920 *** (0.000)	0.0463*** (0.000)	0.0465*** (0.000)
Female	-0.0148 (0.377)	-0.0292* (0.091)	-0.0260 (0.113)	-0.0289 (0.098)	N/A	N/A
Year f.e.	No	Yes	Yes	Yes	Yes	Yes
University effects	No	No	Yes	No	No	Yes
Field f.e.	No	No	No	Yes	N/A	N/A
Individual f.e.	No	No	No	No	Yes	Yes
Constant	11.8170*** (0.000)	11.6341*** (0.000)	11.6555*** (0.000)	11.5629*** (0.000)	11.56564*** (0.000)	11.5607*** (0.000)
R ²	0.1101	0.3702	0.4779	0.3967	0.3407	0.3741
Obsv.	6344	6344	6344	6344	6344	6344

Notes: Table reports results of specification (1). Sample includes BC and Ontario 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 ¹ (β_i)	0.0643*** (0.000)	0.1008*** (0.000)	0.0835*** (0.000)
Transition	0.0654*** (0.000)	0.0803*** (0.000)	0.0676*** (0.000)
Associate	-0.0555*** (0.006)	-0.0535** (0.007)	-0.1120*** (0.001)
Major	0.0693*** (0.003)	0.0685*** (0.003)	-0.0325 (0.136)
Minor	0.0490*** (0.000)	0.0481*** (0.000)	0.0723*** (0.000)
Tenure CRC (β_a)	No	-0.0066*** (0.000)	No
Pre-Treatment Trend (β_b)	No	0.0073*** (0.002)	No
Year f.e.	Yes	Yes	Yes
Individual f.e.	Yes	Yes	Yes
Control Individuals	Yes	Yes	No
Constant	11.5734*** (0.000)	11.5726*** (0.000)	11.6075*** (0.000)
R ²	0.3471	0.3459	0.3907
Obsv.	5399	5399	1350

Notes: Table reports results of specification (2). 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 R² reported when individual fixed effects are used. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: E and A CRC relative cost to I CRC

	(1) Log (Compensation)	(2) Log (Compensation)	(3) Log (Compensation)	(4) Log (Compensation)	(5) Log (Compensation)
β_A	-0.0050 (0.837)	0.0080 (0.727)	0.0017 (0.943)	-0.0011 (0.960)	0.0046 (0.835)
β_E	-0.0481 (0.191)	0.0020 (0.944)	-0.0626* (0.083)	-0.0113 (0.734)	-0.0301 (0.333)
Associate	-0.2620*** (0.000)	-0.2328*** (0.00)	-0.2557*** (0.000)	-0.0264 (0.123)	-0.0274 (0.146)
Major	0.0436 (0.776)	0.0382 (0.713)	0.0131 (0.930)	-0.0326 (0.215)	-0.0335 (0.208)
Minor	0.0924 (0.130)	0.0701 (0.102)	0.0825 (0.151)	0.0741*** (0.000)	0.0733*** (0.000)
Female	-0.0297 (0.205)	-0.0408** (0.047)	-0.0326 (0.214)	-0.0428 (0.048)	-0.0441* (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*** (0.000)	11.8265*** (0.000)	11.8140*** (0.000)	11.7492*** (0.000)	11.7435*** (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). Sample consists of chairholders post nomination only. P-values were calculated using robust standard errors clustered by individual. Overall R² reported when individual random effects are used. * significant at 10%; ** significant at 5%; *** significant at 1%