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Essays on the Economics of Immigration

Phuong Vu, *Western University*

Supervisor: Bowlus, Audra, *The University of Western Ontario*

A thesis submitted in partial fulfillment of the requirements for the Doctor of Philosophy degree in Economics

Abstract

My dissertation consists of three papers studying the impact of social networks and employment mobility on Canadian immigrants, and the effects of economic conditions and immigration policy changes on international Ph.D. students in Canada.

In the first paper, I use the Longitudinal Survey of Immigrants to Canada (LSIC) to examine the effects of social networks on labour market outcomes of newly arrived Canadian immigrants. I find that the presence of initial networks at landing significantly increases the probability of getting a network job (i.e., a job that is obtained through close ties) and reduces the probability of getting a formal job (i.e, a job that is obtained through other formal channels) after landing. Across immigration categories, network effects vary, with the largest effect among the Refugees, followed by the Family Class, and then the Economic Class immigrants. In each class, low-educated immigrants rely more on networks to find a job than high-educated ones. By separating close ties into kinship and friendship, I find that family has stronger effects on employment outcomes. Moreover, the development of the network is important over time. Economic immigrants gain from more diverse networks, while the Refugees improve their employment outcomes by frequently contacting their networks. Finally, social networks play a limited role in determining the quality of immigrants' first jobs.

The second paper examines employment mobility and its effects on long-run earnings inequality among Canadian male immigrants using the Longitudinal Immigration Database (IMDB) and linked tax data. Incorporating employment risk and earnings mobility, I find long-run earnings inequality among male immigrants is up to 34 percent lower than the current, or base-year, inequality (a 90/10 ratio of 4.92 versus 7.51). Further, I find that around 70 to 80 percent of the total long-run inequality reduction happens within the first 5 years with the remainder occurring by 15 years. Among immigration categories, the Refugees experience the highest level of both earnings mobility and employment risk, while employment mobility mainly happens at the bottom of the earnings distribution for the Family Class and Economic Class. These findings indicate high current earnings inequality among the immigrant population is not persistent in the long run. This is good news. One concerning factor is that the employment risk is concentrated at the bottom of the earnings distribution, especially for the Refugees.

In the third paper, I study the effect of changing economic conditions and immigration policies on international Ph.D. students in Canada. After arriving in a host country, they are prone to economic conditions like domestic students and are also affected by immigration policies. Using the IMDB, I find that, unlike domestic students, international doctoral students experience a shorter study duration under adverse economic conditions. At the same time, a higher unemployment rate negatively affects international Ph.D. students as it associates with a lower probability of both getting permanent resident (PR) status during the study and remaining in Canada in the following year after finishing their studies. Immigration policies are also found to significantly correlate with the students' outcomes. When PR policies are less restrictive, international students have shorter study durations and are more likely to get PR while studying and stay in Canada after studying. Although there is no evidence that relaxed work permit policies affect the study duration of international Ph.D. students, I find that they are negatively correlated with their probability of getting PR during the study period and to substantially improve the retention likelihood.

Keywords: Labour, Immigration, International Students, Employment Mobility, Social Networks, Immigration Policies

Summary for Lay Audience

The chapters in my doctoral thesis focus on the effects of social networks and employment mobility on Canadian immigrants and the impacts of changing economic conditions and immigration policies on international Ph.D. students in Canada.

In the first chapter, I provide an introduction to the three papers in my thesis. In the second chapter, I study the effects of social networks including both initial networks and new networks on immigrant job search outcomes and job characteristics and how these effects vary across immigration categories. Using the Longitudinal Survey of Immigrants to Canada, I find that among newly arrived Canadian immigrants, the presence of initial networks at landing significantly increases the probability of getting a network job and reduces the probability of getting a formal job. Across immigration categories, network effects vary, with the largest effect among the Refugees, followed by the Family Class, and then the Economic Class immigrants. In each class, low-educated immigrants rely more on networks to find a job than high-educated ones. Between kinship and friendship, I find that family has stronger effects on employment outcomes. The development of new networks is also important. Economic immigrants gain from more diverse networks, and the Refugees improve their employment outcomes by frequently contacting their networks. Finally, social networks play a limited role in determining the quality of immigrants' first jobs.

The third chapter of this paper is motivated by high degree of earnings inequality among Canadian immigrants. Current inequality measures, however, only capture part of the story. Immigrants are also known to be very mobile with many experiencing significant upward earnings mobility as they assimilate while others experiencing significant employment risk. In this chapter, I examine employment mobility and its effects on long-run earnings inequality among Canadian male immigrants using the Longitudinal Immigration Database (IMDB). By incorporating employment risk and earnings mobility, I find that long-run earnings inequality among male immigrants is up to 34 percent lower than the current inequality and around 70 to 80 percent of the total long-run inequality reduction happens within the first 5 years. Among immigration categories, the Refugees experience the highest level of both earnings mobility and employment risk, while employment mobility mainly happens at the bottom of the earnings distribution for the Family Class and Economic Class.

In the last chapter, I use the IMDB to analyze how changing economic conditions and immigration policies affect international Ph.D. students in Canada. Like domestic students, international students are prone to economic conditions, but unlike them, they are also affected by immigration policies. My findings show that, unlike domestic students, international doctoral students experience a shorter study duration under adverse economic conditions. At the same time, a higher unemployment rate negatively affects international Ph.D. students as it associates with a lower probability of both getting PR during the study and remaining in Canada in the following year after finishing their studies. Immigration policies are also found to significantly correlate with the students' outcomes. When PR policies are less restrictive, international students have shorter study durations and are more likely to get PR while studying and stay in Canada after studying. Although there is no evidence that relaxed work permit policies affect the study duration of international Ph.D. students, they are shown to negatively correlate with their probability of getting PR during the study period and to substantially improve the retention likelihood.

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Chapter 1

Introduction

My thesis contains three chapters that explore different topics of immigration. The second chapter examines the effects of social networks on labour market outcomes of newly arrived Canadian immigrants. In the third chapter, I study employment mobility and its effects on long-run earnings inequality among Canadian male immigrants. In the final chapter, I examine the effects of economic conditions and immigration policy changes on international Ph.D. students in Canada on study duration, the probability of getting permanent residence (PR) during the study period, and the probability of remaining in Canada in the year following the end of their study period.

In the second chapter, I use the Longitudinal Survey of Immigrants to Canada (LSIC) to analyze the effects of social networks on labour market outcomes of newly arrived Canadian immigrants. In particular, I address two research questions: (1) What are the effects of social networks on immigrant job search outcomes and job characteristics? and (2) How do these effects vary across immigration categories and educational levels? I find that initial networks at landing significantly increase the probability of getting a network job by 8.3 percentage points and reduce the probability of getting a formal job by 7.6 percentage points within six months after landing. The impacts of social networks are even larger four years after landing. Across immigration categories, network effects vary, with the largest effect among the Refugees, followed by the Family Class, and then the Economic Class immigrants. In each class, low-educated immigrants rely more on networks to find a job than high-educated immigrants. By separating close ties into kinship and friendship, I find that family has stronger effects on employment outcomes. Further, the development of the network is important over time. Economic immigrants gain from more diverse networks, and the Refugees improve their employment outcomes by frequently contacting their networks. Finally, social networks play a limited role in determining the quality of immigrants' first jobs.

In the third chapter, I examine employment mobility and its effects on long-run earnings inequality among Canadian male immigrants using the Longitudinal Immigration Database (IMDB) and linked tax data. Because the database only contains information for the full immigration population from 2011 to 2015, I estimate long-run annuity values using the short panel method in Bowlus and Robin (2012). Incorporating employment risk and earnings mobility, I find long-run earnings inequality among male immigrants is up to 34 percent lower than the current inequality (a 90/10 ratio of 4.92 versus 7.51). Further, by simulating future earnings streams over 5, 10, 15, and 20 years, I find that around 70 to 80 percent of the total long-run

inequality reduction happens within the first 5 years with the remainder occurring by 15 years. Among immigration categories, I find that the Refugees experience the highest level of both earnings mobility and employment risk, while employment mobility mainly happens at the bottom of the earnings distribution for the Family Class and Economic Class. These findings indicate high current earnings inequality among the immigrant population is not persistent in the long run. The lower inequality in long-run earnings suggests that immigrants also face lower consumption inequality than indicated by current measures. This is good news. One concerning factor is that the employment risk is concentrated at the bottom of the earnings distribution, especially for the Refugees. Thus, to improve the labour market experience of low-paid immigrants, including the Refugees, policymakers should aim to improve job security and enhance their upward earnings mobility.

In the last chapter, I investigate the study duration, probability of getting PR during the study period, and probability of remaining in Canada in the year following the end of their study period of international Ph.D. students in Canada under changing economic conditions and immigration policies. The availability of administrative data, tax data, and permit data of non-permanent residents in the IMDB allows me to construct individuals' study durations and other outcomes. I then use time-varying duration analysis and logistic regressions to study the effects of economic conditions and immigration policies. My findings show that, unlike domestic students, foreign doctoral students experience a shorter study duration under adverse economic conditions. At the same time, a higher unemployment rate negatively affects international Ph.D. students as it associates with a lower probability of both getting PR during the study period and remaining in Canada in the year after finishing their studies. Like economic conditions, immigration policies are found to significantly correlate with the students' outcomes. When PR policies are less restrictive, international students have shorter study durations and are more likely to get PR while studying and stay in Canada after studying. Although there is no evidence that relaxed work permit policies affect the study duration of international Ph.D. students, they are shown to negatively correlate with their probability of getting PR during the study period and to substantially improve the retention likelihood.

Chapter 2

Transition from Landing to Work: The Impacts of Social Networks on Labour Market Outcomes of Canadian Immigrants

2.1 Introduction

In Canada, immigrants are a rich source of labour. Approximately 26% of the core-aged workforce are immigrants, and about 60% of the employment gains in 2017 were contributed by immigrants (Yssaad and Fields, 2018). Due to the significant number of immigrants, their labour market assimilation has drawn much interest from policy-makers and the public. Upon arrival, immigrants bring with them their knowledge, language proficiency, skills, and work experience. However, due to job market barriers, such as language and educational credential transferability, immigrants may find it challenging to get jobs, let alone ones that allow them to utilize their human capital (Bowlus et al., 2016; Imai et al., 2019). It is possible that the presence of immigrant networks within the host country may facilitate their job search process through two main channels. First, social networks can provide immigrants with direct job referrals. Second, with network support, immigrants may learn about the host country's job market and application process which can indirectly help them successfully apply for jobs. Moreover, through networks at landing, or initial networks, immigrants may also create new connections, or new networks, in the host country that support them in obtaining a job later. Indeed, previous studies on the effects of social networks on Canadian immigrants (i.e., Xue, 2006, 2008, 2010; Goel and Lang, 2019) have shown that social networks improve the immigrants' labour market outcomes. However, these papers analyze the effects of networks on all immigrants as a single group rather than as separate classes. Also, they mainly focus on wage and employment and do not study other outcomes such as unemployment spell, job duration, job skill level, and job-to-job or job-to-unemployment transitions.

In this paper, I address two research questions: (1) What are the effects of social networks on immigrant job search outcomes and job characteristics? and (2) How do these effects vary across immigration categories? In this paper, initial networks refer to an immigrant's network

at landing which includes friends and relatives already living in Canada, while new networks refer to the networks that an immigrant has after arriving in Canada. The importance of answering these questions is twofold. First, immigrants are admitted to Canada under different categories (i.e., Family Class, Economic Class, Refugees), and each category has distinct immigration characteristics. As argued by Nakhaie and Kazemipur (2013), the effects of social capital depend on the types of social capital, ethno-racial origins, as well as forms of economic integration. Therefore, it is reasonable to expect the impacts to vary across different immigration classes. Second, besides wages and employment, the effects of networks on other aspects of employment outcomes such as employment/unemployment spells, job transitions, and skill levels of immigrant first jobs are also worth considering because they reflect the quality of job referrals. In particular, examining the network effects on unemployment spells provides information on how job search can be shortened in the presence of social networks. Meanwhile, understanding the association between networks and how long an immigrant stays in the first job, the skill level of the first job, and whether the immigrant transitions to a new job after the first one reflects the quality of network support. Addressing these research questions; therefore, provides a better understanding of the extent to which networks affect labour market outcomes of Canadian immigrants.

The idea that social networks play an important role in the labour market has long been explored by sociologists and economists. A vast literature has theoretically analyzed the role of networks and network composition on job search.[1] Particular consideration has been given to Montgomery (1992) who argues that tie strength is an important dimension of social capital. His model predicts that acquaintances, so-called weak ties, relay job offers more frequently than close friends and relatives, so-called strong ties, and that the reservation wage rises unambiguously as the proportion of weak ties in a job-seekers' network increases.

Compared to natives, immigrants seem to rely more on networks to overcome labour market barriers and find employment. There is an extensive body of work that quantitatively examines the network effects on immigrant employment outcomes. Much of the literature studies U.S. immigrants and finds evidence of social networks' effects on these immigrants, especially on newcomers.[2] For instance, Munshi (2003) argues that an individual is more likely to be employed when his/her network is larger. Sanders et al. (2002) find that reliance on social ties usually operates informally, yet it is most common for transitions into jobs of low occupational prestige. A study on Australian immigrants by Piracha et al. (2016) reaches the conclusion that social capital positively affects immigrants' employment outcomes, especially for women. However, they find that social capital only affects the probability of getting white-collar jobs not blue-collar ones. In Germany, Drever and Hoffmeister (2008) find that nearly half of all job changers who are immigrants obtained their jobs through network support and that the young and the less educated were more likely to rely on their networks. Lancee (2010) identifies two forms of social capital, bonding, which is measured as the strength of family ties, and bridging, which is measured as inter-ethnic contacts and outward orientation, and shows that while bridging networks are positively associated with both employment and income of Dutch immigrants, bonding networks do not affect economic outcomes. In Finland, Ahmad et al.

[1] E.g., Granovetter (1973); Marsden and Lin (1982); Montgomery (1992); Cahuc and Fontaine (2009); Mouw (2003); Calvo-Armengol and Jackson (2004); Kramarz and Skans (2014).

[2] E.g., Sanders et al. (2002); Aguilera and Massey (2003); Munshi (2003); Amuedo-Dorantes and Mundra (2007); Livingston (2006); Beaman (2012)

(2005) shows that social networks not only account for a substantial source of job information and employment opportunities for immigrants but also have a significant role in helping them to secure jobs. While there is clear evidence of network effects on immigrants' employability, the evidence of network effects on immigrant wages is mixed. Amuedo-Dorantes and Mundra (2007), Mouw (2003), and Munshi (2003) find that networks raise migrants' wages. Meanwhile, Goel and Lang (2019) find that the presence of a close tie (at least one relative or friend already living in Canada at the time of the entry) increases the probability of receiving a network offer and that the network-formal wage differential is decreasing in network strength.

Despite its importance, there are only several papers that study network effects on the employment outcomes of Canadian immigrants. Xue (2006, 2008, 2010) has a series of papers that analyze the association between social networks and labour market outcomes of recently arrived immigrants using the LSIC. Xue (2006) indicates that 52% of immigrant respondents looked for employment through social connection beside other formal channels during the first two years after landing. An approach to measuring social capital for three types of networks (kinship, friendship, and organization) is formulated in Xue (2008). In this paper, the author finds that social capital influences the employment probability of immigrants in their initial years after landing and thus facilitates economic assimilation. The network impacts are found to be stronger as immigrants continue to accumulate their social capital after landing. Social capital also has significant effects on immigrants' wages during their first four years in Canada, and strong-tie networks including kinship and friends dominate over weak-tie networks such as organizations in helping immigrants get jobs of higher wages. Among social capital indicators, network ethnicity at workplace is most influential in determining the wages of both genders (Xue, 2010). In contrast, using the Canadian General Social Survey, Thomas (2011) concludes that having more contacts or close ties does not link to having economic advantage or better wages. However, having a diverse network is associated with being employed. Using a mechanism through which social networks help in job search, Goel and Lang (2019) model the effect of increasing the likelihood of receiving a job offer. Their model predicts a counterintuitive implication that the network wage premium decreases with network strength, and this prediction is then verified for recent immigrants to Canada using the LSIC. Their result also confirms that the presence of close ties associates with an increase in the likelihood of generating a job offer from the network rather than with an altered network wage distribution.

I contribute to the literature on immigration and social networks by studying how the effects of social networks vary across immigration categories. In addition, I fill the gap in the literature by studying the effects of social networks on important job aspects other than wage and employment such as employment/unemployment spells, job transitions, and skill level. Compared to Grenier and Xue (2011) who study immigrants' duration to intended occupation, I study the duration to any first job and focus on the effects of network on employment and unemployment spells. My paper also extends past research by examining the lasting effects of social networks over time.

To address the research questions, I use unique information on immigrants' social networks and job details from the LSIC. My estimation methodology and results are as follows. First, I employ a multinomial logistic model to test the validity of close-tie strength as Goel and Lang (2019). The results are consistent with previous findings that social networks considerably enhance network-based job opportunities and reduce the probability of never finding a job. Next, I run the model on the three immigration class samples and use the Wald test to test the equality

of parameters across categories. The result indicates that the model should be run separately for each immigration class. I find that among the three classes, initial networks have the greatest impact on job-search outcomes of the Refugees, followed by Family Class immigrants and then by Economic Class immigrants. Within each class, the effects are larger for immigrants with lower education, although, in general, the effect differential between education groups is marginal. Further investigation using immigrant first-job outcomes within the first four years suggests that the effects of close ties are larger and more significant if a longer period of time is studied. As an illustration, having a close-tie living in Canada before landing improves the probability of getting a network job by 8.3 percentage points and reduces unemployment by 0.7 percentage points within six months after landing. Meanwhile, the chance of getting a network job increases by 9.7 percentage points, and the reduction in unemployment probability is 3 percentage points by four years after landing. Finally, I decompose the social networks into kinship and friendship and test the hypothesis that the impacts of the two networks are similar. The results indicate the effects of social networks are attributable to relatives, not friends, and this is particularly true for the Refugees. However, across immigration categories, kinship effects are highest for lower-educated immigrants.

To further unpack the effects of the initial networks on immigrant employment outcomes, I study the network effects on job characteristics such as skill level, wage, job duration, and job transitions. Put differently, I am interested in testing whether immigrant networks determine the quality of first jobs. In doing so, I apply log wage regressions, logistic and multinomial logistic models, as well as survival analysis across immigration classes. The general finding is that social networks do not impact job quality as much as they affect job search outcomes. However, having networks is negatively associated with the probability of getting a high-skilled job for Economic Class immigrants, and network jobs appear to correlate with lower wages and low-skilled occupations.[3].

I also study the lasting effects of the initial and new networks on immigrants' job search outcomes. For initial networks, I find that the marginal effects of close ties diminish over time. Immigrants without initial networks still have improved probabilities of getting a network job, and this result implies that they rely on new networks after landing to obtain a network job in Canada. Over time, the effects are still the strongest among the Refugees, as Family Class immigrants turn more to formal jobs. For new networks, I find significant effects among the Economic Class immigrants and the Refugees. While ethnic diversity plays an important role in determining employment outcomes of the Economic Class immigrants, frequency of contact matters more for the Refugees.

The remainder of the paper is organized as follows. Section 2 describes the data and methodology and addresses several issues related to the sample. Section 3 provides the estimation results and the explanation for these findings. Section 4 presents a summary and concluding remarks.

[3]Low-skilled occupations including Clerical Occupations, Assisting Occupations in support of health services, Retail Salespersons and Sale Clerks, Cashiers, Occupations in Travel and Accommodation including Attendants in Recreation and Sport, Childcare and Home Support workers, Sales and Service Occupation nec, Primary Production Labourers, Trades Helpers, Construction, and Transportation Labourers and Related Occupations. The remaining occupations listed on the variable JB1G013 of the LSIC (Occupation Major Groups) are considered as high-skilled occupations

2.2 Data and Methodology

2.2.1 The Canadian Immigration System

There are four immigration categories in the Canadian immigration system: Family Class, Economic Class, Refugees, and Other Class. Family Class immigrants are those sponsored to come to Canada by a family member who is a Canadian citizen or permanent resident. Economic Class immigrants are selected based on their skills and ability to contribute to Canada's economy. The Refugees are admitted to Canada after their refugee claims are accepted. Other Class immigrants include people who were granted permanent resident status under a program that does not fall into either the Economic Class, Family Class, or the Refugees. Therefore, by definition, Family Class immigrants should have at least one relative living in Canada before landing, while Economic Class immigrants and the Refugees may or may not have initial networks at landing. Since the Other Class includes unique cases with special circumstances that do not go through a general assessment, they are excluded from the scope of this research.

2.2.2 The Longitudinal Survey of Immigrants to Canada

The LSIC is a comprehensive survey that was designed to study the assimilation process of newly arrived Canadian immigrants. The target population of the survey is people who meet all of the following criteria: (1) arrive in Canada between October 1, 2000, and September 30, 2001; (2) 15 years or older at the time of landing; and (3) applied to come to Canada and landed from abroad. The last criterion implies that individuals who applied and landed from within Canada are excluded from the survey. These people may have been in Canada for a considerable length of time before officially landing and therefore are likely to demonstrate quite different integration characteristics compared to those who recently arrived in Canada. The LSIC has a longitudinal design in which immigrants were interviewed three times: six months, two years, and four years after landing. Only the immigrants that responded in the previous wave were traced for the following wave. The number of respondents was 12,040, 9,500, and 7,716 in Wave 1, Wave 2, and Wave 3, respectively.[4]

The LSIC is unique because it contains complete histories of immigrants' employment within the first four years after landing. It also provides details on immigrants' social networks. Therefore, it allows for the investigation of how social networks affect job search outcomes and job quality of newly arrived immigrants in their transition from landing to work.

2.2.3 Sample restriction

This paper uses data from all three waves of the LSIC. In my sample, individuals are selected according to the following criteria. First, they must be between 25 and 65 at the time of landing.[5] Second, they must be either principal applicants or spouses in the Family Class, Economic Class, or the Refugees.[6] Third, they are active in the labour force at the Wave 1

[4] `http://sites.utoronto.ca/rdc/files/Toronto_RDC_LSIC_Powerpoint.pdf`.

[5] Immigrants in this age group are more likely to participate in the labour force. They are also less likely to take further training or education in Canada than younger immigrants.

[6] Children are excluded from my sample

interview.[7] Fourth, individuals who transition from landing to work in a family business or self-employment are excluded. Finally, my sample includes only individuals without missing data on explanatory variables which are listed in Section 2.4. The final sample consists of 6,489 immigrants.

2.2.4 Explanatory and Outcome Variables

In this paper, the set of explanatory variables includes social network variables, gender, whether an immigrant has a child/children or not, region of residence, level of education, whether an immigrant is a principal applicant or a spouse, previous Canadian experience, country of last residence, whether he or she has previous work experience before coming to Canada, English and French proficiency, previous occupation before landing, and age.[8]

Among these explanatory variables, the network variables are key to the analysis. I construct two groups of immigrant networks in Canada: networks before landing (initial networks) and networks after landing (new networks). For the first group, I follow Goel and Lang (2019) to create a close-tie dummy variable that indicates whether immigrants have at least a relative or a friend already living in Canada before they come to Canada. This variable only reflects the presence of initial networks, not their quality as in the social capital measures of Xue (2008, 2010). However, it is simple to use and, more importantly, is less likely to be co-determined with employment outcome variables. Then, to separately estimate the impact of family-based and friend-based networks on the labour market outcomes of immigrants, I construct two dummy variables: one indicating whether an immigrant has a relative living in Canada before coming to Canada and the other one indicating whether an immigrant has a friend living Canada before arrival. For immigrants' new networks in Canada, since almost everyone has new friends in each wave, I focus only on the quality of the new networks. For the Wave 1 interview, I construct two variables that describe ethnic diversity and the contact frequency of networks.[9] For the Wave 2 interview, I update whether an immigrant has more or less network diversity as well as the contact frequency.

For first-job employment outcomes, there are two groups of interest. The first group includes two variables: (1) outcomes of immigrants' first jobs and (2) first jobless duration.[10] This group relates to job search outcomes in immigrants' transition from landing to work. It illustrates how quickly immigrants found their first jobs, and if they were employed, through

[7] In each wave, respondents are asked if they either worked at a job or business or looked for work. Those who did not have a job and did not look for work at Wave 1 are excluded from my sample.

[8] There are two education levels: having at least a bachelor's degree (high-educated group) and not having at least a bachelor's degree (low-educated group). Canadian experience refers to whether the person ever lived in Canada before coming to Canada as newly arrived Canadian immigrants. Regions of residence are grouped into five categories: Atlantic, Quebec, Ontario, Prairies, and British Columbia. Countries of last residence are divided into eight groups: (1) North America, (2) Europe, (3) Asia, (4) Middle East, (5) Africa, (6) Caribbean and Guyana, (7) South and Central America, and (8) Oceania and Australia.

[9] The more friends of the same ethnic or cultural groups an immigrant has, the less diverse the individual's network is. Meanwhile, the frequency of contact refers to how often immigrants see or talk with their new friends.

[10] There are three possible outcomes: (i) an immigrant has the first job through close ties (network job), or (ii) through other formal channels (formal jobs), or (iii) never found a real job within four years after landing. Jobless duration is calculated as the number of weeks from an immigrant's date of landing to the start date of his/her first job. Those having an arranged job before coming to Canada have a jobless duration of zero. Those who left the interview or did not look for a job in the later waves are coded as having censored jobless durations.

which channels they searched for these jobs. The second group refers to job characteristics, such as hourly wage, job duration, skill level of the job, and job transitions after the first job.[11] I mainly focus on immigrants' first jobs because the initial networks are likely to have the strongest impact on early outcomes in the transition from landing to work.

There are a few important notes with regard to the construction of the outcome variables. First, an immigrant's first job is not necessarily the first job the individual reported having since coming to Canada. An immigrant's first 'real' job, the so-called first job, is defined as the first job in which the immigrant worked for no less than 20 hours a week and at least four weeks. Some immigrants are considered as never having found a real job within four years if they never worked in a job that satisfies the above conditions. Although the 'real' job definition has the caveat attached that many part-time jobs are dropped, it is intended to eliminate jobs in which workers work only a few hours a week or for a short period of time. Second, there are some drawbacks to the definition of network jobs. In the survey, respondents are asked whether they got their job through a relative or a friend, but it is not clear whether the immigrants knew this relative or friend before coming to Canada. Also, there is no detailed information on whether close ties helped the immigrants get jobs directly or provided posting information so that the immigrant could apply for these jobs. In the latter case, the jobs can also be considered formal jobs. Third, there are many jobs in which the reported start date is before the immigrant's landing date or the start date of the second job occurs before the end date of the first job. For the former cases, I treat the landing date as the start date. For the latter cases, I treat the observations as having a job-to-job transition at the end of the first job. Last, the data show that many immigrants held multiple jobs at the same time or during the same period. In this case, I choose the job that was valid at the time of the interview with the highest weekly wage. If there is more than one qualified job with equal wages, the most recent one to the interview is chosen for the analysis.

2.2.5 Descriptive Statistics

Table 2.1 summarizes explanatory and outcome variables across the Family Class, Economic Class, and Refugees. The Economic Class accounts for a large proportion of the sample, 79%. The rest are composed of immigrants in the Family Class and the Refugees at 18% and 3%, respectively. Not surprisingly, the Family Class is the category with the highest rate of having at least one relative already living in Canada before landing (96%). However, theoretically, this rate should be 100%, since all family immigrants are sponsored to come to Canada by at least a relative who is a Canadian citizen or permanent resident already living in Canada. Even if at the time of landing, a Family Class immigrant did not have any relatives living in Canada, it is reasonable to believe that the immigrant's relative left this person some initial networks to settle in the new country. For these reasons, I assume that all Family Class immigrants have at least one family member living in Canada before their landing. Consequently, there is no

[11] Job duration is calculated as the number of weeks from the job's start date to the end date. For individuals who were still working in their first jobs at the date of Wave 3's interview, I calculate the number of weeks they had worked until the last interview date and code these durations as censored. The skill level of the job is coded based on the Canadian National Occupation Classification (NOC) 2011. Job transition can be either job to job if there are less than three weeks between jobs or job to unemployment if it is longer. All wages are adjusted by CPI.

variation in the close-tie variable among the Family Class immigrants. In other words, there is no counterfactual to analyze the effects of having a close tie on the Family Class immigrants. For the other categories, the data show that Economic Class immigrants have more friends but fewer relatives than the Refugees. Overall, the proportion of having at least one close-tie is similar across the Economic Class immigrants and the Refugees.

In terms of education, the Economic Class accounts for 81%, the largest proportion, of high-educated immigrants (i.e., those having at least a bachelor's degree). Similarly, this class also has the highest proportion of immigrants with a high-skilled previous occupation, 87%. In addition, they are the most proficient in both English and French and have more Canadian experience, previous work experience, and pre-assigned jobs in Canada than the other two categories. These descriptive statistics are in accordance with the selection criteria of the Canadian immigration system for the Economic Class, in which more points are given to factors contributing to potential employment success in the Canadian economy. In contrast, the Refugees are at a disadvantage compared to other classes in all the explanatory variables that possibly affect employment outcomes. Only 19% of the Refugees have tertiary or higher education; almost none of them have Canadian experience before landing, and their English proficiency is comparatively lower than the Family and Economic Class immigrants.

As one would expect, the Economic Class immigrants achieve better employment outcomes in their first jobs in Canada. Regarding job outcomes, they have the lowest rate of not finding a real job within four years after landing (16.7%), the highest rate of finding their first job through formal channels (55.3%), and less than one-third of them find their first jobs through their family and friend network. In other words, they are less likely than the other categories to be unemployed or to rely on networks to find jobs. Also, they have the highest hourly wage rate and the highest percentage of high-skilled workers. Meanwhile, the Refugees have the highest proportion of immigrants who never find a real job and the longest average unemployment duration. Only approximately 18% of them find a high-skilled first job. For the Family Class immigrants, although on average it takes them less time than the other categories to find a job, about 18 weeks, their average hourly wage is lower than those of the other groups, and the percentage of immigrants with skilled jobs among this group is only 26%, which is about half of the percentage among the Economic Class immigrants.

Table 2.2 compares the main characteristics of network jobs versus formal jobs. Jobs obtained through formal channels dominate network jobs in most aspects. The former ones have higher average hourly wages and a higher probability to be in high-skilled occupations. Although, on average, employment durations are similar between network jobs and formal jobs, about 46 weeks, the data show that the average time to first jobs is shorter for network jobs than for formal jobs, which are approximately 19 and 22 weeks, respectively.

2.2.6 Estimation methodology

The basic estimating equations used in this paper are multinomial logistic regressions on immigrant labour market outcomes within four years after landing. To test the strength of the close-tie hypothesis, my approach is similar to the approach from Goel and Lang (2019). Job search outcomes within four years include: 'first real job found through a relative or a friend', which is defined as a network job, 'first real job found through other channels', a formal job, and 'no real jobs found within four years', defined as non-employed. Using non-employed as

Table 2.1: Descriptive Statistics of Explanatory Variables

	Immigration Categories		
	Family Class	**Economic Class**	**Refugees**
Observations	0.18	0.79	0.03
Social Networks			
Relative(s)	0.93	0.36	0.64
Friend(s)	0.39	0.72	0.42
Close ties	0.96	0.86	0.81
Demographic variables			
Age	38.87	35.14	35.39
Males	0.49	0.63	0.66
Married	0.94	0.82	0.70
Having a child/children	0.19	0.52	0.52
Canadian Experience	0.05	0.10	-
Previous Work Experience	0.84	0.96	0.83
Region of residence			
Atlantic and Prairies	0.13	0.09	0.26
Quebec	0.12	0.15	0.17
Ontario	0.54	0.62	0.50
British Columbia	0.21	0.13	0.08
Country of last residence			
North America - Europe - Oceania and Australia	0.19	0.24	0.19
Asia	0.60	0.57	0.39
Middle East - Africa	0.09	0.16	0.36
Caribbean - South and Central America	0.12	0.04	0.06
BA and BA plus	0.34	0.81	0.19
High level of English proficiency	0.50	0.72	0.39
High level of French proficiency	0.07	0.14	0.11
Previous Occupation			
Low-skilled job	0.25	0.09	0.25
High-skilled job	0.59	0.87	0.57
New workers	0.16	0.04	0.17
Have a pre-assigned job	0.05	0.09	-
Outcomes of the First Job			
First job channel			
Network jobs	0.47	0.28	0.49
Formal jobs	0.34	0.55	0.28
Not finding a real job	0.19	0.17	0.22
Jobless duration (in weeks)	18.25	21.11	29.40
First job duration (in weeks)	48.68	45.77	52.76
Hourly wage (in dollars)	9.23	12.29	9.72
High-skilled job	0.26	0.48	0.18

Note: Some descriptive statistics are not available (-) due to the release restriction of Statistics Canada on statistics that are calculated using less than 10 observations.

Table 2.2: Descriptive Statistics of Network Jobs and Formal Jobs

	Network Jobs	Formal Jobs
Log hourly wage	2.22	2.40
	(0.51)	(0.51)
Hourly wage (in dollars)	10.15	12.67
	(5.93)	(9.29)
Unemployment duration (in weeks)	19.36	21.89
	(30.58)	(30.96)
Employment duration (in weeks)	46.23	46.67
	(47.80)	(48.05)
High-skilled jobs	0.28	0.40

Note: Standard deviations are shown in brackets.

the base outcome, the multinomial logit model and the multinomial logit regressions are given by

$$Prob(Outcome_i = P_i^j) = \frac{exp(\boldsymbol{\alpha}^j \times \boldsymbol{N}_i + \boldsymbol{\beta}^j \times \boldsymbol{X}_i)}{1 + \sum_{j=NJ,FJ} exp(\boldsymbol{\alpha}^j \times \boldsymbol{N}_i + \boldsymbol{\beta}^j \times \boldsymbol{X}_i)}, \tag{2.1}$$

and

$$ln\frac{P_i^j}{P_i^u} = \boldsymbol{\alpha}^j \times \boldsymbol{N}_i + \boldsymbol{\beta}^j \times \boldsymbol{X}_i + \varepsilon_i, \tag{2.2}$$

respectively, where $j \in$ {Network Job (NJ), Formal Job (FJ)} and u : Non-employed.

In the above equations, $\boldsymbol{N}$ is a set of network variables and $\boldsymbol{X}$ is a set of explanatory variables including age, gender, marital status, having a child/children or not, region of residence, country of last residence, previous Canadian experience, previous work experience, language proficiency, and education level. The models are run separately for different definitions of network variables - close-ties, family, friend, ethnic diversity, and contact frequency of new networks - as explained in section 2.2.4.

For binary outcomes, I use logistic regressions to test the impact of social networks on characteristics of immigrants' first jobs after landing, such as the probability of getting a high-skilled job and the probability of a job-to-job transition if the first job is observed to end within four years. For example, the logistic model and regression for the skill level of first jobs are

$$Prob(\text{Person } i\text{'s first job = High-skilled job} = P_i^h) = \frac{exp(\boldsymbol{\alpha} \times \boldsymbol{N}_i + \boldsymbol{\beta} \times \boldsymbol{X}_i)}{1 + exp(\boldsymbol{\alpha} \times \boldsymbol{N}_i + \boldsymbol{\beta} \times \boldsymbol{X}_i)} \tag{2.3}$$

and

$$ln\frac{P_i^h}{P_i^l} = \boldsymbol{N}_i \times \boldsymbol{\alpha} + \boldsymbol{X}_i \times \boldsymbol{\beta} + \varepsilon_i, \tag{2.4}$$

respectively, where h: High-skilled job and l: Low-skilled job. All explanatory and network variables are the same as described in the multinomial logistic regressions.

To analyze the effect of close ties on wages, I estimate a Mincerian wage regression with the specification given by

$$lnW_i = \boldsymbol{\alpha} \times \boldsymbol{N}_i + \boldsymbol{\beta} \times \boldsymbol{X}_i + \varepsilon_i, \tag{2.5}$$

where network and explanatory variables are as above, and *lnW* is the natural log of CPI-adjusted hourly wages. In addition, I also run a regression in which the network variable is replaced by a dummy variable that indicates whether the job is a network job. These regressions are employed to determine whether having a close tie and having a network job explain the wages of immigrants' first jobs.

Finally, this paper analyzes how initial networks affect jobless and employment duration using survival analysis with an exponential distribution

$$\lambda_i(t, X_i) = \lambda_0(t) exp\{\boldsymbol{\alpha} \times \boldsymbol{N}_i + \boldsymbol{\beta} \times \boldsymbol{X}_i\}, \tag{2.6}$$

where t is either jobless duration or employment duration. Both spells have censored values since many immigrants either cannot find a real job after four years or still work in their first jobs at the time of the last interview. For jobless duration analysis, the model is applied to observations with positive unemployment durations. The set of regressors for the duration analysis is similar to that of other models in this paper.

2.3 Results

2.3.1 Immigrant Job Search Outcomes in Transition from Landing to Work

First, I test the validity of close ties as a measure of network strength as in Goel and Lang (2019).[12] To do so, I use fairly similar sample criteria as Goel and Lang (2019) except that I apply a stricter rule, the real job definition, in constructing the first jobs.[13] The results from Table 2.3 indicate a consistent finding with Goel and Lang (2019) that close ties are statistically significant in determining the outcomes. Particularly, within the first six months, close ties increase the probability of getting a network job by 8.3 percentage points and reduce the probability of getting a formal job by 7.6 percentage points. The effects of family and friend networks are even larger when employment outcomes are studied within a longer period of time: four years instead of six months. Indeed, I find that having a close-tie is associated with a 9.7 percentage point increase in the probability of getting a network job, a 6.9 percentage point decrease in the probability of getting a formal job, and a 2.9 percentage point decrease in the probability of never finding a real job. The results reinforce Goel and Lang's hypothesis that having a close tie boosts network job opportunities and deviates immigrants from formal jobs. They also imply that using data from only Wave 1 results in an underestimate of the effects of close ties on outcomes of immigrants' first jobs, compared to using data from all waves

[12] Goel and Lang (2019) argue that the presence of an immigrant's network is associated with a higher probability of getting a job through his or her network, a lower probability of getting a job through other channels, and a lower probability of never been employed after landing into Canada.

[13] Adapting the sample selection from Goel and Lang (2019), I first use the Wave 1 data. My sample includes immigrants who are in the labor force and excludes those who were self-employed or work in family businesses. I restrict my sample to people aged from 25 to 65 at the time of landing. Meanwhile, in the sample of Goel and Lang (2019), immigrants aged from 15 to 64. Also, I do not exclude immigrants who had an arranged job before coming to Canada or limit the sample to immigrants who live in metropolitan areas in Canada and come from source countries with at least ten immigrants. Finally, while the sample in Goel and Lang (2019) includes principal applicants and their dependents, my sample only includes principal applicants and their spouses.

of the LSIC, because using the longer time horizon allows for observing more uncensored unemployment durations and more outcomes of immigrants' first jobs.

Table 2.3: Validating Close ties as a Measure of Network Strength

Multinomial Logit Marginal Effects (at means of independent variables)			
	Network Job	Formal Jobs	Non-employed
Within six months			
Close Ties	0.083***	-0.076***	-0.007
	[0.015]	[0.020]	[0.021]
Observations		6399	
Within four years			
Close Ties	0.097***	-0.069***	-0.029*
	[0.018]	[0.020]	[0.016]
Observations		6489	

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. *All explanatory variables are controlled. Standard errors are shown in brackets.*

Since all immigrants in the Family Class have a close-tie, one cannot observe the employment outcomes of immigrants without a close-tie in this group, and thus one cannot interpret the effects of close ties on employment outcomes of this category. Therefore, Family Class should be excluded from the analysis of the effects of having initial networks on first-job outcomes. Between the Economic Class and the Refugees, my hypothesis is that the effects of initial networks on job search outcomes of the two classes are different. To test this hypothesis, I run the regressions separately across the Economic Class immigrants and the Refugees using the Wave 1 data. Then, I use a Wald test to test the equality of the coefficients of the model as a whole and of the close-tie coefficient separately. The close-tie coefficients for the Economic Class and the Refugees are significantly different at a 1 percent confidence level, and the coefficients of the full model for the network job outcome are significantly different at a 1 percent level of confidence when comparing Family Class and Economic Class, at a 5 percent confidence level when comparing the Economic Class and the Refugees. Hence, I reject the null hypothesis that the three categories can be considered as one group in the regression, and, therefore, the network effects should be studied independently across immigration categories.

To demonstrate how close ties affect job search outcomes of immigrants with different education levels in the three categories, I predict the probability of each outcome while controlling for their characteristics.[14] Columns of Table 2.4 show the predicted probabilities for a high-educated and low-educated immigrant, respectively. As seen in column 1, among low-educated immigrants with close ties, the Refugees have the highest probability of getting a network job (74%), followed by the Family Class (48%) and then the Economic Class immigrants (38%). Meanwhile, the probabilities of getting a formal job are in reverse order. Moreover, among the

[14]I run the regressions separately for each immigration category. As explained in Section 2.3.1, for the Family Class, I exclude the close-tie variable from the regression as all immigrants in this class have at least a close-tie living in Canada before they arrived in Canada. Regarding educational attainment, I include this explanatory variable in the regressions and report the predicted probabilities of each job search outcomes by different levels of educational attainment (i.e., low-educated or high-educated).

three categories, the gap in probabilities of being non-employed within four years for those with close ties and those without close ties is also the highest and most significant for the Refugees (13.7 percentage points). This result indicates that the Refugees may rely most on close ties to find a job, and they are most likely to work in a network job, compared to immigrants in the other two groups. By contrast, the Economic Class immigrants depend the least on their close ties to search for jobs. This outcome may be due to the fact that Economic Class immigrants are selected for their ability to contribute to Canada's economy through their ability to meet labour market needs, and hence their sets of skills and characteristics allow them to better match with the labour market. Another explanation is that the Economic Class immigrants may attempt to get better jobs that match their human capital or skills, and better jobs are usually available through formal channels. This explanation is also in line with the descriptive statistics that the Economic Class immigrants have a higher probability of having a formal job, and formal jobs are, on average, better paid and in high-skilled occupations.

By comparing the results between the two panels, I find that, in all categories, more educated immigrants appear to rely less on close ties to find their first jobs, and they have higher predicted probabilities of getting a formal job. For illustration, in the Family Class, while 48.3% of low-educated immigrants get network jobs, only 29.7% of high-educated immigrants do. This may be because immigrants with at least a university degree may have more job opportunities, especially skilled jobs, and these jobs are usually obtained through a formal process. This is similar to the findings from previous studies including Drever and Hoffmeister (2008) and Xue (2008) that low-educated immigrants are more likely to rely on their networks in searching for jobs. Also, among the three categories, the probability gap of getting a network job between low- and high-educated immigrants is also highest for Family Class immigrants.

Table 2.4: Predicted Probabilities of Job Outcomes across Immigration Categories

	Predicted outcomes for low-educated immigrants			Predicted outcomes for high-educated immigrants		
	Network Jobs	Formal Jobs	Non-employed	Network Jobs	Formal Jobs	Non-employed
Family Class	0.483	0.426	0.091	0.297	0.57	0.134
Economic Class with close ties	0.376	0.53	0.094	0.331	0.553	0.116
Economic Class without close ties	0.281	0.613	0.106	0.243	0.628	0.129
Refugees with close ties	0.735	0.125	0.139	0.666	0.185	0.15
Refugees without close ties	0.505	0.218	0.277	0.425	0.3	0.275

Note: Predicted probabilities are calculated for a 35-year-old male with children, who comes from Asia, lives in Ontario, has work experience before coming to Canada, and has good English proficiency.

During immigrants' transition from landing to work, close ties also affect their jobless duration. Table 2.5 presents how close ties affect the jobless duration of the Economic Class immigrants and the Refugees. The results indicate that having at least a close-tie increases the hazard of getting out of unemployment and therefore reduces the jobless durations. To

account for the fact that there are observations with negative jobless duration (i.e.,observations who have the start date of their first job in Canada even earlier than their date of landing into Canada as newly arrived Canadian immigrants). I use a Tobit model and find a similar positive correlation between having a close-tie and a reduction in unemployment duration. In particular, having at least a close tie helps an average Refugee to shorten the jobless duration by about 30 weeks (or, equivalently, 7.5 months). However, it does not significantly affect the jobless durations of Economic Class immigrants. One possible explanation is that Economic Class immigrants may direct their job search to the skilled-job market in which application processes usually take longer. Also, with their set of skills and educational qualifications, it may be true that they are willing to search longer for better jobs. The result that close-tie effects on jobless duration are the strongest and most significant for the Refugees strengthen the finding that close ties are more important for the Refugees than for any other classes.

Table 2.5: Coefficients of Closetie on Jobless Duration

	Coefficient of Cox model	Coefficient of Tobit model
Economic Class	0.026	3.656
	[0.055]	[2.535]
Refugees	0.676***	-30.278***
	[0.128]	[7.994]

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. *All explanatory variables are controlled. Standard errors are shown in brackets*

2.3.2 Characteristics of Immigrants' First Jobs in Canada

In this subsection, I present the network effects on the different characteristics of immigrants' first jobs in Canada separately. In particular, I use a Mincerian wage regression to study the effects of close-ties on the wage of immigrants' first job. Then, I use logistic regressions to study network effects on skill level and job transition. Finally, I use duration analysis to study how networks affect immigrant first-job duration. Panel 1 of Table 2.6 shows the estimated coefficients when using close-tie as the network variable, and Panel 2 shows the coefficients of a dummy variable that reflects whether an immigrant has their first job as a network job. As can be seen from the estimated coefficients reported in the first panel of Table 2.6, close ties do not have any significant impact on the wages of immigrants in both the Economic Class and the Refugees. However, as shown in the second panel, when including a dummy variable of network jobs as an explanatory variable, I find that, except for the Refugees, a network job significantly and negatively correlates with wages of immigrants. Particularly, a network job associates with an 8 percentage point reduction in wages of immigrants in both the Economic and Family Classes. Coupled with the statistic that formal jobs offer higher wages than network ones, the finding implies that referrals from a friend or a relative appear to relate to jobs of lower wages.

While close ties do not significantly impact the wages of immigrants' first jobs, they do

affect the job types of the Economic Class immigrants. Using a logistic regression on first-job skill level, I find that the marginal effect of having a close tie is a 4.7 percentage point decrease in the probability of getting a high-skilled job. In general, network jobs are negatively correlated with high-skilled jobs. At the same time, close ties also do not significantly affect the probability of job-to-job transition among the Economic Class immigrants and the Refugees. An exception is that an Economic Class immigrant with a network first job has a significantly lower probability of having a job-to-job transition than immigrants in the other two categories.

Close ties do have an impact job duration of the Refugees. Using a Cox-proportional hazard regression, I find that having a close tie is associated with a hazard ratio of 2.23 times higher and thus a shorter first-job duration for these immigrants. This finding relates to the previous result that the Refugees are more likely to direct themselves to network jobs and low-skilled job markets. Because low-skilled jobs are easier to get but are usually less stable than formal (or high-skilled) ones, one can expect the Refugees' first job duration to be shorter. When replacing the close-tie variable with a network job variable in the regression, I find no evidence that a network job affects the first job duration.

Table 2.6: Effects of Close ties and Network-Job on the Characteristics of Immigrants' First Jobs

	Wage	Skill Level	First-job Duration	Job transition
Estimated Coefficients of Close-tie				
Economic Class	-0.02	-0.19*	-0.04	-0.07
	[0.02]	[0.10]	[0.06]	[0.13]
Refugees	-0.07	0.07	0.80***	-0.14
	[0.05]	[0.47]	[029]	[0.62]
Estimated Coefficients of Network-Job				
Family Class	0.08**	-0.03	-0.03	0.05
	[0.03]	[0.17]	[0.09]	[0.20]
Economic Class	0.08***	-0.46***	-0.02	-0.24***
	[0.02]	[0.08]	[0.05]	[0.09]
Refugees	0.00	-0.25	-0.02	-0.19
	[0.05]	[0.39]	[0.19]	[0.46]

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. *All explanatory variables are controlled. Standard errors are shown in brackets.*

2.3.3 Relatives and Friends: Which Network Matters?

To understand the importance of relatives and friends in determining job search outcomes, I estimate the effects of each type of network separately. In doing so, I construct three dummy network variables that correspond to whether an immigrant has only a family member(s) living in Canada, or only a friend(s), or both a relative(s) and a friend(s) living here. Then, I test two hypotheses: (1) relatives and friends have equal impacts on immigrant job outcomes in the transition from landing to work and (2) having both relatives and friends results in greater impacts on job outcomes than having either relative(s) only or friend(s) only.

Table 2.7 presents predicted probabilities of immigrants' job search outcomes from the logistic regressions of immigrants' job search outcome by network type across immigration categories and education groups.[15] Two important features stand out. First, between relative and friend networks, the former has more impact on labour market outcomes. In the Economic Class and the Refugees, immigrants with only relatives have higher probabilities of getting a network job and lower probabilities of getting a formal job than those with friends only. Second, except for the Economic Class immigrants, having both relatives and friends significantly increase the probability of getting a network job and reduce the probability of never finding a real job. For example, for the Refugees, the predicted probabilities of getting a network job are 81.2%, 72.8%, and 85.3% for immigrants with relatives only, with friends only, and with both networks, respectively.

Regarding job duration, I find that none of the network types affect jobless duration, except for the Refugees. Results for the Refugees show that while having only friends does not help improve job duration, having either both networks or relatives significantly shortens the time to their first jobs. Similar patterns of network effects are observed for the first job duration. The hazard ratio is near 2 for the Refugees with relatives or friends only and is higher, 3.4, for those with both networks. Concerning wages of first jobs, job transitions, and skill level, again I find almost no evidence of network effects. The only exception is the Economic Class immigrants who have a lower predicted probability of having a high-skilled job if they have both networks.

Overall, the results indicate that relatives play a more important role in determining job search outcomes and characteristics of first jobs and that the effects are larger when the networks include both friends and relatives. This is consistent with the finding from the past literature, including Munshi (2003), that the individual is more likely to be employed when the individual's network is larger. For Canadian immigrants, this finding is particularly true for the Refugees.

2.3.4 Effects of Initial Networks and New Networks Over Time

To study the long-term effects of initial networks, I extend the analysis to a longer study period. Table 2.8 reports the predicted outcomes at six months and at four years after landing for the three categories and two levels of education.

For the Family Class, the likelihood of getting a network job at four years after landing is similar to the likelihood after six months. At the same time, over the course of four years, there was an improved chance of getting a formal job and a lower probability of being non-employed. Indeed, for both education levels, there is an approximately 20 percentage point increase in the predicted probability of formal jobs which is offset by a 20 percentage point decrease in the probability of not finding a real job. The result implies that over time the Family Class immigrants rely less and less on networks and turn to other channels for job searching. Similarly, the probability of getting a network job increases over time for Economic Class

[15] I run the regressions separately for each immigration category. As explained in Section 2.3.1, for the Family Class, I exclude the close-tie variable from the regression as all immigrants in this class have at least a close-tie living in Canada before they arrived in Canada. Regarding educational attainment, I include this explanatory variable in the regressions and report the predicted probabilities of each job search outcomes by different levels of educational attainment (i.e., low-educated or high-educated).

Table 2.7: Predicted probabilities of job outcomes by separate network types

	Predicted outcomes for a low-educated immigrant			Predicted outcomes for a high-educated immigrant		
	Network Jobs	Formal Jobs	Non-employed	Network Jobs	Formal Jobs	Non-employed
Family Class						
With relatives only	0.440	0.460	0.100	0.260	0.599	0.141
With both relatives and friends	0.550	0.369	0.081	0.353	0.522	0.124
Economic Class						
With relatives only	0.469	0.457	0.074	0.425	0.484	0.092
With friends only	0.402	0.505	0.092	0.359	0.528	0.113
With both relatives and friends	0.459	0.460	0.081	0.414	0.485	0.101
Refugees						
With relatives only	0.812	0.096	0.092	0.769	0.139	0.092
With friends only	0.728	0.104	0.168	0.685	0.150	0.165
With both relatives and friends	0.853	0.076	0.071	0.816	0.112	0.072

immigrants and the Refugees. After four years, this probability increases by approximately 10 percentage points for the Economic Class, and it is even higher for the Refugees.

Between the two education levels, high-educated immigrants have a lower probability of getting a network job and a higher probability of getting a formal job at both the six-month and the four-year interviews. However, the marginal effects of close ties diminish over time. For example, for low-educated immigrants, the marginal effects of close ties are a 9.5 percentage point increase in network jobs and a 10.3 percentage point decrease in formal jobs after six months. These changes are 7 and -5.8 percentage points for network jobs and formal jobs, respectively, after four years. For high-educated immigrants, at four years after landing, the marginal effect of close ties is significant only for the network job outcome.

Among the Refugees, the results indicate that over three and a half years, those without close ties have a dramatic increase in the likelihood of having a network job, 42.5 percentage points, while the change is only about 18 percentage points for those with close ties. The former also has an improved probability of getting a formal job compared with the latter. Consequently, the marginal effects of close ties for the Refugees decline and weaken over time. Six months after landing, for the low-educated group, the network marginal effects are significant at 39 percentage points for the probability of network jobs, and -39 percentage points for the probability of not getting a real job. However, these marginal effects drop to 14.3 and -5.9 percentage points at the 4-year interview and become insignificant. Across education groups, the results are similar. The findings suggest that, among the Refugees, the initial network effects are the strongest in the first six months for those with initial networks and that these effects fade away as time goes by.

In regard to wages, I only find a significant effect of close ties among the Economic Class, and this effect also diminishes gradually. The presence of a close-tie lowers an Economic Class immigrant's wage by 6.4 log points at six months after landing and by 4.6 log points at four years after landing. For other job characteristics, the effects of initial networks across time are not significant.

Table 2.8: Predicted probabilities for job outcomes at 6-month and 4-year interviews

	Predicted Outcomes for a low-educated immigrant			Predicted outcomes for a high-educated immigrant		
	Network Jobs	Formal Jobs	Non-employed	Network Jobs	Formal Jobs	Non-employed
At 6 months after landing						
Family Class	0.399	0.38	0.221	0.266	0.478	0.256
Economic Class with close ties	0.329	0.418	0.253	0.261	0.386	0.353
Economic Class without close ties	0.234	0.52	0.245	0.184	0.477	0.339
Refugees with close ties	0.526	0.029	0.445	0.367	0.071	0.562
Refugees without close ties	0.135	0.03	0.835	0.077	0.061	0.862
At 4 years after landing						
Family Class	0.39	0.593	0.016	0.253	0.715	0.032
Economic Class with close ties	0.431	0.545	0.024	0.337	0.621	0.042
Economic Class without close ties	0.361	0.602	0.037	0.273	0.665	0.062
Refugees with close ties	0.703	0.193	0.105	0.644	0.183	0.174
Refugees without close ties	0.56	0.277	0.163	0.49	0.251	0.259

After arriving in Canada, immigrants continue to develop their networks by making new friends. Those without initial networks also rely on new networks to find their jobs within their first four years. To study the effects of the new networks, I use the set of variables that indicates the ethnic diversity and contact frequency of the new networks besides the close-tie variable. If the new networks and employment outcomes simultaneously determine each other, an endogeneity issue arises. Similarly, reverse causality may arise if the channel of getting job affects or determine the ethnic diversity and frequency of new networks. Therefore, I use lagged network variables to explain the employment outcomes of the current period. Specifically, the new networks' variables at 6-month and 2-year interviews are used to study the job search outcomes and wages at 2-year and 4-year interviews, respectively.

Particularly, I pool wage observations from Wave 2 and Wave 3 and run a pooled analysis in which I also control for whether an immigrant has worked or studied in the previous period. The results are shown in Table 2.9. Regarding the wages of immigrants, I find that for the Economic Class immigrants, the ethnic diversity of the new networks is a significant determinant of wages and job outcomes. For example, having diverse or very diverse network results in a wage increase of 8.9 to 12.3 log points. Also, having a very diverse network results in a decrease of 8 percentage points in the probability of getting a network job and an increase of 7 percentage points in the probability of getting a formal job. Meanwhile, for the Refugees, the contact frequency of new networks significantly affects the Refugees' job outcomes. Although the frequency of contact does not help improve the Refugees' wages, it does affect job outcomes. In particular, frequent contact results in almost a 55 percentage point increase in

the likelihood of getting a network job and a 30 percentage point decrease in the likelihood of being non-employed. However, there are no significant effects of the new networks among the Family Class immigrants.[16]

Table 2.9: The Effects of New Networks on Job Outcomes and Wages

	Marginal effects of new networks on job outcomes			Wage
	Network Job	Formal job	Non-employed	
Family Class				
Ethnic Diversity				
Diverse	0.058	-0.033	-0.025	0.015
	[0.044]	[0.045]	[0.019]	[0.029]
Very diverse	-0.011	0.009	0.002	0.064
	[0.056]	[0.056]	[0.025]	[0.040]
Contact Frequency				
Frequent	-0.0255	0.104	-0.079	-0.035
	[0.089]	[0.095]	[0.073]	[0.075]
Very frequent	0.102	-0.005	-0.096	-0.046
	[0.084]	[0.088]	[0.074]	[0.069]
Economic Class				
Ethnic Diversity				
Diverse	-0.033	0.031	0.002	0.089***
	[0.020]	[0.021]	[0.008]	[0.021]
Very diverse	-0.077***	0.072***	0.004	0.123***
	[0.024]	[0.025]	[0.010]	[0.024]
Contact Frequency				
Frequent	-0.005	-0.006	0.011	0.019
	[0.037]	[0.039]	[0.014]	[0.048]
Very frequent	0.029	-0.052	0.023*	-0.018
	[0.034]	[0.035]	[0.013]	[0.047]
Refugees				
Ethnic Diversity				
Diverse	-0.006	0.01	-0.004	-0.036
	[0.117]	[0.113]	[0.058]	[0.055]
Very diverse	0.01	0.03	-0.04	-0.094
	[0.126]	[0.125]	[0.053]	[0.058]
Contact Frequency				
Frequent	0.546***	-0.251*	-0.295**	0.061
	[0.130]	[0.148]	[0.125]	[0.078]
Very frequent	0.393***	-0.141	-0.252**	0.033
	[0.105]	[0.132]	[0.124]	[0.053]

Note: The marginal effects of new networks are calculated at means of all variables. The coefficients of new network variables in the wage regression are reported.

To summarize, the results of new network effects imply that, for the Economic Class and Family Class, a high level of network ethnic diversity results in a greater probability of getting a formal job and higher wages. For the Refugees, frequent contact with new networks enhances their chances of getting network jobs and reduces the probability of being unemployed. These results provide supporting evidence on the association of ethnic diversity and economic per-

[16]Even when I control for the initial networks in the analysis or do not pool observations in Wave 2 and Wave 3 together, the patterns of new network effects do not change much across model specifications.

formance of immigrants as suggested in the literature (e.g., Borjas, 1994; Warman, 2005; Xue, 2010).

2.4 Conclusion

In this paper, I study the effects of social networks on job search outcomes and first-job characteristics of Canadian immigrants in their transition from landing to work. I find results consistent with previous studies in that social networks improve the probability of getting a network job, reduce the probability of getting a formal job, and enhance the probability of being employed. The magnitude of network effects is found to be larger if I extend the analysis to a longer period of time. More importantly, my findings indicate that the initial network effects should be studied independently across immigration categories for two reasons. First, because all Family Class immigrants have at least one close tie before landing, there are no observed counter-factual outcomes for this group. Second, results from the Wald test on the equality of close-tie coefficients between the Economic classes and the Refugees confirm that they are significantly different. Among the three categories, I show that the Refugees rely the most on initial networks in finding jobs, while Economic Class immigrants depend on them the least. Within each class, low-educated immigrants rely more on the help of close ties to find jobs than their high-educated counterparts. Between kinship and friendship, the former matters more in improving first-job search outcomes.

The analysis of how social networks affect the quality of immigrants' first jobs also provides interesting findings. Although initial networks are significantly associated with a higher probability of network jobs for immigrants, they are less significant in determining the characteristics of first jobs. Initial networks not only reduce the likelihood of getting a high-skilled job among the Economic Class immigrants but also appear to be associated with lower wages. Social networks also do not improve immigrants' probability of job-to-job transition after their first jobs.

Finally, the study of network effects at different points in time underscores that the effects of the initial networks diminish over time. Regarding the new networks, while the Economic Class immigrants benefit from more diverse networks, the Refugees improve their employment outcomes by frequently contacting their networks.

Findings from this paper provide several policy implications. First, if the policy goal is to improve employment opportunities for newly arrived immigrants, more support should be provided for immigrants without initial networks in Canada, who are at a disadvantage compared to their counterparts in getting network job opportunities and employment opportunities in general. Second, as network jobs appear to associate with low-skilled occupations and lower wages, all immigrants would benefit from policies that help them to search through formal channels for better jobs. Finally, besides policies that directly aim at improving immigrant labour market experience, policies that help immigrants develop new networks after landing would potentially contribute to their economic assimilation success by opening up more opportunities for better jobs through both network and formal channels.

Chapter 3

Employment Mobility and Long-Run Earnings Inequality among Canadian Immigrants

3.1 Introduction

Canada is a country with high immigration. The large inflows of newly arrived immigrants have significantly contributed to the level and growth of the country's population over time. According to the 2016 Census, there are 7.5 million immigrants who represent more than 20 percent of the population and about two-thirds of the population growth in Canada from 2011 to 2016. Given the large size of the immigrant population, their economic outcomes and the effects of their outcomes on the Canadian economy have drawn much attention from both policymakers and the public.

One of the heated debates on the policy agenda of many countries including Canada is the effects of immigrants on earnings and income inequality. High earnings or income inequality can trigger an increase in intergenerational inequality and hinder social mobility. It can also impede the achievement of a good democratic system and a stable political and social structure as well as sustainable growth. Several papers have provided evidence of a gap in inequality between immigrants and natives in Canada. Picot and Hou (2014) indicate that income inequality levels tend to be marginally higher among the immigrant population than among the Canadian-born. Particularly, in 2010, the Gini coefficient of income among the mostly Canadian-born comparison group was 0.362, while it was around 0.384 among immigrants with less than 15 years in Canada. They also conclude that any increase in the immigrant share of the population exerts upward pressure on family income inequality. Picot and Hou (2020) study the low-income rate, which is defined as the proportion of individuals with income less than half of the median income. They find that during the 1980s and 1990s, immigrants had a considerable negative effect on the low-income rate and family income inequality in Canada. The ratio of the low-income rates between immigrants and natives widened from 1.4 in the 1980s to 2.5 in the 2000s. Moreover, Moore and Pacey (2003) find that about one-half of the rise in inequality during the early 1990s was associated with the immigrant population.

If the labour market features employment mobility, current or short-run inequality measures

provide an incomplete picture of inequality. Employment mobility includes two components: (i) earnings mobility, which refers to upward or downward mobility within a stable earnings distribution, and (ii) employment risk, which involves movements in and out of employment. Due to the presence of employment mobility, current or short-run measures of inequality may not be the measure of best interest, because it is long-run earnings upon which individuals make consumption and other important decisions such as retirement or financial investments. If the extent of mobility is considerable, a current or short-run measure of earnings inequality may provide an inaccurate impression of the level of inequality. In this case, it may overstate long-run earnings inequality, as employment mobility acts as an equalizing factor (Garnero et al., 2018; Bowlus and Robin, 2012; Buchinsky and Hunt, 1999; Gottschalk, 1997). This may be particularly true for immigrants as they are likely to face more upward mobility due to assimilation but also more employment risk and earnings uncertainty.

Although the literature on Canadian inequality has provided many insights into current income inequality and low-income rates among immigrants, there is little known about immigrant employment mobility and long-run earnings inequality. Therefore, in this paper, I use the Longitudinal Immigration Database (IMDB) to address two questions: (1) How much employment mobility is there among immigrants to Canada? and (2) What are the implications of employment mobility for long-run earnings inequality? Given that rising earnings inequality among immigrants continues to be an economic, social, and political concern and that there is a potential for a substantial reduction of earnings inequality in the long run, studying employment risk and earnings mobility among Canadian immigrants is a crucial step in understanding their economic performance in Canada and their contribution to Canadian earnings inequality. Further, if immigrants are highly mobile, their high current earnings inequality measures may not be a matter of concern because their long-run earnings inequality, and likely consumption inequality, is much less. Last but not least, understanding employment mobility and its effects on long-run earnings inequality is essential for policy makers to formulate well-suited economic policies that aim at improving the labour market experience of immigrants.

The literature on long-run inequality components can be summarized in two main strands. The first one uses either an observed earnings average as a measure of permanent earnings to calculate long-run earnings inequality or an error-structure model to decompose earnings fluctuations over a long period into permanent and transitory components.[1] In Canada, a prominent example of this approach is Morissette and Berube (1996) who use individual T4 tax files to compare 10-year earnings dispersion measures between 1975-1984 and 1984-1993. They conclude that there is an increase in the persistent component of earnings variation between the two periods, with the coefficient of variation increasing 12 percent from 0.512 in the earlier period to 0.573 in the later period. Using the same tax data, Baker and Solon (2003) decompose Canada's growth in earnings inequality into persistent and transitory components based on an empirical earnings dynamics model. They find that increases in both long-run inequality and earnings instability contribute to the growth in earnings inequality.

The second branch of the literature explicitly attempts to incorporate employment risk, which is missing from the above studies. One particular example is Buchinsky and Hunt (1999)

[1]For example, see Katz and Murphy (1992), Levy and Murnane (1992), Gottschalk (1993), Gottschalk et al. (1994), Gottschalk (1997), Juhn et al. (1993), Beach et al. (1996), Blackburn and Bloom (1993) Morissette and Berube (1996), Picot (1996), DiNardo and Lemieux (1997), Richardson (1997), Katz and Autor (1999).

who take zero wages (nonemployment) into account and decompose mobility into between- and within-group components. While the error-structure literature imposes the assumption that dynamics are the same throughout the wage distribution, the quintile analysis in Buchinsky and Hunt (1999) allows for different dynamics in different parts of the distribution as well as zero wages. Based on the traditional earnings mobility literature (e.g., Gottschalk, 1997; Buchinsky and Hunt, 1999), Bowlus and Robin (2012) build a model of earnings dynamics that accounts for both employment risk and earnings mobility to determine long-run earnings inequality using short panels for estimation. For Canada, they find that due to employment mobility, lifetime earnings inequality is 32 percent lower than current earnings inequality. Their methodology is then adapted by Garnero et al. (2018) who allow for more refined earnings dynamics and unemployment benefit recipiency when estimating long-run earnings inequality and mobility in 24 OECD countries.

Although there has been a large literature that studies earnings dynamics in many countries, there has only been a limited number of studies on immigrant earnings dynamics. In Canada, to date, long-run inequality research has mainly focused on inequality among the total Canadian population only. This study fills this gap in the literature by exploring the earnings and employment dynamics among Canadian immigrants as well as their impact on immigrant long-run earnings inequality. By providing a comprehensive understanding of the role of employment mobility in long-run earnings inequality among immigrants, this paper can serve as a steppingstone in studying immigrant contributions to the overall level of long-run earnings inequality in Canada. A paper that is closest to my study is Ostrovsky (2008) who uses the life-cycle/permanent-income theory and the concepts of permanent and transitory income component to study earnings inequality and earnings instability across different cohorts. Meanwhile, I apply a short-panel method to study the employment mobility and long-run earnings inequality among the population of Canadian immigrants.

To address the research questions, I use the IMDB to create a sample that represents the stock of working-age male immigrants and link these immigrants to their tax records from 2011 to 2015.[2] Because only short panel data are available for the full immigration sample, I adapt the methodology from Bowlus and Robin (2012) to analyze earnings mobility and its effects on long-run earnings inequality. My detailed approach is as follows.

First, I specify the earnings distribution. In doing so, I isolate positional mobility from structural mobility by regressing log earnings against time dummies, education dummies, and their interaction terms. Then, I run a log earnings regression on the filtered data in which, besides education and potential experience, I also include a set of independent variables such as knowledge of the official language, foreign experience, time since landing, country of birth, immigration category, province of residence and a set of interaction terms.[3] Next, I estimate the weighted least squares log earnings regression using the weights from regressing the estimated squared residuals against the set of independent variables. Second, I estimate transition parameters. To do so, I obtain the empirical cumulative distribution function of the normalized residuals, assign ranks for the residuals, and then allocate individuals to 11 states including the 10 residual deciles and the unemployment state. After that, I use a multinomial logistic model

[2]This is the time period in which the database contains information on the full immigration population.

[3]I calculate the foreign experience as the difference between age at landing and the sum of years of schooling and six - the age when people start their education. In turn, I estimate the years of schooling for each individual based on their education level.

to estimate the transition probability of moving across deciles and unemployment state from one period to another period. Finally, to estimate employment insurance benefits parameters, I begin with estimating the probability of receiving unemployment benefits using a logistic regression and then estimate the log unemployment benefits regression.

My methodology includes four departures from Bowlus and Robin (2012) to provide a more precise simulation of long-run earnings and, hence, an improved calculation of long-run inequality for immigrants. First, I include observable characteristics that are relevant to immigrants in the earnings regressions as well as in the probit and logistic models. These variables have been shown in the immigration literature as having significant impacts on immigrants' employment outcomes. Second, my study includes a model specification, the dynamic model, which incorporates lagged residual deciles when estimating the transition probabilities. This approach is introduced by Garnero et al. (2018) who found such lags to be highly significant. Third, I use a logistic regression to estimate the probability of receiving employment insurance benefits as in Garnero et al. (2018). Lastly, instead of using an assumed replacement rate of the employment insurance benefit, I utilize the employment insurance benefit data to estimate an unemployment benefits equation.

After estimating all of the model parameters, I simulate a future earnings stream for all individuals who are in the sample in 2011 and then calculate long-run inequality and equalization ratio under different scenarios. In doing so, I use the marginal distribution of earnings residuals and individual-specific predicted transition probabilities to randomly draw a sequence of states starting with the current state in 2011 assuming that macroeconomic conditions are fixed at the current state. Then, I use a nearest-neighbor procedure to determine the precise rank of each individual within deciles to calculate predicted earnings for employed individuals. Simultaneously, I use an individual-specific predicted probability to randomly draw the probability of receiving employment insurance benefits for unemployed individuals and calculate predicted unemployment benefits for eligible candidates. Following that, I calculate the long-run earnings inequality, which is the 90/10 ratio of the present value of long-run annuities across immigrants of different cohorts. Using Field's (2010) equalization mobility measure, I compare the current and long-run earnings inequality and calculate how much inequality is reduced in the long run. To further study which components of employment mobility - employment risk or earnings mobility - contribute more to earnings inequality reduction, I run counterfactual analyses allowing only one process at a time and compare the results with the full mobility scenario. I also use a sample of the youngest cohort who were less than 38 years old in 2011 and simulate their earnings streams for 5, 10, 15, and 20 years separately to learn about the earnings equalization progress over time.

The model described above is the homogeneous model. Besides this model, I also run two other model specifications, namely the fixed effect model and the dynamic model. The fixed effect model is the same as the homogeneous model except that a fixed effect earnings equation is employed for the earnings distribution specification. The dynamic model differs from the homogeneous model in the sense that it includes a lagged decile of earnings residual (i.e., state) in estimating the transition parameters from one period to another.

Since immigrants in different immigration categories (i.e., the Economic Class, Family Class, and the Refugees) possess different immigration characteristics that may affect their labour market outcomes, it is likely that employment mobility patterns vary across these categories. To verify, I use the base-year sample and the simulated earnings streams over the

long run to calculate the current and long-run earnings inequality in each category. I then do a similar analysis using the youngest cohort sample to study how inequality reduction over the remaining lifetime varies across different immigration categories.

My main results are as follows. First, the 90/10 ratio of earnings among the working-age male immigrants is 7.51 which reflects the current inequality for this population. In the long run, thanks to employment risk and earnings mobility, inequality among immigrants reduces by approximately 12 to 38 percent depending on the model specification. This is a little more than the inequality reduction for the Canadian population of 13 to 34 percent (Bowlus and Robin, 2012). Second, the data show more upward mobility than downward mobility for immigrants. At the top of the earnings distribution, there is much less mobility and little employment risk. In contrast, there are more movements in and out of unemployment and across bottom deciles at the low end of the earnings distribution. Therefore, the reduction in long-run earnings inequality is mainly contributed by low-paid immigrants climbing up the earnings ladder. Third, for the youngest immigrant cohort, 18 to 33 percentage points of the overall 24 to 47 percent reduction in earnings inequality incur after 5 years. Following this period, the inequality reduction continues to happen but at a gradually slower rate. After 15 years, the equalization ratio levels off and remains almost the same in the following period.

Fourth, regarding employment mobility among the Economic Class, Family Class, and the Refugees, I find that the Refugees have the largest earnings inequality reduction in the long run thanks to the high level of mobility across all earnings deciles including the top and the bottom deciles of the earnings distribution. Simultaneously, most of the mobility and earnings inequality reduction among the Economic Class immigrants is due to movement in and out of employment and across bottom earnings deciles as much less mobility is observed at the top earnings deciles. Finally, Family Class immigrants appear to have more mobility than Economic Class immigrants but less mobility than the Refugees. They also tend to have the lowest employment risk among the three categories.

Among the three models, the homogeneous model predicts the highest level of mobility, followed by the dynamic model and then the fixed effect model. Compared to the homogeneous model, the dynamic model allows for a better fit of transition parameters because a lagged decile is included. At the same time, the dynamic model is more flexible than the fixed effect model, because the fixed effect component results in too little mobility of the residuals within the stationary earnings distribution.

Although Canadian immigrants have high current earnings inequality, they also have a large reduction in inequality over time. The results indicate that high current earnings inequality among the immigrant population is not persistent such that the earnings inequality shrinks in the long run, especially after five years for a given cohort. Since employment risk mainly occurs at the bottom of the earnings distribution, more policies should be put in place to increase job security or better matches. Further, more attention should be paid to enhancing upward earnings mobility among immigrants with low earnings.

The rest of the paper is planned as follows. The next section describes the theoretical framework for inequality analysis. Section 3 describes the data. The results are discussed and analyzed in Section 4, and the conclusion is given in Section 5.

3.2 Data

3.2.1 The Longitudinal Immigration Database (IMDB)

To estimate the earnings dynamics and employment risk among Canadian immigrants, I use data on immigrants from the IMDB panel data, which combines administrative files on immigrant admissions and non-permanent resident permits from Immigration, Refugees and Citizenship Canada (IRCC) since 1980 and the T1FF tax files from the Canada Revenue Agency for the period from 1982 to 2015. It is the only annual Canadian dataset that studies all Canadian immigrants who landed since 1980. More than just a detailed tax dataset, the IMDB is also rich in immigrant demographic and landing information. In addition, as the tax data are extracted directly from the tax returns, the IMDB is less prone to measurement error than self-reported surveys or derived data.

Like other datasets, the IMDB has some caveats. One of the main issues is that it only includes landing information and tax files of immigrants who landed from 1980 onwards and filed at least one tax return since 1982. Consequently, it does not cover the entire stock of Canadian immigrants over the sample period. In particular, the IMDB does not have information on those who did not file a tax return, those who landed before 1980, and the tax data of those who left Canada. Another drawback is that the data do not provide information on the immigrants' current education or employment status. Due to this limitation, one cannot precisely determine the labour force status of the immigrants each year. Lastly, it is possible that there is a selection problem associated with the data. This problem stems from the fact that the IMDB is tax-file based data where earnings measures are obtained from tax returns since the tax-filing decision is itself endogenous and varies across time according to tax filing incentives. However, for my sample of interest, the tax filing rate of the immigrants is high at about 93 to 94 percent annually. Also, Messacar (2017) has shown that, for Canada, the consequences of tax filing delay for economic analysis are generally small.[4]

3.2.2 Data Construction

Previous studies on long-run inequality and earnings dynamics usually use long panel data for estimation. However, as the IMDB is a flow data set that does not cover the entire stock of Canadian immigrants during the early period, I cannot utilize all of the data from the IMDB long panel structure for the purpose of my analysis, as having a stock sample is necessary for an accurate cross-sectional earnings inequality measure.

To construct a sample that represents the stock of working-age male immigrants, I apply the following criteria. First, they must be male immigrants in the Economic Class, Family Class, or the Refugees category who landed in Canada on or before 2011, the base year for this study.[5]

[4]Messacar (2017) finds that 3.5 to 4.8 percent of tax filers delay filing their returns each year. This behaviour has generally small consequences, which do not bias estimates of income distributions, aggregate statistics, or inequality.

[5]There are four immigration categories in the Canadian immigration system: Family Class, Economic Class, Refugees, and Other Class. Family Class immigrants are those sponsored to come to Canada by a family member who is a Canadian citizen or permanent resident. Economic Class immigrants are selected based on their skills and ability to contribute to Canada's economy. The Refugees are admitted to Canada after their refugee claims are accepted. Other Class immigrants include people who were granted permanent resident status under a program

As the IMDB only includes the inflows of immigrants since 1982, it does not represent the full stock of immigrants during the early period. Therefore, I select 2011 as the base year because by this year the IMDB has a good representation of immigrants with time since landing varying from one to more than 30 years. This variation is important for the inequality study as time since landing plays a crucial role in determining immigrant employment outcomes (Yssaad and Fields, 2018). The choice of 2011 as the base year also ensures that my sample potentially has at least four years of tax data. I choose male immigrants because males have more consistent and predictable labour market participation than females. Second, they must be at least 25 years old at the time of landing and must be 25 to 54 years old in 2011. I also restrict my sample to immigrants who were at least 25 years old at the time of landing to limit the sample to adult immigrants only. Hence, they are likely to be different from Canadian-born workers who have either Canadian education or a native's career path or both. These adult immigrants are also likely to experience more hardship in the Canadian labour market and thus may have the largest impact on earnings inequality.

After constructing the sample of immigrants and choosing 2011 as the base year, I merge the chosen sample with their tax records from 2010 to 2015.[6] Since there is no variable in the IMDB that reflects the labour force status of the immigrants, I create this variable by assigning an individual as being employed if the individual's annual employment income from T4 slips is greater than employment insurance benefits received and is at least $2,439, while all else are defined as unemployed.[7] For unemployed individuals, those with positive employment insurance benefits are assigned as being eligible for employment insurance benefits, while the rest are not. Tax records of immigrants in the first year after landing in Canada are discarded because the first-year earnings may not reflect an immigrant's true earnings level. I also exclude annual observations in which immigrants have self-employment income, a newborn or an adopted child, or any disability amount. The reason is that self-employed and paid-employed workers have different earnings mobility and employment risk patterns, and the self-employed workers are not under the scope of this study. Annual tax records with a presence of a newborn or an adopted child, or any disability amount are also excluded to ensure that the employment insurance benefits that immigrants received are due to unemployment.[8] Similarly, I drop tax observations that have a positive amount of full-time or part-time education which indicates participation in an educational institution. Lastly, after excluding the first tax year after landing, I only include immigrants who have at least four consecutive years of tax data of which there are at least two years with positive earnings. This is to provide a more precise estimation of the earnings dynamics and employment risks and to ensure that the immigrants in my sample are more likely to be active in the labour market. All earnings or benefits while being employed or unemployed are adjusted by Consumer Price Index in 2011 and trimmed at 1 percent top and 1 percent bottom of the 2011 earnings distribution by education. In the end, my sample

that does not fall into either the Economic Class, Family Class, or the Refugees. Since the Other Class includes unique cases with special circumstances that do not go through a general assessment, they are excluded from the scope of this research.

[6] I include 2010 tax data to allow for the effects of lagged earnings on current earnings in the analysis.

[7] I assume the cut-off earnings of $2,439 by calculating the minimum annual earnings of a person who works 20 hours a week at a minimum hourly wage of $8.71 for 14 weeks. This is the minimum hourly wage reported by Statistics Canada for the whole of Canada in 2011.

[8] These dropped tax observations account for a very small proportion of the total number of tax records.

includes 505,225 individuals.

3.2.3 Descriptive Statistics

Descriptive statistics of the sample are shown in Table 3.1.[9] Approximately 60 percent of the sample is Economics Class immigrants while the percentages of Family Class immigrants and the Refugees are about 26 percent and 14 percent, respectively. A majority of the male immigrants in the sample are from Asia, which accounts for 57.19 percent of the sample. The rest includes those who are from the Americas, Europe, or Africa accounting for 12.56 percent, 18.48 percent, and 10.93 percent of the sample, respectively, and less than 1 percent of the male immigrants originated from Oceania or Antarctica. With regards to their education level, the male immigrant population is dominated by those who have a bachelor's degree, 34.57 percent, followed by the some-college group, 24.65 percent. The sample proportion that has more than a BA is 13.35 percent, while 27.43 percent of the sample has only high school or less than high school education. Regarding the choice of language for communication, 64 percent of the sample have English as their preferred language whereas only 5 percent of them have French. Almost 10 percent of the sample use both languages.

Another feature of the sample is that approximately 30 percent of the male immigrants were in Canada before which implies that they had some Canadian experience before landing. Recent immigrants account for a larger proportion of the sample. In particular, 53.81 percent of the sample landed in Canada during the period from 2002 to 2012, 34.73 percent of them landed in Canada from 1992 to 2001, and the oldest landing cohort, 1982 to 1991, accounts for 11.46 percent of the sample. In 2011, the average age of the sample is 43.14 with about 40 percent of the sample aged from 35 to 44, 47 percent of them aged from 45 to 54, and only 13.53 percent of them belonging to the younger age cohort, 25 to 34. Their average time in Canada is 9.73 years, and their average potential foreign work experience is 13.2 years.

3.3 Methodology

By applying the above-mentioned sample selection criteria, I have a sample that represents the stock of working-age male immigrants in the period from 2010 to 2015. However, this results in having only a short panel of tax data for the mobility analysis, which does not meet long panel requirements for using a dynamic earnings model. Nonetheless, it is of sufficient length for the methodologies adopted by Buchinsky and Hunt (1999), Bowlus and Robin (2012), and Garnero et al. (2018). This paper follows Bowlus and Robin's (2012) methodology, which allows for the simulation of future earnings streams and hence the calculation of long-run earnings inequality. The key feature of this methodology is to use a statistical model to capture employment mobility and to incorporate unemployment as one of the possible employment states to account for employment risk. The methodology includes the following steps. First, to

[9]To protect data confidentiality and privacy of respondents, Statistics Canada requires IMDB researchers to round sample sizes and frequency counts to the nearest 5. Also, all proportions must be rounded depending on the size of the underlying population, and all income values must be rounded to the nearest 100. All results presented throughout this paper satisfy these conditions and should be interpreted as such.

Table 3.1: Sample Statistics

Age at landing	33.41
Age at base year	43.14
Time in Canada at base year	9.73
Potential foreign work experience	13.20
Education level (percent)	
Less than High School	17.51
High School	9.92
Some college	24.65
BA	34.57
BA plus	13.35
Country of birth (percent)	
Americas	12.56
Europe	18.48
Africa	10.93
Asia	57.19
Oceania or Antarctica	0.84
Age cohort at base year 2011 (percent)	
25-34	13.53
35-44	39.59
45-54	46.87
Landing cohort (percent)	
1982-1991	11.46
1992-2001	34.73
2002-2012	53.81
Been in Canada before (percent)	29.76
Language (percent)	
English	64.21
French	5.05
Both languages	9.97
No language	20.77
Immigration category (percent)	
Economic Class	59.27
Family Class	26.32
Refugees	14.41
Number of observations	505,225

specify a stable earnings distribution, any structural mobility is removed. Then, using a stationary distribution of earnings residuals, transition parameters of earnings residuals across deciles are estimated. These transition parameters are used later along with earnings regression coefficients to predict future earnings streams. The simulation process is based on the assumption that the best guess for young people for tomorrow is what is happening to older people today. Besides the main approach from Bowlus and Robin (2012), I also incorporate a methodology improvement from Garnero et al. (2018) who include a lagged decile of earnings residual to the estimation of transition parameters of earnings residuals across deciles. They also use a probit model to estimate the probability of receiving unemployment benefits among the unemployed and only assign unemployment benefits to those who are eligible. Going further from that, I take advantage of the employment insurance benefit data to provide a more precise estimation of immigrant earnings while unemployed. Details of my methodology are as follows.

3.3.1 Specifying the Earnings Distribution

As explained in MaCurdy (2007), when assessing the degree of equalization mobility, it is necessary to isolate positional mobility from structural mobility. Positional mobility refers to changes in individuals' earnings across a stable earnings distribution, while structural mobility concerns changes in the earnings distribution over time due to macroeconomic conditions, policy changes, or any other structural changes. To isolate positional mobility, I remove any structural variation by regressing log earnings against time dummies interacted with education dummies using 2011 as the base year. The earnings in this regression are total T4 earnings, or total employment earnings, reported in the tax records. Then, I run the following log earnings regression on detrended data from the previous step:

$$lnw_{it} = \mathbf{x}_{it}\boldsymbol{\beta} + e_{it}, \tag{3.1}$$

where $\mathbf{x}_{it}$ is the set of regressors including education dummies, a quartic function in the time since landing, a quadratic function in foreign experience, region of birth, immigration category, language, Canadian experience before landing, and the set of interaction terms of time since landing and education, time since landing and region of birth, time since landing and immigration category, foreign experience and region of birth, foreign experience and time since landing, and foreign experience and immigration category. These variables and interaction terms are shown to greatly impact immigrant labour market outcomes.[10] The model which uses an OLS earnings regression as the specification for the stationary earnings distribution is referred to hereafter as the *homogeneous model*.

Next, I regress the estimated squared residuals $\hat{e}_{it}^2$ on $\mathbf{x}_{it}$:

$$Var(e_{it}|\mathbf{x}_{it}) = \mathbf{x}_{it}\boldsymbol{\gamma}, \tag{3.2}$$

and then re-estimate $\boldsymbol{\beta}$ by weighted least squares regression with the new weights proportional to $\frac{1}{(\mathbf{x}_{it}\hat{\boldsymbol{\gamma}})^{1/2}}$. By doing so, I allow for conditional heteroskedasticity and improve regression efficiency. The residuals from the weighted least squares regression are then used to estimate transition parameters.

[10] See Frenette and Morissette (2003); Aydemir and Skuterud (2005); Begin et al. (2010); Green and Worswick (2010).

I also run a fixed-effect regression model of the earnings distribution in which the fixed effect component captures the effects of all time-invariant regressors such as education, immigration category, country of origin, foreign work experience, previous Canadian experience, language knowledge, and the interaction of foreign work experience with country of birth or immigration category. The model version that employs a fixed-effect regression to specify the stationary earnings distribution is referred to as the *fixed effect model.*

3.3.2 Estimating Transition Parameters

To analyze employment dynamics and simulate individual earnings profiles, I estimate transition parameters of earnings residuals across deciles to characterize the employment mobility of immigrants. Employment mobility reflects different dynamics across different parts of the stationary earnings distribution, especially at the two extremes because individuals tend to move up if they are at the bottom of the distribution and vice versa. Estimation of this type of earnings dynamics can be made possible by adopting the common practice of examining matrices of transition probabilities across deciles (e.g., Buchinsky and Hunt, 1999; Bowlus and Robin, 2012; Garnero et al., 2018). First, I obtain the empirical cumulative distribution function $\hat{G}$ of the normalized residuals from the earnings distribution specification, $\hat{u}_{it} = \frac{\hat{e}_{it}}{\sqrt{\mathbf{x}_{it}\hat{\gamma}}}$. Next, I assign values for $\hat{r}_{it}$ as an empirical version of r_{it}, which is the rank of the residual $\hat{u}_{it}$ in the standardized residual distribution. Then, I allocate individuals to ten residual earnings deciles and treat unemployment as an additional state. As a result, in total, there are eleven possible origin and destination states. Including unemployment as a state in the transition matrix allows for incorporating employment risk in the employment mobility analysis, which is often ignored in the literature on permanent-transitory components.

Using a multinomial logistic model, I then parameterize the transition probabilities for each state. Let $P(i, j|\mathbf{x}_{it})$ be the probability of moving from state $q_{it} = i$ at time t to state $q_{i,t+1} = j$ at time $t + 1$ conditional on the set of independent variables $\mathbf{x}_{it}$. The transition probabilities from state i at time t to all possible states at time $t + 1$ sum up to 1. Each transition probability can be estimated by the following specification:

$$P(i, j|\mathbf{x}_{it}) = \frac{exp[\mathbf{x}_{it}\boldsymbol{\theta}(i, j)]}{\sum_{k=0}^{K=10} exp[\mathbf{x}_{it}\boldsymbol{\theta}(i, k)]}, \tag{3.3}$$

where $\mathbf{x}_{it}$ is a vector of covariates including a quartic function in the time since landing, a quadratic function in foreign experience, education dummies, region of birth, immigration category, language, and their interaction terms. Following Garnero et al. (2018), I also estimate transition parameters by including the lagged decile of the earnings residual as a regressor in the above-mentioned multinomial logistic model.[11] This model specification is referred to as the *dynamic model*, and the purpose of this model is to capture the actual earnings dynamics more closely.

[11] In order to estimate the transition parameters in the dynamic model, I use the standardized earnings residuals from the homogeneous model as the model inputs.

3.3.3 Estimating Employment Insurance Benefits Parameters

In the previous studies, including Bowlus and Robin (2012) and Garnero et al. (2018), unemployment income is calculated using unemployment insurance replacement rates. If an individual worked in the previous year, the unemployment income is equal to the product of the previous period's annual earnings and a country-specific replacement rate. If the annual earnings from the previous year is not available, or if the simulated unemployment income is less than a minimum earnings level, then the minimum earnings level is applied. However, as the data on employment insurance benefits are available in the IMDB, I take advantage of the information to simulate the unemployment income of the unemployed more accurately.

In Canada, employment insurance benefits include regular benefits for individuals who lose their jobs through no fault of their own and are available and able to work, but they cannot find a job.[12] To be eligible for regular employment insurance benefits, individuals must have been employed in insurable employment, lost their job through no fault of their own, have been without work and without pay for at least seven consecutive days in the last 52 weeks, have worked for the required number of insurable employment hours, are ready and able to work, and are actively looking for work. For most people, the basic rate for calculating employment insurance benefits is 55 percent of their average insurable weekly earnings, and the benefits are capped by a maximum amount.[13] Although the IMDB does not have information regarding the eligibility for employment insurance benefits or insurable earnings, thanks to the availability of receipt of employment insurance benefits in the IMDB, I can estimate the probability of receiving employment insurance benefits and the unemployment earnings equation without the need of employing assigned replacement rates.

In particular, I follow Garnero et al. (2018) and use a probit regression to estimate the probability of receiving employment insurance benefits:

$$P(eib = 1|\mathbf{x}_{it}) = \frac{exp(\mathbf{x}_{it}\boldsymbol{\Delta})}{exp(\mathbf{x}_{it}\boldsymbol{\Delta}) + 1}, \tag{3.4}$$

where $P(eib = 1|\mathbf{x}_{it})$ is the probability of receiving employment insurance benefits conditional on the set of covariates $\mathbf{x}_{it}$, which includes a set of immigrant characteristics, its lagged employment status, and whether an individual received employment insurance benefit in the previous period. Then, I run the log benefits equation for the unemployed against the same set of regressors:

$$lnw_{it}^{U} = \mathbf{x}_{it}\boldsymbol{\kappa} + \epsilon_{it}. \tag{3.5}$$

In this regression, unemployed benefits include both employment insurance benefits and T4 earnings, if there are any. Of the two earnings components, the employment insurance benefits

[12] Employment insurance benefits are also for sickness, maternity and parental leave, caregiving benefits and leave, and others. Among them, regular benefits, or unemployment benefits, accounted for almost 60 percent of recipients in 2007 according to Statistics Canada, Employment Insurance Program (see https://www150.statcan.gc.ca/n1/pub/71-222-x/2008001/sectionk/k-ei-ae-eng.htm for more information). Since my sample covers only male workers who are 25 to 54 in 2011 and does not include female immigrants or annual tax observations which indicate a presence of a newborn, an adopted child, or any disability amount, employment insurance benefits are likely to be unemployment benefits rather than other benefits.

[13] In 2011, the maximum insurable earnings are $44,200, so the maximum employment insurance benefits are $24,310.

mainly account for the total unemployed earnings of the unemployed workers. Coefficients from this regression are used to predict earnings while unemployed when individuals move into unemployment and are eligible for unemployment benefits. For unemployed workers who are not eligible for unemployment benefits, their earnings are assumed to be zero.

3.3.4 Long-run Earnings Simulations

The estimated parameters from the above steps are used to simulate earnings trajectories for all individuals present in the base year. Long-run earnings simulations are based on the idea that the best guess that young people can make regarding their future earnings is what is happening to older people today, assuming that macro conditions do not change over time. The process of simulating employment risk and earnings trajectories is as follows.

The simulation starts with the current employment state and earnings and continues until the age of 58.[14] Using a sequence of random draws for each year and the individual-specific predicted transition probabilities, I assign an employment status, employed or unemployed, to individuals as well as their earnings decile each year if they are assigned to employment, and eligibility for employment insurance benefits if they are unemployed.

Once I obtain the joint distribution of deciles at times t and $t+1$ given an individual's specific characteristics, I use a nearest-neighbor procedure as in Bowlus and Robin (2012) to determine the precise rank of each individual within deciles. This method allows for the rank prediction at time $t+1$, $r_{i,t+1}$, that yields the closest match to the original rank, $r_{i,t}$, and the predicted decile, $q_{i,t+1}$.[15]

After producing an approximation of the rank distribution, I generate the standard normal distribution of log earnings residuals. The residual log earnings for each employed individual is produced by multiplying $\hat{u}_{it}$ by $\sqrt{\mathbf{x}_{it}\hat{\boldsymbol{\gamma}}}$. Then, I calculate earnings levels for employed persons in each year within the simulation period as follows:

$$\hat{w}_{it}^{E} = exp(\mathbf{x}_{it}\hat{\boldsymbol{\gamma}} + \hat{u}_{it}\sqrt{\mathbf{x}_{it}\hat{\boldsymbol{\gamma}}}). \tag{3.6}$$

For unemployed individuals, I use the parameters from the probit regression on the probability of receiving employment insurance benefits to determine if they would be eligible to receive the benefits. If they would not be eligible, I assign their earnings in this period as zero. Otherwise, I use the parameters from unemployed earnings regression to predict the amount of earnings an immigrant receives:[16]

$$\hat{w}_{it}^{U} = exp(\mathbf{x}_{it}\hat{\boldsymbol{\kappa}} + \hat{\epsilon}_{it}). \tag{3.7}$$

[14]The oldest individuals in my sample aged 54 in the base year of 2011, and I can observe their earnings until the age of 58. Therefore, I simulate earnings until this age only.

[15]Randomly assigning a rank within deciles or maintaining the rank within deciles even if individuals move across deciles are other ways to obtain the rank approximation.

[16]For the purpose of comparison, I also simulate the earnings of unemployed individuals using a replacement rate of 55% of the individuals' earnings in the previous period with a maximum amount of $24,310. In this simulation approach, the unemployed earnings only include the employment insurance benefits and do not reflect any T4 earnings as reported in the tax data.

3.3.5 Long-run Earnings Inequality and Mobility Equalization

I calculate the long-run earnings as the discounted sum of simulated future earnings until the age of 58, $\bar{a}$, as follows:

$$\varepsilon_{at}(w) = \sum_{a}^{\bar{a}} \frac{\hat{w}^{E}_{iat} + \hat{w}^{U}_{iat}}{(1+r)^{\bar{a}-a+1}}. \tag{3.8}$$

Then, I convert the stock value $\varepsilon_{at}(w)$ into annuity value $A_{at}(w)$. At the interest rate r, the annuity $A_{at}(w)$ is calculated by the following equation:

$$A_{at}(w) = \frac{\varepsilon_{at}(w)}{\sum_{t=1}^{\bar{a}-a+1} \frac{1}{(1+r)^{t}}}. \tag{3.9}$$

To compare current and long-run earnings inequality, I use Field's (2010) equalization mobility measure (i.e. equalization ratio), which is defined as the ratio of the long-run inequality measure to the base-year inequality measure.

3.3.6 Counterfactual Analysis

In the next step, I analyze the contribution of earnings mobility and employment risk to long-run earnings inequality by simulating the annuities under different counterfactual scenarios. Specifically, I allow for the scenario of earnings mobility only or that of employment risk only to predict the relative importance of these two forms of mobility to long-run earnings inequality. Besides these two counterfactual scenarios, I also simulate the earnings data in different counterfactual settings which include the following cases: (i) There is only positive wage mobility with no negative wage shocks and no risk of unemployment for those who are employed in the base year and (ii) There is only negative wage mobility with no positive wage shocks and no risk of unemployment for those who are employed in the base year. Finally, I simulate the earnings stream for 5 years, 10 years, 15 years, and 20 years separately using the youngest cohort including male immigrants who were less than 38 years old in 2011 to study how long-run earnings inequality reduces over time.

3.4 Results

3.4.1 Stationary Earnings Distribution

Table 3.2 shows the predicted stationary distribution of earnings in comparison with the actual unemployment rate and earnings distribution across deciles in the data where Decile 0 represents the unemployment state. In general, the model produces an earnings distribution that is close to the data. In the homogeneous model, the unemployment rate is 5.7 percent, which is 0.5 percentage points higher than that in the data. The actual percentage of each decile, 9.48 percent, is calculated by subtracting the unemployment rate from 1 and then dividing the earnings distribution of the remaining immigrant population into 10 deciles. In the ideal case when the model does a perfect job of removing the structural mobility over time, an equal distribution across deciles of 9.43 percent would occur. Although there are slight fluctuations in

Table 3.2: Stationary Distribution of Earnings

Decile	Actual	Homogeneous Model	Fixed Effect Model
0	0.0521	0.0572	0.0580
1	0.0948	0.0966	0.0955
2	0.0948	0.0957	0.0946
3	0.0948	0.0943	0.0944
4	0.0948	0.0937	0.0923
5	0.0948	0.0933	0.0917
6	0.0948	0.0929	0.0924
7	0.0948	0.0927	0.0935
8	0.0948	0.0931	0.0947
9	0.0948	0.0947	0.0959
10	0.0948	0.0959	0.0970

the predicted stationary earnings distribution across deciles, the homogeneous model captures closely the actual distribution. Both the homogeneous model and the fixed effect model produce a similar unemployment rate, at 5.7 percent and 5.8 percent, respectively. However, the homogeneous model produces a more equal distribution across deciles compared to the fixed effect model.

The average transition probability matrix across deciles from one period to the next period in the homogeneous model is presented in Table 3.3. As shown in the diagonal of the matrix, the probability of staying in the same decile is around 0.5 except for the top ones. Specifically, at Decile 9, the average probability of staying at the same decile is 59 percent, and at Decile 10, it is 79 percent. When summing up the probabilities of transition to upper deciles only and lower deciles only, I find that the probability of transitioning to higher deciles is higher than that of transitioning to lower deciles, which implies an upward trend of mobility among the immigrants. Around each decile, a one-decile deviation is most likely to occur, and there is only a small probability of moving far from the origin decile. For unemployment, the average probability of staying unemployed for two consecutive periods is 47 percent, while approximately 38 percent of the unemployed workers transition to Deciles 1 and 2. Meanwhile, employment risk is very low at the top deciles. Particularly, when individuals are in Deciles 8, 9, and 10, the probability of transitioning into unemployment is less than 1 percent.

3.4.2 Model Fit

Cross-section Earnings Distribution

To examine the performance of the homogeneous model and the fixed effect model in capturing the earnings data, I compare the moments of the earnings distributions of the employed and the unemployed in the data to those of the earnings predicted using the model parameters. As can be seen from Columns 2 to 4 of the upper part of Table 3.4, the mean and variance of predicted earnings from the homogeneous model are slightly higher than those in the data at $56,200 versus $55,400 and $41,687 versus $36,652, respectively. This is because the predicted earnings construction is based on both predicted log earnings and a random component

Table 3.3: Average transition matrix of earnings residuals from the homogeneous model's earnings specification

Decile	0	1	2	3	4	5	6	7	8	9	10
0	0.47	0.28	0.10	0.05	0.03	0.02	0.02	0.01	0.01	0.01	0.01
1	0.12	0.54	0.17	0.07	0.04	0.02	0.01	0.01	0.01	0.01	0.00
2	0.06	0.15	0.49	0.16	0.06	0.03	0.02	0.01	0.01	0.01	0.00
3	0.04	0.06	0.15	0.48	0.16	0.05	0.03	0.02	0.01	0.01	0.00
4	0.03	0.03	0.05	0.16	0.47	0.16	0.05	0.03	0.01	0.01	0.004
5	0.02	0.02	0.03	0.04	0.17	0.46	0.17	0.05	0.02	0.01	0.01
6	0.02	0.01	0.02	0.02	0.04	0.18	0.46	0.18	0.05	0.02	0.01
7	0.01	0.01	0.01	0.01	0.02	0.04	0.18	0.48	0.18	0.04	0.01
8	0.01	0.01	0.01	0.01	0.01	0.02	0.04	0.18	0.51	0.17	0.03
9	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.17	0.59	0.15
10	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.02	0.14	0.79

Table 3.4: Actual and predicted moments from the earnings samples of the employed and unemployed immigrants in the homogeneous model

	Detrended earnings	Predicted earnings		Log detrended earnings	Predicted log earnings	
		Homogeneous model	Fixed effect model		Homogeneous model	Fixed effect model
Employment earnings						
Number of observations	2,578,240	2,578,240	2,578,240	2,578,240	2,578,240	2,578,240
Mean	55,400	56,200	55,800	10.71	10.71	10.71
Standard deviation	36,653	41,687	39,007	0.69	0.69	0.69
Skewness	1.59	2.06	1.77	-0.45	0.04	-0.20
Kurtosis	4.02	6.05	4.71	0.28	-0.01	-0.05
Unemployment earnings						
Number of observations	32,795	32,860	32,850	32,795	32,860	32,850
Mean	15,900	15,100	15,200	9.44	9.44	9.45
Standard deviation	8,553.39	10,001.74	10,003.94	0.83	1.04	1.04
Skewness	0.16	0.34	0.33	-1.88	-0.07	-0.07
Kurtosis	-0.78	-1.32	-1.34	5.33	0.05	0.05

of the residuals which is drawn from a standard normal distribution. However, the residuals from the regression; in fact, do not perfectly follow a standard normal distribution, which results in a gap between predicted and actual earnings moments. In the actual data, although the earnings are already detrended and trimmed at 1 percent at the top and bottom, the earnings distribution still demonstrates a positive skewness level of 1.59 and a high kurtosis level of 4.02, which implies that the earnings data are skewed right and that there are heavy tails, or extreme values, at both ends of the earnings distribution. Similar to the homogeneous model, the fixed effect model produces very close predicted moments to the ones from actual data. Specifically, the predicted mean and variance of earnings for the employed are $55,800 and $39,007. However, the fixed effect model seems to outperform the homogeneous model in predicting higher-order moments such as standard deviation, skewness, and kurtosis. For the log earnings levels, which are shown in Columns 5 to 7, the mean and standard deviation of natural log earnings generated by the models, 10.71 and 0.69, match well with corresponding moments from the detrended log earnings regression, and skewness and kurtosis levels of the predicted log earnings are close to the data values.

Among 114,230 unemployed observations in the data, approximately 29 percent of them, or 32,795 observations, are cases in which individuals receive employment insurance benefits. For the unemployed, the earnings while being unemployed combine both employment insurance benefits and T4 earnings. In general, the average T4 earnings during unemployment only contributes a small amount to the average total earnings of the unemployed. However, for some workers, it is positive because they have positive earnings from working for part of the year. Similar to the mean of predicted log earnings, the mean of predicted log unemployment earnings and benefits is near the mean value from the data. The average detrended earnings for the unemployed is $15,900, while the predicted values in the homogeneous model and the fixed effect model are $15,100 and $15,200, respectively. Other statistics of predicted unemployment earnings such as standard deviation, skewness, and kurtosis are overestimated by a small amount, which is due to the construction of predicted earnings. Despite these slight differences in higher-order moments, in general, the homogeneous model does a good job of reproducing the earnings data for both employed and unemployed individuals.

Transitions

To evaluate how well the three models - homogeneous model, fixed effect model, and dynamic model - perform in specifying the earnings dynamics, I examine the model fit of higher-order earnings mobility using Spearman's rank correlation across pairs of years and across deciles. For actual rank correlation, I only include in the calculation individuals who worked in both periods, and, for the model's Spearman rank correlation, I include individuals who worked in the first period and are predicted to work in the second period. I calculate two types of Spearman's rank correlation: (i) the rank correlation between log earnings across pairs of years with a gap ranging from one to three years and (ii) the rank correlation between log earnings of two consecutive years conditional on earnings decile in year 1. Spearman's rank correlation of earnings between two years provides a measure of model fit for the overall data, while the rank correlation across deciles between two consecutive years indicates how well the transition parameters capture the residual mobility at decile levels. It is important to note that the purpose of this exercise is not to compare the levels of actual and predicted log earnings but to compare

Table 3.5: Model fit of earnings mobility using Spearman's rank correlation across 1 to 3 years

	Detrended Data	Homogeneous Model	Fixed Effect Model	Dynamic Model
1-year gap	0.91	0.91	0.91	0.91
2-year gap	0.87	0.83	0.89	0.86
3-year gap	0.83	0.76	0.87	0.81

the ranks of actual log earnings and ranks of predicted log earnings because earnings mobility relies entirely on the rank dynamics given the fixed marginal distribution of earnings. Also, instead of using only the residuals, I use the predicted and actual log earnings for the rank correlation exercise because the log earnings better capture the fit of the whole model including both the specification of a stationary earnings distribution and the transition parameters.

Table 3.5 shows the overall fit of the rank correlation in the observed and predicted earnings from the three models. In the actual data, the rank correlation is highest, 0.91, when the gap is 1 year, and it reduces to 0.83 when the gap is three years.[17] The results show that the three models capture well the rank correlation of log earnings for the one-year gap as well as the decline of the rank correlation over three years. However, the rank correlation of log earnings for 2-year and 3-year gaps gradually deviates from the actual values. For example, while the actual rank correlation for the 2-year gap is 0.87, the rank correlation of predicted log earnings in the homogeneous model, fixed effect model, and dynamic models are 0.83, 0.89, and 0.86, respectively. Also, it can be seen from the results that the actual rank correlations range between the predicted values of the homogeneous model and the fixed effect model, which implies that the homogeneous model has the tendency to underestimate the rank correlations while the fixed effect model tends to overestimate them. The rank correlation values produced by the dynamic model appear to be the closest match to the actual values.[18]

Table 3.6 presents the model fit of earnings mobility using the Spearman's rank correlations between Period 1 and Period 2 earnings conditional on the Period 1 earnings decile. In the actual data, the Spearman's rank correlation of earnings gradually increases across deciles with a rank correlation of 0.26 for the first decile and 0.73 for the top decile.[19] Small values of the rank correlation at the bottom deciles indicate more earnings mobility in this part of the earnings distribution. Meanwhile, the earnings dynamics are lower at higher deciles, especially

[17]There are slight differences in rank correlation values between the dynamic model and non-dynamic models (i.e. the homogeneous and fixed effect models. Particularly, the corresponding rank correlation values in actual data when using the dynamic model for 1-year, 2-year, and 3-year gaps are 0.92, 0.87, and 0.85, respectively. The slight differences in rank correlation values between the dynamic model and non-dynamic models are due to data discrepancy. The dynamic model requires observations to have no missing earnings data in the last two periods, while the homogeneous model and the fixed effect model only require non-missing data in the previous period.

[18]Comparing to the Spearman's rank correlation of the log earnings for the full Canadian population reported in Bowlus and Robin (2012) using the Survey of Labour and Income Dynamics (SLID) in 1998, the actual rank correlations for the immigrant population are almost the same. The actual rank correlations for the 1-year, 2-year, and 3-year gaps for the full Canadian population are 0.92, 0.87, and 0.84, respectively, while they are 0.91, 0.87, and 0.83 for the immigrant population.

[19]Similar to what is explained in Table 3.5, there are slight differences in rank correlation values between the dynamic model and non-dynamic models. The actual rank correlation values of the dynamic model are reported in Table A.1 of the Appendix.

Table 3.6: Spearman's rank correlation between Period 1 earnings and Period 2 earnings conditional on Period 1 earnings decile

Deciles	Actual	Homogeneous model	Fixed Effect Model	Dynamic Model
1	0.26	0.26	0.35	0.26
2	0.29	0.31	0.34	0.32
3	0.30	0.29	0.31	0.30
4	0.31	0.28	0.29	0.29
5	0.32	0.28	0.30	0.29
6	0.36	0.31	0.32	0.32
7	0.40	0.35	0.36	0.35
8	0.46	0.38	0.41	0.39
9	0.53	0.44	0.47	0.46
10	0.73	0.64	0.70	0.66

at the top of the earnings distribution. This finding suggests that overall earnings mobility and inequality equalization are much attributable to the movement across the bottom deciles of the earnings distribution.

In general, all three models perform well in capturing the earnings dynamics of the data. However, similar to the rank correlation across pairs of years, the rank correlation values across deciles are the lowest in the homogeneous model and the highest in the fixed effect model. The fixed effect model produces higher rank correlations than the homogeneous model for all deciles because the removal of the fixed effect component induces less mobility in the residuals compared to the homogeneous model. Meanwhile, the dynamic model produces values of rank correlations in the middle of the three models because the lagged earnings residual decile captures some persistence but not as much as the fixed effect component.[20]

3.4.3 Current and Long-run Inequality

Current and Long-run Inequality Across Groups

The first column of Table 3.7 shows the average earnings and average earnings ratio across different groups in the base year, while the second column reports the corresponding measures for the predicted long-run annuities. In particular, I report the average earnings ratios between the three pairs of groups based on immigration category, education level, and time in Canada in 2011 and then compare them with the corresponding long-run measures using the simulated earnings data.

In the base year, an average Economic Class immigrant earns $59,200 per year, which

[20]When comparing the rank correlations of earnings between the immigrant population and the full Canadian population, it appears that earnings mobility at the bottom of the earnings distribution is more prevalent among immigrants, while there is more earnings mobility at the top of the earnings distribution among the full Canadian population. At the same time, while immigrants' earnings mobility reduces gradually from Decile 1 to Decile 10, the full Canadian population's earning mobility is more concentrated in the middle of the stationary earnings distribution. In particular, the rank correlations among the immigrant population are lower for Decile 1 to Decile 5 but higher for Decile 6 to Decile 10.

Table 3.7: Average earnings and long-run annuity ratios across groups

	Base year average earnings	Average long-run annuity
Economics Class	59,200	62,100
Refugees	39,900	42,700
Average earnings/annuity ratio	1.48	1.45
University graduates	60,700	63,500
High-school graduates	40,000	42,500
Average earnings/annuity ratio	1.52	1.49
Time in Canada of more than 15 years	54,900	54,200
Time in Canada of less than 5 years	41,700	51,700
Average earnings/annuity ratio	1.32	1.05

is approximately 50 percent higher than an average Refugee with earnings of $39,900. The average earnings ratio based on education level is a little higher, 1.52, with the university graduates' average earnings of $60,700 and the high school graduates' average earnings of $40,000. Regarding the ratio between groups with different Canadian experience, the data show that, in 2011, immigrants who stay more than 15 years earn on average $54,900 a year while those with fewer than 5 years of Canadian experience since landing have average annual earnings of only $41,700, resulting in the ratio between the two groups of 1.32. In the long run, all earnings ratios decline implying inequality reduction or earnings equalization over time. However, the reduction is relatively small when considering the earnings ratios across immigration categories and education levels, suggesting that these differences remain in the long run.

The earnings ratio does reduce significantly for immigrants with different years of Canadian experience after landing in the long run. The average earnings ratio of those who landed in Canada for more than 15 years and those who landed in Canada for less than 5 years in 2011 is 1.32, while the long-run annuity ratio of these two groups is 1.05. This result highlights that as time goes by, recent immigrants accumulate more years of experience in Canada. Therefore, their annual earnings increase in the long run ($41,700 to $51,700). Meanwhile, the average long-run annuity of the former group is almost the same as the average earnings in the base year. Consequently, in the long run, the earnings of the less Canadian experience group become more comparable with those of the more Canadian experience group.

Long-run Inequality and Equalization Ratio

To calculate the long-run earnings inequality and the equalization ratio, I simulate the future earnings stream of all immigrants who are present in the sample in 2011 and calculate annuity values based on their remaining working lives. In doing so, I first calculate the 90/10 earnings ratio in 2011 and then compare it with the 90/10 ratio of long-run annuities calculated from the simulated future earnings stream using the model parameters. The equalization ratio is the ratio of the long-run and current 90/10 ratios. The simulation results in the full mobility case as well as in all counterfactual scenarios under the homogeneous model, fixed effect model, and dynamic model are presented in Table 3.8.

As shown in row 1 of Table 3.8, in the base year of 2011, the earnings at 10^{th} and 90^{th}

Table 3.8: Comparison of 90/10 ratios of base-year earnings and long-run annuity values under different mobility assumptions

		10^{th} percentile	90^{th} percentile	90/10 ratio	Equalization ratio
	Base year	13,400	100,600	7.51	-
1. Full mobility	Homogeneous model	21,400	100,000	4.68	0.62
	Fixed effect model	14,600	96,500	6.61	0.88
	Dynamic model	20,600	101,300	4.92	0.66
2. Positive earnings mobility only	Homogeneous model	26,800	134,300	5.01	0.67
	Fixed effect model	19,000	118,100	6.21	0.83
	Dynamic model	23,400	130,900	5.60	0.75
3. Negative earnings mobility only	Homogeneous model	12,200	82,900	6.81	0.91
	Fixed effect model	11,800	85,100	7.23	0.96
	Dynamic model	12,300	86,000	6.99	0.93
4. Earnings mobility only	Homogeneous model	21,000	102,000	4.86	0.65
	Fixed effect model	15,700	99,900	6.38	0.85
	Dynamic model	18,900	103,000	5.44	0.72
5. Employment risk only	Homogeneous model	15,600	107,900	6.92	0.92
	Fixed effect model	13,000	97,400	7.48	0.99
	Dynamic model	15,800	108,900	6.89	0.92

percentiles are $13,400 and $100,600, respectively, resulting in a high 90/10 earnings ratio of 7.51 among the full sample of working-age male immigrants.[21] Under full employment mobility, using the homogeneous model, I find that in the long run, the 90/10 ratio is 4.68, which implies an equalization ratio of 0.62 or a reduction of 38 percent. Further, I find that the 10^{th} percentile long-run annuity, $21,400, is approximately 1.6 times the earnings in the base year, $13,400. Despite a dramatic increase in value at the bottom of the earnings distribution from the short run to the long run, earnings almost remain unchanged at the top percentiles with an annuity value of $100,000. The result indicates a high degree of upward mobility at the bottom of the earnings distribution and earnings rigidity at the top of the earnings distribution. Consequently, the reduction in inequality is mainly attributable to unemployed individuals moving out of unemployment or individuals at the bottom of the earnings distribution transitioning to higher earnings deciles.

Compared to the homogeneous model, the fixed effect model generates higher long-run inequality. In particular, my findings indicate that the 90/10 ratio of long-run annuities predicted by the fixed effect model is 6.61, which implies a higher equalization ratio of 0.88 or a lower earnings inequality reduction of 12 percent. Also, in the fixed effect model, the predicted annuity value at the 10^{th} percentile, $14,600, is much less than the corresponding predicted value from the homogeneous model, $21,400. This is because, compared to the homogeneous model, the fixed effect model predicts more persistence in earnings over time and produces less mobility in individual ranks within the stationary earnings distribution.

Meanwhile, using a dynamic model yields a 90/10 ratio of 4.92 and an equalization ratio of 0.66, which are values in between the ratios predicted by the homogeneous and the fixed effect models. The predicted annuity value at the 10^{th} percentile is slightly lower in the dynamic

[21] To calculate the current earnings inequality, I use T4 earnings for the employed immigrants and T4 earnings plus employment insurance benefits for the unemployed immigrants.

model than in the homogeneous model, whereas at the 90^{th} percentile, the predicted annuity from the dynamic model is slightly higher. According to Bowlus and Robin (2012), the true value of the equalization ratio may lie between the ratios reported by the homogeneous model and fixed effect model, so the equalization ratio predicted by the dynamic model is likely a good candidate.

3.4.4 Counterfactual and Sensitivity Analysis

To investigate the contribution of employment mobility and earnings mobility to long-run inequality, I run different simulations which separately allow for employment mobility only and earnings mobility only. Below I discuss the results of the dynamic model. Similar patterns of results are observed for the homogeneous model and the fixed effect model with the exception that the homogeneous model always produces the lowest 90/10 ratios while the fixed effect model always produces the highest 90/10 ratios.

As can be seen from row 5 in Table 3.8, when there is only employment risk and no earnings mobility, the long-run 90/10 ratio is 6.89, or equivalently, the equalization ratio is only 0.92. At the same time, when there is earnings mobility and no employment risk, the long-run 90/10 ratio and equalization ratio in row 4 are 5.44 and 0.72, respectively. These counterfactual findings show that between earnings mobility and employment risk, the former plays a more important role in reducing earnings inequality in the long run. Particularly, as illustrated in row 5, when only employment risk is allowed, earnings increase proportionally at both top and bottom percentiles from \$13,400 and \$100,600 in the base year to \$15,800 and \$108,900 in the long run, respectively. At the same time, as in row 4, when only earnings mobility is allowed, earnings increase by 1.41 times at the 10^{th} percentile from \$13,400 in the base year to \$18,900 in the long run, whereas there is only a slight change in earnings at the 90^{th} percentile from \$100,600 in 2011 to \$103,000, respectively. As a result, there is a lower reduction in earnings inequality in the long run in the case when there is employment risk only than in the case when there is earnings mobility only or when there is full mobility.

I also run two other simulations which allow for only positive earnings mobility (row 2) and only negative earnings mobility (row 3) with no employment risk. In the presence of negative earnings mobility only, the earnings decrease at the 10^{th} decile in the long run is relatively small, from \$13,400 in the base year to \$12,300 in the long run. However, as earnings at the 90^{th} decile decrease at a faster pace, the 90/10 earnings ratio in the long run is 6.99 resulting in the equalization ratio of 0.93. Meanwhile, when there is only positive earnings mobility, the rate of increase at the 10^{th} decile is much faster than the rate at the 90^{th} percentile, resulting in a large reduction of inequality from 7.51 in the base year to 5.60 in the long run.

For sensitivity analysis, I also simulate unemployment earnings using a replacement rate. In particular, for those who are drawn to be unemployed and receive unemployment benefits, I give them the unemployment earnings of 55 percent of the earnings in the previous period. These unemployment earnings are capped at \$24,310, which is 55 percent of the maximum insurable income in Canada in 2011. The simulations yield a similar pattern of results as before with the 90/10 ratios being slightly larger when the replacement rate is employed in calculating unemployment benefits. This is because when estimating the unemployment earnings regression, both employment insurance benefits and T4 earnings are combined, whereas when using the replacement rate, unemployment earnings comprise only employment insurance benefits.

Table 3.9: Changes in long-run earnings inequality and equalization ratio over time

		10^{th} percentile	90^{th} percentile	90/10 ratio	Equalization ratio
	Base year	12,000	92,000	7.70	-
5 years	Homogeneous model	19,000	97,000	5.13	0.67
	Fixed effect model	15,000	95,000	6.33	0.82
	Dynamic model	17,000	96,000	5.64	0.73
10 years	Homogeneous model	22,000	100,000	4.61	0.60
	Fixed effect model	16,000	96,000	6.10	0.79
	Dynamic model	19,000	98,000	5.27	0.68
15 years	Homogeneous model	23,000	101,000	4.31	0.56
	Fixed effect model	16,000	96,000	5.99	0.78
	Dynamic model	20,000	99,000	5.05	0.66
20 years	Homogeneous model	25,000	100,000	4.07	0.53
	Fixed effect model	16,000	95,000	5.89	0.76
	Dynamic model	21,000	100,000	4.82	0.63

The detailed results of these simulations are reported in Table A.2 of the Appendix.

3.4.5 Inequality Reduction Over Time

In the simulation exercise, I simulate the earnings of all individuals in the base year until they reach the age of 58. This exercise allows for the study of how inequality changes in the long run for the full sample. To study how it changes for a cohort over time, I repeat the exercise by simulating the earnings over 5 years, 10 years, 15 years, and 20 years separately using the sample of people who were less or equal 38 years old and therefore have at least 20 years until they reach the age of 58.

As shown in row 1 of Table 3.9, the 90/10 ratio, or current earnings inequality, in the base year is 7.7 for this sample. Using the dynamic model, I find that the 90/10 ratios of earnings after 5, 10, 15, and 20 years are 5.64, 5.27, 5.05, and 4.82, respectively. As a result, the equalization ratios over the corresponding time periods are 0.73, 0.68, 0.66, and 0.63, respectively. Across all model specifications, the homogeneous model always provides the lowest equalization ratios, next the dynamic model and last the fixed effect model. Specifically, after five years, the equalization ratios produced by the homogeneous model, dynamic model, and fixed effect model are 0.67, 0.73, and 0.82, respectively, indicating an inequality reduction of 33, 27, and 18 percent over a 5-year period, respectively. After 20 years, while the homogeneous model predicts a reduction in earnings inequality of 47 percent, the dynamic model predicts 37 percent, and the fixed effect model predicts only 24 percent.[22] These results clearly indicate that most earnings equalization happens in the first 5 years, slows down within 10 to 15 years, and then remains almost the same after 15 years.

[22]Similar simulation results over time using the replacement rate are reported in Table A.3 of the Appendix.

3.4.6 Earnings Inequality Across Immigration Categories

To study how employment mobility and long-run earnings inequality vary across immigration categories, I run the analysis separately for each category. Then, I compare and contrast the mobility patterns across categories as well as their implications for long-run earnings inequality within each group. All results presented are from the dynamic model.[23]

Table 3.10 demonstrates the average transition matrix of earnings residuals across deciles for each immigration category. As with the full sample, for each category, I sum up the values on the diagonal of the transition matrix, the values above the diagonal, and the values below the diagonal of each matrix to compare their probabilities of staying in the same deciles, moving upward, and moving downward in the stationary earnings distribution. Among the three categories, the Economic Class is the least mobile class with the highest probability of staying in the same deciles and the lowest probability of moving either upward or downward across the distribution of earnings residuals. Meanwhile, the Refugees have the highest level of mobility. They are more likely to move across deciles including moving out of the current deciles in both upward and downward directions. Also, by summing up the first column of the transition matrix, I calculate the probability of transitioning into unemployment in each category and find that the employment risk is highest for the Refugees and lowest for the Family Class. Looking closely at the transition probabilities at the top deciles, Deciles 8 to Decile 10, I find that earnings are very rigid at the top of the stationary earnings distribution, especially for the Economic Class.

To study the overall transitions of earnings across earnings deciles, I examine how the Spearman's rank correlations between Period 1 earnings and Period 2 earnings conditional on Period 1 earnings decile differ across immigration categories. As can be seen from Table 3.11, at the bottom deciles, the Economic Class immigrants have the lowest rank correlation, 0.25 versus 0.31 and 0.29, or equivalently, the highest earnings mobility among the three categories. However, at the top deciles, their rank correlation is the highest at 0.73 versus 0.63 and 0.72, which implies the lowest mobility level for high-paid Economic Class immigrants. Meanwhile, the Refugees tend to be more mobile across the whole earnings distribution. Compared to the Economic Class, the Refugees' top earners are more likely to move out of the top of the earnings distribution resulting in their lower rank correlations than the other two groups. As a result, mobility among the Refugees comes from both directions with low-paid refugees climbing up the earnings ladder and high-paid refugees coming down from top deciles, making this class the most mobile one. For the Family Class, earnings mobility at the bottom deciles is similar to that of the Refugees, while earnings mobility at the top deciles is close to that of the Economic Class. Overall, the earnings mobility level of the Family Class is less than the Refugees but more than the Economic Class.

The effects of employment risk and earnings mobility on long-run earnings inequality across immigration categories are demonstrated by the long-run annuities, 90/10 ratios, and the equalization ratios in Table 3.12. Several important results stand out. First, in the base year, the current inequality value is highest for the Refugees at 7.78, followed by that for the Economic Class and Family Class at 7.27 and 6.42, respectively. The Economic Class has the highest earnings values at both the 10^{th} and 90^{th} percentiles. Particularly, the 90^{th} percentile earnings of the Economic Class is $111,300, which is much higher than that of the Family Class

[23] Corresponding results from other models are available upon request.

Table 3.10: Average transition matrix of earnings residuals by immigration category

Economic Class											
Decile	0	1	2	3	4	5	6	7	8	9	10
0	0.45	0.2	0.1	0.06	0.04	0.03	0.03	0.02	0.02	0.02	0.02
1	0.27	0.31	0.14	0.08	0.05	0.04	0.03	0.02	0.02	0.02	0.02
2	0.16	0.15	0.28	0.14	0.08	0.05	0.04	0.03	0.03	0.02	0.02
3	0.11	0.08	0.13	0.3	0.14	0.08	0.05	0.04	0.03	0.02	0.02
4	0.08	0.05	0.06	0.13	0.31	0.16	0.08	0.05	0.03	0.03	0.02
5	0.06	0.04	0.04	0.05	0.14	0.33	0.17	0.08	0.05	0.03	0.03
6	0.04	0.03	0.03	0.03	0.05	0.15	0.35	0.18	0.08	0.04	0.03
7	0.03	0.02	0.02	0.02	0.03	0.05	0.15	0.37	0.19	0.07	0.03
8	0.02	0.01	0.01	0.01	0.02	0.03	0.05	0.16	0.42	0.2	0.06
9	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.05	0.16	0.48	0.2
10	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.04	0.17	0.67
Refugees											
Decile	0	1	2	3	4	5	6	7	8	9	10
0	0.43	0.19	0.11	0.07	0.05	0.04	0.03	0.03	0.03	0.02	0.01
1	0.27	0.27	0.13	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.02
2	0.19	0.14	0.23	0.12	0.08	0.07	0.05	0.04	0.04	0.03	0.01
3	0.14	0.09	0.13	0.24	0.12	0.08	0.06	0.05	0.04	0.03	0.02
4	0.11	0.06	0.07	0.13	0.26	0.13	0.08	0.07	0.04	0.03	0.02
5	0.08	0.04	0.05	0.06	0.14	0.28	0.15	0.08	0.06	0.04	0.03
6	0.06	0.03	0.03	0.04	0.06	0.15	0.3	0.16	0.08	0.05	0.03
7	0.04	0.02	0.03	0.03	0.03	0.06	0.17	0.33	0.18	0.08	0.04
8	0.03	0.01	0.02	0.02	0.02	0.03	0.06	0.17	0.37	0.19	0.06
9	0.02	0.01	0.01	0.01	0.02	0.02	0.03	0.06	0.18	0.45	0.19
10	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.05	0.19	0.64
Family Class											
Decile	0	1	2	3	4	5	6	7	8	9	10
0	0.4	0.21	0.11	0.07	0.05	0.04	0.03	0.03	0.02	0.02	0.01
1	0.25	0.29	0.15	0.09	0.06	0.05	0.04	0.03	0.02	0.02	0.01
2	0.15	0.15	0.26	0.14	0.08	0.06	0.05	0.03	0.03	0.02	0.02
3	0.11	0.09	0.14	0.27	0.13	0.08	0.06	0.04	0.04	0.03	0.02
4	0.08	0.06	0.07	0.13	0.28	0.15	0.08	0.06	0.04	0.03	0.02
5	0.06	0.04	0.05	0.06	0.15	0.29	0.16	0.08	0.05	0.04	0.03
6	0.05	0.03	0.03	0.04	0.06	0.15	0.31	0.17	0.08	0.05	0.03
7	0.03	0.02	0.02	0.03	0.04	0.06	0.16	0.32	0.19	0.09	0.03
8	0.02	0.02	0.02	0.02	0.02	0.04	0.06	0.17	0.37	0.21	0.07
9	0.02	0.01	0.01	0.01	0.02	0.02	0.03	0.06	0.17	0.45	0.21
10	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.05	0.18	0.67

Table 3.11: Spearman's rank correlation between Period 1 earnings and Period 2 earnings conditional on Period 1 earnings deciles by immigration category

Deciles		Economic Class	Refugees	Family Class
1	Detrended data	0.25	0.31	0.29
	Dynamic model	0.23	0.31	0.28
2	Detrended data	0.29	0.32	0.34
	Dynamic model	0.29	0.33	0.34
3	Detrended data	0.31	0.33	0.34
	Dynamic model	0.28	0.32	0.33
4	Detrended data	0.31	0.34	0.34
	Dynamic model	0.27	0.32	0.31
5	Detrended data	0.32	0.34	0.35
	Dynamic model	0.27	0.31	0.3
6	Detrended data	0.36	0.36	0.37
	Dynamic model	0.31	0.32	0.33
7	Detrended data	0.4	0.41	0.41
	Dynamic model	0.35	0.37	0.36
8	Detrended data	0.47	0.43	0.45
	Dynamic model	0.39	0.38	0.38
9	Detrended data	0.55	0.48	0.51
	Dynamic model	0.47	0.43	0.43
10	Detrended data	0.73	0.63	0.72
	Dynamic model	0.67	0.55	0.64

Table 3.12: Long-run earnings annuities and earnings equalization ratios under full mobility assumption and by immigration category

		10^{th} percentile	90^{th} percentile	90/10 ratio	Equalization ratio
Economic Class	Base year	15,300	111,300	7.27	-
	Full mobility	23,000	112,200	4.88	0.64
	Positive earnings mobility only	26,600	144,600	5.44	0.71
	Negative earnings mobility only	14,400	95,200	6.61	0.87
	Earnings mobility only	21,500	114,000	5.3	0.7
	Employment risk only	17,600	120,500	6.85	0.9
Refugees	Base year	9,600	74,700	7.78	-
	Full mobility	16,600	74,600	4.49	0.48
	Positive earnings mobility only	15,300	94,100	6.15	0.66
	Negative earnings mobility only	8,500	64,900	7.64	0.82
	Earnings mobility only	12,900	75,700	5.87	0.63
	Employment risk only	12,200	81,400	6.67	0.71
Family Class	Base year	13,000	83,400	6.42	-
	Full mobility	19,700	83,100	4.22	0.61
	Positive earnings mobility only	22,900	108,100	4.72	0.68
	Negative earnings mobility only	11,600	70,200	6.05	0.87
	Earnings mobility only	18,300	84,500	4.62	0.66
	Employment risk only	15,100	91,000	6.03	0.87

and the Refugees at $83,400 and $74,700, respectively. Second, in the long run, under the full mobility assumption, the earnings equalization ratio of the Economic Class, Family Class, and the Refugees are 0.64, 0.61, and 0.48, respectively. These results indicate that, among the three groups, the Refugees have the largest earnings inequality reduction and the highest employment mobility in the long run. Third, while there is only a slight change in earnings at the 90^{th} percentile, there is a large improvement in earnings at the 10^{th} percentile for all three groups. As a result, the reduction in earnings inequality in the long run is mainly contributed by an earnings increase at the bottom of the earnings distribution. For example, at the 90^{th} percentile, earnings remain almost the same in the long run for the Refugees, $74,600 versus $74,700. At the same time, at the 10^{th} percentile, earnings increase from $9,600 to $16,600, resulting in an earnings inequality reduction from 7.78 in the base year to 4.49 in the long run. As the rate of earnings increase at the 10^{th} percentile is highest for the Refugees, this class has the largest earnings inequality reduction. Meanwhile, as the rates of change in earnings at the top decile and bottom deciles are similar for Economic Class and Family Class, equalization ratios for the two categories are almost the same.

Finally, I study the rate of earnings inequality reduction over time across immigration categories for those who were less than 38 years old in the base year. As can be seen from Table 3.13, compared to the full sample, the youngest cohort in all three categories has lower current earnings inequality. After five years, earnings inequality reduces significantly for all three categories. The reduction is notably highest for the Refugees at 49 percent and is 24 percent

Table 3.13: Changes in long-run earnings inequality and equalization ratio over time by immigration category

		10^{th} percentile	90^{th} percentile	90/10 ratio	Equalization ratio
Economic Class	Base year	15,900	102,800	6.47	-
	5 years	21,000	106,700	5.08	0.76
	10 years	22,700	109,100	4.81	0.72
	15 years	24,000	110,800	4.62	0.69
	20 years	25,200	112,300	4.46	0.67
Refugees	Base year	7,300	62,100	8.51	-
	5 years	11,800	63,500	5.38	0.51
	10 years	13,200	64,100	4.86	0.46
	15 years	14,400	64,400	4.47	0.42
	20 years	15,300	64,700	4.23	0.4
Family Class	Base year	12,000	74,000	6.17	-
	5 years	15,200	76,400	5.03	0.76
	10 years	16,700	77,700	4.65	0.7
	15 years	17,700	78,900	4.46	0.67
	20 years	18,800	79,800	4.24	0.64

for the Economic Class and Family Class. In the following 15 years, the rate of reduction is slower, and after 20 years, the earnings inequality reduction is 60 percent for the Refugees and about 35 percent for the Economic Class and Family Class. Overall, the Refugees see the fastest earnings inequality reduction, while the other two categories have the same rates.

To sum up, among the three categories, the Refugees have the largest earnings inequality reduction in the long run thanks to the high level of mobility across all earnings deciles including the top and the bottom of the earnings distribution. Meanwhile, the Economic Class seems to be divided into two groups. The first group includes those who landed at the top of the distribution and hardly move out of these top deciles and therefore do not contribute much to the mobility of this class. Examples of these Economic Class immigrants include professionals such as university professors, lawyers, and doctors. The second group includes Economic Class immigrants who may come to Canada without a job, and this group does provide a lot of mobility. Immigrants in this group do not necessarily find work right away after landing in Canada and may even cycle in and out of unemployment until they start moving up the earnings distribution. Finally, there are Family Class immigrants who appear to have more mobility than Economic Class immigrants but less than the Refugees. In addition, they tend to have low employment risk, or more secure jobs, than the other two categories.

3.5 Conclusion

In this paper, I study employment risk, earnings mobility, and long-run earnings inequality among Canadian male working-age immigrants using a short panel by applying the methodology of Bowlus and Robin (2012) to the IMDB. My research differs from the previous papers in the literature because it is the first paper to study employment mobility and long-run earnings inequality among immigrants. I also depart from the original methodology by using a dynamic model of transitions which includes a lagged decile, data on employment insurance benefits, and other administrative data on immigrants to simulate the future earnings streams of the immigrants more precisely.

The results from the dynamic model show that, although current inequality among the immigrants in the base year is high, there is a substantial reduction of inequality in the long run, from a 90/10 ratio of 7.51 to 4.92. This is equivalent to an equalization ratio of 0.66, or a reduction of inequality by 34 percent. Between employment risk and earnings mobility, the latter has a significant contribution to earnings equalization over time. In particular, if I allow for employment risk only, I find that the long-run 90/10 ratio reduces to 6.92. Meanwhile, if there were only earnings mobility, the 90/10 ratio falls to 5.44 in the long run. To study how fast the equalization occurs over time, I conduct the earnings simulation for 5, 10, 15, and 20 years for the youngest cohort. Equalization ratios for the four scenarios are 0.73, 0.68, 0.66, and 0.63, respectively. The results indicate that most of the equalization happens in the first 5 years, with equalization continuing over the next 15 years at a slower rate.

Employment mobility also varies across immigration categories. Particularly, the Refugees are the most mobile category with a lot of transitions in and out of employment as well as movement across deciles in both directions, from high deciles to low deciles and vice versa. Although the overall mobility level of the Family Class immigrants is slightly higher than that of the Economic Class immigrants, the two classes have similar mobility patterns with more mobility at the bottom deciles and much less mobility at the top deciles. As a result, earnings inequality reduction is mainly associated with the employment mobility of low-paid immigrants.

This paper provides the first analysis that use the short panel method to study employment mobility among immigrants in general and among Canadian immigrants in particular. Findings from the paper suggest a high level of employment mobility among immigrants with a significant reduction in earnings inequality. The results indicate high current earnings inequality among the immigrant population is not persistent, and therefore, it may not be a matter of concern. However, as employment risks and earnings mobility mainly occur at the bottom of the earnings distribution with much less mobility observed at the top of the earnings distribution, the results suggest that policies should be aimed at helping immigrants remain employed after finding a job and enhance upward earnings mobility for low-paid immigrants. These policies could vary from general and specific job training, language training, to more regulations and incentives for employers to encourage them to recruit and retain immigrant workers.

In Bowlus and Robin (2012), the authors find that, for the full Canadian population, the equalization ratio is 0.66, and it appears that earnings mobility is more prevalent across the whole stationary earnings distribution including the top deciles. However, these results are not directly comparable to the results from this paper because while Bowlus and Robin (2012) simulate lifetime earnings streams of individuals who are employed in the base year of 2008,

I simulate long-run earnings streams over the remaining working lifetime of all individuals in the base year of 2011. Also, they use replacement rates to simulate the earnings of unemployed workers, whereas I use data on employment insurance benefits and earnings while being unemployed to do so. Thus, to provide an understanding of the differences in employment mobility between the immigrant and native populations as well as their contribution to the overall long-run earnings inequality in Canada, my future work will be to study the earnings dynamics of the immigrant and the native populations using the same data and time frame.

Chapter 4

The Effects of Economic Conditions and Immigration Policy Changes on International Ph.D. Students in Canada

4.1 Introduction

In recent years, Canada has witnessed a significant increase in the number of international students. According to data from Immigration, Refugees and Citizenship Canada (IRCC), the number of study permit holders accelerated from 122,660 in 2000 to 638,960 in 2019.[1] In 2021, Canada welcomed an all-time record of 445,775 new international students, increasing the total number of international students to 621,600 in the same year.[2] International students accounted for a majority, if not all, of the growth in post-secondary enrolments in the recent years. From 2018/2019 to 2019/2020, Canadian colleges and universities saw an increase of 13.7% in enrolments of international students, while there was a decline in enrolments of Canadian students by 0.9%.[3] International students not only create a substantial economic impact on the Canadian economy during their study period but also are viewed as ideal candidates for temporary skilled worker permits and permanent immigration because of their relatively young ages, proficiency in English and/or French, Canadian education credentials, and Canadian work experience.[4] In addition, they are familiar with the culture and have social networks in Canada which can help them successfully integrate into the Canadian labour market. Simultaneously, international students can help address the Canadian labour market's needs, particularly the need for skilled workers.[5] Therefore, attracting international students and facilitating their

[1] IRCC data - Table: Canada, Study permit holders with a valid permit on December 31st, 2000-2020

[2] IRCC data - Table: Study permit holders by province/territory of intended destination, study level, and year in which permit(s) became effective, January 2015 – March 2022

[3] https://www150.statcan.gc.ca/n1/daily-quotidien/211124/dq211124d-eng.

[4] A report by Canmac Economics Limited (2020) estimates that international students in Canada spent $18.4 billion and $22.3 billion on tuition, accommodation and discretionary spending in 2017 and 2018, respectively. This is an equivalent of $16.2 billion and $19.7 billion contribution to the country's GDP in the corresponding periods. The presence of international students also helps to sustain approximately 170,000 jobs for Canadians in 2016.

[5] Five among ten first-time study permit holders who studied at a graduate level become landed immigrants within 10 years Choi et al. (2021). Also, the annual number of new Post-Graduation Work Permits (PGWP)

work opportunities and transition to permanent resident (PR) status are considered important goals for the government of Canada's immigration system.

Like domestic students, international students may face adverse economic conditions during their studies and at graduation. Under this circumstance, they may have several options. They may choose to finish their studies earlier to return to their home countries or move to another country, delay graduation, or participate in the labour market with unfavourable conditions. Simultaneously, the host country's immigration policies also factor into international students' decisions of whether to remain in Canada and affect their probability of getting PR status and greater access to the labour market at the end of their studies. Despite the importance of international students to the Canadian economy and to the potential immigration pool, little is known about the effects of economic conditions and immigration policies on these students, which is mainly due to the lack of proper data.

In this study, I take advantage of the Longitudinal Immigration Database (IMDB), a unique data on non-PRs in Canada including international students, to address the following question: How do economic conditions and changes in immigration policies affect the study duration, the probability of getting PR during their studies, and the temporary retention of international Ph.D. students in Canada? Particularly, I use time-varying duration analysis to study the length of their study period under changing economic conditions and immigration policies. Then, I use logistic regressions to examine how economic conditions and immigration policy changes affect the probability of getting PR while studying and the probability of remaining in Canada in the year following the end of their study period. The answer to this question provides an understanding of how international students are impacted by business cycles and immigration policy changes. It also illustrates whether the government can retain international students as potential high-skilled foreign workers and economic immigrants using its means of immigration policies. My main contribution in this paper is twofold. First, to my knowledge, this is the first paper that sheds light on the effects of these changes on international Ph.D. students with regard to their study duration, the probability of getting PR while studying, and the retention likelihood in the year following the study period. Second, I provide a summary of changes in economic conditions and immigration policies that affected international students in Canada from 1988 to 2018.

Although many studies have emphasized the economic impacts of international students on the host economies (e.g., Peri et al., 2020; Canmac Economics Limited, 2020), there are almost no studies that investigate the effects of economic conditions or business cycles on international students. So far, the literature has mainly focused on how changes in macroeconomic conditions affect domestic students. Under adverse labour market conditions, domestic students may respond by either anticipating or delaying graduation or reallocating to a different local labor

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also increased significantly in the 10-year period from 10,300 in 2008 to 64,700 in 2018. 16% of international students with study permits that expired in 2008 had obtained a PGWP one year after the expiration of their study permits compared to 43% in 2017. Five years after the study permits expired, the 2013-graduate cohorts had a lower rate of obtaining PGWP compared to the 2008 cohort, with the PGWP rates of 52% and 29%, respectively (Crossman, Lu, and Hou, 2022). Crossman et al. (2022a) find that over the 2000-2019 period, the proportion of new economic principal applicant immigrants with Canadian education increased from 6% to 38%. They also observe that immigrants with Canadian study experience tend to be younger, more educated, speak one of the official languages, and are much more likely to have pre-admission earnings in Canada than other immigrants without Canadian education.

market (Von Wachter, 2020). In general, many studies suggest that fresh graduates experience long-lasting negative effects on labour market outcomes if they enter the labour market during economic downturns. Indeed, even temporary adverse initial labour market conditions can have substantial long-term effects on earnings (e.g. Schwandt and Von Wachter, 2019; Altonji et al., 2016; Oreopoulos et al., 2012; Kahn, 2010; Genda et al., 2010; Oyer, 2006, 2008). For example, Schwandt and Von Wachter (2019) find that graduating during a recession leads to large initial earnings losses. In addition, Kahn (2010) shows that, in the U.S., earnings reductions last up to 15 years for college graduates entering the labour market during the deep recession in the early 1980s. Over the past 40 years, the Canadian economy has experienced three large recessions: 1981-1982, 1990-1992, and the Great Recession in 2008-2009 (Cross and Bergevin, 2012). Oreopoulos et al. (2012) find that those graduating during recessions in Canada suffer persistent earnings declines lasting ten years and only partially recover through a gradual process of mobility toward better firms. Frenette et al. (2020) also find a similar result such that due to the COVID-19 economic downturn, high school and post-secondary graduates could face long-term earnings declines.

Changes in economic conditions also affect domestic students with respect to their enrolment, college major choice, and study effort. The literature has shown that during economic recessions, enrolment in higher education tends to increase (see e.g., Charles et al., 2018; Méndez and Sepúlveda, 2012; Clark, 2011). Students starting college in economic downturns tend to graduate with better grades and earn higher wages conditional on their grades (Bičáková et al., 2021). Their better outcomes result from the extra efforts they made during their study (Bičáková et al., 2021; Blom et al., 2021). Also, according to Blom et al. (2021), changes in economic conditions affect students' choice of major toward ones with high earnings and better employment prospects. In addition, Beiler (2017) finds that the probability of college graduates engaging in entrepreneurship is higher during good economic conditions than during a recession. While the impact of economic conditions on domestic graduates has long been studied, their effects on international students, not only in Canada but also in other countries, remain unknown. This gap in the literature is mainly due to the lack of data on international students with regard to their study history and labour market outcomes over a long period of time.

Besides economic conditions, the previous literature has shown that immigration policies at the time of graduation may also play an important role in determining the choices and economic outcomes of international students. Morris-Lange (2015) show that between 50 to 80 percent of international students in Canada, Germany, the Netherlands, and Sweden plan to gain work experience in the host country after graduation. However, tight visa restrictions and a lack of knowledge about the host country's labour market are often barriers for them to do so. By introducing favourable immigration policies towards international students, host countries can help encourage the retention of international students. In Canada, the number of Post-Graduation Work Permit (PGWP) holders has dramatically increased from 5,400 in 2005 to over 143,000 in 2018. Since the introduction of PGWP, the number of international students in Canada has tripled over the last decade to just over 572,000 in 2018.[6] However, in Canada, as well as in other countries, there has been no extensive study on international students' re-

[6]https://www.cicnews.com/2019/12/canadas-post-graduation-work-permit-program-is-booming-1213209.html#gs.5swaq8

sponses to policy changes with regards to their study duration, time to PR, and retention after graduation.

In Canada, international students are viewed as a crucial source of high-skilled labour supply and a pool of potential Economic Class immigrants. A series of research studies conducted jointly by IRCC and Statistics Canada has examined international students in their role as a source of labour for the Canadian labour market. These articles focus on recent trends in the number and characteristics of international students, their transition to PR, their labour market engagement during their study period and between graduation and becoming a PR, as well as the period after they become PRs in Canada (Choi et al., 2021;Choi, 2021; Crossman et al., 2021a; Crossman et al., 2021b; Crossman and Hou, 2022;Crossman et al., 2022b). A study by Lu and Hou (2015) indicates that approximately 20 to 27 percent of international students became PR within 10 years from the effective date of their first study permit and almost 50 percent of immigrants first coming to Canada between 2000 and 2004 as study permit holders applied as principal applicants for PR in the Economic Class.

So far, there have not been studies that focus on the effect of economic conditions and recessions on international students and Ph.D. students in particular. Also, the literature on international students mainly addresses why they decide to migrate to a host country and to remain in the host country after graduation, and their economic outcomes as temporary and permanent residents, while little is known about their study duration, the probability of getting PR while studying, and their retention in the host country under varying economic conditions and immigration policy changes.

Thanks to the availability of a long panel dataset on non-PRs in Canada that includes international students, I can fill the gaps in the literature by examining the impacts of both economic conditions and immigration policy changes on international students in Canada. Specifically, in this study, I use the unique Canadian Longitudinal Immigration Database (IMDB) which includes a permit history of all non-PRs in Canada from 1982 to 2017, tax data of those who filed tax returns in the corresponding period, and records of those who became PR. To construct the study duration, I use information from the study permit history of all international students and from annual education amounts in the tax data. I also utilize tax data and administrative data to examine the PR status of an individual in a particular year. Finally, in identifying whether an international student remains in Canada one year after their study period ends, I use his/her tax record presence and tax information in the year following the final year of their study. I employ time-varying duration analysis to study the effects of economic conditions and immigration policy changes on international Ph.D. students' study duration. This method allows for incorporating the changes in macroeconomic conditions and immigration policies over time. To study the probability of having PR status and staying in Canada after graduation, I use logistic regressions. Economic conditions are summarized by a recession indicator and the unemployment rate, and immigration policies are divided into work-permit policies and PR policies, which are also coded by a dummy variable in which "0" indicates less-restrictive policies.

Results from my analysis indicate that, in general, international Ph.D. students experience unfavourable outcomes during economic downturns. When the unemployment rate is high, international students tend to shorten their study period which might be due to the financial challenges and limited resources that international students face because of job shortage. Higher unemployment rates also reduce the probability of getting PR during their study period and

make it less likely for international Ph.D. students to remain in Canada after they finish their studies. My findings also indicate that Ph.D. students who study for more than four years are less likely to remain in Canada after their studies if they face a recession in the last year of studying.

Immigration policies are found to have substantial impacts on international Ph.D. students. Less restrictive PR policies result in shorter study duration. Students who experienced relaxed PR policies at arrival time are more likely to get PR during their study period, and at the time of study completion, the more open PR policies will increase the retention likelihood in the following year among international doctoral students. Less restrictive work permit policies also encourage the students to stay, but they are shown to be negatively associated with the probability of having PR status while studying among these students.

The remainder of the paper is as follows. In Section 2, I describe the economic conditions and immigration policies in Canada from 1988 to 2018. In Sections 3 and 4, I explain the data construction and methodology, respectively. Section 5 provides the analysis results, and Section 6 concludes the paper.

4.2 Economic Conditions and Immigration Policies in Canada from 1988 to 2018

Changes in economic conditions and immigration policies from 1988 to 2018 are summarized in Figure 4.1, and details of these changes are described below.

4.2.1 Economic Condition

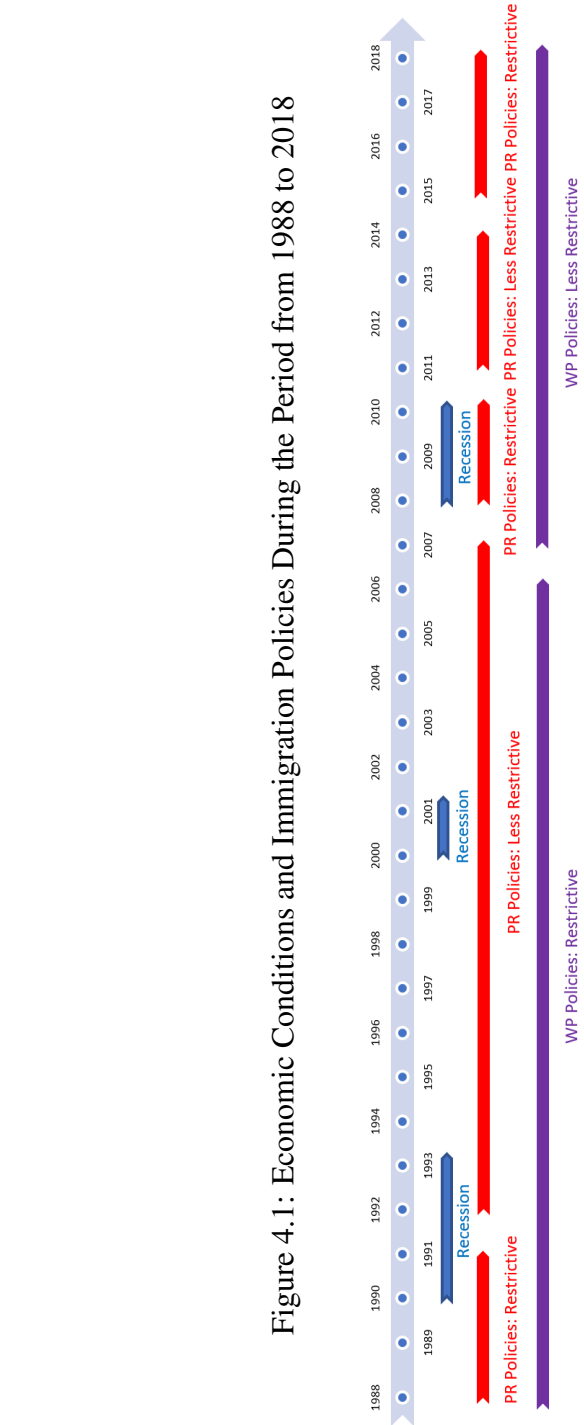
From 1988 to 2018, Canada's economy experienced two large recessions, the 1990-1992 recession and the Great Recession of 2008-2009 (Cross and Bergevin, 2012).[7] Besides these two recessions, Canada also witnessed an economic downturn in 2000-2001. As can be seen from Figure 4.2, the unemployment rate declines between the economic downturns and then increases rapidly in the recessionary years. Among the economic recessions, the early 1990s recession has the highest unemployment rates and the longest recovery period. The unemployment rate rose from 7.5 percent in 1989 to 10.3 percent in 1990 and peaked at 11.3 percent in 1993. Meanwhile, during the 2008-2009 recession, the unemployment rate did not reach the same heights and increased for a shorter period. The short downturn in 2000 had the mildest effect on unemployment when compared to the other two recessions.[8]

In the 1990-1992 recession, there was a sharp decline in manufacturing resulting in stagnant GDP growth at about 0.3 percent per quarter. Employment and monthly GDP dropped significantly in the second quarter of 1990. The economic downturn worsened when the goods and service tax (GST) was introduced in 1991 in combination with the Gulf War. From Quarter 2 of 1991, both real GDP and employment started to recover, and from the end of April 1992, monthly GDP and employment leveled off starting May 1992. In September 2008, the collapse

[7] Cross and Bergevin, 2012, p. 4 states that "the notion that a recession is defined by two or more consecutive quarterly declines in GDP has become well entrenched in popular discussions."

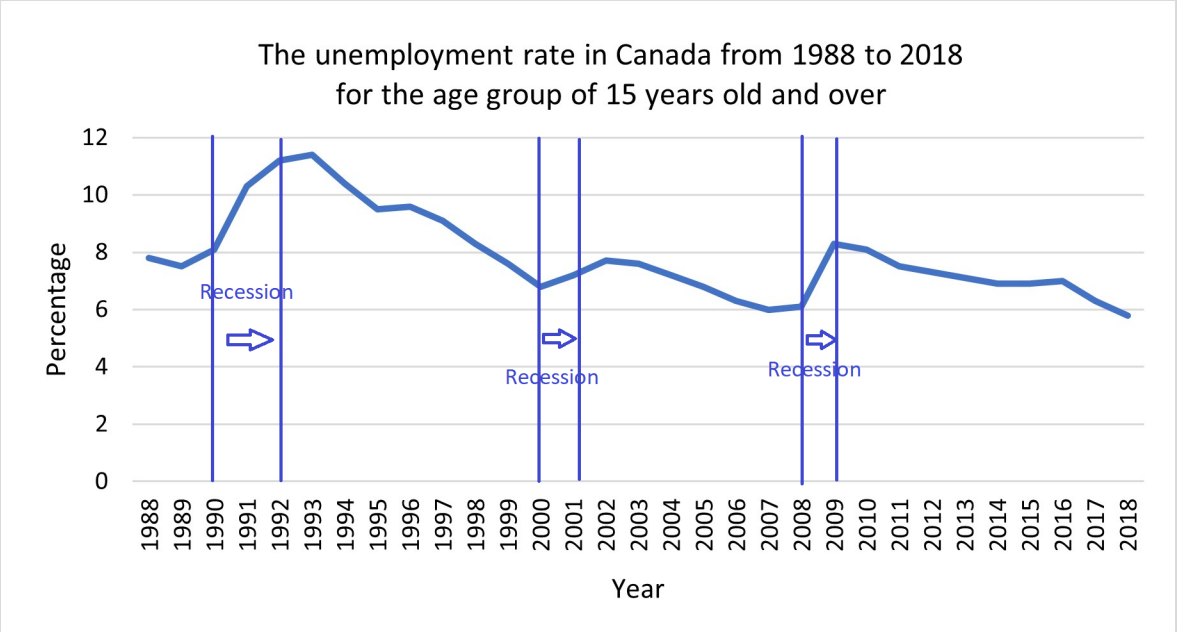
[8] Detailed unemployment rates during the 1988-2018 period are presented in Table B.1 of the Appendix.

Figure 4.1: Economic Conditions and Immigration Policies During the Period from 1988 to 2018



of the investment bank Lehman Brothers created domino effects on the financial market and consequently froze credit flows in the U.S. and in other countries subsequently. The Great Recession started in the last quarter of 2008 and lasted until May 2009 when monthly output started to recover with a slight lag in employment (Cross and Bergevin, 2012).

Figure 4.2: Unemployment rate in Canada over the period from 1988 to 2018



4.2.2 Immigration Policies

Besides economic conditions, immigration policies also play a key role in determining the choices and outcomes of international students in Canada. In this paper, immigration policies are categorized into two subgroups - work permit policies and PR policies. I include in my analysis two dummy variables that indicate whether work-permit policies and PR policies in each year are restrictive or less restrictive depending on the openness of effective policies during that year.[9] The summary of important immigration policies that are relevant to international

[9]In the previous literature, there are several approaches to constructing immigration policy indices or indicators. For example, the Migrant Integration Policy Index (MIPEX) is a tool that measures policies to integrate migrants in 56 countries across six continents. The MIPEX covers eight policy areas including labour market mobility, education, political participation, access to nationality, family reunion, health, permanent residence, and anti-discrimination. Another database that offers a comprehensive way to measure immigration policies is the Immigration Policies in Comparison (IMPIC) project. The IMPIC dataset provides information on the degree of restrictiveness of immigration policies in 33 OECD countries for the period from 1980 to 2010 (Helbling et al., 2017). Finally, there is also an ongoing project, the International Migration Law and Policy Analysis (IMPALA) project, which aims to comprehensively measure immigration law and policy for nine countries between 1999 and 2008 (Beine et al., 2016). However, these indices and measures are not suitable for the purpose of this study. First and foremost, since these measures focus on general immigration policies targeting all immigrant groups, they are not tailored for international students. Furthermore, except for the MIPEX, there are no measures that are up-to-date with recent immigration policies. Finally, some of the indices almost stay unchanged over a long period of time, making it impossible to study the effects of immigration policies across different periods.

students in recent years is provided in Table B.2 of the Appendix.

PR policies

From 1988 to 1991: Restrictive policy period Before 1986, the government cut immigration levels drastically and required non-sponsored applicants to have pre-arranged employment to obtain entry. However, in 1985, due to a declining birth rate and aging population, the government followed the Council of Immigration's recommendation to plan for immigration levels that ensure an annual one percent overall population growth increase until 2000. With the removal of the requirement to have pre-arranged employment in 1986, Canada opened its door to potential economic immigrants. In 1988, under the pressure of some lobbying groups, the government expanded the Family Class and made family immigrants a priority in the application process. In implementing this change, the government sacrificed its economic goals by admitting fewer Economic Class immigrants (Green and Green, 1995, 1999).

In 1989, a three-year Demographic Review indicated that the targeted demographic goals were not achieved through immigration policies. Consequently, from the early 1990s, more emphasis was put on increasing the inflow of economic immigrants. Potential applicants in the Economic Class were given extra points if their occupation was on the list of designated occupations, and their applications were processed on a high-priority basis (Green and Green, 1995, 1999).

In general, during this period, immigration policies were still restrictive for international Ph.D. students with regard to getting PR status or obtaining work permits after graduation. There were no specific policies that supported the students to get PR during their studies. Likewise, there were no extra points granted to those who obtained a Ph.D. at a Canadian institution. The list of limited designated occupations also created a barrier for international Ph.D. students in non-listed fields to remain in Canada.

From 1992 to 2007: Less-restrictive policy period The 1992-2007 period witnessed a couple of changes in immigration policies that aimed to boost the levels of Economic Class immigrants. In 1992, the Conservative government introduced a new Immigration Act that helped to better control the immigration flow and reduce the proportion of family immigrants in the immigrant population. From the early 1990s, due to a huge backlog of applications and difficulties in managing the selection scheme based on the list of designated occupations, the government turned away from addressing specific occupational shortages. Instead, it focused on a human capital selection model to attract immigrants with high levels of human capital who could meet the labour market needs. The policy changes helped attract more foreign workers to come to Canada to fill all occupations, not just the ones in excess demand (Qiu et al., 2014).

The point system was adjusted two times during this period. In 1992, more points are awarded for factors that were thought to contribute to the adaptability of immigrants to the Canadian labour market in both the short run and the long run. These factors included general characteristics such as education, age, and language proficiency as well as specifically targeted characteristics such as whether an applicant has a job arrangement and whether their occupation is on the list of occupation shortages in Canada.[10] In 1995, more points were assigned to

[10]A minimum of 70 points out of 100 points is required for applicants to be admissible. If they cannot pass

education and language proficiency reflecting once again the government's focus on Economic Class immigrants and its priority in selecting immigrants based on their human capital.[11]

On June 28, 2002, the new Immigration and Refugee Protection Act (IRPA) legislation was introduced with new requirements affecting applicants under the Skilled Worker category. The new Act put more weight on factors such as education, experience, and language ability rather than specific occupations. It, therefore, reflected a shift away from the focus on short-run labour market needs toward a human capital model of selection (Ferrer et al., 2014).[12] Further, on May 3, 2006, the government reduced the Right of Permanent Residence Fee by 50 percent to make it easier and more attractive for people to come to Canada (Immigration, Refugees and Citizenship Canada, 2005, 2006, 2007, 2008).

This period reflected more immigration opportunities for international doctoral students with respect to their transition to PR. As international students possess a high level of educational attainment, they were favoured by the human capital based selection model. Since more points were awarded to education and personal suitability factors, compared to previous periods, international students including Ph.D. students were at an advantage for having higher educational attainment and previous Canadian work experience.

From 2008 to 2010: Restrictive policy period The 2008-2010 period experienced significant changes in PR policies. In September 2008, the Canadian Experience Class (CEC) program was launched. This program allowed certain skilled temporary workers and international students with Canadian degrees and Canadian work experience who had demonstrated their ability to succeed in Canada to apply for PR from within the country. In addition, in November 2008, the "Ministerial Instructions" legislation was introduced at the federal level. This legislation was designed to increase the focus on occupational shortages and to reduce the application backlog. It emphasized the processing of new Federal Skilled Worker (FSW) applications of immigrants who have the ability to work in Canada either because of their arranged employment or prior experience in Canada as a student or temporary foreign worker or because these applicants have skill and experience in one of the high-demand occupations. At the same time, unprocessed applicants that were not aligned with the Canadian government's objectives were returned by CIC. This resulted in a significant reduction in the backlog of applications from 2008 to 2011 (Immigration, Refugees and Citizenship Canada, 2009, 2010, 2011a).

Although these changes favoured applicants who have Canadian work experience and education, they provided no direct support to international students who aimed to get PR during their studies. As a result, the policies in this period are still restrictive.

From 2011 to 2014: Less-restrictive policy period Starting on November 5, 2011, under the fourth set of the Ministerial Instructions, Citizenship and Immigration Canada (CIC) launched

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the threshold, they can get an extra 15 points if they have relatives in Canada. 43 out of 100 points are awarded to factors related to occupation skills, experience, and occupation demand, as well as bonus points for designated occupations. The point system works on a first-come first-served basis for applicants who exceed the threshold.

[11]The new point systems awarded 16% to 20% of the total possible points to education and 15% to 20% to language proficiency. Besides, there was also an increase in points from 10% to 16% for personal suitability factors.

[12]Under the IRPA regime, principal applicants to the main federal economic program must now take an approved language test and submit the results.

a new eligibility stream for international students pursuing doctoral studies. 1,000 international students who are studying at the doctoral level in Canada were eligible to apply for PR through the FSW program.[13] In 2012, a temporary pause was imposed on the acceptance of new FSW applicants from which applicants with valid job offers and students pursuing Ph.D. studies in Canada were exempt. This pause was not removed until May 2013 allowing CIC to achieve the goal of processing all FSW applicants by the end of 2014.[14]

Modernized selection criteria for the FSW program were launched in May 2013 by CIC, making the FSW program faster and more flexible for temporary foreign workers and international student graduates with Canadian work experience to stay in Canada permanently. As of January 2013, the work experience requirement was reduced from 24 months to 12 months. Also, the time to accumulate work experience increased to 36 months for workers in high-skilled occupations (Immigration, Refugees and Citizenship Canada, 2012, 2013, 2014, 2015a). Given specific policies that aimed to promote the opportunities for international doctoral students in getting PR during their studies as well as fewer restrictions on this group, 2011-2014 can be considered as a period of less-restrictive PR policies.

From 2015 up to present: Restrictive policy period On January 1, 2015, IRCC introduced a new immigration scheme, Express Entry (EE), under which most applications are processed in six months or less. The EE system is intended to help prevent backlogs and better coordinate application volumes with the annual immigration level plan. The EE selection criteria value the most core/human capital factors, skill transferability factors, and arranged employment, and hence, the system is in favor of young, highly educated potential applicants with Canadian experience and fluency in English/French Immigration, Refugees and Citizenship Canada (2016).

In general, the new EE system gives favourable conditions to international students in Canada as their qualities including a high level of educational attainment and Canadian work experience match well with the requirement of the immigration system. However, the new system does not provide any specific policies that support current doctoral students in Canada. It is still hard for them to obtain PR during their study as the advantages of the new EE system can only be applied to international Ph.D. students after they graduate, which can take several years. At the same time, the system provides the same open door to all other potential Economic Class immigrants from all over the world and, therefore, creates tougher competition for international doctoral students in Canada.

The most recent change that favours international students is the revision to the EE system in 2016 in which extra points were awarded toward PR for international graduates who attended Canadian universities Immigration, Refugees and Citizenship Canada (2017). Moreover, international students were permitted to count half of their time in Canada while in school towards the citizenship requirement to a maximum of one year. Despite these changes, this period is still labeled as a restrictive policy period.

[13] https://www.canada.ca/en/immigration-refugees-citizenship/corporate/publications-manuals/operational-bulletins-manuals/bulletins-2011/351-november-4-2011.html

[14] https://www.canada.ca/en/immigration-refugees-citizenship/corporate/mandate/policies-operational-instructions-agreements/ministerial-instructions/other-goals/mi5.html

Work permit policies

From 1988 to 2005: Restrictive policy period In the period from 1988 to 2005, immigration policies related to work opportunities during a Ph.D. study or after graduation were restrictive. There are no specific policies that enhance off-campus or post-graduation work opportunities for international students. Before April 2006, international students may work on campus at the institution where they study without a work permit if they have valid study permits and are full-time students at a public or private post-secondary institution. When a pilot project was launched on April 18, 2005, international students were allowed to work in Canada for two years after their graduation, rather than one year. Particularly, international students at Canadian post-secondary institutions were allowed to work in Canada, outside of Montreal, Toronto, and Vancouver, for a second year after their graduation.

Another change to the international student program in 2005 was that the government of Canada streamlined the Study Permit application process. From 2005, international students could obtain a study permit that was valid for the full length of their intended period of study, and students in post-secondary studies could transfer between programs of study and institutions (public and private) without first making an application to CIC (Immigration, Refugees and Citizenship Canada, 2005, 2006).

From 2006 to present: Less restrictive policy period Under another pilot project, starting from April 2006 onward, international students at public post-secondary institutions were allowed to work off-campus while completing their studies so that they could accumulate Canadian labour market experience and gain a better understanding of Canadian society.

In June 2008, the e-Channel to the off-campus work permit program was first released. International students in Canada also saw significant changes in 2008 to the PGWP Program in which full-time international students who graduate from a Canadian university and/or college were offered an open work permit with no restrictions on the type of employment with an option to extend the duration for up to three years. The PGWP program also allowed international student graduates to work at any location across the country.[15] In 2009, CIC modernized the immigration system by extending additional online application services to international students and their spouses already living in Canada. During the 2009-2010 period, CIC issued over 16,400 off-campus permits and more than 18,300 post-graduation permits (Immigration, Refugees and Citizenship Canada, 2007, 2008, 2009, 2010, 2011a).

The combination of the CEC program and updates to the PGWP program significantly increased the opportunity for international students to stay in Canada by allowing them to work up to three years after graduation. This, in turn, gave international students the opportunities to accumulate Canadian work experience that makes them eligible for immigration programs under the Economic Class.

A milestone in the international student program was marked in 2014 as eligible study permit holders could qualify to work off campus without a work permit.[16] From June 2014, a

[15]Before 2008, eligible graduates must secure pre-arranged employment that must be related to their field of study prior to applying for a work permit.

[16]Prior to June 1, 2014, international students studying at public and certain private post-secondary institutions who wish to work off-campus were required to apply for a work permit. Since June 1, 2014, some study permit holders can qualify to work off campus without a work permit. Under the new regulations, international students

study permit became invalid 90 days after a student completed their study. After that, graduate students are required to have a valid work permit or other authorization to remain and work in Canada. However, eligible international students can work full-time while waiting for the approval of their PGWP application (Immigration, Refugees and Citizenship Canada, 2012, 2013, 2014, 2015a).

4.3 Data

4.3.1 The Longitudinal Immigration Database

The IMDB is an annual Canadian data set that combines administrative files on immigrant admissions and non-PR permits from IRCC, and tax data from Canada Revenue Agency (CRA). The IMDB is unique for two reasons. First, it contains detailed information on (i)the socio-demographic characteristics of immigrants who landed and received PR, in Canada since 1980 and (ii)permits of non-PRs since 1980. Second, it has linked tax data of PRs and non-PRs since 1982 if they ever filed tax returns. The data on non-PR permits include information on the type of permit (i.e., Work Permit, Study Permit, Refugee Claims, or other types of claims), effective date, valid date, as well as personal data of all non-PRs admitted since the 1980s such as country of last residence, birth year and month, and the number of permits. Thus, the IMDB allows for the study of immigration status, study duration, duration to PR, temporary/permanent retention, and labour market outcomes of all non-PRs in Canada including the universe of international students. Further, the long nature of this panel allows for observing and investigating behaviours and outcomes of international students under varying economic conditions and immigration policies.[17]

4.3.2 Data Construction

Sample Selection

My sample includes individuals who first came to Canada as international Ph.D. students,[18] with an effective date of their first study permits between 1988 and 2014. This is to ensure that the individuals in my sample are newly arrived international Ph.D. students and that I can observe their history in Canada for at least five years.[19] I exclude from my sample individuals

pursuing academic, vocational, or professional training programs offered by designated learning institutions are allowed to work off-campus for up to 20 hours per week during the school year, and full-time during the regularly scheduled academic breaks. Study permits holders of language programs are not eligible to work off-campus.

[17]Non-PRs are not considered immigrants. They come from other countries and have a work permit or a study permit, or they are refugee claimants. They are allowed to be in Canada for the period of time indicated on their permit. An international student is a person authorized by the Canadian government to enter Canada with the intention of pursuing an education.

[18]Their first permit in Canada is a study permit at the Ph.D. level.

[19]As the permit file includes information of all non-PRs' permits that are recorded by IRCC since 1980, the first study permit of all individuals in the sample could be either their first permit since arriving in Canada or a subsequent permit of a Ph.D. student who already commenced their study before the 1980s. Individuals with the first study permit recorded in the IMDB being effective from 1986 and beyond are very likely to be new international Ph.D. students in Canada. However, I only include in my sample individuals who started their Ph.D.

who have two or more gaps of at least 180 days between their study permits.[20] I only include in my sample males or females between 22 and 30 years old at the time of arriving in Canada as international students. Students whose first province of destination is Quebec as well as Yukon, Northwest Territories, and Nunavut are also not included.[21] Anyone who has a previous attachment with Canada; e.g., being a PR in the past or having their first tax year before the effective year of their first study permit is excluded from my sample. All observations with missing information are also excluded. My final sample includes 15,705 individuals.

Study Duration

To construct the study duration of an individual, I utilize two sources of data - the study-permit history and tax data - to identify the start date and the end date of the study period. Although the study permit data allow for identifying the valid date of the last study permit and therefore a calculation of study duration based on permit records, a drawback of this approach is that it can only be applied to international students who are not PR during their study period. Those who become PR at any point during their study period no longer need to obtain a study permit. Another issue with this approach is that many international students may not remain in Canada or study until the end date of their last study permit. Therefore, calculating the study period length based only on permit data does not yield accurate durations.

For the above reasons, I primarily use tax data to determine the study period. First, I assume that the start date of an individual is the effective date of their first study permit unless the tax data indicate differently. Second, I use information from tax data to identify the end date of their study period. In any particular year, if an individual has a positive educational amount and a positive tuition amount on their tax return, I assume the person studied in this year. The study period continues if they study continuously between the years, or if there is any gap in the period, the gap is of at most one year. After identifying the last year of the study period, I use the monthly educational amount to calculate how many months an individual studied in the last year.[22] For those who do not have any tax data, I impute their study duration using the study duration distribution of international Ph.D. students with short duration (i.e., students who finished their study in less than two years after the starting year). It is important to note that the main disadvantage of this approach is that, although a majority of Ph.D. students do file tax returns as they are likely to have income through teaching assistance, research assistance,

studies from 1988 onward. This is because in the initial years, 1986 and 1987, when Canada started to receive international students, the number of international Ph.D. students is low, and the drop-out rate after one year is high. Thus, these periods are likely not indicative of what is going on in the economy or with the policies. I allow in my sample the students starting their study in 2014 at the latest so that I can observe the tax records of individuals in my sample for at least five years.

[20]There is a small proportion of international students in my sample who go in and out of education several times. These students are not included under the scope of this analysis because their education history is likely driven by other factors not considered here.

[21]Students arriving in Quebec are excluded because Quebec has immigration programs that are different from the federal programs. PhD students in Yukon, Northest Territories, and Nunavut are also not included because they only account for a significantly small proportion of the sample.

[22]Monthly educational amounts by year are provided in Table B.3 of the Appendix. The education deduction amount for full-time students represents the calculated amount that a tax filer may claim for each whole or part month during the tax year in which they were enrolled as full-time students in a qualifying program. This amount is calculated by the CRA.

or other on-campus/off-campus work, there are students that did not file a tax return every year throughout their study period and/or after that. As a result, identifying the end date based on tax data may result in an under-calculation of the actual length of one's study period. Despite that, I choose the latter approach as it provides a more reliable calculation of the length of the study period.

PR status at the end of the Study Period

To determine whether an individual has PR status at the end of their study period or at graduation, I use the following definition. If the landing year is before or the same as the last year of study, then I assume that the student has PR during their study period. When running sensitivity analysis with this outcome, I also apply two other different definitions to test whether the timing of PR status matters. First, if the landing year is before the last year of study, or if the landing year is the same as the last year of study and the landing month is before September, then I assume that the student has PR during their study period. Second, if the landing year is before the last year of studying, or if the landing year is the same as the last year of study and the landing month is no later than the last month studying in the final year, then I assume that the student has PR during their study period.

Retention of International Ph.D. Students after the End of the Study Period

At the end of their study period, international students who have PR have the right to stay and work in the country. Meanwhile, those without PR have to apply for a work permit to work in Canada as a temporary foreign worker or a visitor visa to remain in Canada as a visitor. Otherwise, they are required to leave the country. In this paper, I study the temporary retention of international Ph.D. students in Canada in the year following the end of the study period. To examine their retention decision, I use the tax data of the year following graduation or study completion. A person is considered to have left the country if one of these conditions holds: (1) they do not have any tax record in this year or, (2) they have a tax record in this year, but the tax record indicates that they are a non-resident. Otherwise, they are assumed to remain in Canada.

4.3.3 Sample Statistics

Table 4.1 shows descriptive statistics of the sample. Of 15,705 individuals, 65% of them are males. The average age at arrival is 26.39. Ontario is the province that attracts the largest number of international Ph.D. students, 45% of the sample. British Columbia and Alberta rank second and third with 23% and 18% of the total number of international Ph.D. students, respectively. Other provinces welcome a much smaller proportion of international doctoral students. In terms of the arriving cohort, the number of international doctoral students increases significantly over the period. In the initial period from 1988 to 1990 and from 1991 to 1995, there are approximately 3 and 4 percent of the sample, respectively. However, it almost triples in the next five years from 1996 to 2000 compared to the previous period, from 4% to 11%. The number of international Ph.D. students continued to increase with about 30 percent of the sample arriving in the last period, 2011 to 2014. With regards to their region of birth,

Table 4.1: Descriptive Statistics

Gender			Region of birth	
	Male	0.65	*America*	0.16
	Female	0.35	*Europe*	0.14
Average age at arrival		26.39	*Africa*	0.06
			Asia	0.63
			Ocean and Antarctica	0.01
Arriving cohort			Province of Destination	
	1988-1990	0.03	*NFL, PEI, NS and NB*	0.08
	1991-1995	0.04	*ON*	0.45
	1996-2000	0.11	*MA and SA*	0.07
	2001-2005	0.20	*AL*	0.18
	2006-2010	0.30	*BC*	0.23
	2011-2014	0.31		
Length of study period by tax data			Average length of study period	
	<=12 months	0.19	*All*	45
	From 12 to 24 months	0.10	*Studied in more than 48 months*	65
	From 24 to 36 months	0.08	Having PR during their study period	0.39
	From 36 to 48 months	0.14	Retention	
	More than 48 months	0.49	*With PR*	0.87
			Without PR	0.39

NFL: Newfoundland and Labrador, PEI: Prince Edward Island, NS: Nova Scotia, NB: New Brunswick, ON: Ontario, MA: Manitoba, SA: Saskatchewan, AL: Alberta, BC: British Columbia

63% of the students come from Asia, 16% of them are from America, and 14% of them come from Europe. Over the 1988-2014 period, Canada also welcomes approximately 940 African students and 160 students from Oceania and Antarctica, an equivalence of 6% and 1% of the sample, respectively.

In terms of the length of the study period by tax data, the drop-out rate among Ph.D. students is relatively high. Approximately 20% of the sample study for less than or equal to one year and about 10% of the sample study from 12 to 24 months. Those who study for more than 48 months account for approximately half of the sample, and this is the group that is the most likely to complete their Ph.D. study. The average length of the study period for everyone in the sample is 45 months, and the average for those who study for more than 48 months is 65 months. Among the international Ph.D. students who finished their studies, 39% of them had PR during their study period. Lastly, regarding their retention, 87% of the students who had PR at the end of their studies remained in Canada in the following year, while only 39% of the students without PR are observed to remain in Canada shortly after their studies.

4.4 Methodology

4.4.1 Duration Analysis with Time-Varying Covariates

In this study, I am interested in studying the effects of economic conditions and immigration policies on the length of the study period of international doctoral students in Canada. Because economic conditions vary and immigration policies change over time, these covariates are time-varying. Therefore, I use the Cox regression model with time-varying covariates to estimate the effects of economic conditions and immigration policy changes on the study duration of these international Ph.D. students.

The general hazard model for failure time proposed is:

$$\lambda(t|\boldsymbol{X}) = \lambda_0(t)e^{(\boldsymbol{\beta}'\boldsymbol{X})}, \tag{4.1}$$

where λ_0 is the baseline hazard function and $\boldsymbol{\beta}'$ is a vector of regression coefficients and $\boldsymbol{X}$ is a vector of time-fixed covariates. $\lambda_0(t) = e^{\alpha(t)}$ is the baseline hazard function at time t. The risk associated with the covariate values is reflected in the term $e^{(\boldsymbol{\beta}'\boldsymbol{X})}$.

An extended version of the Cox proportional hazard model that allows for time-varying covariates is as follows (Xue and Lai, 2017):

$$\lambda(t|\boldsymbol{Z}(t)) = \lambda_0(t)e^{(\boldsymbol{\beta}'\boldsymbol{X}+\boldsymbol{\gamma}'\boldsymbol{Y}(t))}, \tag{4.2}$$

where $\boldsymbol{\beta}'$ and $\boldsymbol{\gamma}'$ are coefficients of time-fixed and time-varying covariates, respectively. $\boldsymbol{Z}(t)$ is a vector of both time-fixed covariates ($\boldsymbol{X}$) and time-varying covariates ($\boldsymbol{Y}(t)$).
The hazard ratio is a non-constant hazard rate, and it is as follows:

$$\text{Hazard Ratio} = \frac{\lambda(t; \boldsymbol{Z}^*(t))}{\lambda(t; \boldsymbol{Z}(t))} = e^{(\boldsymbol{\beta}'(\boldsymbol{X}^*-\boldsymbol{X})+\boldsymbol{\gamma}'(\boldsymbol{Y}^*(t)-\boldsymbol{Y}(t))}. \tag{4.3}$$

In the context of this study, the set of time-varying covariates includes indicator variables that describe the difficulty level of immigration policy including work permit policy and PR policy, an indicator of recession, and the unemployment rate.[23] The time-varying covariates are recorded at the annual level. Other time-fixed covariates include gender, age at arrival, region of birth, and the first province of destination. The outcome of interest for the time-varying duration analysis is the length of the study period.

4.4.2 Logistic Regression

To study the probability of becoming a PR among international Ph.D. students in Canada and their probability of retention after the study period, I employ binary logistic regressions. In the case when the response of a subject takes one of two values 0 or 1, the logistic regression model is as follows:

$$\text{logit}\{PR(Y = 1|\boldsymbol{X})\} = log\Big\{\frac{Pr(Y = 1|\boldsymbol{X})}{1 - Pr(Y = 1|\boldsymbol{X})}\Big\} = \boldsymbol{\beta}'\boldsymbol{X}, \tag{4.4}$$

[23] The unemployment rate reflects general fluctuations of the labour market, and recession indicator reflects whether there is a big shock to the economy in a specific year.

where $\boldsymbol{\beta}$ is a vector of coefficients and $\boldsymbol{X}$ is a vector of explanatory variables including a constant term. Solving for the probability $Prob(Y = 1|\boldsymbol{X})$ in the logit model gives the following equation:

$$Prob(Y = 1|\boldsymbol{X}) = \frac{e^{(\beta' X)}}{1 + e^{(\beta' X)}}. \tag{4.5}$$

Outcome variables in the logistic regressions are whether sample individuals obtained PR status at the end of their study period and whether they remain in Canada in the year following the end of their study period. To study the probability of getting PR status at the end of the study period, I use explanatory variables that reflect the economic conditions and immigration policies in the first year of their Ph.D. study. Meanwhile, for the retention outcome, I use the economic conditions and immigration policies in the last year of their study period. I also include other demographic variables such as gender, age at arrival, region of birth, and province of destination. Finally, I add to the regressions a variable that describes the length of one's study period.

4.5 Results

4.5.1 The Effects of Economic Conditions and Immigration Policies on Study Duration

Table 4.2 gives the parameter estimates from a time-varying duration analysis of the international doctoral students' study duration. Column (1) shows the estimated results from the analysis that employs the whole sample. With regards to the economic conditions, while there is no significant impact of recessions, a higher unemployment rate significantly increases the hazard rate and therefore shortens the study duration. One explanation for this result is that when the unemployment rate is high, it is harder for everyone including international Ph.D. students to find jobs. As a result, it becomes more challenging to pay for the living cost and tuition fees for those who are out of their funding period. Since Ph.D. students are more likely to be adult students or have a family to take care of, they are more likely to struggle when the unemployment rate is high and hence to finish their studies earlier due to unfavourable economic conditions. Another possible explanation is that with the high unemployment rate, international Ph.D. students may face reduced future job opportunities. As a result, it is less likely for them to be able to accumulate work experience to be eligible for PR application, not to mention the more limited opportunity to become PR given the lack of jobs in the domestic labour market. Consequently, international Ph.D. students may wish to finish their studies earlier. They may leave Canada for a different labour market by going back to their home country or going to another country.

It is important to note that this result for international Ph.D. students is not consistent with the findings for domestic students. Von Wachter (2020) finds that under unfavourable market conditions, domestic students may either delay graduation or move to a different local labour market. For international Ph.D. students, moving to a different labour market may require them to graduate early, i.e. shorten their study duration, and relocate. However, unlike domestic students, delaying graduation might not be an option for all international Ph.D. students as they may have limited resources in a foreign country. They are less likely to get access to other

Table 4.2: Estimates for the Proportional Hazard Model with Time-Varying Covariates of the Study Duration

Regressors	Estimates	
	1988-2014	1988-2013
Female	-0.03	-0.03
	[0.02]	[0.02]
Age at arrival	-0.01**	-0.01**
	[0.00]	[0.00]
Destination province		
Alberta	-0.27***	-0.2***
	[0.03]	[0.03]
British Columbia	-0.46***	-0.29***
	[0.04]	[0.04]
MA-SA	-0.44***	-0.29***
	[0.04]	[0.02]
NFL-PEI-NS-NB	-0.45***	-0.11
	[0.04]	[0.09]
Region of birth		
Africa	-0.2***	-0.28***
	[0.03]	[0.03]
America	-0.31***	-0.47***
	[0.04]	[0.04]
Europe	-0.29***	-0.45***
	[0.02]	[0.04]
Oceania or Antarctica	-0.12	-0.47***
	[0.09]	[0.04]
Recession	0.01	0.00
	[0.02]	[0.03]
Unemployment rate	0.11***	0.10***
	[0.01]	[0.01]
WP policies	0.02	0.01
	[0.02]	[0.02]
PR policies	0.11***	0.07***
	[0.02]	[0.02]
No. of observations	65,850	61,385

NFL: Newfoundland and Labrador, PEI: Prince Edward Island, NS: Nova Scotia, NB: New Brunswick, ON: Ontario, MA: Manitoba, SA: Saskatchewan, AL: Alberta, BC: British Columbia

funding sources, and they may have less support when studying overseas as international Ph.D. students. These factors may result in a shorter study period for international Ph.D. students during high unemployment periods.

With regard to immigration policies, the results indicate that after-graduation work permit policies do not have significant impacts on the study duration of international Ph.D. students. Meanwhile, when PR policies are less restrictive, the hazard rate for the students is higher, and hence the study duration is shorter. It is possible that when it is easy to get PR during the study period, international doctoral students are at no disadvantage compared to domestic students when it comes to the labour market, which allows them to graduate earlier. Another reason for shorter study durations during less restrictive PR periods is that having PR allows the students to remain permanently in Canada without the need to obtain any permits. In contrast, if they do not receive PR during their study, they may need to stay longer in the program to be eligible for a temporary work permit after graduation or PR application, or simply to remain in Canada as international students.

Besides economic conditions and immigration policies, age at arrival, destination province, and region of birth also significantly correlate with the study duration. The results indicate that younger students tend to have shorter study durations. International Ph.D. students whose first province of destination is Ontario have, on average, a higher hazard rate, or a shorter study duration, than students arriving in different provinces. International Ph.D. students originating from Asia are more likely to spend more time in education than those coming from Africa, America, Europe, or Oceania and Antarctica.

Since the censoring rate is high for the group of students in the sample who started in the last few years of the study period, I run a sensitivity analysis with the restricted sample from 1988 to 2013. A similar pattern of results for this sample is illustrated in Column (2).

4.5.2 The Effects of Economic Conditions and Immigration Policies on the Probability of Getting PR during the Study Period

To estimate the probability of getting PR during the study period, I use the measures of economic conditions and immigration policies at a student's arrival time. Specifically, I am interested in estimating how the initial context of both labour market and immigration policies at arrival time affects the probability of getting PR within the Ph.D. students' study period. I run the analysis with the sub-sample of the students who started in 2010 or before so that the individuals are potentially observed for at least 8 years.[24] I also include a variable that indicates the length of one's study period to account for the fact that everyone has a different study period length. Table 4.3 exhibits the marginal effects from logistic regressions in which the outcome variable is whether the individual receives PR status within their study period.[25] Columns (1), (2), and (3) have the same explanatory variables and differ from each other only in the way the outcome variable is defined.[26] Findings in Column (1) indicate that a higher age at arrival

[24]For those who have not finished their study by 2018 - the last year that their tax data is available, I can observe whether they have PR within at least their eight years of studying.

[25]Regression coefficients are reported in Table B.4 of the Appendix.

[26]In Column (1), an individual is assumed to have PR status during their study period if their landing year is before or the same as the final year of study. Meanwhile, in Column (2), an individual is assumed to have PR status during their study period if the landing year is before the last year of study, or if the landing year is the same as the last year of study, and the landing month is before September. Lastly, in Column (3), having PR status during one's study period is defined when the individual's landing year is before the last year of studying, or if the landing year is the same as the last year of studying, and the landing month is before the last month of studying

Table 4.3: Estimates for the Logit Model:
The Probability of Getting PR During the Study Period

Regressors	Marginal Effects		
	(1)	(2)	(3)
Female	-0.012	-0.009	-0.009
	[0.008]	[0.008]	[0.008]
Age at arrival	0.011***	0.012***	0.011***
	[0.002]	[0.002]	[0.002]
Destination province			
Alberta	0.011	0.004	0.009
	[0.010]	[0.010]	[0.010]
BC	-0.061***	-0.059***	-0.059***
	[0.010]	[0.010]	[0.010]
MA-SA	-0.014	-0.011	-0.016
	[0.014]	[0.014]	[0.014]
NFL-PEI-NS-NB	-0.056***	-0.068***	-0.052***
	[0.016]	[0.016]	[0.016]
Region of birth			
Africa	0.022	0.02	0.027*
	[0.015]	[0.015]	[0.015]
America	-0.301***	-0.285***	-0.291***
	[0.009]	[0.009]	[0.009]
Europe	-0.164***	-0.152***	-0.159***
	[0.010]	[0.010]	[0.01]
Oceania or Antarctica	-0.280***	-0.277***	-0.277***
	[0.028]	[0.026]	[0.027]
Recession	-0.004	-0.002	0.00
	[0.012]	[0.012]	[0.012]
Unemployment rate	-0.007**	-0.006*	-0.005*
	[0.003]	[0.003]	[0.003]
WP Policies - Less Restrictive	-0.117***	-0.121***	-0.134***
	[0.019]	[0.019]	[0.018]
PR Policies - Less Restrictive	0.063***	0.063***	0.057***
	[0.017]	[0.017]	[0.017]
Years of study			
4-to-5 years	0.312***	0.304***	0.307***
	[0.008]	[0.008]	[0.008]
More than 5 years	0.499***	0.505***	0.506***
	[0.008]	[0.008]	[0.008]
No. of observations		10660	

NFL: Newfoundland and Labrador, PEI: Prince Edward Island, NS: Nova Scotia, NB: New Brunswick, ON: Ontario, MA: Manitoba, SA: Saskatchewan, AL: Alberta, BC: British Columbia

correlates with a higher probability of obtaining PR status while studying. A better chance of having PR status is also observed among students that have Ontario as their destination and among Asian students. In addition, as one would predict, the length of an individual's study duration also affects the probability of getting PR status. In particular, the longer the study period, the higher the probability of becoming a PR.

Arriving in Canada among adverse economic conditions, i.e., high unemployment rates, negatively affects Ph.D. students as it is associated with a lower probability of getting PR during their study period. Particularly, a one percentage point increase in the unemployment rate at arrival reduces the probability of getting PR during their study period by one percentage point, and the result is statistically significant at the 5% confidence level. Again, the results show no significant impact of the recession indicator for the analysis sample.

Regarding immigration policies, I find that immigration policies, both work-permit and PR policies, have significant impacts on the probability of getting PR during their study period. Compared to students who came to Canada in a year with more restrictive PR policies, the probability of getting PR status while studying increases by 6.3 percentage points for students who arrived in Canada when the PR policies are less restrictive. The result that easy PR policies at arrival time lead to a better chance of getting PR status for international Ph.D. students during their study is intuitive. In less restrictive policy periods (1992-2007 and 2011-2014), the immigration system witnessed significant changes that work in favor of international Ph.D. students, which, in turn, improved the probability of getting PR during their study. They included a focus on a human capital selection model to attract immigrants with high levels of human capital, changes in the point system that emphasizes the importance of human capital, and an immigration program that aimed specifically toward international Ph.D. students.

In contrast, the finding that less restrictive after-graduation work-permit policies reduce the probability of having PR status is not straightforward. The work permit policies became less restrictive starting from 2006 when a pilot project was launched followed by new policies introduced in 2008 that allow international students to work off-campus while studying and allowed full-time international students who graduate from a Canadian university and/or college to work in Canada for up to three years with no restrictions on employment types. When work permit policies are easier, it is possible that having PR status becomes less valuable as international students are allowed to remain and work in Canada with an open work permit.

4.5.3 The Effects of Economic Conditions and Immigration Policies on the Retention Rate in the Year following the End of the Study Period

At the end of their study period or at graduation, international Ph.D. students either leave Canada or remain in the country as temporary foreign workers, visitors, or PRs. To be eligible to stay, generally, they need to get a work permit or PR status. My initial exploratory analysis shows that almost all international Ph.D. students who obtained PR during their study period stay in Canada after graduation. Therefore, for the group of students with PR status, I only study the effects of economic conditions on their retention probability. Meanwhile, for the group of students without PR status at the end of their study period, I study the effects of both

in the final year.

economic conditions and immigration policies on their retention outcomes. In this analysis, I employ the economic conditions and immigration policies in the final year of an individual's study period because they are most relevant to the person's decision of whether to stay as well as his/her eligibility of staying in Canada after completing their studies. An individual is assumed to leave Canada if one of the two following conditions hold: (i) no tax data are available in the year following the end of the study period, or (ii) a tax return is available in this year, but it indicates a non-resident status of the individual. I also restrict the analysis to the sample of international doctoral students who started in 2010 or before and finished their study period in 2017 or before. By restricting the starting year to 2010, I can assure that everyone is given an 8-year tax window, and by restricting the end year to 2017, I can observe whether they stayed in Canada in the year following the end of their study as the tax data are only available up to 2018. The marginal effects of economic conditions and immigration policies on the probability of remaining in Canada one year after the end of the study period are shown in Table 4.4.[27] Column (1) shows the regression results from the sample of students who have PR at the end of their study period.[28] Column (2) shows the results from the analysis of individuals without PR at the end of their study period. The regression results for those who are non-PR when they left their program but study at least four years are shown in Column (3). Finally, Column (4) demonstrates the results for non-PR students who study less than four years.

As can be seen from all of the columns in Table 4.4, the probability of remaining in Canada in the year after the end of the study period significantly correlates with many explanatory variables. It is lower for females than for males and is higher for individuals who arrive at an older age. Students from Africa are the most likely to remain in Canada one year after graduation followed by students from Asia, Europe, America, and Oceania and Antarctica. International Ph.D. students studying in Alberta and Manitoba-Saskatchewan have a higher probability of staying than those from Ontario. For example, in Column (2), the marginal effects of arriving in Alberta and Manitoba-Saskatchewan are 6.3 and 7.6 percentage points, respectively.

For students with PR at graduation or the end of their study period, results from Column (1) show that economic conditions seem to not affect them. The higher unemployment rate does not affect the retention probability. The recession indicator negatively correlates with the probability of staying, but this result is significant only at the 10% confidence level. These results are driven by the fact that almost all students with PR remain in Canada in the year following the end of their study period.

However, the results from Column (2) indicate that students who do not have PR are affected by both economic conditions and immigration policies. In particular, in an economic downturn, whether it is a recession or a high unemployment rate, the probability of remaining in Canada after their study period among international Ph.D. students is reduced. In particular, a one percentage point increase in the unemployment rate lowers the probability of staying by 1 percentage point and a recession reduces the probability by 3 percentage points. Compared to the economic conditions, immigration policies have an even larger impact. Both less restrictive PR and work permit policies significantly improve the likelihood of remaining in Canada after

[27] Regression coefficients are reported in Table B.5 of the Appendix

[28] Under this analysis, an individual is assumed to have PR status during their study period if their landing year is before or the same as their final year of study.

Table 4.4: Estimates for the Logit Model: The Probability of Remaining in Canada in the Year Following the End of Study Period

Regressors	Marginal Effects			
	(1)	(2)	(3)	(4)
Female	-0.014	-0.035***	-0.071***	-0.017
	[0.012]	[0.012]	[0.021]	[0.014]
Age at arrival	0.007***	0.010***	0.011**	0.009***
	[0.003]	[0.003]	[0.005]	[0.003]
Destination Province				
Alberta	0.051***	0.063***	0.026	0.087***
	[0.012]	[0.016]	[0.028]	[0.020]
BC	-0.012	-0.01	-0.048*	0.012
	[0.014]	[0.014]	[0.025]	[0.017]
MA-SA	0.054***	0.076***	0.077*	-0.073**
	[0.015]	[0.024]	[0.040]	[0.030]
NFL-PEI-NS-NB	0.022	-0.033*	-0.047	-0.024
	[0.023]	[0.02]	[0.043]	[0.023]
Region of birth				
Africa	0.033*	0.045*	0.123**	0.023
	[0.018]	[0.026]	[0.052]	[0.029]
America	0.003	-0.145***	-0.158***	-0.132***
	[0.025]	[0.013]	[0.026]	[0.015]
Europe	-0.047**	-0.129***	-0.125***	-0.127***
	[0.019]	[0.014]	[0.028]	[0.016]
Oceania or Antarctica	-0.202	-0.171***	-0.198**	-0.148***
	[0.134]	[0.038]	[0.081]	[0.041]
Recession	-0.02	-0.033*	-0.155***	0.013
	[0.012]	[0.018]	[0.033]	[0.022]
Unemployment rate	0.008	-0.01**	0.002	-0.013**
	[0.006]	[0.005]	[0.011]	[0.006]
WP policies - Less restrictive	-	0.166***	0.102***	0.197***
	-	[0.014]	[0.026]	[0.017]
PR policies - Less restrictive	-	0.05***	-0.052*	0.099***
	-	[0.019]	[0.031]	[0.022]
Years of study				
4-to-5 years	-0.024	0.199***		
	[0.020]	[0.016]		
More than 5 years	-0.029*	0.24***		
	[0.017]	[0.016]		
No. of observations	3,970	6,680	2,245	4,435

(1) Students who have PR at the end of their study period; (2) Students who do not receive PR at the end of their study period; (3) Students who do not receive PR at the end of their study period and study at least four years; (4) Students who do not receive PR at the end of their study and study less than four years.

NFL: Newfoundland and Labrador, PEI: Prince Edward Island, NS: Nova Scotia, NB: New Brunswick, ON: Ontario, MA: Manitoba, SA: Saskatchewan, AL: Alberta, BC: British Columbia

the students finish their studies. Easy PR policies increase the probability of staying among international Ph.D. students by 5 percentage points, while holding everything else constant, easy WP policies improve the probability by approximately 17 percentage points. Last, another important factor that determines the retention probability for students without PR is the length of their study period. In particular, non-PR students who study less than four years are less likely than other students to remain in Canada after finishing their studies. Compared to those who study less than four years, the probability of remaining in Canada in the year following the end of the study period increased by 20 percentage points among students who study between 4 to 5 years and by 24 percentage points among students who study more than 5 years. One potential explanation is that students who study for less than four years have dropped out from their study program and left the country as they do not qualify to stay or do not wish to do so.

I continue to divide the non-PR students sample into two sub-groups. Column (3) includes students who study for at least four years so they are likely to complete their doctoral study and qualify to stay, and Column (4) consists of students with less than four years of studying, so it is likely that they drop out from their Ph.D. program at some point. By running the analysis separately for the two groups, I can further analyze whether the impacts of economic conditions and immigration policies vary between those who are likely to complete their study and those who are not. Some of the results from Column (3) and Column (4) are worth mentioning. First of all, similar to the results from Column (2), economic conditions seem to discourage non-PR students to stay. A recession statistically and significantly reduces the probability of staying among students who study for at least four years by about 15.5 percentage points, while a high unemployment rate is a factor that lowers the probability of staying among drop-out students with a 1 percentage point increase in unemployment rate lowering the retention probability by 1.3 percentage point. It is possible that when the unemployment rate is high, it is harder for drop-out students to secure a job to remain in Canada. Meanwhile, for those who are likely to complete their study, the high unemployment rate does not significantly impact them, unless the adverse economic conditions lead to unfavourable condition, or a recession, which makes them less likely to stay. As Ph.D. graduates, they may have other and better outside options that allow them to move out of Canada when the economy is in a recession.

With immigration policies, both less-restrictive policies for work permits and PR in the last year of their study period significantly improve the probability of retention among students who study less than four years. As explained above, students with less than four years of studying are likely to have not completed their doctoral study, so it is likely that their probability of staying relies on the openness of immigration policies and general economic conditions at the end of their study period. In contrast, for those who study at least four years, the results are slightly different. When Canada makes it easier for them to obtain a work permit after the end of their study, they are more likely to stay. However, when it is easier to get PR in the last year of their study, it seems that they are less likely to stay. It may be possible that for these non-PR students, as they did not have PR during their study, they are at a disadvantage when applying for jobs in the Canadian labour market, and therefore do not stay, given that they likely have job opportunities in other countries.

4.6 Conclusion

International students, particularly doctoral students, are an important source of Canadian labour supply either as temporary foreign workers or as potential Economic Class immigrants. They tend to be young and have a high level of educational attainment and proficiency in at least one of the two official languages of Canada. A majority of them have some Canadian work experience and a local network that makes them well-adapted to Canada. Given the importance of international students and the focus of the Canadian government on core/human capital factors and skill transferability factors, there have been significant changes in immigration policies since the 1980s in order to attract and retain these high-quality candidates.

Like domestic students, international students are prone to business cycles. Along with macroeconomic conditions, they are also very likely to be affected by immigration policies. Nevertheless, these hypotheses have not been tested. In this paper, thanks to the availability of the IMDB, I make use of both tax data and permit history of all non-PRs in Canada to examine the effects of economic conditions and immigration policies on international doctoral students, a particular group of international students. My outcomes of interest include international Ph.D. students' study duration, the probability of getting PR during their study period, and the probability of remaining in Canada one year after their study completion.

My findings indicate that studying during an economic downturn is unfavourable for international Ph.D. students. Ongoing higher unemployment rates result in shorter study durations. It is important to note that the result is not consistent with the "delayed graduation" behaviour among domestic students during economic downturns that has been observed in the previous literature. It is possibly due to the fact that international Ph.D. students have limited resources and support, financially and psychologically, to stay in the program and sit out of the unfavourable economic conditions. Also, international Ph.D. students who experience a higher unemployment rate upon arrival are less likely to get PR status during their studies. It is highly likely that during a period of high unemployment rate, due to limited job opportunities, it is harder and takes longer for international Ph.D. students to accumulate enough work experience to qualify for PR. With regards to retention probability, in general, adverse economic conditions are found to discourage international doctoral students to stay, particularly non-PR students.

Findings also indicate that immigration policies significantly impact international Ph.D. students in all interested outcomes. In many cases, Ph.D. students remain in the program so that they can obtain PR status at graduation and be able to compete with other domestic candidates in the labour market. Less-restrictive PR policies probably help the students to get PR faster and shorten their study duration. Similarly, relaxed PR policies are also associated with a higher probability of getting PR during the study period and encourage the students to remain in Canada in the year following the end of their studies. Although easy work permit policies also positively affect the likelihood of retention among these students, they negatively correlate with the probability of getting PR during one's study period. It may be due to the fact that less restrictive work permit policies make PR less necessary in order to remain and work in Canada.

In summary, changes in immigration policies and economic conditions have significant effects on international Ph.D. students. Because international Ph.D. students are like domestic students in that they are negatively affected by economic downturns, it is necessary for the

government to alter immigration policies to support them. This occurred during the COVID-19 pandemic when Canada extended the PGWP for permit holders whose work permits expired between September 20, 2021, and December 31, 2022. Recent immigration policies appear to work successfully in temporarily retaining international Ph.D. students by giving them more opportunities for PR in Canada. Depending on immigration goals, the government can adjust the eligibility criteria for a work permit or PR. For example, if the government aims to encourage international Ph.D. students to remain until the end of their studies or to pursue higher education in Canada, it should increase the eligibility requirements for PR or PGWP applications by requiring more years of education or a higher level of educational attainment obtained at a Canadian institution. Similarly, to attract and retain international Ph.D. students in Canada, the government should consider giving them an open work permit with a longer valid time or launching specific immigration schemes, aside from the provincial nomination programs, that give them incentives to apply for PR during their study and/or early after graduation. Given that the majority of the students who have PR during their study period remain in Canada after graduation, new policies should specifically target international Ph.D. students and give them more opportunities to get PR while being a student to retain high-quality workers in Canada.

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Appendix A

Chapter 3 Appendix

Table A.1: Spearman's rank correlation between Period 1 earnings and Period 2 earnings conditional on Period 1 earnings decile - Dynamic Model

Deciles	Actual	Dynamic Model
1	0.28	0.26
2	0.32	0.32
3	0.32	0.3
4	0.32	0.29
5	0.33	0.29
6	0.36	0.32
7	0.41	0.35
8	0.46	0.39
9	0.54	0.46
10	0.73	0.66

Table A.2: Comparison of 90/10 ratios of base-year earnings and long-run annuity values under different mobility assumptions using replacement rate approach

		10^{th} percentile	90^{th} percentile	90/10 ratio	Equalization ratio
	Base year	13,400	100,600	7.51	-
Full mobility	Homogeneous model	21,300	99,900	4.69	0.58
	Fixed effect model	14,500	96,600	6.68	0.82
	Dynamic model	20,500	101,200	4.94	0.61
Positive earnings mobility only	Homogeneous model	26,900	134,400	5.00	0.61
	Fixed effect model	18,900	118,200	6.24	0.77
	Dynamic model	23,400	130,800	5.59	0.69
Negative earnings mobility only	Homogeneous model	12,200	82,800	6.80	0.84
	Fixed effect model	11,800	85,200	7.22	0.89
	Dynamic model	12,300	86,100	7.02	0.86
Earnings mobility only	Homogeneous model	21,000	102,100	4.86	0.60
	Fixed effect model	15,700	99,900	6.37	0.78
	Dynamic model	19,000	103,200	5.43	0.67
Employment risk only	Homogeneous model	15,400	108,000	7.01	0.86
	Fixed effect model	12,800	97,500	7.60	0.93
	Dynamic model	15,600	109,000	6.99	0.86

Table A.3: Changes in long-run earnings inequality and equalization ratio over time using replacement rate

		10^{th} percentile	90^{th} percentile	90/10 ratio	Equalization ratio
	Base year	12,000	92,000	7.70	-
5 years	Homogeneous model	19,000	97,000	5.18	0.67
	Fixed effect model	15,000	95,000	6.4	0.83
	Dynamic model	19,000	98,000	5.29	0.69
10 years	Homogeneous model	22,000	100,000	4.60	0.60
	Fixed effect model	16,000	97,000	6.16	0.79
	Dynamic model	21,000	101,000	4.82	0.63
15 years	Homogeneous model	23,000	100,000	4.31	0.56
	Fixed effect model	16,000	96,000	6.03	0.78
	Dynamic model	22,000	102,000	4.58	0.59
20 years	Homogeneous model	24,000	100,000	4.09	0.53
	Fixed effect model	16,000	95,000	5.96	0.77
	Dynamic model	23,000	102,000	4.34	0.56

Appendix B

Chapter 4 Appendix

Table B.1: Unemployment rate in Canada among the age group from 15 to 64 years old from 1986 to 2018

Year	Unemployment rate (%)	Year	Unemployment rate (%)
1988	7.8	2004	7.2
1989	7.5	2005	6.8
1990	8.1	2006	6.3
1991	10.3	2007	6.0
1992	11.2	2008	6.1
1993	11.4	2009	8.3
1994	10.4	2010	8.1
1995	9.5	2011	7.5
1996	9.6	2012	7.3
1997	9.1	2013	7.1
1998	8.3	2014	6.9
1999	7.6	2015	6.9
2000	6.8	2016	7.0
2001	7.2	2017	6.3
2002	7.7	2018	5.8
2003	7.6		

Source: CANSIM Table 14-10-0018-01 (formerly CANSIM 282-0002)

Table B.2: Summary of Important Immigration Policies in Recent Years

Policy/Program	Date	Description of Changes	Effects on Int'l Ph.D. Students	
			Work Permit	PR
Streamlining the SP application process	2005	International students can obtain a study permit valid for the full length of their intended period of study, and those in post-secondary studies can transfer between programs of study and institutions (public and private) without first making an application to CIC	N/A	N/A
PGWP Program	May 2005	International student graduates from a recognized Canadian educational institution outside Montreal, Toronto and Vancouver can work after graduation in Canada for an additional year (up to a total of two years)	Positive	Positive
OCWP Program	Apr 2006	Full-time international students with an OCWP at participating educational institutions can work off campus during their studies for up to 20 hours per week	Positive	Positive
PGWP Program	Apr 2008	International student graduates can obtain an open work permit (for up to three years), with no restrictions on the type of employment and no requirement for a job offer.	Positive	Positive
Canadian Experience Class	Sep 2008	International student graduates with professional, managerial and skilled work experience have access to a new immigration stream that allows their education and work experience in Canada to be considered as key selection criteria for permanent residence.	N/A	Positive
Ministerial Instructions	Nov 2011	New FSW eligibility stream is launched for international students pursuing doctoral studies.	N/A	Positive
OCWP Program	Jun 2014	International students can qualify to work off-campus for up to 20 hours per week during their studies without a work permit	Positive	Positive
Express Entry (EE)	Jan 2015	EE is a new application management system for certain immigration programs including Federal Skilled Worker Program, Federal Skilled Trades Program, Canadian Experience Class and a portion of the Provincial Nominee program	N/A	Positive
Express Entry (EE)	Nov 2016	Up to 30 points are awarded for eligible credential from programs in Canada	N/A	Positive

Source: Immigration, Refugees and Citizenship Canada (2005, 2006, 2007, 2008, 2009, 2010, 2011a,b, 2012, 2013, 2014, 2015a,b, 2016, 2017, 2018, 2019)

Table B.3: Monthly Full-time Education Amount for Tax Purposes

Year	Dollar per month
1983 to 1987	50
1988 to 1991	60
1992 to 1995	80
1996	100
1997	150
1998 to 2000	200
2001 to 2005	400
2006 to 2016	465

Source: IMDB Tax Dictionary (2018)

Table B.4: Estimates for the Logit Model:
The Probability of Getting PR During the Study Period

Regressors	Coefficient Estimates		
	(1)	(2)	(3)
Intercept	-3.17***	-3.59***	-3.43***
	[0.41]	[0.41]	[0.41]
Gender	-0.08	-0.06	-0.06
	[0.06]	[0.06]	[0.06]
Age at arrival	0.08***	0.08***	0.08***
	[0.01]	[0.01]	[0.01]
Destination province			
Alberta	0.08	0.02	0.06
	[0.07]	[0.07]	[0.07]
BC	-0.42***	-0.42***	-0.42***
	[0.07]	[0.07]	[0.07]
MA-SA	-0.10	-0.08	-0.11
	[0.10]	[0.10]	[0.10]
NFL-PEI-NS-NB	-0.39***	-0.48***	-0.37***
	[0.11]	[0.11]	[0.11]
Region of birth			
Africa	0.15	0.14	0.19*
	[0.10]	[0.10]	[0.10]
America	-2.23***	-2.19***	-2.21***
	[0.09]	[0.10]	[0.09]
Europe	-1.17***	-1.11***	-1.16***
	[0.08]	[0.08]	[0.08]
Oceania or Antarctica	-2.30***	-2.40***	-2.35***
	[0.33]	[0.35]	[0.34]
Recession	-0.03	-0.01	0.00
	[0.08]	[0.08]	[0.08]
Unemployment rate	-0.05**	-0.04*	-0.04*
	[0.02]	[0.02]	[0.02]
WP Policies - Less Restrictive	-0.81***	-0.85***	-0.94***
	[0.13]	[0.13]	[0.13]
PR Policies - Less Restrictive	0.43***	0.44***	0.40***
	[0.12]	[0.12]	[0.12]
Years of study			
4-to-5 years	2.13***	2.13***	2.15***
	[0.07]	[0.07]	[0.07]
More than 5 years	3.03***	3.10***	3.11***
	[0.06]	[0.07]	[0.07]
No. of observations		10,660	

NFL: Newfoundland and Labrador, PEI: Prince Edward Island, NS: Nova Scotia, NB: New Brunswick, ON: Ontario, MA: Manitoba, SA: Saskatchewan, AL: Alberta, BC: British Columbia

Table B.5: Estimates for the Logit Model: The Probability of Remaining in Canada in the Year Following the End of Study Period

Regressors	Coefficient Estimates			
	(1)	(2)	(3)	(4)
Intercept	-0.34	-1.89***	-0.54	-2.22***
	[0.76]	[0.41]	[0.69]	[0.52]
Female	-0.13	-0.17**	-0.32***	-0.09
	[0.10]	[0.06]	[0.09]	[0.07]
Age at arrival	0.07***	0.05***	0.05**	0.05***
	[0.03]	[0.01]	[0.02]	[0.02]
Destination Province				
Alberta	0.52***	0.31***	0.12	0.43***
	[0.14]	[0.08]	[0.13]	[0.10]
BC	-0.11	-0.05	-0.22*	0.06
	[0.12]	[0.07]	[0.11]	[0.09]
MA-SA	0.61***	0.37***	0.35*	0.37**
	[0.21]	[0.11]	[0.19]	[0.14]
NFL-PEI-NS-NB	0.22	-0.17	-0.21	-0.13
	[0.25]	[0.10]	[0.19]	[0.12]
Region of birth				
Africa	0.35*	0.22*	0.59**	0.12
	[0.21]	[0.13]	[0.27]	[0.15]
America	0.03	-0.74***	-0.69***	-0.75***
	[0.24]	[0.07]	[0.11]	[0.09]
Europe	-0.39***	-0.66***	-0.55***	-0.74***
	[0.14]	[0.08]	[0.12]	[0.10]
Oceania or Antarctica	-1.25**	-0.95***	-0.87**	-0.96***
	[0.63]	[0.25]	[0.36]	[0.35]
Recession	-0.18*	-0.16*	-0.68***	0.07
	[0.11]	[0.09]	[0.15]	[0.12]
Unemployment rate	0.07	-0.05**	0.01	-0.07**
	[0.05]	[0.03]	[0.05]	[0.03]
WP policies - Less restrictive	-	0.79***	0.45***	0.99***
	-	[0.07]	[0.11]	[0.09]
PR policies - Less restrictive	-	0.25***	-0.24*	0.56***
	-	[0.10]	[0.15]	[0.13]
Years of study				
4-to-5 years	-0.22	0.93***	-	-
	[0.18]	[0.08]	-	-
More than 5 years	-0.27*	1.12***	-	-
	[0.16]	[0.08]	-	-
No. of observations	3,970	6,680	2,245	4,435

(1) Students who have PR at the end of their study period; (2) Students who do not receive PR at the end of their study period; (3) Students who do not receive PR at the end of their study period and study at least 4 years; (4) Students who do not receive PR at the end of their study and study less than 4 years.

NFL: Newfoundland and Labrador, PEI: Prince Edward Island, NS: Nova Scotia, NB: New Brunswick, ON: Ontario, MA: Manitoba, SA: Saskatchewan, AL: Alberta, BC: British Columbia

Curriculum Vitae

Name:	Minh Phuong Vu
Post-Secondary Education and Degrees:	University of Western Ontario London, Ontario, Canada 2015-2023 Ph.D. University of Queensland Brisbane, Queensland, Australia 2009 - 2010 M.A. Foreign Trade University Hanoi, Vietnam 2004 - 2008 B.A.
Honours and Awards:	Graduate Student Academic Award Competition Centre of Research on Social Inequality 2021-2022 Western Graduate Research Scholarship University of Western Ontario 2018-2019 Social Science Graduate Alumni Awards University of Western Ontario, Canada 2018 Gervan Fearon Ph.D. Award in Economics University of Western Ontario, Canada 2017 Ph.D. Fellowships Vietnam Government Scholarship 2015 - 2018

Related Work Experience:

Research and Teaching Assistant
The University of Western Ontario
2015 - 2021

Lecturer
The University of Western Ontario
2019 - 2023

Lecturer
Foreign Trade University
2010-2015