An Investigation of Brain Drain/Gain in Atlantic Canada (2011-21) Using a Revised Index and Probit Model

by

Nabeel Iqbal

Bachelor of Business & Commerce, Monash University Malaysia, 2011

Master of Economics, University of New South Wales, 2014

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Supervisors: Fariba Solati, PhD, Department of Economics
Murshed Chowdhury, PhD, Department of Economics

Examining Board: Luc Thériault, PhD, Department of Economics, Chair
Weiqiu Yu, PhD, Department of Economics
Mehmet Dalkir, PhD, Department of Economics

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ABSTRACT

Brain drain or gain, through changes in the stock of human capital, can affect the productivity and economic growth of a region. However, precisely determining whether a province inside a country has experienced brain drain or gain during a period can be challenging since it depends on the net flow, both inflow and outflow, of skilled workers. This study utilizes a revised Brain Drain/Gain Index (BGDI*) to investigate brain drain/gain in Atlantic provinces and compare their situation to other provinces in Canada. The BGDI*s, calculated using the Canadian National Household Survey (2011), Census 2016 and 2021, and Postsecondary Student Information System (PSIS) data, indicate that most of the Atlantic provinces experienced brain drain during 2011-16 and brain gain during 2016-21. Estimation from a probit model reveals that recent immigrants, more educated individuals, higher income groups, and ethnic minorities have a higher tendency to move out of the Atlantic provinces.

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List of Symbols, Nomenclature or Abbreviations

AB	Alberta
BC	British Columbia
BGDI	Brain Drain/Gain Index
BGDI*	Revised Brain Drain/Gain Index
CA	Canada
MB	Manitoba
NB	New Brunswick
NF	Newfoundland and Labrador
Non-PR	Non-Permanent Residents
NS	Nova Scotia
NT	Northwest Territories
NU	Nunavut
ON	Ontario
PEI	Prince Edward Island
QB	Quebec
SK	Saskatchewan
Stat Can	Statistics Canada
UK	United Kingdom
UNESCO	The United Nations Educational, Scientific and Cultural Organization
US	United States of America
YT	Yukon

1. Introduction

Atlantic Canada, one of the five regions of Canada, is composed of the provinces Newfoundland and Labrador (NL), Prince Edward Island (PEI), Nova Scotia (NS) and New Brunswick (NB). NL has the largest area of the four provinces followed by NB, NS and PEI. As of the second quarter of 2024, the total population of the entire Atlantic Canada region was approximately 2.64 million, 6.4% of the entire population of Canada (Statistics Canada, 2024a). Out of the four provinces, NS has the highest population, followed by NB, NF and PEI. The other regions in Canada are Central Canada, containing the provinces Quebec (QB) and Ontario (ON); Prairie Provinces, composed of Manitoba (MB), Saskatchewan (SK) and Alberta (AB); West Coast containing British Columbia (BC) only; and North, constituting the territories Nanuvat (NU), Northwest Territories (NT) and Yukon Territory (YT).

Although the provinces of Atlantic Canada have historically experienced low output per capita and high unemployment rate as compared to overall Canada, the gap had been narrowing between 1997 to 2010 (McMahon, 2022). However, after 2010 the gap in terms of GDP per capita and unemployment rate started widening again (McMahon, 2022). The real median incomes in the Atlantic provinces have also been among the lowest of all the provinces in recent times, represented in Figure 1 next page (Statistics Canada, 2024b). Whereas the real median incomes in the other provinces and regions converged to the overall Canada level in 2021, in the Atlantic provinces it still lagged behind as of 2021.

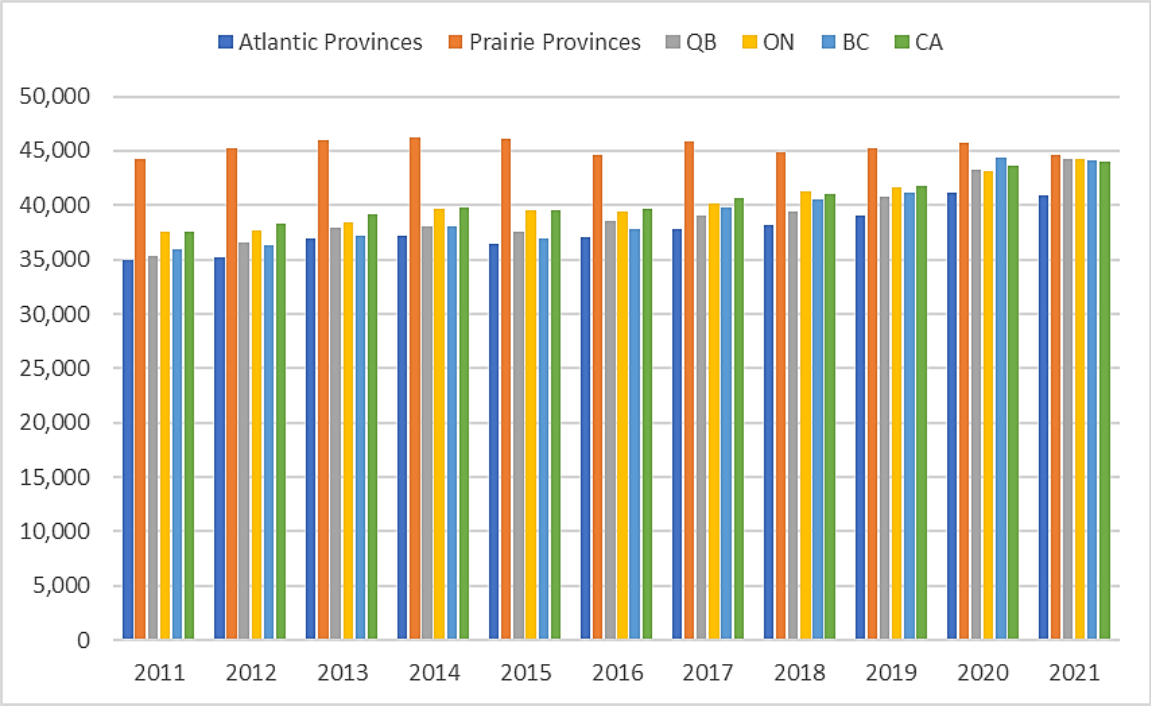

Figure 1: Real median income by province and region (Source: Statistics Canada, 2024b. See Table 5 in Appendix)

Since one of the important determinants of productivity and economic growth is human capital (Romer, 1986; Becker, 1993; Fuente & Ciccone, 2002; Zhang & Lucey, 2019), it is not surprising that the poor performance of the Atlantic provinces in certain economic indicators in recent times overlaps with lackluster growth in the stock of human capital. Imbalances of human capital flows can pose a serious threat to the social and economic development of certain regions and lead to spatial disparities (Sano et al. 2020; Zhang & Lucey, 2019; Robichaud, 2013 as cited in Hillier et al. 2020). Drummond and McIntosh (2018) note that one of the Atlantic region's biggest challenges is a lack of population growth and a rapidly aging population. As per Census 2021 data, the percentage of the population aged 25-64 with a minimum of bachelor's degree in Atlantic Canada was 13.4%, whereas overall in Canada it was 19.4%. Between 2016 and 2021 the percentage of skilled workers increased by 16.3% in Atlantic Canada, as compared to a 33% increase

at the national level. Figure 2, illustrates that the proportion of population with tertiary education has increased much less in the Atlantic provinces as compared to overall Canada and the gap between the two have been persistent.

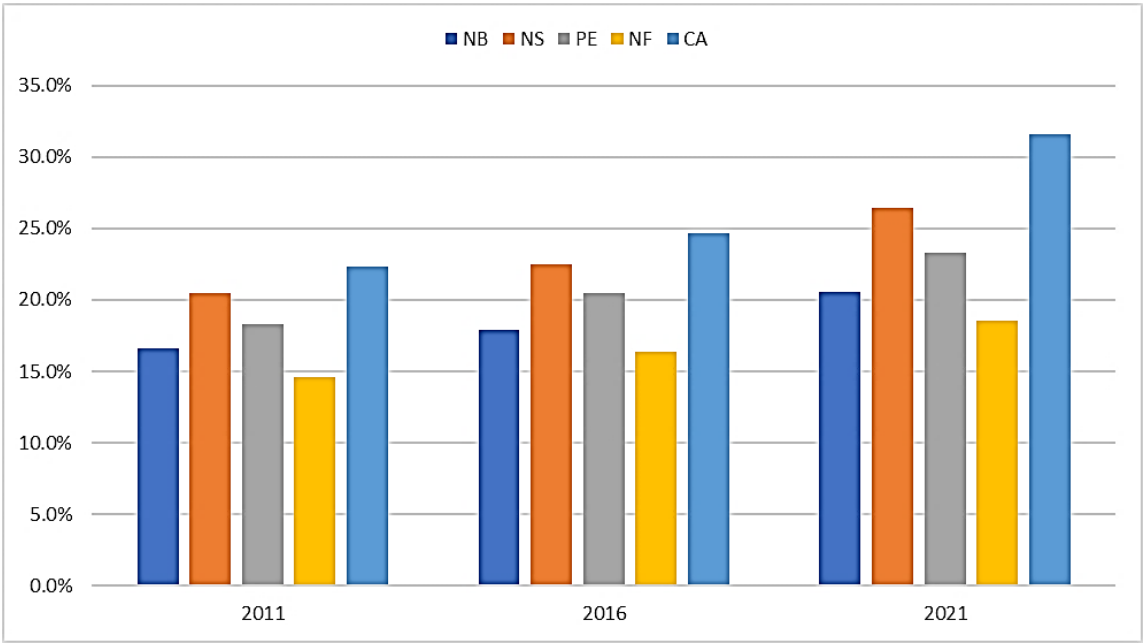

Figure 2: Percentage of working-age population aged 25-64 with tertiary degrees (Source: Census 2011, 2016 and 2021. See Table 7 in Appendix)

Possible sources of human capital for a province or region are the inflow of internal migrants (from other provinces in Canada) and external migrants (from abroad) as well as tertiary graduates from its universities (Zhang & Lucey, 2019). The inflow of skilled migrants can improve the rate of accumulation of human capital and improve the economic performance of a region (Boschma & Fritsch, 2009; Champion et al., 2014; Florida et al., 2008; Fu & Gabriel, 2012; Gottlieb & Joseph, 2006; Tang et al., 2014 as cited in Hu et al., 2022). The outflow of skilled migrants can deplete the stock of human capital or thwart its growth rate compromising the productivity, income, and economic growth of a region (Hu et al., 2022; Zhang & Lucey, 2019; Artz, 2003).

Between 2011 and 2016 most of the Atlantic provinces experienced significant negative net interprovincial migration (out-migration > in-migration) (Statistics Canada, 2024d). During 2016-2021, the scenario reversed, and most of the Atlantic provinces experienced significant positive net-migration (in-migration > out-migration) (Statistics Canada, 2024d). However, we cannot conclude whether a province experienced brain drain/gain from aggregate flows alone. Whether a region experiences brain drain or gain during a period depends on the net flow (inflow – outflow) of skilled migrants who are a subset of the aggregate flows (Zhang and Lucey, 2019; Zong and Lu, 2018; Zhao et al., 2000).

To examine various attributes relevant to brain drain/gain in Atlantic Canada, this study addresses the following questions:

1. What are the challenges of using current measures of brain drain/gain at the provincial level in Canada? How can these measures be improved?

2. Was there brain drain/gain in Atlantic Canada during 2011-2016? Was the trend the same in 2016-2021?

3. What are the determinants of brain drain from Atlantic Canada? Do education, work status, knowledge of language, and income affect migration decisions of skilled workers? To what extent does age, minority status, immigration status and year, and family structure affect migration decisions? Has there been any change in the determinants over time?

To answer the above questions, we use a revised version of the Brain Drain/Gain Index[1] (BGDI*) developed by Zhang and Lucey (2019). The socioeconomic and demographic factors associated with the out-migration of skilled workers (brain drain) are investigated using a probit model adapted from the literature (Hu et al., 2022; White & Haan, 2021; Greenwood, 2005).

The revised index indicates that all the Atlantic provinces experienced brain drain during 2011-16 and during 2016-21 all the Atlantic provinces except NL experienced brain gain. The regression results indicate that in addition to socioeconomic and demographic factors immigration status and years since immigration significantly affect the out-migration decision of skilled workers from Atlantic Provinces. Our findings have important policy implications related to the retention of skilled workers.

Henceforth, the report is divided into the following parts: 2) literature review (also contains a section on relevant policy changes in Canada), 3) methodology and data, 4) results and discussion, and 5) conclusion and policy recommendations.

2. Literature Review

2.1 Relevant Theories and Models

The theories related to brain drain/gain can be divided into two groups: 1) models or theories explaining the impact of brain drain/gain on origin and destination countries and 2) migration theories and models investigating factors associated with migration of skilled workers. The impact of brain drain/gain at the macroeconomic level can be

[1] BGDI denotes the index developed by Zhang and Lucey (2019). BGDI* denotes the revised index developed in this study.

explained by endogenous or new growth theory, proposed by Romer (1986), which predict that additional human capital will lead to technological externalities which affect productivity and economic growth positively (Lowell and Findlay, 2001; Zhang and Lucey, 2019; Berger, 2022). Romer's model argues that knowledge or ideas, unlike capital and labor, do not have a decreasing return to scale, rather the returns to scales are increasing. This is due to the fact that knowledge is non-rival, use by one agent does not exclude its use by other agents (Romer, 2012; Zhang and Lucey, 2019). Tertiary education is a proxy for knowledge or capacity to generate ideas through research and innovation (Zhang and Lucey, 2019). Therefore, migration of tertiary educated skilled workers[2] can affect the economic growth of a region through generation of new ideas as predicted by the new or endogenous growth theory.

At a microeconomic level the human capital theory (Becker, 1993) explains the link between education/training and productivity. Becker (1993) explains schooling raises earnings and productivity mainly by providing knowledge, skills, and a way of analyzing problems. Becker (1993) also notes an alternate view which argues that schooling, in and of itself, does not raise productivity but conveys information about the latent abilities of a person—persistence, integrity, etc.—which are positively related to productivity. López-Bazo and Motellón (2009) argues that human capital facilitates the generation and adoption of technological innovations that improve productivity. Whichever the case, theory indicates education and productivity are positively associated, and higher productivity leads to higher wages (Mincer, 1974; Becker, 1962 as cited in Afxentiou and Kutasovic,

[2] Whenever we use the term skilled worker, it implies working age tertiary educated individuals. Vice versa.

2009). Therefore, there is a positive association between wage and productivity and one can be proxied for the other (Strain, 2019; Policardo et al., 2019).

Brain drain/gain is an issue of the migration of skilled workers and hence the theories and models related to migration are also relevant to our study. The theoretical foundations of migration research can be divided into the following: 1) the disequilibrium perspective and 2) the equilibrium perspective. The disequilibrium perspective argues that differences in income present opportunities for utility gain and hence motivates migration and this was the foundation of migration research prior to the late 1970s (Greenwood, 2005). The equilibrium perspective, a more recent theory, posits that differences in wages are compensated by other factors, such as costs of living, and therefore do not offer opportunities for utility gains (Greenwood, 2005).

The empirical models of migration used in brain drain/gain studies can be broadly categorized into two types (Greenwood, 2005; Molho, 1986): 1) gravity and modified gravity models and 2) the human capital model. The original gravity model of migration, conceptualized in the 1940s, focuses on the nexus between distance and migration (Greenwood, 2005). Later, in the modified gravity models, developed in the 1960s, additional variables such as income and unemployment rates were added (Greenwood, 2005; Molho, 1986). There are two main variations of the human capital model: 1) present value comparisons model and 2) spatial job-search model. In the former, an individual will select the location at which the real value of the expected net benefit that accrues to him or her from migration is the greatest. In the spatial-job search model, an individual search for employment opportunities in different locations and if the wage of an offered job exceeds the individual's reservation wage--the lowest wage they would accept in a potentially new

region of residence--then the individual migrates. The reservation wage in turn depends on the person's socioeconomic and demographic characteristics (Greenwood, 2005). Therefore, decision to migrate depends upon the socioeconomic and demographic characteristics of the individuals (Hu et al. 2022; White and Haan, 2021). Since there is a scope for utility gain from wage differences, the spatial job-search model is grounded in the disequilibrium perspective (Greenwood, 2005). In this study, we adopt this framework.

Next, we investigate the brain drain/gain literature at both the country level and the provincial level.

2.2 Brain Gain/Drain: Country Level

In a comprehensive review of the literature on brain drain at the country level, Docquier and Rapoport (2011) categorize the extant literature into three batches. The first batch focusing on welfare analyses came out in the late 1960s (Grubel and Scott, 1966 as cited in Docquier and Rappoport, 2011; Johnson, 1967; Berry and Soligo, 1969). The general conclusion of these earlier theoretical studies is that the impact of brain drain on source countries is neutral because of benefits from emigration, such as remittances and scientific discovery, offsetting losses (Johnson, 1967). However, the flow of brains can benefit the world economy through assets left behind by skilled workers and remittances (Berry and Soligo, 1969). The second batch of studies in the 1970s reached a different conclusion and argued that because of institutional factors brain drain can affect the source countries negatively by dampening economic growth (Bhagwati and Hamada, 1974; McCulloch and Yellen, 1977 as cited in Docquier and Rappoport, 2011). The third batch of studies in the 1990s offered a more balanced view and sought to characterize the conditions under which brain drain resulted in positive and negative outcomes. It was

during this time that evidence-based empirical research began to surface, complementing the balanced view (Docquier and Rappoport, 2011). For example, Beine et al. (2011) utilizing a dynamic regression model on panel data from 1975-2000 of 147 countries found that outflow of skilled workers may benefit the origin countries as long as out-migration rate takes intermediate values between 20-30%. Batista et al. (2012) finds evidence of this in Cape Verde where probability of future migration is positively related to probability of school completion. Beine et al. (2001) uses cross-section data of 37 developing countries and identifies the economic conditions necessary for origin countries—no underdevelopment trap and high growth performance—to derive net benefits from brain drain. These studies labelled as the "new brain drain literature" highlight the possibility of source countries benefitting from outflow of skilled workers.

Despite the optimistic tone of the "new brain drain literature", there is still skepticism about the idea that brain drain may ultimately benefit origin countries. Schiff (2005), in a theoretical paper, mathematically shows that benefits to origin countries are exaggerated in many studies and can even be negative. This is because individuals with higher ability are more likely to migrate leaving behind workers with lower ability. The benefits from the positive association between tertiary education migration and future migration probability can be offset by the benefits of unskilled migration which results in negative incentive for tertiary education. Robertson (2006) notes that remittances from skilled workers are not necessarily more than unskilled workers since the former tends to migrate on a more permanent basis with family. In addition, remittances may push up prices and reduce purchasing power. Additionally, brain drain can transfer costs and risks to the less powerful countries (Robertson, 2006).

Some papers have focused on the conceptualization and reconceptualization of brain drain/gain. Baldacchino (2006) highlights the importance of reconceptualizing brain drain/gain in light of changing international economic context, such as globalization, by drawing on secondary data and emphasizing cyclical and non-linear migration patterns. Zong and Lu (2018) argues that thinking about brain drain or gain only in terms of net flow is insufficient and utilization of brain should also be factored in these studies. From a 1997-99 survey, the authors find evidence of brain waste in Canada because of "devaluation of foreign credentials and non-recognition of foreign work experience (p. 288)". This in turn can trigger return migration to origin countries. Robertson (2006) argues brain gain is not only about attracting, but also retaining talented workers. Therefore, brain drain/gain studies should not only focus on outflow and inflow of skilled workers, but also the utilization and retention of skilled workers.

Zhao et al. (2000) investigate brain drain from Canada to USA and brain gain in Canada from the rest of the world in the 1990s, and concludes that although there is a net loss of skilled workers to USA, the inflow of skilled workers from rest of the world more than compensates the outflow of skilled workers to USA. Brain gain in Canada is particularly important because of expansion of knowledge-based industries and contraction of non-knowledge-based occupations. Immigration of skilled workers was especially important in meeting demand for high-technology sectors during the 1990s (Zhao et al., 2000).

Although overall brain drain does not seem to be a serious issue in Canada, but there is evidence of sector specific brain drain (Finnie, 2001). Hence, policies vis-à-vis brain drain/gain should be sector specific so as to reduce any negative externalities upon

other sectors (Finnie, 2001). Kuhn (2001) documents the salary and benefits gap between US and Canada in the academia which works as a push factor for academics residing in Canada. A solution to this problem could be structuring wages according to individual merit and market demand (Kuhn, 2001). Barett (2001) also confirms that there is brain drain in the health sector and advocates for urgent strategies and policies to address the issue. These studies conclude that brain drain is not a serious issue at the aggregate level since immigration of skilled workers more than compensates for the outflow, but there is sector specific brain drain especially to US. One limitation of these studies is that there is lack of reliable data on people leaving Canada on a temporary basis (Zhao et al., 2000). This may make it difficult to empirically assess the brain drain/gain situation of Canada as a whole and regions inside Canada. Finnie (2001) also argues that it is difficult to assess the actual scenario of brain drain in Canada because of a lack of data. A possible solution to this problem can be proxy the net flow of skilled workers using a brain drain/gain index.

Since there is significant evidence of a positive association between economic growth and human capital (Romer, 1986; Romer, 1987; Lucas, 1988 as cited in Berger, 2022), developed countries, including Canada, have sought to attract skilled workers from around the world (Lowell and Findlay, 2001; Dirks, 2024; Troper, 2024). The Immigration Act of 1976 positioned Canada to become a destination for migrants from all countries, with three admission criteria: 1) points for skills, education and language ability, 2) sponsorship and 3) refugee status (Challinor, 2011). The 1976 act was replaced in 2002 with a greater emphasis on education, language, and adaptability which fueled migration flows to Canada (Troper, 2024). In 2010, 81 percent of all economic immigrant admissions were under the Federal Skilled Worker Program (FSWP) (Challinor, 2011). The Express

Entry is Canada's application management system for certain economic immigration programs including the Federal Skilled Worker Program, Federal Skilled Trades Program, Canadian Experience Class and a portion of the Provincial Nominee program was launched in 2015. Express Entry was designed with the following objectives in mind: 1) flexibility in selection and application management, 2) responsiveness to labor market and regional needs and 3) speed in application processing (Government of Canada, 2015).

However, historically, the skilled immigrants always exhibited the tendency to settle in larger cities in Ontario, Quebec, and British Columbia (Trovato, 1988, Newbold 1996). In response to this challenge, the Provincial Nominee Programs (PNP) were introduced in 1998 which allows provincial governments to nominate specific immigrant applicants, with the requirement that they reside for a period of time in that province. The Atlantic Immigration Program (AIP) was introduced in 2017 as a pilot program and became permanent in 2022 in order to boost population growth and human capital (CANADIM, 2024). Unique to the AIP immigration program is the employer's obligation to create a settlement plan for the immigrant that is hired (House of Commons, 2017).

2.3 Brian Drain/Gain: Regional/Provincial Level

Although significant work has been done on brain drain/gain at the country level, studies focusing on migration of skilled workers within the same country is limited (Zhang & Lucey, 2019). Artz (2003) studies migration in relation to brain drain in rural America and finds evidence of metropolitan areas gaining college-educated workers at the expense of certain non-metropolitan and rural areas in the USA. Similarly, in Germany, studies indicate human capital flight from the east to the west (Brücker & Trubswetter, 2007; Cuhls, 2007). Brücker and Trubswetter (2007) uses a switching regression model to find

that the wage and employment differences drive the east to west migration in Germany. In a study focusing on the 100 largest studies in the UK, Cowling (2009) finds that talented individuals are attracted by "entrepreneurial culture" and some cities in the UK had three times more highly educated workers than others. Hu et al. (2022) study the migration of skilled workers from Beijing, China, to other provinces, using a probit selection model and finds that out-migration of skilled workers is affected by house ownership and ease of access to schools.

In Canada, Hillier et al. (2020) and Sano et al. (2020) studies rural out-migration of youth population. Hillier (2020) investigates north-south out-migration among the age group 17 to 30 in Canada using Statistics Canada's Youth in Transition Survey. The study implements survival analysis, instead of logistic regression, and finds that probability of migration increases with age (until a certain point), parent's education, and individual's education level. Decision to migrate is also influenced by occupation level, family structure, and province. Sano et al. (2020) using the same data set investigate the characteristics of youth out-migrants and return migrants in rural Canada and finds results similar to Hillier (2020). Many studies have also looked into why the interprovincial migration inside Canada has decline over time. White and Haan (2021) use decomposition analysis to find that the effect of changes in demographic characteristics on migration decisions are behind the decline in interprovincial migration.

Contemporary studies investigating brain drain/gain or human capital flows vis-à-vis Atlantic provinces are scarce. Lionais (2020) et al. in a descriptive study using 2006-11 data investigates the importance of mobile oil work in Alberta to the economy of Atlantic Canada. They find that communities from NF and the Cape Breton region is

relatively more dependent on mobile oil work in Alberta. In another descriptive study, McMahon (2022) investigates the evolution of the economy of Atlantic Canada between 1961-2019. A key finding of this study is that during 1997 and 2014 Atlantic provinces rapidly closed its gap with the rest of Canada with respect to GDP per capita and unemployment levels. However, during 2010-19 the gap in terms of GDP per capita between Atlantic provinces and the rest of Canada started widening again. This could be due to the lackluster growth in the stock of skilled workers as compared to the rest of Canada (Drummond & McIntosh, 2018).

To our knowledge, there are no papers on brain drain/gain in relation to NB. Wu (1999) analyzes the competitiveness of NB during 1961-96 using indicators suggested by World Bank. The paper finds that although the GDP per capita and labor productivity in NB was lower, their growth rates on average was higher as compared to overall Canada. Echoing McMahon's (2022) study on Atlantic Canada, Wu (1999) also finds that the government consumption expenditure as a percentage of GDP in NB is significantly higher as compared to the national level. Interestingly, the post-secondary enrollment in NB as a percentage of the population was significant lower as compared to overall Canada. In a conceptual paper, Savoie (2010) argues that out-migration from NB has been a problem. Resonating with McMahon (2022), Savoie (2010) also argues that relatively higher transfer payments in NB may have created economic dependency. In addition, the paper identifies slow economic growth and inability to attract new Canadians as challenges for NB and calls for a greater participation from the academia in policy making.

Many of the above studies, investigating brain drain at the regional level, inside a country, assume that brain drain is "the out-migration of young, college-educated workers"

(Artz, 2003). However, whether a region experiences brain drain/gain is connected to the net flow of migrants, both in-migrants and out-migrants. Zong and Lu (2018) draw attention to this fact. To precisely and empirically answer the question—is a particular region actually experiencing a brain drain/gain—we can utilize a brain drain/gain index that accounts for both inflow and outflow of skilled workers. To our knowledge, none of the studies investigating regional brain drain/gain inside a country considers the net effect of internal migration (within the country), immigration, and emigration to empirically answer the important policy question: is a region actually experiencing brain drain or is there a brain gain?

Zhang and Lucey (2019) develops a novel brain drain/gain index (BGDI) which takes into account both inflow and outflow of skilled workers to empirically assess brain drain/gain at the country level in the EU region. The BGDI weighs the change in the stock of the skilled workers in a country against the number of skilled workers generated by the country and does not require data of in- and out-migrants. In this study, we employ a revised version of the BDGI to investigate the net effect of interprovincial migration, immigration, and emigration on the Atlantic provinces inside Canada between 2011 to 2021. The BGDI can provide an answer to the important policy question, is there an issue of brain drain in Atlantic Canada?

2.3 Integration of the Literature

To our knowledge, the literature does not draw attention to an important conceptual difference between the study of brain drain/gain at the country level and regional level. Whereas the net flow at the national level depends upon immigration (inflow) and emigration (outflow), the net flow at the provincial level depends upon immigration,

emigration, interprovincial in-migration, and interprovincial out-migration. Also, many studies, especially at the regional level, explicitly or implicitly define brain gain as the inflow of skilled workers from a region and brain drain as the outflow of skilled workers from a region (Stark et al. 1997; Hillier et al. 2020; Sano et al. 2020). This abstraction can be rationalized in situations where the flow of skilled workers is mostly unilateral, for example, from developing to developed countries or regions. However, in many cases, such as for a region inside Canada, this conception can be problematic. This is because there is significant inflow of immigrants into a typical a province in Canada and there can also be significant outflow in the form of interprovincial migration. Therefore, whether a province or region ultimately experiences brain drain or gain depends on both outflow and inflow of skilled workers, that is, the net flow of skilled workers (Zong & Lu, 2018; Zhang & Lucey, 2019). A problem, however, is that detailed data on the outflow and inflow of migrants are not always available (Zhong et al., 2020).

In this study, we use a revised version of the Brain Drain/Gain Index developed by Zhang and Lucey (2019) to empirically assess whether a region experienced brain drain/gain by approximating the net flow of skilled workers. The index does not require detailed microdata of the in- and out-migrants, only the change in the stock of tertiary educated population and the number of tertiary graduates, and can be applied when such information is lacking. However, the original version of the index cannot approximate the net flow accurately because it does not account the depletion of human capital due to aging. Therefore, we revise the index to incorporate depletion of the stock of human capital due to aging and then utilize it to empirically assess brain drain/gain in the Atlantic Canada. We also use a probit model based on the disequilibrium theory and spatial job-search model

of migration (Hu et al. 2022; White & Haan 2021; Greenwood, 2005) to investigate the socioeconomic and demographic factors associated with the out-migration of skilled workers from Atlantic provinces during 2011-16 and 2016-21 using Census microdata. To our knowledge, there is no study on the out-migration of skilled workers from the Atlantic provinces. This study can fill that gap.

Our contribution to the literature are as follows: 1) establishing conceptual differences between brain drain/gain at the country level and regional/provincial level, 2) conceptualizing brain drain/gain at the regional level in Canada in terms of net flow, 3) mathematically connecting the net flow conception to a revised Brain Drain/Gain Index, and 4) investigating the socioeconomic and demographic factors associated with the out-migration of skilled workers from Atlantic provinces using probit model based on the disequilibrium theory and spatial job-search model of migration.

3. Methodology and Data

3.1 Brain Drain/Gain Index (BGDI)

Our investigation of brain drain/gain in Atlantic Canada begins by establishing conceptual differences between brain drain/gain at the country level and provincial level. For both, we adopt the net flow definition of brain drain/gain (Zhao et al., 2000; Finnie 2001). A region or country is a brain drain (gain) region if the net flow of skilled workers is negative (positive). The net flow is positive when in-migration of skilled workers is greater than the out-migration of skilled workers, and the net flow is negative when the out-migration of skilled workers is greater than the in-migration of skilled workers. However, the net flow of workers at the country level constitutes only two variables,

immigration and emigration. Therefore, country level studies can focus on only two factors, immigration and emigration of skilled workers, to empirically determine whether a country is experiencing net brain drain or gain. In contrast, the net flow of skilled workers in a province or region inside a country, in addition to emigration and immigration, is also affected by interprovincial migration. Therefore, studies at the provincial level also needs to factor in interprovincial out-migration and interprovincial in-migration as well as immigration and emigration. Microdata of all these variables might not be available. For example, in Canada we do not have reliable data of individuals leaving Canada temporarily (Zhao et al., 2000). This makes answering the important policy question "Is there an issue of brain drain in a province in Canada?" difficult.

A revised version of the brain drain/gain index developed by Zhang and Lucey (2019) can proxy the net flow of skilled workers in a region by weighing the change in the stock of tertiary educated skilled workers adjusted for aging against the total number of tertiary students graduating from universities. The original index, which does not consider aging of population, for region i at time $t+n$ is as follows:

$$BDGI_{i,t+n} = \frac{S_{i,t+n} - S_{i,t}}{\sum_{j=1}^{j=n} G_{i,t-j}} \quad (1)$$

At time t the stock of skilled workers in region i is $S_{i,t}$ and at time $t+n$ the stock of skilled workers is $S_{i,t+n}$. The change in the stock of human capital between time t and $t+n$ in region i is then $S_{i,t+n} - S_{i,t}$. $G_{i,t}$ is the number of students graduating with tertiary degrees in region i. The j is used to accommodate a lag that accounts for the graduates from previous year who will be entering the skilled worker bracket during the period that is being analyzed. Zhang and Lucey (2019) argues if $S_{i,t+n} - S_{i,t} > \sum_{j=1}^{j=n} G_{i,t-j}$, then

region i is a brain gain region, and if $S_{t+n} - S_t < \sum_{j=1}^{j=n} G_{i,t-j}$ then the region is a brain drain region. Zhang and Lucey (2019), however, do not connect the formula to the net flow definition of brain drain/gain and does not consider depletion of human capital due to aging which is significant for Canada.

Here, we factor in the depletion of human capital due to aging and connect the formula to the net flow of tertiary educated skilled workers. Let us assume that A_i represents the decline in the stock of skilled workers in region i due to aging during a period[3]. A portion of the in-migrants and tertiary graduates will contribute towards the replacement of aging population which Zhang and Lucey (2019) does not consider. To derive the necessary conditions for a brain drain/gain and to derive the revised index, we consider annual or yearly changes in order to simply the problem[4]:

$$S_{i,t+1} - S_{i,t} = I_i - O_i + G_i - A_i \qquad (2)$$

Equation 2 states that the annual change in the stock of tertiary educated skilled workers in province i $(S_{i,t+1} - S_{i,t})$ is a function of the inflow (I) and outflow (O) of skilled workers, the number of students graduating from the tertiary institutions of that province (G), and aging of population which causes skilled workers to enter retirement and thus move out of the skilled worker bracket (A).

$$S_{i,t+1} - S_{i,t} = I_i - O_i + G_i - A_i$$

$$\rightarrow \quad S_{i,t+1} - S_{i,t} + A_i = I_i - O_i + G_i$$

[3] For example, if we are analyzing the period 2016-21 and if 1,000 individuals were aged 59-64 in 2016, then in 2021 all of them would enter retirement. Hence, $A_i = 1{,}000$ in this case. These individuals would drop out of the skilled workers bracket during 2016-21.

[4] The RHS of the equation represents annual changes between t and $t + 1$.

Since we are defining brain gain as positive net flow, the corresponding mathematical condition is, $I_i - O_i > 0 \rightarrow S_{i,t+1} - S_{i,t} + A_i - G_i > 0 \rightarrow S_{i,t+1} - S_{i,t} + A_i > G_i$

$$\rightarrow \frac{S_{i,t+1} - S_{i,t} + A_i}{G_i} > 1$$

. Now, if we define the revised index as:

$$BDGI^*_{i,t+n} = \frac{S_{i,t+n} - S_{i,t} + A_{i,t+n}}{\sum_{j=1}^{j=n} G_{i,t-j}} \quad (3),$$

then $\frac{S_{i,t+1} - S_{i,t} + A_i}{G} > 1 \rightarrow BGDI > 1 \rightarrow I_i - O_i > 0 \rightarrow$ positive net flow → brain gain.

Similarly, we can derive the necessary condition of a brain drain which we define here as negative net flow and mathematically represent as, $I_i - O_i < 0 \rightarrow S_{i,t+1} - S_{i,t} + A_i - G_i < 0 \rightarrow S_{i,t+1} - S_{i,t} + A_i < G_i \rightarrow \frac{S_{i,t+1} - S_{i,t} + A_i}{G_i} < 1$

If we do not consider the fact that the stock of human capital of a region depletes naturally due to aging and that a portion of in-migrants and local graduates will contribute towards that replacement, the BGDI formulae will have a downward bias. Arguably, this is the reason that Zhang and Lucey (2019) finds that most of the countries in Europe experienced brain drain even though many of these countries attract a significant number of skilled migrants. We can show the downward bias by assuming that a fraction of the tertiary graduates, α, generated by a province or country will offset the depletion of the stock of human capital due to aging. Therefore:

$$BDGI_{i,t} = \frac{S_{i,t+n} - S_{i,t} + A_{i,t+n}}{\sum_{j=1}^{j=n} G_{i,t-j}}$$

$$\rightarrow BDGI_{i,t} = \frac{S_{i,t+n} - S_{i,t} + \alpha \sum_{j=1}^{j=n} G_{i,t-j}}{\sum_{j=1}^{j=n} G_{i,t-j}}$$

$$\rightarrow BDGI^{*}_{i,t} = \frac{S_{i,t+n} - S_{i,t}}{\sum_{j=1}^{j=n} G_{i,t-j}} + \alpha > \frac{S_{i,t+n} - S_{i,t}}{\sum_{j=1}^{j=n} G_{i,t-j}} = BDGI_{i,t}$$

Since α is a positive fraction the original BGDI on the RHS has a clear downward bias[5].

Next, we show that the way skilled workers are categorized can affect the result of the index significantly. Docquier and Marfouk (2006) identifies university degree holders aged 25-64 as skilled workers. Zhang and Lucey (2019) adopts this view in their BGDI calculations. However, considering this particular cohort results in certain uncertainties in the BGDI calculation which we discuss here. In many countries, as in Canada, a significant number of students finish tertiary education before 25 and therefore many students from previous years will be entering into the 25-64 bracket during the time period we are investigating. To account for these individuals, the denominator in the original BGDI formula contains a lag of 1 ($t - j, where\ t = 0\ and\ j = 1$). However, Zhang and Lucey (2019) does not consider the fact that students from two or three years back, who finished graduation at 22 and 23, will also be entering the 25-64 age group later during the time period we are analyzing, or it is possible they assumed the number of such graduates are negligible. However, our estimates of Canada indicate that the number of such graduates are significant. Accurately identifying these students is impossible without detailed data which is rarely available.

As a solution to this problem, we can consider the tertiary educated group aged 18-64 or 15-64. Since a negligible number of students complete university before 18 or 15, we

[5] Note: the purpose of this exercise is to mathematically show the downward bias in the original BGDI developed by Zhang and Lucey (2019). We do not use this for calculation the index. Rather, Equation 3 derived in the previous section is the main formula that is being used to calculate the brain drain/gain indices in this study.

no longer have to consider students from previous years entering into this group. This makes our calculation of the BGDI more accurate. In this report, we consider the age group 15 to 64 because these are the legal working and retirement ages in Canada, respectively. Hu et al. (2022) also adopt this technique to define the age of skilled workers in their paper on Beijing, China. Now, the revised formula is simplified to the following, where we do not need to consider lagged values of the number of graduates:

$$BDGI_{i,t}^{*} = \frac{S_{i,t+n} - S_{i,t} + A_{i,t+n}}{\sum_{j=1}^{j=n} G_{i,t+j}}$$

It is also worth noting that there is no need to consider the number of graduates at year t because they are already incorporated into $S_{i,t}$ and does not contribute to the change in the numerator. Lucey and Zhang (2019) considered that cohort because of the possibility of younger graduates entering the age 25-64 stream from time period t. Now, we use the revised version of the index to empirically determine whether the Atlantic provinces experienced brain drain during 2011-16 and 2016-21.

3.2 Determinants of Brain Drain

The socioeconomic and demographic factors associated with the outmigration of skilled workers are investigated using a probit regression equation grounded in the disequilibrium theory and spatial job-search model of migration (Hu et al., 2022; White and Haan, 2021; Greenwood, 2005). Specifically, we test the following hypothesis which will give as an understanding of the out-migration of skilled workers from Atlantic provinces:

(H1) Older skilled individuals will be less likely to move out of Atlantic provinces as compared to younger individuals

(H2) Individuals with a degree higher than Bachelor's will be more likely to move out of Atlantic provinces

(H3) Recent immigrants are more likely to move out of Atlantic provinces

(H4) Ethnic minorities are more likely to move out of Atlantic provinces

(H5) Presence of children is likely to lower out-migration of skilled workers

To test these hypotheses, we use a probit model since the dependent variable is dichotomous or binary. The disequilibrium theory of migration argues there is scope for utility gains because of that spatial differences in wages or income. The spatial job-search model, based on the disequilibrium theory, postulates that an individual will conduct a job search with a reservation wage in mind (the lowest wage they would accept in a new region of residence). If the offered wage exceeds the reservation wage, then there is opportunity for utility gains and hence the rational utility maximizing individual moves, otherwise not (Greenwood, 2005). The reservation wage, in turn, depends on socioeconomic and demographic characteristics. Therefore, the decision to migrate depends on the socioeconomic and demographic characteristics of the individual. Hu et al. (2022) and White and Haan (2021) adopts this approach in their investigation of regional migration in China and Canada, respectively

A probit model produces fitted values of the dependent variable (Y_i) between 0 and 1 based on a latent variable (Y_i^*) which is explained by observed explanatory variables (X_i') (Bailey, 2020; Woolridge, 2020).

$$Y_i^* = X_i'\beta + \varepsilon_i \quad \text{with} \quad Y_i = 1 \quad \text{if} \quad Y_i^* > 0\,, \quad \text{and} \quad Y_i = 0 \quad \text{if} \quad Y_i^* \leq 0 \qquad (1)$$

$$Y_i^* \geq 0 \;\rightarrow\; \varepsilon_i > -X_i'\beta \;\rightarrow\; \Pr\,(Y_i = 1|X) = \Pr\,(\varepsilon_i > -X_i'\beta)$$

Since one of the main assumptions in a probit model is that the error in equation 1 above is normally distributed (Bailey, 2020), we can write:

$$\Pr(Y_i = 1|X) = \Pr(\varepsilon_i < X_i'\beta)$$

Here, Y_i^* is the unobserved latent variable that indicates expected net returns of an individual i, who is a potential out-migrant from an Atlantic province. Y_i is a binary variable which takes $Y_i = 1$ if i leaves Atlantic Canada. This happens when Y_i^*, expected net returns of the individual i, is positive. $Y_i = 0$ if the individual does not leave Atlantic Canada. This occurs if Y_i^* is zero or negative. The unobserved net returns from potential migration depends upon observed explanatory variables. X_i is a column vector of these explanatory variables which affects the decision to migrate out of Atlantic Canada through the unobserved net returns (Y_i^*) of migration. β is the column vector of parameters that capture the effect of the explanatory variables on net returns to migration and hence the decision to migrate.

β is estimated using maximum likelihood estimation (MLE). The estimates will be normally distributed and consistent if the sample is large and there is no omitted variable bias. Our data set has 71,085 observations and the explanatory variables are based on the literature. Therefore, the conditions for normality and consistency are likely to be satisfied. The set of explanatory variables adapted from the literature (Hu et al., 2022; White and Haan, 2021; Greenwood, 2005) are as follows: age groups (15-24, 25-34, 35-49, and 55-64), gender (male and female), type of work undertaken (full time, part time, or did not work), degrees (bachelor's or equivalent, a degree above bachelor's, knowledge of language (English only, French only, both, or neither), income group (less than $20,000; $20,000-45,000 ; $45,000-75,000; $70,000-100,000; greater than $100,000).

In order to determine the effect of an explanatory variable on the probability of a skilled worker to migrate out of Atlantic Canada, we use the *average marginal effect approach* instead of the *partial effect at the average* (Bailey, 2020; Woolridge, 2020). The average marginal effect approach uses calculus to determine the slope of the fitted line (Bailey, 2020). First, a second scale factor is calculated from averaging the individual partial effects across the sample. Then this is multiplied with each β to calculate the average partial effects (Woolridge, 2020)[6]. This approach allows us to overcome the ambiguity related to dummy variable when using the *partial effect at the average* approach.

The specification of the base model (2016 Census data) and any issue of omitted variable bias were checked using the *Linktest* function of Stata. *Linktest* in Stata is commonly used to test for model specification in case of probit and logit models (Debalke, 2022; UCLA, 2021). It is based on the idea that we should not find any additional predictors that are statistically significant if the model is correctly specified. The robustness of the model was checked by adding other independent variables: activity limitations and child benefits.

Since the STATA syntax for Variance Inflation Factor (VIF), commonly used for checking multicollinearity, cannot be used in RDC NB because of a restriction on internet usage, we used a pairwise correlation matrix to check for multicollinearity as suggested by Vatcheva et al (2016) and Shrestha (2020). If there is any correlation above 0.8, then this indicates a case of severe multicollinearity.

[6] In Stata this is calculated using the command *margins, dydx (varlist)*

3.3. Data

To calculate the BGDI and BGDI*, we use the Census of Population public data 2016, 2006, and 2021, National Household Survey (NHS) public data 2011, and the Postsecondary Student Information System (PSIS) public data. These data are available in the Statistics Canada website. For the regression analysis we used Census 2016 and 2021 microdata accessed through the New Brunswick Research Data Center (NB RDC).

The Census data, collected every five years, are a 25% random sample of the population, with a response rate of around 95%. They provide information about the population, gender at birth, age, type of housing, family structure, marital status, Canadian military experience, income, language, Indigenous peoples, immigration, place of birth and citizenship, ethnocultural and religious diversity, mobility and migration, education, labor, and commuting (Statistics Canada, 2024). In 2011, information previously collected by the mandatory long-form census questionnaire was collected as part of the voluntary National Household Survey (NHS). The Postsecondary Student Information System (PSIS) surveys are conducted annually and provide detailed information on enrolments and graduates of Canadian public postsecondary institutions.

We use NHS 2011 and Census 2016 and 2021 public data to calculate the changes in the stock of human capital adjusted for aging. The PSIS public data provides the number of Canadian students aged 15 and above graduating with a university degree

annually in the different provinces. The Census 2016 and 2021 microdata accessed through NB RDC is used to run the probit model[7].

Finnie (2004) notes an important limitation of Census data: they only provide information on the current province of residence, the province of residence one year ago, and that of five years ago. If there are any other interprovincial movements between census periods, it is missed by the census data. In addition, Census data does not contain information on individuals leaving Canada on a permanent or temporary basis.

4. Results and Discussion

4.1 Skilled Workers: Who and Why?

This part begins by rationalizing the categorization of--working age individuals with a minimum of bachelor's degree--as skilled workers. Since both endogenous growth theory (Romer, 1986) and human capital theory (Becker, 1993) argue that knowledge and additional years of schooling lead to higher productivity, there is a theoretical foundation for considering tertiary educated workers as skilled workers as is done by Zhang and Lucey (2019) and Docquier and Marfouk (2006). In this section, we check whether this argument holds up empirically in case of Canada. To do this, we investigate whether working age tertiary educated workers in Canada do indeed have better labor marker outcomes as

[7] In order for any statistical analysis to be released from NB RDC, it must go through a vetting process. The researcher has to submit three versions of any statistical output: unweighted, weighted, and weighted and rounded (to nearest 5 or 10). An analyst at NB RDC, then goes through the outputs and releases the weighted and rounded versions only. The weighting converts the sample numbers to population numbers. This is necessary because the Census is a random sample of 1 out of 4 households, and response rate varies across different subsamples. The weighting takes these factors into consideration. Rounding is important to minimize any risk of identification of respondents. Any statistics related to income must pass a dollar test and median, minimum, and maximum values are usually not released. Therefore, in the results and discussion section we use only mean values of income.

compared to groups having lower or no qualifications (no degree, high school diploma, apprenticeship, and college degree). If the tertiary educated group in Canada is found to have better labor market outcomes, then it strengthens the case of conceptualizing tertiary educated workers as skilled workers and it also justifies the investigation of brain drain/gain, the net flow of tertiary educated workers.

	2011			2016			2021		
	Unemp loyed (%)	Not in Labor Force (%)	Empl oyed (%)	Unemp loyed (%)	Not in Labor Force (%)	Empl oyed (%)	Unemp loyed (%)	Not in Labor Force (%)	Empl oyed (%)
No degree	10.4	44.8	44.9	9.9	45.7	44.4	8.2	50.6	41.2
High school diploma	9.0	23.6	67.4	8.9	23.8	67.3	10.5	26.8	62.7
Apprenti nceship	7.3	15.0	77.7	7.8	14.4	77.9	7.3	15.0	77.6
College degree	6.0	14.4	79.6	6.1	14.6	79.3	7.4	16.0	76.6
BA and above	5.4	13.3	81.3	5.8	12.5	81.7	5.8	12.3	82.0

Table 1: Labor force outcomes by education in Canada, 2011-21 (Source: NHS 2011 and Census 2016 and 2021).

Consistent with the predictions of new growth theory (Romer, 1986) and human capital theory (Becker, 1993), table 1 indicates that in Canada during 2011, 2016 and 2021 tertiary educated workers, having a minimum of bachelor's degree, had overall better labor market outcomes as compared to non-tertiary educated workers, college or high school graduates, and workers with no degrees. Tertiary educated workers exhibited a higher tendency to participate in the labor force, higher employment and lower unemployment. Similar differences in labor force participation is also seen in other parts of the world such as the US where tertiary graduates have a significantly higher labor force participation as compared to other graduates (U.S. Bureau of Labor Statistics, 2022). Therefore, we find

empirical evidence vis-à-vis Canada, in addition to existing theoretical foundation, that supports the argument of categorizing tertiary educated workers as skilled workers.

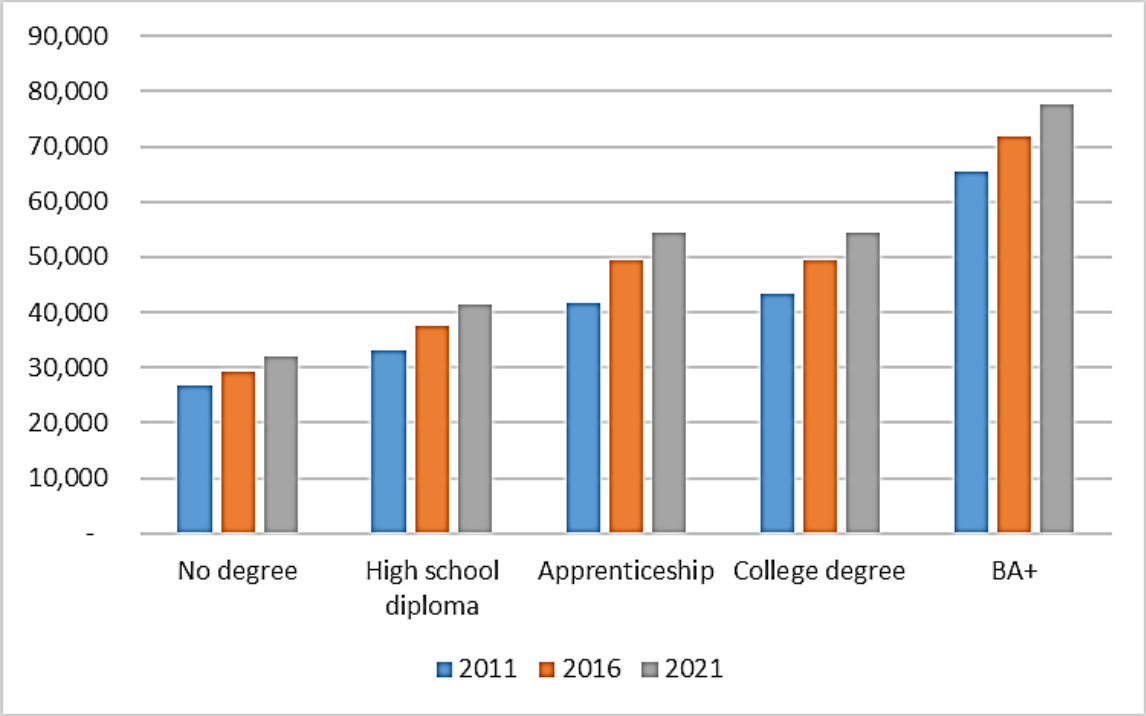

Figure 3: Mean employment income of working age individuals in Canada (Source: NHS 2011, Census 2016 and 2021) (See Table 6 in Appendix).

As evident in Figure 3 above, tertiary educated workers in Canada during 2011, 2016 and 2021 also enjoyed significantly higher mean employment income as compared to workers with lower degrees or no degrees. The mean employment income of working age university graduates in paid employment positions was 46% more college graduates during 2011-16 period (see Table 6, Appendix). Since wage is a proxy for productivity (Strain, 2019; Policardo et al., 2019), it can be argued that tertiary educated workers in Canada tend to be more productive as compared to the other groups. This again strengthens the argument that tertiary educated workers should be considered as skilled workers (Zhang and Lucey, 2019; Docquier and Marfouk, 2006). Consistent with our results, Afxentiou

and Kutasovic (2009) and Moretti (2013) also finds there is a significant and widening wage gap between high school graduates and tertiary graduates in the US. These findings are also in agreement with the human capital theory (Becker, 1983).

4.2 Proportion of Skilled Workers by Provinces

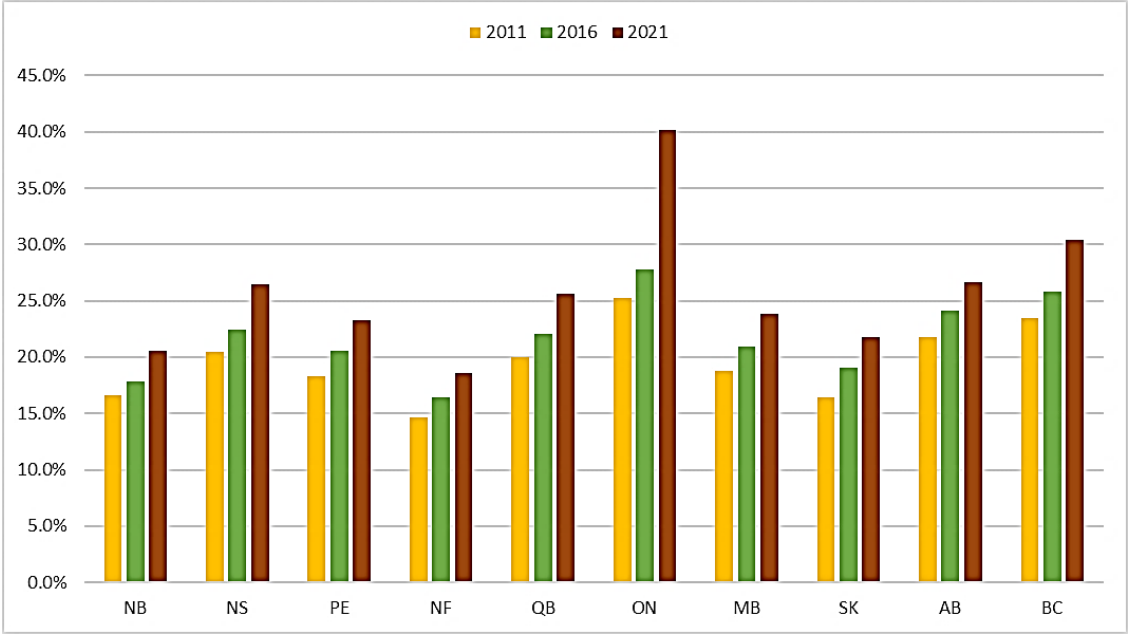

Figure 4: Percentage of working age population with tertiary degree by province, 2011-21 (Source: NHS 2011, Census 2016 and 2021) (See Table 8 in Appendix).

Since both the endogenous growth theory and human capital theory argue education and productivity are positively related and we also find indication of this Canada, in this section, we investigate the proportion of working wage population with tertiary degrees across the different provinces across Canada. Figure 4 illustrates that the percentage of working age population with tertiary degrees have been steadily increasing throughout Canada during 2011-21, a portion of which can be attributed to during that time important policy changes which targets skilled workers all across the globe; the Express Entry System was launched in 2015 to streamline the process of bringing in skilled workers into Canada

and the Atlantic Immigration Program (AIP) was launched in 2017 to attract skilled workers to Atlantic provinces (Government of Canada, 2015; CANADIM, 2024). The increase in percentage of tertiary educated workers also reflects the global trend of increasing participation in tertiary education (UNESCO, 2022). Among the Atlantic Provinces, NS has consistently been the front-runner in terms of tertiary educated workers as percentage of the working age population. NS has been at par with other provinces across Canada except for ON and BC. It is concerning for Atlantic Canada that the proportion of working age population with tertiary degrees has been the lowest in NF amongst all the provinces throughout 2011-21. Although NB was at the same stage as SK in 2011, SK overtook NB in 2016 and 2021. In 2021, the percentage of working age population with a tertiary degree was the lowest in NB and NF amongst all the provinces in Canada.

Between 2016 and 2021, ON registered the sharpest increase in the percentage of working wage population with tertiary degrees amongst all the provinces which can be attributed to both the large number of students graduating from universities in ON and the spike in number of immigrants during 2017-20 (Statistics Canada, 2024c) probably due an increase in the allocations of Ontario Immigrant Nominee Program (OINP) during that time period (Ontario, 2024). The other provinces showed similar improvements in the proportion of working age population with tertiary degrees, but these improvements are significantly lower than that of ON. The increasing concentration of tertiary educated workers in ON is not surprising and corroborates other studies in Canada which find immigrants are attracted towards larger ethnocultural diversities in big cities (Trovato, 1988; Newbold, 1996). Cowling (2009) and Artz (2003) also find that human capital tends to concentrated in certain cities in UK and US respectively. Nonetheless, this is concerning

for federal policymakers of Canada since disparity in the concentration of skilled workers can lead to inequality among the provinces in Canada (Zhang and Lucey, 2017; Sano et al. 2020; Robichaud 2013 as cited in Hillier et al. 2020).

4.3 Overall In- and Out-Migration in Atlantic Provinces

So far, we have found evidence that tertiary educated workers tend to have better labor market outcomes and the proportion of working age population with tertiary degrees are lower in most Atlantic provinces as compared to the other provinces. The stock or proportion of tertiary educated workers can be affected by the inflow and outflow of migrants, among other factors. Therefore, in this part of the report, we look into the characteristics of the in-migrants and out-migrants in relation to Atlantic Canada during 2011-21.

The Census microdata divides the in-migrants of a province into two categories: internal and external migrants. The internal migrants refer to individuals moving into a province from inside Canada and the external migrants refer to the individuals moving into a province from outside Canada. However, the Census data does not contain information on individuals leaving Canada temporarily or permanently, but only information on interprovincial out-migrants. Therefore, in the following discussions, the term "in-migrants" can apply to both 1) individuals moving into a Atlantic province from another provinces of Canada and 2) individuals moving into a Atlantic province from outside of Canada. Out-migrants refer to the individuals moving from a Atlantic province to another province of Canada.

	2011-16		2016-21	
	N = 105,375	*N = 80,350*	*N = 166,330*	*N = 67,405*
Gender	In-migrants (%)	Out-migrants (%)	In-migrants (%)	out-migrants (%)
Female	49.1	50.0	48.8	49.7
Male	50.9	50.0	51.2	50.3
Age				
0-14	13.4	11.1	13.0	10.8
15-24	15.0	16.8	16.6	13.9
25-64	65.0	66.4	62.3	66.4
65+	6.6	5.7	8.1	8.9
Education				
Less than 15 years old	13.4	11.1	13.0	10.8
No certificate	11.3	9.3	8.9	8.4
Highschool diploma	21.3	21.2	20.4	20.9
Apprenticeship	6.6	6.7	4.8	5.9
College diploma	16.0	17.7	17.1	16.3
University less than BA	2.4	1.9	3.2	2.0
BA and above	29.1	32.1	32.6	35.7
Immigration status				
Non-immigrants	65.0	85.4	57.0	76.7
Immigrants	22.9	13.2	23.2	21.5
Non-PR	12.1	1.4	19.8	1.8
Language(s) spoken				
English only	77.3	75.7	81.7	75.0
French only	1.6	1.4	1.5	1.7
Both	18.0	22.3	15.4	22.5
Neither	3.0	0.6	1.5	0.7
Origin				
Internal	65.4	100	60.8	100
External	34.6	-	39.2	-
Type				
Skilled	27.5	30.6	30.7	33.4
Unskilled	72.5	69.4	69.3	66.6

Table 2: Characteristics of the in- and out-migrants in Atlantics Canada during 2011-16 and 2016-21.

Table 2 presents select socioeconomic and demographic characteristics of the all the in-migrants and out-migrants vis-à-vis Atlantic Canada during 2011-16 and 2016-21. During both the time periods, a slightly larger portion of the in-migrants were males.

The composition of the out-migrants during 2011-16 was perfectly balanced with 50% of each gender. However, the gender distribution of the out-migrants during 2016-21 changed with slightly more males. Overall, this indicates that males have a higher tendency to migrate in and out of Atlantic Provinces. This is consistent with the findings of White and Haan (2021) and Hu et al. (2022), who also finds that males have a higher tendency for interprovincial migration in Canada and China, respectively.

More than 60% of the in- and out-migrants were of working age, aged 15-64, during both 2011-16 and 2016-21. The percentage of in- and out-migrants who belonged in the retirement age groups increased by 1.5% points and 3.2% points, respectively, during 2016-21. This indicates that the propensity of individuals in the retirement age groups to migrate in and out of Atlantic provinces may have increased. This reflects the overall national trend in Canada. White and Haan (2021) finds that the proportion of interprovincial migrants belonging to retirement age groups have increased in recent times. Around 13% and 11% of the in- and out-migrants, respectively, were children less than 15 years during 2011-16. Documenting and predicting demographic characteristics of in- and out-migrants can facilitate policymaking. For example, if the net-flow of migrants are positive and composed of a large number of school going children, then timely expansion of capacity of educational institutions can prevent shortages.

Table 2 further indicates that during 2016-21 a larger portion of both in- and out-migrants had a minimum of bachelor's degree as compared to their counterparts in 2011-16. This indicates that mobility of tertiary educated individuals in and out of Atlantic Canada may have increased during 2016-21. The percentage of in and out migrants having no degrees, high school diploma or apprenticeship decreased during 2016-21, indicating

that the mobility of these cohorts may have decreased. White and Haan (2021) find these patterns are also true for interprovincial migration in Canada as a whole. Overall, the bulk of the migrants vis-à-vis Atlantic provinces had a minimum of college education.

The majority of in-migrants and out-migrants throughout 2011-21 were non-immigrants which mirrors the overall interprovincial migration pattern in Canada (White and Haan, 2021). However, during 2016-21, the proportion of in-migrants and out-migrants who were non-immigrants dropped significantly by 8% points and 8.7% points respectively, and the proportion of out-migrants who were immigrants rose significantly by 8.3% points in 2016-21. This is reflective of the overall pattern in Canada (White and Haan, 2021) and may indicate that the ability of certain provinces to retain immigrants is decreasing since immigrants tend to be attracted towards ethnocultural diversity of larger cities (Trovato, 1988; Newbold, 1996). Notably, the percentage of in-migrants that were non-PR holders increased by 7.7% points which may indicate people are moving into Atlantic provinces because it may be easier to obtain permanent residency (PR) in these provinces through Provincial Nomination Pathways (PNP).

More than 75% of the in- and out-migrants during 2011-21 spoke English but not French, and less than 2% spoke French but not English. A larger portion of the in-migrants in 2016-21 were English only speakers. More than 15% of the in- and out-migrants spoke both English and French and less than 5% spoke neither. During 2011-16 around 65% of the in-migrants were from within Canada while 35% were from outside Canada. During 2016-21, the numbers were 61% and 39%, respectively, indicating that more people from outside Canada were moved into Atlantic provinces during 2016-21. A portion of this increase could be attributed to the Atlantic Canada Immigration Program which

commenced in 2017 as a pilot program and was made permanent at the beginning of 2022. A larger percentage of both in-migrants and out-migrants were skilled workers during 2016-21 as compared to 2011-16.

Although the above discussion gives us an idea about the characteristics of the individuals who moved into and out of Atlantic provinces during 2011-16 and 2016-21, we cannot determine whether Atlantic Provinces experienced brain drain or gain from aggregate flows alone. This is because the outflow contains only interprovincial out-migrants and does not contain information on individuals leaving Canada which can be a channel for brain drain[8]. A revised version of the BGDI developed by Zhang and Lucey (2019) can be used to empirically approximate the net flow without requiring detailed information of inflow or outflow. The following table presents the BGDIs and revised BGDIs (BGDI*) of the provinces in Atlantic Canada as well as the other provinces during 2011-16 and 2016-21.

[8] However, from Census data, we can determine whether Atlantic Canada experienced brain drain or gain vis-a-vis interprovincial migration. Our calculations indicate that there was a brain drain during 2011-16 and brain gain during 2016-21.

4.4 The Brain Drain/Gain Index

	Age 15-64, BA +			University graduates*		BGDI		BGDI*	
	2011	2016	2021	2012-16	2017-21	2011-16	2016-21	2011-16	2016-21
NB	85,335	87,135	100,335	19,734	17,811	0.091	0.741	0.506	1.189
NS	129,010	136,040	163,160	40,662	38,961	0.173	0.696	0.483	1.041
PEI	17,285	18,975	22,840	3,843	3,708	0.440	1.042	0.929	1.525
NF	52,030	56,395	59,745	14,898	13,995	0.293	0.239	0.617	0.585
QB	1,076,675	1,175,620	1,371,815	260,460	270,732	0.380	0.725	0.732	1.104
ON	2,196,595	2,500,665	3,007,750	508,395	523,095	0.598	0.969	0.955	1.371
MB	150,480	174,840	205,180	33,732	32,631	0.722	0.930	1.141	1.380
SK	111,530	135,560	154,580	27,555	28,794	0.872	0.661	1.231	1.027
AB	554,430	672,385	751,340	102,576	108,645	1.150	0.727	1.577	1.197
BC	707,130	801,780	993,070	126,606	134,478	0.748	1.422	1.290	1.969

Table 3: BDGIs and revised BGDIs (BGDI*) of the different provinces in Canada (Source: Stat Can, Census 2011, 2016, and 2021). (*Note: University graduates refers to Canadian students only and does not include international students)

Table 3 above lists all the variables used to calculate the BGDIs and the revised BGDIs (BGDI*)[9] for the different provinces in Canada. The first three columns indicate the stock of skilled workers (aged 15-64 with a minimum of bachelor's degree) in 2011, 2016 and 2021. The total number of students graduating from tertiary institutions in the respective provinces during 2012-16 and 2017-21 are presented in the third and fourth columns. It should be noted that we do not require the number of students graduating in 2011 and 2016 because they are already incorporated in the stock of tertiary educated workers in 2011 and 2016, respectively, and do not contribute to the change in stock of skilled workers. The BGDIs and revised BGDIs (BGDI*) for the periods 2011-16 and 2016-21are presented in the last four columns.

[9] The BGDI is the original brain drain/gain index developed by Zhang and Lucey (2019). The revised BGDI (BGDI*) is the one adjusted for aging developed in this report.

There is significant disparity in the rate of increase of the stock of tertiary educated workers amongst the provinces. During 2011-21, NF and NB registered the lowest increases at 14% and 17.6% respectively, whereas BC registered the highest increase at 40% with MB, SK, AB, and ON following closely behind. Interestingly, the total number of Canadian students graduating from all the Atlantic provinces decreased during 2017-21 as compared to 2012-16. MB is the only other province in which such a decline was observed. All the other provinces registered an increase in the total number of tertiary graduates. The equation of BDGI predicts that a decline in the number of graduates (the denominator term) is likely to increase the value of brain drain/gain index and lower the probability of a brain drain, ceteris paribus. This makes intuitive sense since a decrease in the number of graduates is also likely to lower the probability of the outflow of skilled workers.

As hypothesized, the original BGDIs, in columns 7 and 8 of Table 3, have a downward bias and indicate that almost all the provinces in Canada except AB during 2011-16 and BC and PEI during 2016-21 experienced brain drain throughout 2011-21. This finding is inconsistent with the data (Statistics Canada, 2024). For example, the net interprovincial migration in BC during 2011-16 was significantly large and positive and yet the unrevised BGDI indicates there was a brain drain, which is unlikely to be the case. The revised BGDIs (BGDI*) (columns 9 and 10), in contrast, indicate that a significant number of provinces—MB, SK, AB and BC—experienced brain gain during 2011-16, and all the provinces except for NF experienced brain gain during 2016-21. These findings are consistent with the net interprovincial migration data and corroborates earlier studies which conclude that Canada overall does not have an issue of brain drain (Finnie 2001; Zhao,

2000). The provinces which experienced brain drain during 2011-16, such as ON and QB, are also the ones which experienced significantly high negative net interprovincial migration (Statistics Canada, 2024).

All of the Atlantic provinces except for NF registered significant improvements in the BGDI* scores and reversed their position from a brain drain region to a brain gain region during 2016-21. This is evident from the fact that the BGDI* scores, in columns 9 and 10 of Table 3, change from less than one to greater than one during 2016-21 for all the Atlantic provinces expect NF, the BGDI* of which remains below 1 indicating a drain. NB's improvement in the BGDI and BGDI* scores are particularly striking, registering the highest percentage wise increase among all the Atlantic provinces. Although NB's BGDI and BGDI* scores were the lowest among all the Atlantic provinces during 2011-16, it was the second highest during 2016-21. NS and PEI also experienced significant improvements in their BGDI scores, but not as much as NB. An improvement in the BGDI or BGDI* score implies that the capacity of a province to attract and retain skilled workers has improved (Zhang and Lucey, 2019). In this paper, we have also shown that it also implies an improvement of the net flow of skilled workers. Therefore, we find evidence that the capacity to attract and retain skilled workers as well as the net flow of skilled workers have improved in all the Atlantic provinces, particularly more so in NB, except for NF. The Atlantic Immigration Program (AIP) which began in 2017 may have contributed to the improved ability of the Atlantic provinces to attract more skilled workers during 2016-21 leading to a brain gain as indicated by the BGDI* values.

The above findings are consistent with interprovincial migration patterns in Atlantic Canada. The Atlantic provinces except for NF experienced a significant surge in

in-migrants during 2018-21. In fact, during 2018-21, the net flow of provincial migrants was positive and the highest on-record for both NS and PEI (Statistics Canada, 2024d). Therefore it is not surprising that all the provinces except for NF, which experienced negative net-migration during 2016-21, experienced brain gain during 2016-21. The net-interprovincial migration during 2011-16 dominantly negative in the Atlantic provinces (Statistics Canada, 2024), which is consistent with our finding that the Atlantic provinces experienced brain drain during 2011-16.

In the next part of this report, we look at factors associated with the outflow of skilled workers from Atlantic Provinces during 2011-16 and 2016-21.

4.5 Determinants of Out-Migration vis-à-vis Atlantic Canada

In order to specifically test the hypothesis presented in the methodology section and to generally investigate the socioeconomic and demographic factors associated with the outmigration of skilled workers, we utilized a probit model grounded in the disequilibrium theory of migration and the spatial job-search model of migration (Hu et al. 2022; Haan 2021; Greendwood, 2005) the results of which are presented here:

	2016 data (*N* = 71,085) Pseudo R^2 = 0.168		2021 data (*N* = 75,695) Pseudo R^2 = 0.156	
Age groups (years)	Marginal effect (SE)	Z score	Marginal effect (SE)	Z score
15-24 (ref.)				
25-34	0.031*** (0.007)	4.62	0.035 (0.006)	5.84***
35-49	-0.088*** (0.007)	-12.89	-0.042 (0.006)	-6.96***
55-64	-0.133*** (0.007)	-20.14	-0.082 (0.006)	-14.16***
Gender				
Female (ref.)				
Male	0.014*** (0.002)	6.07	0.016 (0.002)	7.79***
Education				
Bachelor's degree				

	2016 data (*N* = 71,085) Pseudo R^2 = 0.168		2021 data (*N* = 75,695) Pseudo R^2 = 0.156	
	Marginal effect (SE)	Z score	Marginal effect (SE)	Z score
Higher than bachelor's	0.028*** (0.003)	10.59	0.029 (0.002)	12.39***
Medicine, veterinary or dentistry	0.032*** (0.007)	4.57	0.055 (0.007)	7.78***
Immigration status and year				
Non-immigrants (ref.)				
Before 1990	0.015 (0.008)	1.8	0.016 (0.010)	1.62
1991-2005	0.056*** (0.008)	6.71	0.060 (0.008)	7.49***
2006-2016	0.119*** (0.009)	12.61	0.128 (0.008)	15.42***
2016-21	-	-	0.118 (0.010)	12.37***
Non-PR	0.001 (0.009)	0.08	0.004 (0.007)	0.64
Knowledge of Language				
English only (ref.)				
French only	-0.009 (0.015)	-0.59	0.001 (0.013)	0.04
English and French	0.021*** (0.002)	7.81	0.021 (0.003)	8.16***
Neither	0.285*** (0.062)	4.62	0.358 (0.066)	5.34***
Income groups				
< 20,000 (ref.)				
20,000-45,000	-0.027*** (0.003)	-7.55	-0.019 (0.003)	-6.03***
45,000-70,000	-0.029*** (0.003)	-7.39	-0.023 (0.003)	-7.01***
Income groups				
70,000-100,000	0.022*** (0.005)	4.20	-0.023*** (0.003)	-6.87
100,000 +	0.057*** (0.007)	7.89	0.011* (0.004)	2.48
Type of work (in 2015)				
Didn't work (ref.)				
Mainly FT	-0.015*** (0.004)	-3.28	-0.012** (0.004)	-3.14
Mainly PT	-0.011* (0.005)	-2.12	-0.006 (0.004)	-1.34
Province of residence				
NF (ref.)				
PEI	0.006 (0.004)	1.36	-0.008 (0.004)	-1.83
NS	0.028*** (0.002)	9.75	-0.009** (0.003)	-3.14

	2016 data (*N* = 71,085) Pseudo R^2 = 0.168		2021 data (*N* = 75,695) Pseudo R^2 = 0.156	
	Marginal effect (SE)	Z score	Marginal effect (SE)	Z score
NB	0.006 (0.003)	1.85	-0.016*** (0.003)	-5.09
Ethnic minority				
Non-minority				
Aboriginal	-0.005 (0.005)	-1.00	0.007 (0.005)	1.39
Ethnic minority	0.069*** (0.007)	10.15	0.058*** (0.005)	10.74
Family status				
Married/common-law without children (ref.)				
Married/common-law with children	-0.059*** (0.003)	-20.02	-0.047*** (0.003)	-17.47
Lone parent	-0.068*** (0.005)	-12.33	-0.047*** (0.005)	-8.95
Child of parent(s)	-0.098*** (0.003)	-30.57	-0.079*** (0.003)	-25.71
Living alone or not in a census family	0.030*** (0.004)	7.65	0.011** (0.003)	3.10
Notes: Standard p-value notation as follows: * $p \leq 0.05$, **$p \leq 0.01$, *** $p \leq 0.001$. 'Ref.' indicates reference groups for categorical variables.				

Table 4: Probit model of out-migration of skilled workers from Atlantic provinces during 2011-16 and 2016-21.

As discussed in the methodology section, in order to investigate the effects of the explanatory variables on the probability of skilled workers to move out of Atlantic Canada, the average marginal effect approach was used. These values are presented in the marginal effect columns in Table 4. Compared to the 15-24 age group, the 25-34 age group were 3.1% and 3.5% more likely to move out of Atlantic Provinces to other provinces inside Canada during 2011-16 and 2016-21 respectively. The probability of moving out for 35-49 and 55-64 age groups were significantly lower as compared to the 15-24 group during both 2011-16 and 2016-21. This provides evidence in support of hypothesis (H1) that older skilled workers are less likely to migrate out of Atlantic Provinces and also corroborates the findings of White and Haan (2023) and Hillier et al (2020) who found similar trends

for interprovincial migration for Canada as a whole and for North-South[10] migration inside Canada, respectively. By comparing the marginal effects of 2016 and 2021, we find evidence that the propensity of the 35-49 and 55-64 age groups to migrate out of Atlantic Canada decreased during 2016-21. This indicates that the capacity of Atlantic provinces to retain skilled workers may have increased. This is consistent with our BGDI values of 2016-21 which also indicate a significant improvement in the retention capacity of the Atlantic provinces.

During 2011-16 and 2016-21, males were 1.4% and 1.6% more likely to move out of Atlantic provinces, respectively, as compared to females. Hu et al. (2022), White and Haan (2021) and Brücker and Trübswetter (2007) also finds that males are more likely to migrate interprovincially in China, Canada and Germany, respectively.

As compared to individuals having a bachelor's degree, individuals with a degree higher than bachelor's or with a degree in medicine, veterinary, or dentistry were more likely to move out of Atlantic provinces during both 2011-16 and 2016-21. This supports the hypothesis (H2) that tendency to migrate increases with completed level of education. Hillier et al. (2020) and White and Haan (2021) also finds that tendency to migrate interprovincially increases with education. By comparing the 2016 and 2021 marginal effects, we find evidence of increasing tendency to move out of Atlantic Canada during 2016-21 among individuals with a degree related to medicine or health science to move out of Atlantic provinces . This lends support to the idea that there may be an issue of sector specific brain drain (Finnie, 2001; Barrett, 2001).

[10] From Northern territories in Canada to regions located in the South.

Skilled immigrants who immigrated to Canada recently were more than 10% likely to move out of Atlantic provinces as compared to non-immigrants during both 2011-16 and 2016-21 which provides evidence in support of the hypothesis (H3) that skilled immigrants are more likely to move out as compared to non-immigrants. This also indicates that despite improvements in retention capacity in recent years, Atlantic provinces may have a problem of retaining recent immigrants who have a greater propensity to move out of Atlantic provinces as compared to immigrants who moved earlier. This is consistent with earlier studies on Canada. Trovato (1988) also finds that recent immigrants exhibit a greater propensity to migrate to larger centers and settle there. Newbold (1996) argues larger cities with bigger ethnocultural communities exercise a stronger pull on immigrants.

Individuals who speak only French were less likely to move out during 2011-16 but more likely to move out during 2016-21 as compared to English only speakers. Individuals who speak both English and French are morel likely to move out of Atlantic Canada as compared to English only speakers during both 2011-16 and 2016-21. White and Haan (2021) finds that for overall Canada French only speakers are more likely to move interprovincially as compared to English only speakers. Although this contradicts our 2011-16 finding, it is not entirely surprising because of the fact that the second largest province in Atlantic Canada, New Brunswick, is the only bilingual province in Canada where both French and English are the official languages. This most likely explains the fact why French only speakers were less likely to move out of Atlantic Canada during 2011-16. Although the number of skilled individuals who spoke neither English nor French are a very small fraction of the out-migrants, they were 28.5% and 35.8% more likely to move out of Atlantic provinces during 2011-16 and 2016-21, respectively, as compared to

English only speakers. This finding is consistent with other studies on interprovincial migration in Canada (Robinson and Tomes, 1982; White and Haan, 2021).

Individuals belonging to the highest income group ($100,000+) were more likely to move out of Atlantic provinces as compared to the lowest income group (<$20,000) during both 2011-16 and 2016-21. However, the probability of out-migration of individuals belonging to the highest income group decreased during 2016-21. Interestingly, individuals belonging to the second highest income group (70,000-100,000) were more likely to move out during 2011-16, but they were less likely to move out during 2016-21. These findings once again suggest that the capacity of the Atlantic provinces to retain skilled workers in this case specific to high income groups increased during 2016-21. As compared to people who did not work[11], people who worked full time or part-time were less likely to move out during both time periods corroborating the findings of White and Haan (2021).

Interestingly, we find a reversal of the effect of province of residence on the decision of skilled workers to out-migrate during 2016-21. Whereas skilled individuals residing in PEI, NS and NB were more likely to move during 2011-16 as compared to NL, they were less likely to move out during 2016-21. This is consistent with interprovincial migration data (Statistics Canada, 2024) which indicates that the out migration in Atlantic provinces except NL fell significantly during 2016-21, whereas in NF it was steady. This indicates that the retention rates of skilled workers may have improved in NB, PEI and NS. This is consistent with the BGDI* scores we found previously which shows that there was

[11] Includes people who are unemployed and not in labor force.

a brain gain and improved retention of skilled workers in all the Atlantic Provinces except NL during 2016-21.

Overall, we find evidence in support of hypothesis (H5), ethnic minorities are more likely to move out of Atlantic provinces possibly being attracted to large ethnocultural diversities in big cities (Newbold, 1996). During both time periods 2011-16 and 2016-21, ethnic minorities were 6.9% and 5.8% more likely to move out of Atlantic provinces as compared to non-ethnic minorities. This is consistent with other studies on interprovincial migration in Canada which also find ethnic minorities exhibit a greater propensity to migrate among (White & Haan, 2021). However, the tendency of ethnic minorities to out-migrate was lower in 2016-21 as compared to 2011-16 which once again suggests the retention of ethnic minorities may have improved during 2016-21.

Family status played an important role in the decision to migrate out of Atlantic Canada during both 2011-16 and 2016-21. In both the time periods, married or in common-law partners with children, lone parents and children of living parents were less likely to move out of Atlantic provinces as compared to married or in common-law partners with children, which provides evidence in support of hypothesis (H4). These findings also corroborate the findings of Hu et al. (2022) who also find presence of children affects decision to out-migrate negatively. Not surprisingly, individuals living alone or not in census family were more likely to move out of Atlantic provinces during both the time periods, 2011-16 and 2016-21.

4.5 Regression Diagnostics

As mentioned in the Methodology section, the specification and any issue of omitted variable bias were checked using the *linktest* function of Stata. The model passed

the *linktest* to indicate that the model is correctly specified and there is no omitted variable bias. The robustness of the model was checked by adding other independent variables. Addition of variables such as activity limitations and child benefits did not change the signs and significance of the predictors of the core model indicating that the mode is structurally valid (Lu and White, 2014). The *estat classification* function of Stata indicates that 90% of the predictions were correctly classified.

White and Haan (2021) use the variables "immigration status" and "years since immigration" in their study. We used a categorical variable[12] from Census 2016 microdata that contains information on both the immigration status and years since immigration to avoid the problem of multicollinearity.

The likelihood ratio chi-squares and the p-values of both the 2016 and 2021 models indicate that the respective models as a whole are statistically significant. In other words, they explain the variation in the dependent variables, probability of a skilled worker to move out of Atlantic provinces during 2011-16 and 2016-21, significantly better than a model with no predictors. The overall significance of the categorical variables for which some of the categories appear to be insignificant was tested using the *test* function of Stata. We find evidence that overall all the categorial variables are significant in explaining the decision of skilled workers to migrate out of Atlantic provinces.

[12] In the Census 2016 and 2021 microdata files, this categorical variable is coded as PERIMMB and represents information on the immigration status and period of immigration.

6. Conclusion and Policy Recommendations

6.1 Key Findings

A part of this paper is a continuation and refinement of the work on BGDI by Florida et al. (2006) and Zhang and Lucey (2019). We have identified certain ambiguities that may arise in the BGDI calculation depending on how we categorize skilled workers and we addressed this issue in our case by considering the age 15-64 tertiary educated group instead of the 25-64 group. Importantly, this paper has mathematically connected a revised version of the BGDI developed by Zhang and Lucey (2019) to the net flow conception of brain drain/gain and illustrated its scope in empirically assessing brain drain gain at the provincial level in Canada. A key concept incorporated into the revised index is that a portion of the university graduates and in-migrants will contribute towards the replacement of aging population and if we do not account for this in the BGDI formula then there will be a downward bias.

Our findings indicate that although Atlantic Canada experienced brain drain during 2011-16, the situation improved significantly during 2016-21 and there was a brain gain in most of the Atlantic provinces. The BGDI and BGDI* scores indicate that during 2016-21 the ability of the Atlantic provinces except for NF to attract and retain skilled workers improved significantly. The improvement in retention capacity, as indicated by the BGDI and BGDI* scores of 2016-21, are consistent with a large portion of the regression results. We find that during 2016-21 the probability of out-migration decreased considerably for the skilled workers belonging to the 35-49 and 50-64 age groups, the highest income group ($100,000+), and ethnic minority groups. Also, skilled workers belonging to the $70,000-100,000 income group were less likely to out-migrate during 2016-21, but they were more

likely to out-migrate from Atlantic provinces during 2016-21. Skilled workers were less likely to move out from the NB, NS and PEI during 2016-21, but they were more likely to move out from these provinces during 2011-16 as compared to NF. These findings support the claim that overall the retention capacity of skilled workers have likely improved in all the Atlantic provinces except for NF during 2016-21.

Although our findings suggest that the overall capacity of most Atlantic provinces to retain skilled workers may have improved, for some cohorts the tendency to out-migrate is still high and have increased slightly. Specifically, we find that skilled workers who immigrated to Atlantic provinces recently, in the last several years, have a 12-13% chance of moving out and the probability did not decrease in 2016-21. The propensity of individuals having a degree in medicine, dentistry, or veterinary increased during 2016-21. This may indicate towards an issue of sector specific brain drains in Atlantic Canada. Interestingly, French only speakers were less likely to move out of Atlantic provinces during 2011-16, but they were more likely to move out during 2016-21. These findings point towards the fact that there is scope for the improvement of retention rates of certain cohorts.

6.2 Policy Recommendations

The results of this research can guide and provide new directions for policy making in the Atlantic provinces. Firstly, the evidence of better labor market outcomes among skilled or tertiary educated workers in Canada justifies the federal and provincial policymakers' concern with attracting and retaining skilled workers from all across the world via friendly immigration policies. Generally, if a province experiences brain gain, then the policymaking can target utilizing, retaining, and sustaining this brain gain. One

the other hand, if the net migration patterns has not resulted in a brain gain, then the policymaking can focus on how to promote brain gain in the future. Since resources are limited and need to be allocated between competing uses, it is important to know the precise nature of the situation, in this case whether there is an issue of brain drain or gain, before ringing any alarm or victory bells.

Our study indicates that most of the Atlantic provinces experienced brain gain during 2016-21 most probably an indication of the success of Atlantic Canada Immigration Program. It is imperative that the region maximizes the benefit of this gain. Policymaking can focus on utilizing and retaining this brain gain as well as pay special attention so there is no brain waste. Brain waste occurs when the talents of skilled workers remain underutilized (Zong and Lu, 2017). One way to prevent brain waste is to give recognition to foreign degrees and experiences (Zong and Lu, 2017). Otherwise, it may lead to return migration of skilled workers. The government can facilitate matching workers with employees through job-fairs and employment counselling centers. Tax incentives can be provided to industries that require skilled workers. More privatization can lead to higher job creation and better absorption and retention of skilled workers. Florida (2002) argues it is important to create "an environment or habitat that can attract and retain talent or human capital" (p. 754). Cowling (2009) finds creating an entrepreneurial culture and higher provision for public goods are important for attracting human capital.

We find evidence that immigrants who recently moved to Atlantic provinces have a high tendency to move out. The government can conduct focus group discussions to identify the reasons behind their departure and formulate policies accordingly. Since people possessing provincial health insurance cards are required to notify the respective

offices before leaving a province, the government can interview a sample of these individuals to decipher the reasons behind their leaving the province. Previous research indicates that immigrants are attracted towards bigger cities (Trovato, 1988). It is likely that providing amenities typically found in larger cities, such as better public transport, can retain new immigrants.

Notably, individuals with a degree in medicine or a related field were more likely to move out of Atlantic province during 2016-21 as compared to 2011-16. Since health care is an important sector, focus group discussions can elucidate the reasons why it is becoming more likely for graduates with a health-related degree to move out of Atlantic provinces. Not surprisingly, we find that presence of children lowers the probability of skilled workers from moving out of Atlantic provinces and hence policies that incentivize couples or individuals to conceive may improve retention rates. Paid maternity leaves and child benefits or subsidies have been found to affect birth rates positively (Brainerd, 2014). In Atlantic provinces, like most other provinces except QB, it is not mandatory to provide paid maternity leaves and length of the leave in NB and PEI is among the lowest in Canada (LWL, n.d.). Also, NB and NL were offering the second the lowest child benefits in Canada as of May 2018 and PEI is set to launch a child benefit program from January 2025 (Firstcall, 2018; Government of Prince Edward Island, 2024). Mandating payment during maternity leaves and increasing its length and offering more child benefits can affect birth rates positively in Atlantic Canada which is likely to affect future out-migration rates of skilled workers negatively.

It is possible that the Atlantic provinces have a small window of opportunity to retain and maximize the benefit of the brain gain that have occurred recently, during 2016-

21. This may be particularly truer for NB, since in NB periods of positive net interprovincial migration are followed by negative net migration. If this trend holds into the future, then NB policymakers should urgently prioritize the retention of the skilled workers. If appropriate policies and public expenditure do not complement this brain gain, then the skilled workers may eventually leave Atlantic provinces for larger provinces (Trovato, 1988; Newbold, 1996).

6.3 Limitations

A limitation of our study is that we did not consider brain-drain or gain in relation to specific sectors. Finnie (2001) argues brain drain is more problematic in certain industries in Canada. Therefore, future research can use an industry or sector specific BGDI to investigate industry or sector specific brain drain or gain. In addition, our research does not reveal any information on the utilization of brain and/or brain waste in Atlantic provinces. A province may not really benefit from a gain if in-coming skilled workers are not properly utilized. The BGDI and BGDI* does not take this depreciation into account. Future research can explore how brain utilization can be incorporated into the BGDI. Another limitation of our study is that we did not explore out-migration of skilled workers from Atlantic provinces to other countries. Future research can explore the volume and characteristics of the individuals who permanently or temporarily leave Atlantic provinces for other countries.

Since our data is cross-sectional, some endogeneity is inevitable (Finnie, 2004). Endogeneity occurs when an independent variable is correlated with another unobserved variable which, in turn, affects the dependent variable (Bailey, 2020; Woolridge, 2020). Therefore, it becomes difficult to establish causation since the independent variable in our

study may simply be capturing the effect of an unobserved variable. This makes it difficult to establish causality. One to minimize endogeneity is to add all relevant explanatory variables, which we have done as per suggestion of the literature (Bailey, 2020). Other ways to tackle endogeneity is to use instrumental variables ((Bailey, 2020; Woolridge, 2020) which can be the scope of future research.

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Appendix

Province	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Atlantic	34,900	35,200	36,900	37,200	36,500	37,100	37,800	38,200	39,000	41,100	40,900
Prairie	44,300	45,200	46,000	46,200	46,100	44,600	45,800	44,900	45,300	45,700	44,600
QB	35,300	36,600	37,900	38,100	37,600	38,500	39,100	39,400	40,800	43,300	44,300
ON	37,600	37,700	38,400	39,700	39,500	39,400	40,200	41,300	41,700	43,100	44,200
BC	35,900	36,300	37,200	38,000	37,000	37,800	39,800	40,500	41,200	44,400	44,100
CA	37,600	38,300	39,200	39,800	39,500	39,700	40,600	41,000	41,800	43,600	44,000

Table 5 : Real median income in Atlantic Provinces, Prairie Provinces, Quebec, and Ontario, 2011-21 (Source: Statistics Canada, 2024).

Education	2011	2016	2021
No degree	26,674	29,133	32,089
High school diploma	33,029	37,650	41,373
Apprenticeship	41,641	49,296	54,318
College degree	43,480	49,498	54,503
BA+	65,504	71,714	77,531

Table 6: Mean employment income of working age population in paid employment by education in Canada (Source: NHS 2011, Census 2016 and 2021).

`	2011	2016	2021
NB	16.6%	17.9%	20.6%
NS	20.5%	22.5%	26.4%
PE	18.3%	20.5%	23.3%
NF	14.6%	16.4%	18.6%
CA	22.3%	24.6%	31.6%

Table 7: Percentage of working age population aged 15-64 with tertiary education, 2011, 2016 and 2021 (Source: Census 2011, 2016 and 2021).

	2006	2011	2016	2021
NB	14.1%	16.6%	17.9%	20.6%
NS	17.9%	20.5%	22.5%	26.4%
PE	15.4%	18.3%	20.5%	23.3%
NF	12.5%	14.6%	16.4%	18.6%
QB	17.9%	20.0%	22.0%	25.6%
ON	22.2%	25.3%	27.8%	40.1%
MB	15.9%	18.8%	20.9%	23.9%
SK	14.2%	16.4%	19.0%	21.7%
AB	18.5%	21.8%	24.1%	26.6%
BC	20.7%	23.5%	25.8%	30.4%
CA	19.5%	22.3%	24.6%	31.6%

Table 8: Percentage of working age population with tertiary degree by province, 2011-21 (Source: NHS 2011, Census 2016 and 2021)

Glossary

Internal migrants: Interprovincial migrants moving from one province to another inside Canada.

External migrants: Individuals moving into a province inside Canada from outside of Canada.

Human capital: technical skills and knowledge of workers utilized in the production of goods and services.

Immigrants: Individuals who have moved to Canada permanently from another country.

Emigrants: Individuals who have left Canada permanently.

Net flow: inflow of migrants – outflow of migrants

Non-permanent residents: Individuals who have moved to Canada from another country on a temporary basis.

UNESCO: The United Nations Educational, Scientific and Cultural Organization is a specialized agency of the United Nations with the aim of promoting world peace and security through international cooperation in education, arts, sciences and culture.

Curriculum Vitae

Candidate's full name: Nabeel Iqbal

Universities attended: Master of Economics (course-based), University of New South Wales, Feb 2014-Dec 2014; Bachelor of Business and Commerce, Monash University Malaysia, 2009-2011.

Publications: Iqbal, N. (2023). Teaching introductory economics: an interdisciplinary approach. Compass Journal of Learning and Teaching, 16(1), 11–19. doi:10.21100/compass.v16i1.1418

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