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Asymmetric information, credential assessment services and earnings of new immigrants

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ABSTRACT

Based on the 2016 Canadian Census of Population, some immigrant groups have higher entry-earning returns on their ability than others, and experience a lot more variation in earnings given similar variations in ability compared to other groups. The uneven variance in earnings given similar variances in ability is an indication of statistically discriminated immigrant groups due to information gaps. I show that credential assessment is an essential service to reduce information gaps between employers and immigrant workers. While assessors do not reveal an immigrant worker's true ability without error, they may supply contextual and/or specific information about the worker and their source country. The more about the source country that goes unexplained, variance in ability and immigration increases, while variance in earnings decreases. However, these results are generated only if the credential assessor faces considerable difficulty in learning about the source country and migrants are of low ability.

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Statistical discrimination; immigrants; entry earnings; labour market intermediaries; credential assessment services; asymmetric information; unobserved ability

1. Introduction

Hiring the right candidate for a job is fraught with uncertainty. The source of uncertainty is predominantly attributed to information asymmetries that exist between what the employer can observe and what potential candidates possess. While credentials tell employers a lot about a candidate, it is limited as a source of information for employers in comparing multiple job candidates with similar credentials. Additionally, credentials do not indicate potential quality, ability and talent. This creates an information gap that leads to employers undercutting salaries to account for the uncertainty in outcomes when ability is not observed. Employers will be able to make better hiring decisions and wage offers if they have more complete information on potential workers' ability.

Labour market intermediaries (LMI) provide an important service to employers. LMIs decrease the uncertainty that employers face in making a hiring decision or wage setting in the job market. LMIs provide additional contextual or specific information to employers, leaving employers in a better decision-making position than if they had to make

a decision under uncertainty or obtain the information themselves. The most frequently studied type of LMIs in the literature has been temporary help agencies, online job boards and labour unions (Autor, 2008).

LMIs contribute to firms and workers by facilitating better skill matches to the employers' needs, providing training services for workers, resolving conflicts between the employer and worker, and/or decreasing search costs (Autor, 2004; Autor, 2008). In addition to the formal institutional structure of the LMI, firms may also use informal social networks and professional references to decrease persistent information gaps (Hensvik & Skans, 2016; Ioannides & Loury, 2004). Informal mechanisms are inexpensive and personalized, while formalized LMIs provide reliable services at scale.

LMIs that specialize in the supply of information will do so at a lower cost than if employers had to gather the same information themselves. LMIs also alleviate asymmetric information in cases where workers know more about their quality than employers in the market. Asymmetric information leads to employers statistically discriminating against workers whose qualities are not easily observed in favour of those whose abilities are easily observed. In this paper, I provide empirical evidence that new immigrants from some source countries experience a lot more discriminatory entry earnings due to unobserved ability than others. I formulate a theoretical model with a credential assessment service that evaluates the credentials of foreign-born workers, revealing workers' ability by supplying contextual and/or specific knowledge about the new immigrant's source country at a price. I further show that group size has feedback effects on the determination of revealed ability and subsequent entry earnings in the job market. Not all the information about the immigrant's source country is revealed. There will always be some random noise that remains. The amount of noise is the source of exogeneity that is hypothesized to affect total immigration, the ability that is signalled to employers and entry earnings.

2. Background

Canada ranks high relative to other OECD countries in terms of labour market outcomes. Participation rates among the foreign born in Canada were 2.4 percentage points higher than the OECD average. Similarly, the employment rate among foreign-born people in Canada is 3.6 percentage points higher than the OECD average. Even compared to native-born, the foreign-born employment rate difference is 2 percentage points lower, which is the same as the OECD weighted average of 1.9 percentage points lower than native-born (OECD, 2019). On the other hand, the entry earnings of new immigrant men from the 2010 cohort are only 57% (53% for immigrant women) of the comparison group (i.e., Canadian born, plus immigrants that have lived in Canada for more than 10 years) (Hou & Picot, 2016). Entry earnings are based on the earnings of new immigrants that have lived in Canada for less than 2 years. Entry earnings capture the returns to foreign credentials, foreign experience and innate ability. While the returns to foreign credentials and experience are observed in the Canadian Census of Population, innate ability is not.

Innate ability is discussed in parallel with unobservables. The term unobservables is a catch-all for the unexplained variation in entry earnings among new immigrants, after controlling for a set of observable factors in the data. Selection on unobservables includes talent, ability and the general quality of immigrants. Unobserved heterogeneity has

received a lot of attention in the literature on positive/negative selection of immigrants. The majority of research studies in this area is conclusive to the positive role that unobservables have on the selection of immigrants from the source country, and that these are relatively more important than the observable factors (such as education, location of study, age and gender) (Borjas, 1987; Borjas, Kauppinen, & Poutvaara, 2018; Dostie & Leger, 2009; Grogger & Hanson, 2011; Cobb-Clark, 1993; Borjas & Bratsberg, 1996; Chiquiar & Hanson, 2005).

Innate ability is known to the workers and unobserved to the employers and econometrician. While the ability is difficult to capture empirically, its effects may be inferred. For those immigrants who completed their highest level of education outside Canada, the selective-ness of the institution is an indicator of their ability level within the ability distribution of the source country. However, this piece of information is not captured in any known data set. Credential assessment agencies, such as World Education Services in Ontario and International Credential Evaluation Services in British Columbia, translate the value of a foreign credential into local variants, but these agencies do not account for differences in the selective-ness of foreign education institutes.

More recently, aside from ability, there has been considerable discussion surrounding the soft skills gap among new immigrants and how these are becoming barriers to integration in the labour market. Like ability, soft skills are generally unobserved without additional data sources. Individual workers' soft skills are not observed by the econometrician, but employers can gauge them through interviews, testing and certification requirements. But even the tools available to employers are inaccurate measures of soft skills. For instance, standardized achievement test scores, such as the GRE and SAT scores conducted in US schools, have been used as a measure of aptitude and general knowledge by employers and graduate school admissions. However, research suggests that standardized achievement test scores are not accurate indicators of personality traits, goals and motivations that are valued in the labour market (Heckman & Kautz, 2012). Even if soft skills are measured with error, they are important to employers for workplace integration (Lai, Shankar, & Khalema, 2017). Based on an importance ranking of skills by employers in Canada, people skills and communication ranked highest, followed by problem solving, analytical and leadership skills. Industry-specific knowledge/experience, functional knowledge and technological literacy ranked lower (Grant, 2016). For new immigrants, a lack of soft skills is a clear disadvantage due to a lack of awareness about Canadian business practices. Soft skills are intangible but can be learned by new immigrants (Bartel, 2018). Soft skills are essential for entry earnings because they make workers more productive, but also convey important information about a person's innate ability. In addition to acting as a signal for a person's innate ability; to new immigrants, a strong set of soft skills can also signal to employers the value of their foreign credential. Although this paper is not about soft skills, due to its unobservability, some of the results that I attribute to ability might instead be confounded by the effect of soft skills on entry earnings.

The effect of unobservables on the labour market outcomes of migrants has been studied to varying degrees in the literature. Dostie & Léger (2009) show that unobservables with varying returns across Canadian provinces are important for migration decisions among physicians, and omitting the unobservables leads to false results.

Furthermore, Borjas, Kauppinen & Poutvaara (2018) provide strong evidence that immigrants are positively selected on unobservables, not simply in terms of higher expected earnings, but along the entire earnings distribution. These papers get close to identifying the self-selection in the migration decision, but cannot provide evidence of the returns in unobservables. Dostie & Léger (2009) are somewhat close to identifying whether Canadian physicians' returns to unobservables are higher or lower outside of Ontario, Quebec and British Columbia, but not in real value terms. In this paper, I do not provide estimates of the returns to unobservables because data on individual ability and soft skill levels are limited. And unobservables must be inferred from regression model residuals.

Instead, this paper provides empirical evidence that variations in unobservables (as measured by the model error) are not supported by the observed variation in earnings within immigrant group. That is, the entry earning returns on unobservables vary dramatically across source country groups. Consider the following hypothetical scenario with two pairs of immigrants originating from two source countries A and B. Suppose y is entry earnings and x ability. The two immigrants from country A have earnings y_1^A and y_2^A such that $y_1^A < y_2^A$. Similarly, the two immigrants from country B have earnings such that $y_1^B = y_2^B$. It does not matter how earnings between the two source countries compare, but suppose additionally that the variation in ability within the two immigrants of each of the countries is identical $x_1^A - x_2^A = x_1^B - x_2^B$. Figure 1 depicts this hypothetical scenario. Among country B immigrants, the immigrant with higher ability does not experience higher earnings. On the other hand, country A immigrants did experience an increase in their earnings for greater ability. We could conclude that immigrant 2 from country B is negatively discriminated against and insufficiently compensated relative to immigrant 2 in country A with similar ability. The standard interpretation is that the returns to unobservables vary across source country groups. However, this interpretation abstracts from the inherent statistical discrimination between source country groups.

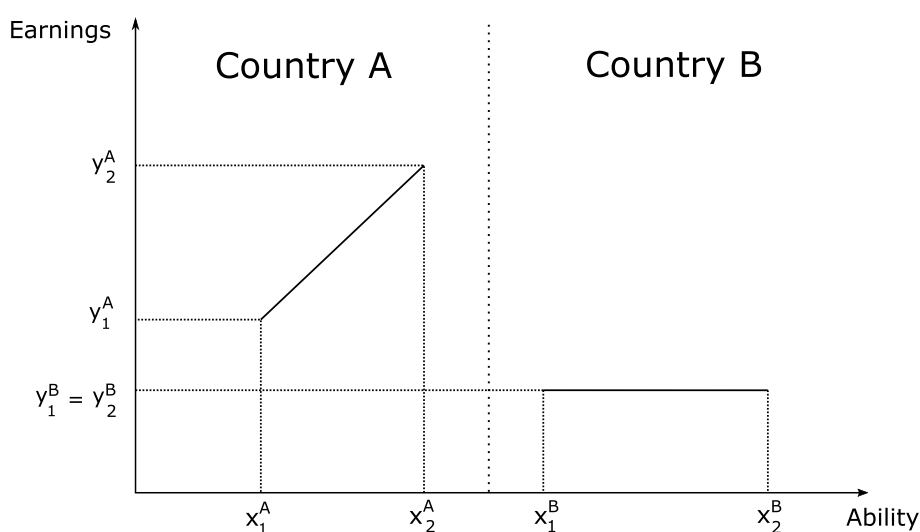


Figure 1. A hypothetical scenario depicting variations in earnings against variations in ability.

Figure 1 says that country B immigrants experience a lot more variation in their earnings given the variation in ability. Alternatively, country A immigrants experience a lot less variation in their earnings given the variation in ability. In the following section, I use the 2016 Canadian Census of Population Individuals Public Use Microdata File to provide evidence that variations in earnings do not always respect variations in ability.

Since migration decisions are endogenous, the size of an immigrant group has a simultaneous effect on variations in ability and earnings through the role of labour market intermediaries, such as credential assessment service providers. However, credential assessors cannot possibly uncover all the required information about migrants' source country or their personal attributes to infer true ability. I hypothesize that there is some random noise associated with revealing workers' ability. I hypothesize that the random noise that goes unexplained by the credential assessor affects the variance in earnings, variance in signalled ability and total immigration. This hypothesis is a variant of the paper by Lazear (2017) where the number of immigrants from a source country is inversely related to average immigrant earnings and education, where the intermediary is the immigration authorities in the host country selecting migrants across many source countries. In Lazear (2017), immigrants are selected from the higher end of the earnings or education distribution in the source country if fewer immigrants are being selected, even without a stricter selection policy in the host country. This leads to the empirical observation that the number of immigrants from a source country being inversely related to average earnings and education. Instead of average earnings and education, I am interested in the variance of earnings and ability within source country groups, where the intermediary is a credential assessor, and there are no policy defined barriers to the size of the source country group. Additionally, Lazear (2017) treats source country group size as an exogenous policy decision. In this paper, migration decisions are endogenous.

A theoretical model is formulated to capture the regularities observed in the data. A statistical discrimination-type model (Farmer & Terrell, 1996; Fang & Moro, 2010; Altonji & Pierret, 2001; Arrow, 1998; Phelps, 1972) is utilized to model employers underpaying immigrants in the presence of uncertainty about their ability. Employers may choose to utilize the services of a credential assessor to decrease the noise associated with unobserved ability, for a fee that is passed onto the worker.¹ Furthermore, foreign-born workers choose to migrate to the host country conditional on net earnings and the noise in unobserved ability.

This paper presupposes that the entry earnings gap is due to frictions caused by an information gap between employers and the signals that new immigrants convey about their skill level. The size of the information gap is reduced by employers paying for the services of a credential assessor. The credential assessor supplies a signal with less noise through research on the immigrant's source country. But the efficiency of the research that is conducted by the credential assessor depends on the total amount of revenue and cost of conducting research, both of which depend on the size of the immigrant group in the host country. Finally, as a policy recommendation, I propose that ability signals can be reinforced with less uncertainty through a more efficient credential assessment service that captures the selective-ness of the educational institute in the source country.

¹In the model, the fee is passed onto the worker as a deduction from their earnings, because normally the migrant worker pays for credential assessment services.

3. Empirical evidence

This section provides empirical evidence that within-immigrant group variations in entry earnings do not always respect variations in ability. I measure ability/talent/quality (henceforth ability) using the residuals from Mincerian earnings regressions with a set of observable post- and pre-immigration covariates included; analogous to the literature on positive/negative selection of immigrants (Borjas et al., 2018; Dostie & Leger, 2009). I utilize within-immigrant group variations to show that unobservables have a limited impact on earnings, especially among those immigrant groups with fewer immigrants in total.

The data for this study come from the 2016 Canadian Census of Population Individuals Public Use Microdata File. I subset the data to employed persons that worked at least 40 full-time weeks in the previous year, 25–64 years old, excluding non-permanent residents and self-employed. Native-born and new immigrants (those that have lived in Canada for at most 5 years) are included in the sample. The native-born are further subset to 25–34 years old as a comparison group because this age group is most likely to represent new graduates and early-career labour market entrants, which is most similar to the experience of new immigrants in the Canadian labour market (Green & Worswick, 2011). I run separate regressions for each of the 31 immigrant groups identified in the public use census file² with the Canadian native-born as a control group. The regression model is a log-wage model for native-born and new immigrants from source country c ,

$$\ln(y) = \alpha_n z + \alpha_c (I \times z) + \epsilon_c \quad (1)$$

where $\ln(y)$ is logged employment earnings, I is a dummy variable that takes a value of 1 for immigrant and 0 for native-born, z is a set of observed covariates, and ϵ_c is the unobserved heterogeneity within source country c . A separate regression is run for each source country $c \in \{1, 2, 3, \dots, 31\}$ and a mean squared error is extracted from the model. If x_c is individual ability in country c , then the variation in ability is measured by

$$\sigma_{x_c} = \frac{1}{N_c} \sum_{i=1}^{N_c} (\epsilon_c)^2 \quad (2)$$

where N_c is the total number of immigrants within group c . A list of the variables used in the regression analysis is provided in Table 1. The results of this exercise are provided in Figure 2. The x-axis is the mean squared error of equation (2) relative to native-born for each of the 31 source countries. The y-axis is the variance in log earnings relative to native-born, or $\sigma_{\ln(y)}$. And the size of the circle represents the share of immigrants living in Canada based on the 2011 National Household Survey.

The north-east quadrant indicates that new immigrants from India, China and the United States experience a large amount of variation in their log earnings corresponding to a comparatively large amount of variation in their ability. Similarly, immigrants from Italy and the Philippines experience less variation in log earnings to a comparatively small amount of variation in their ability. This is seen in contrast to immigrants from Hong Kong, Portugal, Poland and East Africa (north-west quadrant), who experience

²The Public Use Microdata File does not detail all the place of birth groups. For a more detailed country list, the Master File is required, but this is not likely to yield different results.

Table 1. List of variables used in the regression model.

Variable name	Variable type	Use
Wages, salaries and commissions	Continuous	Dependent variable
Age at immigration	Factor	Independent variable
Highest level of education	Factor	Independent variable
Classification of Instructional Program	Factor	Independent variable
Census Metropolitan Area	Factor	Independent variable
Knowledge of official language	Factor	Independent variable
Language of work	Dummy	Independent variable
Marital status	Factor	Independent variable
North American Industry Classification System (NAICS)	Factor	Independent variable
National Occupational Classification (NOC)	Factor	Independent variable
Children living in the household	Dummy	Independent variable
Gender	Dummy	Independent variable
Visible minority	Factor	Independent variable
Location of study	Factor	Independent variable
Place of birth	Factor	Subset across all place of birth levels; a separate regression for each level
Class of worker	Factor	Subset to employees
Labour force status	Factor	Subset to employed in reference week
Work activity in 2015	Factor	Subset to worked at least 40 weeks full time
Age group	Factor	Subset to those 25–64 years old; and native-born are further subset to those 25–34 years old
Immigration status	Factor	Subset to immigrant or non-immigrant; excludes non-permanent residents and not available
Year of immigration	Continuous	Subset to new immigrants in the last 5 years and native-born; excluding all older immigration cohorts and not available

high variation in earnings with a relatively small amount of variation in ability. Comparing immigrants from the Philippines to those from East Africa reveals that Filipinos experience a lot less variation in earnings given similar variations in ability. Based on the logic of Figure 1, Filipinos appear to be relatively more discriminated against than their East African counterparts. Similarly, it could be said that immigrants from Northern Africa experience more discriminatory earnings than similar Pakistanis working in Canada. Now, the size of the circle in the figure provides a notional theory that the observed relationship between variance in earnings and the variance in ability might be related to the size of the source country group working in Canada. Figure 3 plots the relationship between the variance in log earnings and variance in ability against the place of birth share of the total population, along with a fitted line showing the strength and the direction of correlation. There is a clear positive relationship between the share of the source country population and variations in ability. There is also a negative relationship between the share of the source country's population and variations in earnings.

This may be the case that the measure used to estimate variance in log earnings is affected by extreme income values. Figures 4 and 5 provide estimates for all immigrant source groups that fall within the 10th and 90th percentile (or the middle 80%) of the income distribution. Firstly, there is much less variation among all source country groups, as expected. Secondly, where countries fall relative to others in this subset of the data is a noticeable change from Figure 2. One of the notable differences is that immigrants from the United States, China and India have similar variations in earnings

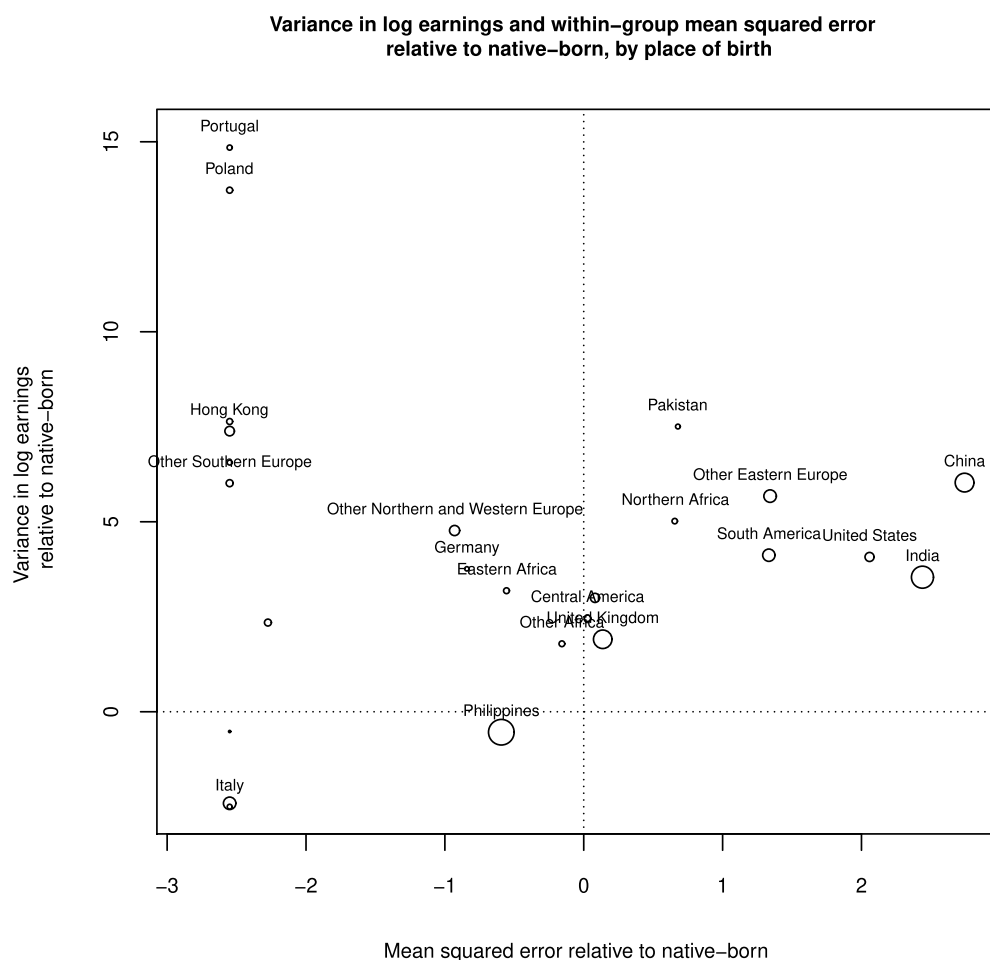


Figure 2. The variance in log earnings and mean squared error, by country of birth. The density of the circle represents the share of place of birth population.

given vastly different variations in ability. In this case, Indians are relatively more discriminated against than their Chinese counterparts, who in turn are relatively more discriminated against than Americans working in Canada. On observation of [Figure 5](#) that plots the relationship between the variance in log earnings and variance in ability against the place of birth share of the total population for the middle 80%, the positive relationship between share of the source country population and variations in ability still holds, as well as the negative relationship between share of the source country population and variations in earnings.

Furthermore, since the regression model (1) might have been misspecified, the estimates of the mean squared error are probably erroneous. For this reason, I also estimate a non-parametric regression model with the same variables described in [Table 1](#) for each of the 32 source country groups. [Figure 6](#) shows the variance in log earnings relative to native-born Canadians on the y-axis (the same measure used in [Figure 2](#)) and a non-parametric estimate of the mean squared error relative to native-born Canadians

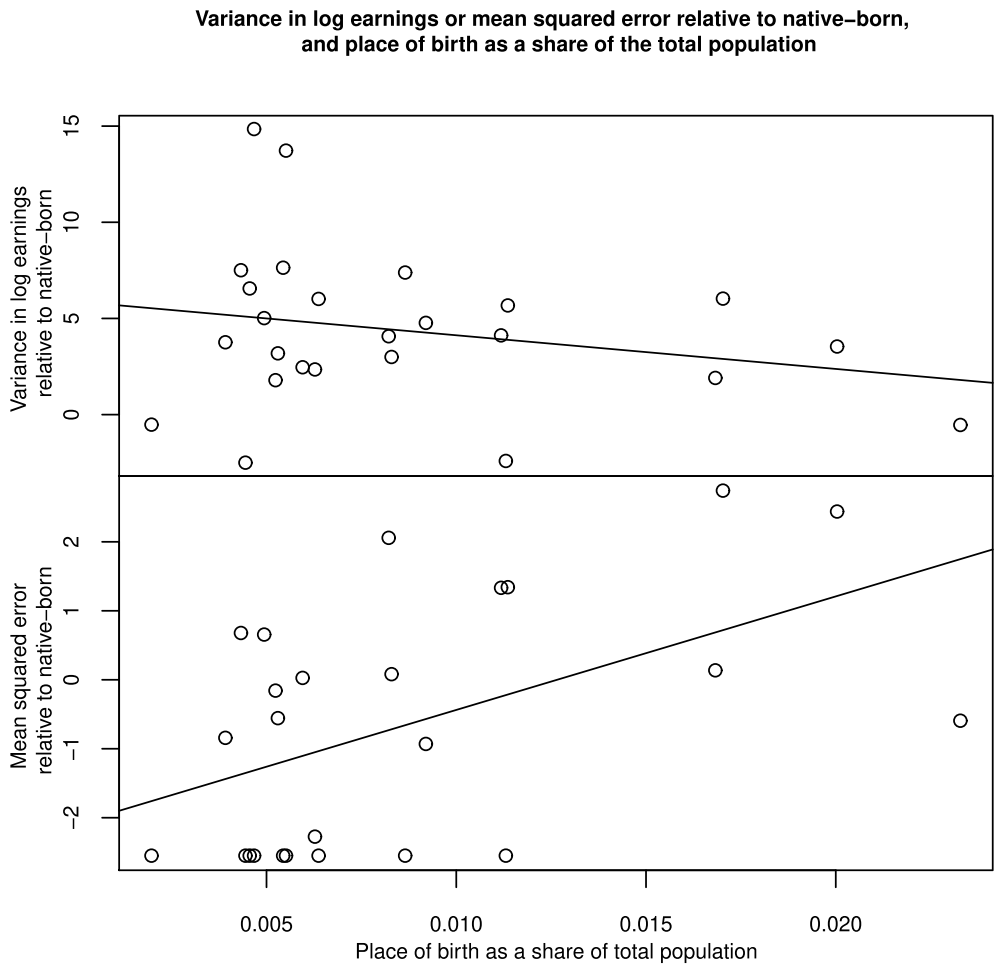


Figure 3. The variance in log earnings and mean squared error, by the share of place of birth population. The diagonal line is the fitted relationship between variables. Each circle represents the share of place of birth population.

on the x-axis. Since non-parametric regression models generally do well in fitting the data, naturally the mean squared errors are smaller. However, what matters is where the source country's immigrant groups fall relative to others. Along the x-axis, immigrants from India, Philippines, United States, Pakistan, Poland and Italy appear to hold the same positions relative to the other source countries. To see this more clearly, [Figure 7](#) excludes India, Philippines and the United States. Immigrant groups from China, Central America and North Africa have shifted in position compared to [Figure 2](#). While it is still the case that Indians are relatively more discriminated against than their American counterparts, I cannot draw a conclusion about how Chinese immigrants are fair relative to Indians and Americans working in Canada. Finally, in [Figure 8](#), the positive relationship between the share of the source country population and variations in ability still holds, as well as the negative relationship between the share of the source country population and variations in earnings.

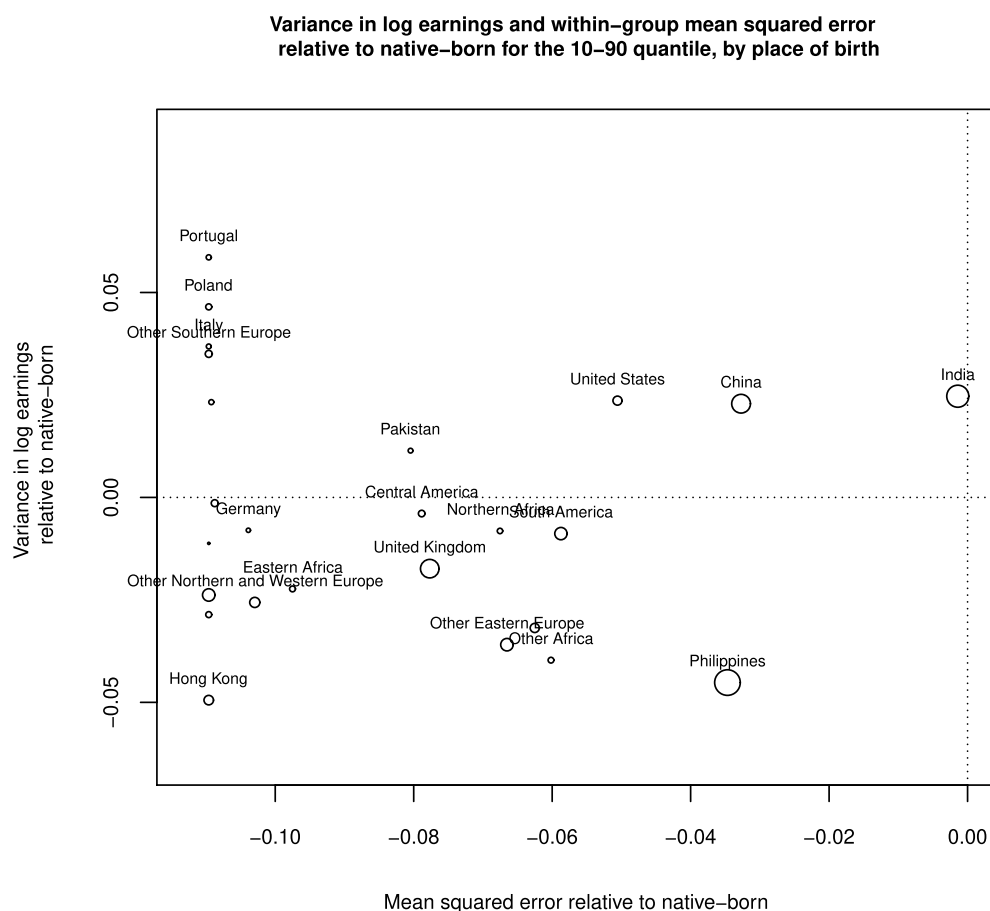


Figure 4. The variance in log earnings and mean squared error, by place of birth. The density of the circle represents the share of place of birth population.

Preliminary evidence provided by [Figures 2–8](#) indicates that new immigrants from source countries with a larger presence in Canada are more likely to experience smaller variations in log earnings and larger variations in ability. This indicates that larger source country groups have, on average, lower returns on their ability than those from smaller immigrant groups. That is, larger source country groups experience more discriminatory entry earnings than smaller groups. Since total immigration, variance in earnings and variance in ability are endogenous, the exogenous variation is hypothesized to be coming from information (or lack of information) held by credential assessors about the source country group. It should be noted that educational credential assessments became mandatory for principal applicants in the Federal Skilled Worker Program in 2013 but is not required from non-primary applicants and those coming to Canada through other programs (Canada, 2020; Banerjee, Hou, Reitz, & Zhang, 2021). This does not affect the results of this paper because the type of information revealed through credential assessment did not change and employers still experienced information gaps about immigrants' ability. For instance, a credential assessment report by World Education Services (1) identifies and describes credentials, (2) verifies that those

Variance in log earnings or mean squared error relative to native-born for the 10–90 quantile and place of birth as a share of the total population

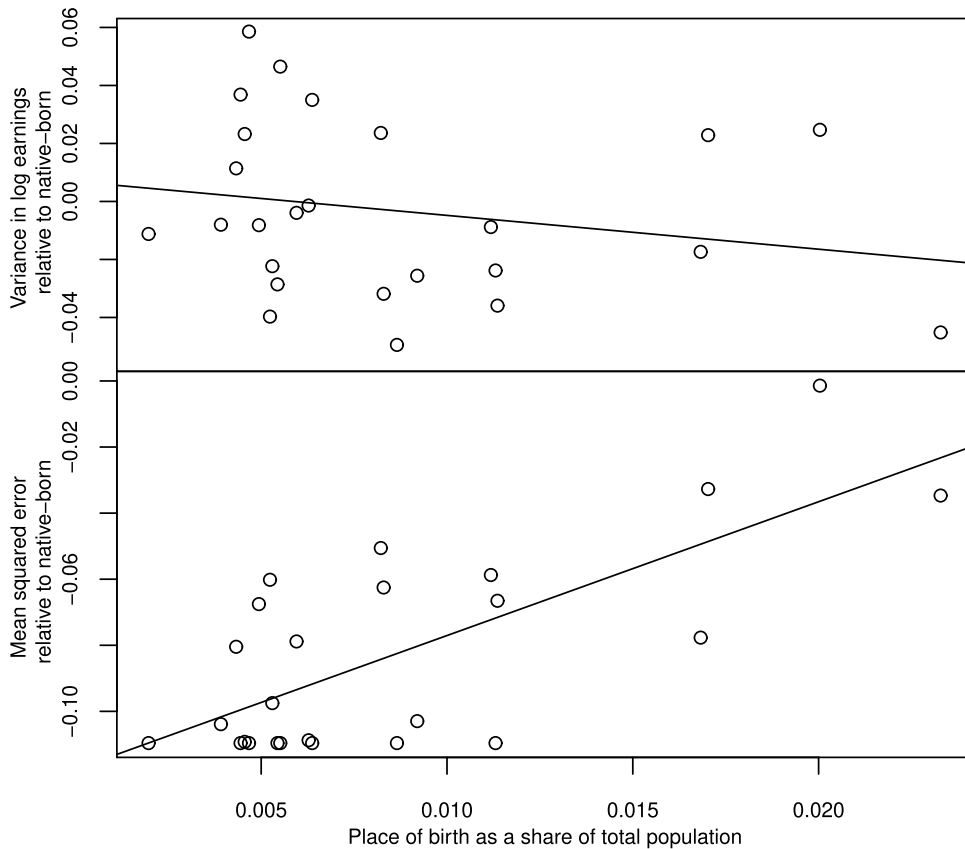


Figure 5. The variance in log earnings and mean squared error, by place of birth. The data is subset to the middle 80% (or 10–90 quantile). The diagonal line is the fitted relationship between variables. Each circle represents a source country group.

credentials are authentic, (3) may include a grade point average (GPA) equivalency, and (4) includes an evaluation of the authenticity of those documents (World Education Services, 2022).

4. Theoretical model

The theoretical model used to explain the findings of this paper comes from the statistical discrimination literature. This model takes into account the size of the immigrant group, variations in earnings and variations in ability. A credential assessor plays the role of a labour market intermediary that provides value to firms by supplying credential assessment services.

There are two countries: North and South. The North is a rich developed country, and the South is a poor less developed country. Each country has its own set of workers that migrate from the poor South to the rich North, and employers only operate in either the

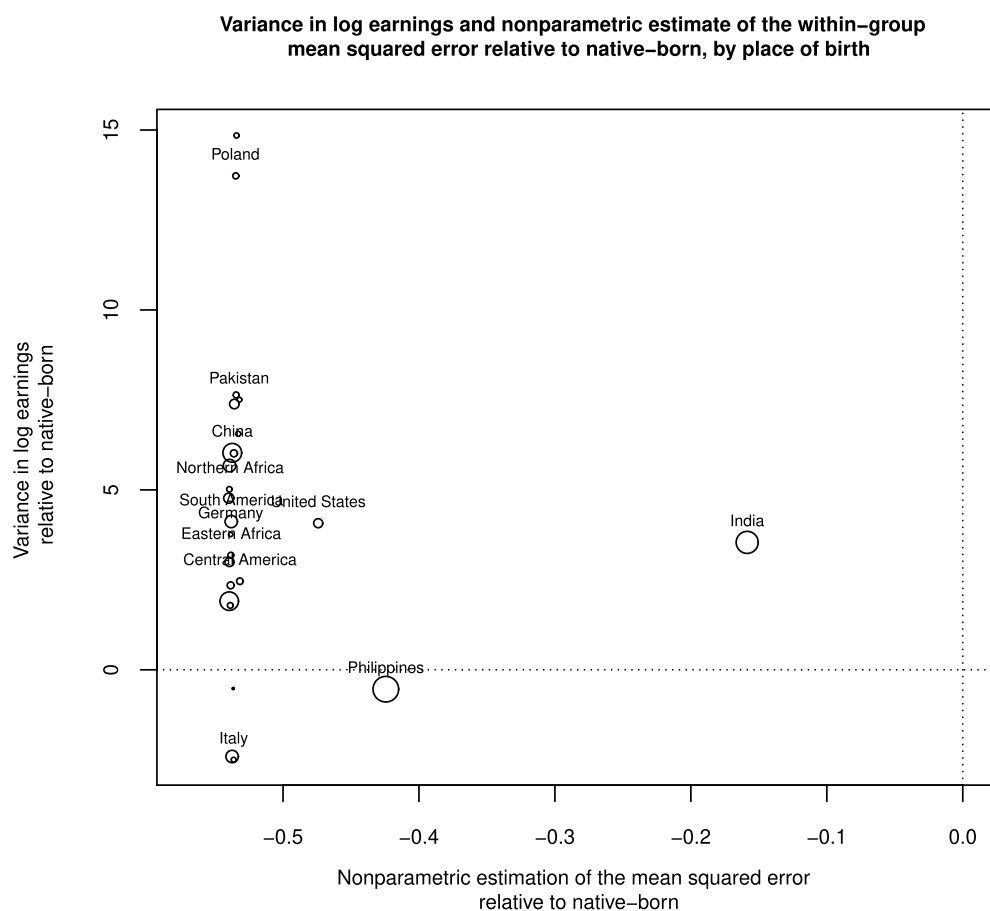


Figure 6. The variance in log earnings and non-parametric estimates of the mean squared error, by country of birth. The density of the circle represents the share of place of birth population.

North or South. All workers, North or South, have an innate ability A to perform a set of tasks required by employers. However, this ability is observed by employers as a signal θ with error, such that

$$\theta = A + e \quad (3)$$

where $A \sim N(\mu, \text{Var}[A])$ and A and e are independent. The distribution of the error term e depends on the location of the employer and whether the employer chooses to use the services of the credential assessor. Employers in the South (North) observe the ability of Southern (Northern) workers without error, so that $e = 0$. Employers in the North observe the ability of Southern workers with error, such that $e = e_1 \sim H_1(e_1)$ if the employer does not use the services of a credential assessor, and $e = e_2 \sim H_2(e_2)$ if the employer does use the services of a credential assessor. The expected value of the errors are $E[e_1] = E[e_2] = 0$. The variance of e_1 is given by $\text{Var}[e_1]$, but the variance of e_2 is determined endogenously by the credential assessment service providers research

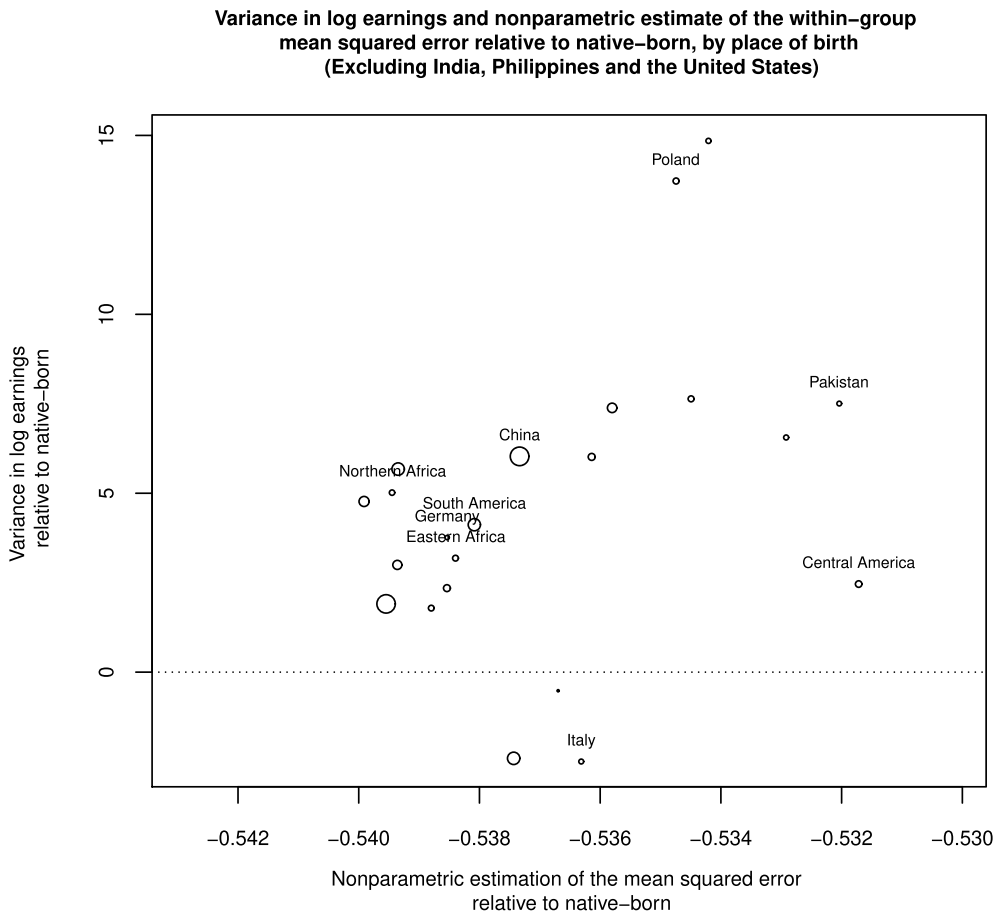


Figure 7. The variance in log earnings and non-parametric estimates of the mean squared error, by country of birth. The data excludes estimates of Indian, Chinese and American immigrants. The density of the circle represents the share of place of birth population.

spending optimizing condition. The more research the assessor conducts, the closer it gets the signal θ to the true ability A . The optimal research spending that minimizes the error e_2 is derived in the next subsection.

The signal θ derives its distribution from A and e , where e is either e_1 or e_2 . Let $\theta \sim T(\theta)$ such that

$$\begin{aligned}
 T(\theta) &= \Pr(A + e \leq a) \\
 &= \int_{\chi} \int_{-\infty}^{\infty} \Phi(A) H(e) dA de \\
 &= \int_{\chi} \Phi(a - e) H(e) de
 \end{aligned} \tag{4}$$

where Φ is the normal cumulative distribution function and χ is the range of values for e .

Variance in log earnings or nonparametric estimate of the mean squared error relative to native-born, and place of birth as a share of the total population

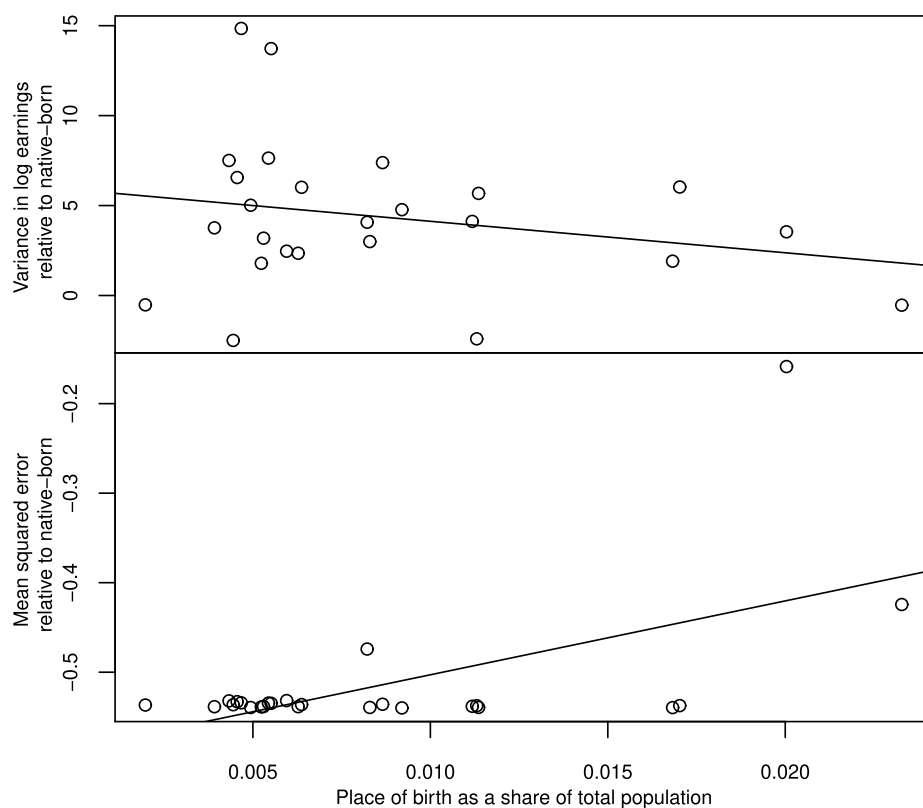


Figure 8. The variance in log earnings and mean squared error, by the share of place of birth population. The diagonal line is the fitted relationship between variables. Each circle represents a source country group.

4.1. Credential assessment services

The credential assessment service provider is an important source of information for employers in the North. They supply employers with more precise information about migrants than what the employers could gather themselves. The assessor supplies this information to the employer at a per worker fee of t . The assessor supplies a product that minimizes $\theta - A = e_2$ but also yields a profit for itself. The profit maximization problem for the credential assessment service provider is

$$\Pi = \max_r \quad rM \times (1 - (e_2)^2)v - f(rM)^2$$

$$s.t. \quad e_2 = e(r) + \lambda \tag{5}$$

where $f > 0$ is a research cost factor (i.e., wages paid for research skills), $v > 0$ is the value of the assessor in producing more reliable estimates, r is research spending per worker, $\lambda \sim N(0, \text{Var}[\lambda])$ represents unattainable knowledge or noise, and M is the total number of immigrants that need to be assessed. The $\text{Var}[\lambda]$ is assumed to be unrelated to the amount of research conducted by the assessor, and represents the spread of unattainable knowledge that the credential assessor cannot know of the source country. The $\text{Var}[\lambda]$ is the exogeneity that will generate variations in earnings, variations in ability, and changes in the size of the source country group. Intuitively, $\text{Var}[\lambda]$ is the breadth of knowledge that remains unexplained regardless of the credential assessor's research efforts. Henceforth, I refer to $\text{Var}[\lambda]$ as the random noise component. The first term rM represents the total research budget spent on M immigrants. The second term $(1 - (e_2)^2)v$ and the constraint $e_2 = e(r) + \lambda$ represent the value attached to product creation from minimizing the error in the signal, plus some noise. I assume that $\text{Cov}(e(r), \lambda) = 0$, $e'(r) < 0$ and $e''(r) < 0$. The third component $f(rM)^2$ is the total research cost function. Credential assessors select the amount of research spending that will lead to a smaller signal error and a higher yield from the research investment. The first-order condition that determines the optimal research spending per worker can be reduced to

$$\begin{aligned} r &= \frac{v}{2fM} \times (1 - (e(r) + \lambda)^2 - 2re(r)e'(r)) - \frac{rve'(r)}{fM}\lambda \\ &\equiv \frac{v}{2fM} \times G(\lambda, r) - \frac{rve'(r)}{fM}\lambda. \end{aligned} \quad (6)$$

Equation (6) implicitly defines the research spending function. Let $r(\lambda; M, v, f)$ be the optimized research spending undertaken by the assessor, where λ is the source of heterogeneity representing the amount of unexplained noise in the signal error. The per worker research cost is given by

$$t = \frac{f(r(\lambda; M, v, f)M)^2}{M} = fr(\lambda; M, v, f)^2 M. \quad (7)$$

And substituting the optimized research spending function into the constraint $e_2 = e(r) + \lambda$ gives the error function

$$e_2 = e(r(\lambda; M, v, f)) + \lambda. \quad (8)$$

Equation (8) partially addresses the questions initially raised by the empirical evidence. Assuming that λ is multiplicative separable from $e(\cdot)$, such that $e(r(\lambda; M, v, f)) = \lambda e(r(M, v, f))$, and taking the variance of equation (8) gives the following result

$$\begin{aligned} \text{Var}[e_2] &= \text{Var}[\lambda e(r(M, v, f)) + \lambda] \\ &= \text{Var}[\lambda(e(r(M, v, f)) + 1)] \\ &= \text{Var}[\lambda] \times (e(r(M, v, f)) + 1)^2, \end{aligned} \quad (9)$$

where equation (9) is the variance in the error from using the services of the credential assessor. The variance in signal ability is then given by

$$\text{Var}[\theta_2] = \text{Var}[A] + \text{Var}[\lambda] \times (e(r(M, v, f)) + 1)^2. \quad (10)$$

Which is the variance in ability observed with error from equation (3).

4.2. Migration decision

Employers in the North and South produce output Q from the worker's skill level H . The per worker production function is

$$Q = H. \quad (11)$$

The employer compensates the skill contribution with a wage that is equal to its expected marginal product. The employer's skill demand function is given by

$$w = E[H] \\ \ln(w) = E[\ln(H)] \quad (12)$$

The skill level is not completely observed by employers in the North and South. Skill can be disaggregated into ability and credential components, as follows

$$\ln(H) = \alpha\theta + \beta\zeta \quad (13)$$

where θ is the signal from equation (3), ζ is credential level, α and β are parameters. It is assumed that $\text{Cov}(\theta, \zeta) = 0$; although relaxing this assumption could change the results drastically. Substituting equation (13) into equation (12) produces the skill demand function dis-aggregated into the observed credential level and the observed but uncertain ability signal

$$\ln(w) = \alpha E[\theta] + \beta E[\zeta] \\ = \alpha E[\theta] + \beta \zeta. \quad (14)$$

Southern employers observe the ability of Southern workers with certainty. That is, from equation (3) the signal error is $e = 0$ and substituting in equation (14) gives

$$\ln(w_0) = \alpha A + \beta \zeta. \quad (15)$$

Northern employers that do not utilize a credential assessor will pay wages with uncertainty in the signal error $e = e_1 \sim H_1(e_1)$.

$$\ln(w_1) = \alpha E[A + e_1 | \theta] + \beta \zeta \\ = \alpha E[A | \theta] + \alpha E[e_1 | \theta] + \beta \zeta \\ = \alpha \left(\frac{\text{Var}[A]}{\text{Var}[A] + \text{Var}[e_1]} \right) \theta + \alpha \left(\frac{\text{Var}[e_1]}{\text{Var}[A] + \text{Var}[e_1]} \right) \mu + \beta \zeta. \quad (16)$$

Northern employers that do utilize a credential assessor will pay wages with uncertainty in the signal error $e = e_2 \sim H_2(e_2)$.

$$\begin{aligned}
\ln(w_2) &= \alpha E[A + e_2 | \theta] + \beta \zeta - t \\
&= \alpha E[A | \theta] + \alpha E[e_2 | \theta] + \beta \zeta - t \\
&= \alpha \left(\frac{\text{Var}[A]}{\text{Var}[A] + \text{Var}[e_2]} \right) \theta + \alpha \left(\frac{\text{Var}[e_2]}{\text{Var}[A] + \text{Var}[e_2]} \right) \mu + \beta \zeta - t.
\end{aligned} \tag{17}$$

where t is per worker cost of utilizing the services of the credential assessor. Migration occurs when the earnings from migration exceed the earnings from staying, while employers account for the uncertainty in the signal and pay a fee to use the services of the credential assessor. The fee is passed onto the worker through a deduction from their earnings. The Southern worker migrates to the North, while the Northern employer pays the assessor a fee to reduce the uncertainty surrounding the ability signal, according to the following condition

$$\begin{aligned}
(\ln(w_2) - \ln(w_0)) - c &= \alpha \left(\frac{\text{Var}[A]}{\text{Var}[A] + \text{Var}[e_2]} \right) \theta + \alpha \left(\frac{\text{Var}[e_2]}{\text{Var}[A] + \text{Var}[e_2]} \right) \mu - A - t \\
&\equiv I_2
\end{aligned} \tag{18}$$

where c is the cost of migration between the North and the South. The emigration rate from the South is given by

$$\begin{aligned}
\Pr(I_2 > 0) &= \Pr \left(\theta > \frac{A - \mu \frac{\text{Var}[e_2]}{\text{Var}[A] + \text{Var}[e_2]} + \frac{t}{\alpha}}{\frac{\text{Var}[A]}{\text{Var}[A] + \text{Var}[e_2]}} \right) \\
&= \Pr \left(\theta > \frac{A - \mu \frac{\text{Var}[e_2]}{\text{Var}[\theta_2]} + \frac{t}{\alpha}}{\frac{\text{Var}[A]}{\text{Var}[\theta_2]}} \right) \\
&= \Pr \left(\theta > \frac{(A + \frac{t}{\alpha}) \text{Var}[\theta_2] - \mu \text{Var}[e_2]}{\text{Var}[A]} \right) \\
&\equiv 1 - T(\bar{\theta}_2).
\end{aligned} \tag{19}$$

Let the total population in the South be P . Then, the total number of migrants to the North M is given by

$$M = P \times (1 - T(\bar{\theta}_2)). \tag{20}$$

The total number of migrants varies according to $\text{Var}[\theta_2]$ and $\text{Var}[e_2]$ through the emigration rate of equation (19), which then feeds back into the $\text{Var}[\theta_2]$ and $\text{Var}[e_2]$ through $e(r(M, v, f))$ of equation (9) and (10).

Now that the equations satisfying the total number of migrants have been determined, the final step is to derive the variance in earnings for those employed migrants who are subject to assessment. The variance in earnings using equation (17) is given by

$$\begin{aligned}
\text{Var}[\ln(w_2)] &= \alpha^2 \left(\frac{\text{Var}[A]}{\text{Var}[A] + \text{Var}[e_2]} \right)^2 \text{Var}[\theta] - \text{Var}[t] \\
&= \alpha^2 \left(\frac{\text{Var}[A]^2}{(\text{Var}[A] + \text{Var}[e_2])^2} \right) (\text{Var}[A] + \text{Var}[e_2]) - \text{Var}[fr(\lambda; M, v, f)^2 M] \\
&\stackrel{\ddagger}{=} \alpha^2 \left(\frac{\text{Var}[A]^2}{(\text{Var}[A] + \text{Var}[e_2])^2} \right) (\text{Var}[A] + \text{Var}[e_2]) - \text{Var}[f\lambda^2 r(M, v, f)^2 M] \\
&= \alpha^2 \left(\frac{\text{Var}[A]^2}{\text{Var}[A] + \text{Var}[e_2]} \right) - f^2 r(M, v, f)^4 M^2 \text{Var}[\lambda^2] \\
&= \alpha^2 \left(\frac{\text{Var}[A]^2}{\text{Var}[A] + \text{Var}[e_2]} \right) - f^2 r(M, v, f)^4 M^2 (\mathbb{E}[\lambda^2] - \mathbb{E}[\lambda^2]^2) \\
&= \alpha^2 \left(\frac{\text{Var}[A]^2}{\text{Var}[A] + \text{Var}[e_2]} \right) - f^2 r(M, v, f)^4 M^2 \text{Var}[\lambda] (1 - \text{Var}[\lambda]) \\
&= \alpha^2 \left(\frac{\text{Var}[A]^2}{\text{Var}[\theta_2]} \right) - f^2 r(M, v, f)^4 M^2 \text{Var}[\lambda] (1 - \text{Var}[\lambda]). \tag{21}
\end{aligned}$$

Where t comes from equation (7), and the equality \ddagger follows from the multiplicative separability assumption $e(r(\lambda; M, v, f)) = \lambda e(r(M, v, f))$.

4.3. Equilibrium

Putting together the credential assessment service provider's variations in the signal with the migration decision gives the following set of conditions

$$\text{Var}[\ln(w_2)] = \alpha^2 \left(\frac{\text{Var}[A]^2}{\text{Var}[\theta_2]} \right) - f^2 r(M, v, f)^4 M^2 \text{Var}[\lambda] (1 - \text{Var}[\lambda]),$$

$$\text{Var}[\theta_2] = \text{Var}[A] + \text{Var}[\lambda] \times (e(r(M, v, f)) + 1)^2,$$

$$M = P \times (1 - T(\overline{\theta_2})),$$

$$M \geq 0$$

$$\text{where } \overline{\theta_2} = \frac{\left(A + \frac{fr(M, v, f)^2 M}{\alpha} \right) \text{Var}[\theta_2] - \mu \text{Var}[e_2]}{\text{Var}[A]}, \text{ and}$$

$$\text{Var}[e_2] = \text{Var}[\lambda] \times (e(r(M, v, f)) + 1)^2 \tag{22}$$

Since migration is endogenous, and the variance in earnings and unobservables is a function of the size of immigration, there are multiple equilibria in this model. Increases in the size of immigration have implications for the variance in earnings and ability signal, which in turn affect the migration rate. The effect of these changes are discussed further.

I will identify the conditions that lead to positive or negative shifts in the variance of signal ability and earnings, given a change in the stock of immigrants. The change in $\text{Var}[\theta_2]$ due to changes in M is given by differentiating equation (10) in terms of M , as follows:

$$\begin{aligned} \frac{d\text{Var}[\theta_2]}{d\text{Var}[\lambda]} &= (e(r(M, v, f)) + 1)^2 + \text{Var}[\lambda] \times 2(e(r(M, v, f)) + 1) \\ &\quad \times e'(r) \times \frac{dr(M, v, f)}{dM} \times \frac{dM}{d\text{Var}[\lambda]} \\ &\equiv \mathcal{F} + \mathcal{G} \times \frac{dM}{d\text{Var}[\lambda]}, \end{aligned} \quad (23)$$

where the second equality makes substitutions from the previous. The sign for $d\text{Var}[\theta_2]/d\text{Var}[\lambda]$ depends on the sign of $dr(M, v, f)/dM$ and $dM/d\text{Var}[\lambda]$, which are derived in the appendix. The sign of $dr(M, v, f)/dM$ depends on the noise factor λ that goes unexplained by the credential assessor. Assuming that $e'(r) < 0$ and λ is sufficiently large,³ then $dr(M, v, f)/dM > 0$, then $\mathcal{F} > 0$ and $\mathcal{G} < 0$. Similarly, equation (21) is a function of $\text{Var}[\theta_2]$. Differentiating $\text{Var}[\ln(w_2)]$ in terms of M yields

$$\begin{aligned} \frac{d\text{Var}[\ln(w_2)]}{d\text{Var}[\lambda]} &= -\alpha^2 \frac{\text{Var}[A]^2}{\text{Var}[\theta_2]^2} \times \frac{d\text{Var}[\theta_2]}{d\text{Var}[\lambda]} - f^2 r(M, v, f)^4 M^2 (1 - 2\text{Var}[\lambda]) \\ &\quad - f^2 r(M, v, f)^3 M \times \frac{dM}{d\text{Var}[\lambda]} \\ &\quad \times \left(4M \times \frac{dr(M, v, f)}{dM} + 2r(M, v, f) \right) \\ &\quad \times \text{Var}[\lambda] (1 - \text{Var}[\lambda]) \\ &\equiv -\mathcal{C} \times \frac{d\text{Var}[\theta_2]}{d\text{Var}[\lambda]} + \mathcal{D} + \mathcal{E} \times \frac{dM}{d\text{Var}[\lambda]}, \end{aligned} \quad (24)$$

where $d\text{Var}[\theta_2]/dM$ is equivalent to equation (23). It is further assumed that $\text{Var}[\lambda] > 1$, in which case $\mathcal{C}, \mathcal{D}, \mathcal{E} > 0$. Both equation (23) and (24) are a function of $dM/d\text{Var}[\lambda]$, which is given by⁴

³This assumption is discussed in the appendix.

⁴Derivation is provided in the appendix.

$$\frac{dM}{d\text{Var}[\lambda]} = \frac{-PT'(\bar{\theta}_2) \times \frac{1}{\text{Var}[A]} \times \frac{d\text{Var}[\theta_2]}{d\text{Var}[\lambda]} \left(A - \mu + \frac{fr(M, v, f)^2 M}{\alpha} \right)}{1 + PT'(\bar{\theta}_2) \times \frac{1}{\text{Var}[A]} \times \frac{fr(M, v, f)}{\alpha} \text{Var}[\theta_2] \left(2M \times \frac{dr(M, v, f)}{dM} + r(M, v, f) \right)}$$

$$\equiv \frac{-\mathcal{A} \times \frac{d\text{Var}[\theta_2]}{d\text{Var}[\lambda]}}{1 + \mathcal{B}}, \quad (25)$$

where $\mathcal{B} > 0$, but $\mathcal{A} > 0$ for $A > \mu + fr(M, v, f)^2 M/\alpha$, and $\mathcal{A} \leq 0$ otherwise. The three differential equations (23)-(25) are a system of three equations in three unknowns. Solving this system of equations yields the reduced form

$$\frac{d\text{Var}[\theta_2]}{d\text{Var}[\lambda]} = \frac{\mathcal{F}(1 + \mathcal{B})}{1 + \mathcal{B} + \mathcal{GA}},$$

$$\frac{d\text{Var}[\ln(w_2)]}{d\text{Var}[\lambda]} = \frac{\mathcal{F}(\mathcal{EA} + \mathcal{C}(1 + \mathcal{B}))}{1 + \mathcal{B} + \mathcal{GA}} + \mathcal{D},$$

$$\frac{dM}{d\text{Var}[\lambda]} = \frac{-\mathcal{AF}}{1 + \mathcal{B} + \mathcal{GA}}.$$

For $e'(r) < 0$, $\text{Var}[\lambda] > 1$, λ sufficiently large, for all potential high-ability migrants (i.e., $A > \mu + fr(M, v, f)^2 M/\alpha$ or $\mathcal{A} > 0$) and $1 + \mathcal{B} + \mathcal{GA} > 0$, then

$$\frac{d\text{Var}[\theta_2]}{d\text{Var}[\lambda]} > 0, \frac{d\text{Var}[\ln(w_2)]}{d\text{Var}[\lambda]} > 0 \text{ and } \frac{dM}{d\text{Var}[\lambda]} < 0. \quad (26)$$

As the breadth of knowledge about the source country that goes unexplained increases (i.e., $d\text{Var}[\lambda] > 0$), there is less immigration, higher variance in earnings and higher variance in signalled ability. The sign of $d\text{Var}[\theta_2]/d\text{Var}[\lambda]$ and $d\text{Var}[\ln(w_2)]/d\text{Var}[\lambda]$ are as expected, but not $dM/d\text{Var}[\lambda]$. The rationale behind such an outcome is that an increase in the breadth of unexplained knowledge about a source country could lead to a decrease in total migration for those with high ability because their ability levels are more likely to be misjudged as low ability. However, this does not appear to be the case in reality because the empirical regularities depicted in [Figures 2–8](#) are only partially explained by (26).

Instead, consider the case of potential low ability migrants (i.e., $A < \mu + fr(M, v, f)^2 M/\alpha$ or $\mathcal{A} < 0$) and the additional assumption $\mathcal{EA} + \mathcal{C}(1 + \mathcal{B}) < 0$ (or $|\mathcal{EA}| > |\mathcal{C}(1 + \mathcal{B})|$), then the comparative statics yield

$$\frac{d\text{Var}[\theta_2]}{d\text{Var}[\lambda]} > 0, \frac{d\text{Var}[\ln(w_2)]}{d\text{Var}[\lambda]} < 0 \text{ and } \frac{dM}{d\text{Var}[\lambda]} > 0. \quad (27)$$

Where all the signs are as expected and match the empirical regularities observed in [Figures 2–8](#). As the credential assessor's error in researching the source country increases, among low ability migrants there is more immigration, decreasing variance in earnings and increasing variance in ability.

On the other hand, the same regularities cannot be generated when λ is sufficiently small (i.e., $dr(M, v, f)/dM < 0$). The signs of the components in the reduced form system of equations would become $\mathcal{B} \leq 0, \mathcal{C} > 0, \mathcal{D} > 0, \mathcal{E} \leq 0, \mathcal{F} > 0, \mathcal{G} > 0$ without making any additional assumptions. By assuming that $dr(M, v, f)/dM$ is sufficiently less than zero, such that $2M \times dr(M, v, f)/dM + r(M, v, f) < 0$, then the ambiguously signed components in the reduced form system of equations become $\mathcal{B}, \mathcal{E} < 0$. In the case of high-ability migrants (i.e., $A > \mu + fr(M, v, f)^2 M/\alpha$ or $\mathcal{A} > 0$), the results in (27) cannot be derived. The additional assumptions that would have to be made are $1 + \mathcal{B} < 0$ and $1 + \mathcal{B} + \mathcal{G}\mathcal{A} < 0$ (or $|1 + \mathcal{B}| > |\mathcal{G}\mathcal{A}|$) which would make $dM/d\text{Var}[\lambda] > 0$ and $d\text{Var}[\theta_2]/d\text{Var}[\lambda] > 0$. However, these assumptions will also force $\mathcal{E}\mathcal{A} + \mathcal{C}(1 + \mathcal{B})$ to be negative and $d\text{Var}[\ln(w_2)]/d\text{Var}[\lambda] > 0$, which does not match what was observed in the data. In the case of low ability migrants (i.e., $A < \mu + fr(M, v, f)^2 M/\alpha$ or $\mathcal{A} < 0$) the additional assumptions would be $1 + \mathcal{B} > 0$ (or $|\mathcal{B}| < 1$) and $1 + \mathcal{B} + \mathcal{G}\mathcal{A} > 0$ (or $|\mathcal{B} + \mathcal{G}\mathcal{A}| < 1$). However, these assumptions will force $\mathcal{E}\mathcal{A} + \mathcal{C}(1 + \mathcal{B})$ to be positive and $d\text{Var}[\ln(w_2)]/d\text{Var}[\lambda] > 0$, which again does not match what was observed in the data.

Alternatively, if $dr(M, v, f)/dM$ is not sufficiently less than zero, such that $2M \times dr(M, v, f)/dM + r(M, v, f) > 0$, then the ambiguously signed components of the reduced form system of equations become $\mathcal{B}, \mathcal{E} > 0$. Even with this configuration, the results do not match the empirical regularities of (27).

To summarize, the empirical regularities of [Figures 2–8](#) and the signs in (27) cannot be generated for small λ for both potential high and low ability migrants. Similarly, the results in (27) cannot be generated for large λ and potentially high-ability migrants. The only case where they could be generated is from the unique configuration of large λ and potentially low-ability migrants with the additional assumption of $|\mathcal{E}\mathcal{A}| > |\mathcal{C}(1 + \mathcal{B})|$. This is as expected because decreasing variance in entry earnings and increased variance in ability were initially hypothesized to be associated with discriminatory entry earnings across source country groups. However, it is interesting to note that these results are generated by low ability migrants in a state where credential assessors face a lot of random noise when gathering knowledge about the source country.

4.4. Discussion

The empirical regularities observed in [Figures 2–8](#) show a positive relationship between total immigration and variance in ability, but a negative relationship with variance in entry earnings. I hypothesized that each is determined by what can be revealed about immigrant workers' ability. Ability is either uncovered through learning about the source country context or specific information about migrants' ability. That is, credential assessors reveal migrants' hidden personal characteristics or place migrants within the ability distribution of the South. But even with a significant amount of spending or effort into researching the source country there is still some unexplained random noise that cannot be uncovered by the credential assessor. Random noise positively affects the variance in signalled ability and total immigration but has a negative effect on variance in entry earnings. However, the empirical regularities that were observed in the Canadian data are only generated among low ability potential migration to the North and when the credential assessor faces sufficient difficulty in learning about immigrants' source

country. In other words, the model predicts that high ability potential migrants that move to the North or where the credential assessor only face small difficulties in learning about the source country, the observed empirical regularities of [Figures 2–8](#) cannot be generated.

In the scenario where the credential assessor faces sufficient difficulty in learning about immigrants' source country, three effects are generated in equilibrium. The first effect is an *intermediary effect*. This effect is associated with the equilibrium response to actions taken by the credential assessor. The assessor affects the outcome through the optimal research spending decision, which in turn affects the per worker cost of credential services paid. Optimal research spending also affects the variance in signal ability because of what is revealed about immigrant workers.

The second effect is a *selection effect*. This effect is associated with the decision to migrate by Southerners with varying levels of ability. The selection effect involves an understanding by potential Southern migrants about the state of credential assessment in the North. Those potential Southern migrants who are of high (low) ability are less (more) likely to migrate if the error in assessing their ability level is uncertain. This uncertainty is disadvantageous (advantageous) for high (low) ability migrants because they will be misjudged as being of low (high) ability.

The third effect is a *feedback effect* associated with the effect of changes in the migration rate on per worker cost of credential services, which in turn affects optimal research spending by the credential assessor and what is revealed about the ability signal. This feedback effect is particularly important because it explains to a large extent the rationale behind the main results of this study. The size of the source country group is a source of revenue for the credential assessor but could also be related to co-ethnic networks living in Canada. As was seen in the data, a larger source country group is associated with decreasing variance in entry earnings and increasing variations in ability. These relationships can also be found in an ethnic enclave where co-ethnic networks function to attract new immigrants. Ethnic businesses that employ co-ethnics pay lower wages on average (Allen & Turner, 1996; Warman, 2007; Xie & Gough, 2011), but are better able to recognize immigrants' ability (Damm, 2009). In this case, immigrants working in ethnic businesses are not expected to be experiencing discriminatory entry earnings based on their unobserved ability. This indicates that the observed empirical regularities could have been generated by immigrants using their co-ethnic networks to get a job in an ethnic business. On the other hand, the presence of a large co-ethnic network in some localities over others provides ethnic amenities that are attractive to new immigrants (Edin, Fredriksson, & Aslund, 2003; Chiswick & Miller, 2005). This could encourage low and high-ability new immigrants to live and work in neighbourhoods occupying a few niche occupations (Edin et al., 2003; Portes, 1998) and hence similar earnings. In this case, immigrants living and working in ethnic enclaves would appear to be experiencing discriminatory entry earnings based on their unobserved ability. While I was able to include a dummy variable for whether an immigrant is working in a job predominantly speaking a non-official language (non-English/French) to proxy for working in an ethnic business, there is no simple way to control for the selection into ethnic enclaves using cross-sectional data. Thus, the latter effect might still be influencing the results.

In the long-run, immigrant earnings tend to catch-up relative to comparable native-born Canadians. That is, average earnings increase overtime as immigrants learn about the Canadian job market and get more local work experience (Baker & Benjamin, 1994; Grant, 1999; Frenette & Morissette, 2003). However, there is little evidence to indicate that immigrants will experience less discriminatory earnings on unobservables overtime compared to similar immigrants from other source country groups. That is, an important question remains as to whether immigrants from discriminated source country groups will catch-up with comparable immigrants from other groups. According to Zhang & Banerjee (2021), there are long-term repercussions (10–11 years after arrival) on immigrant earnings due to initial scarring effects caused by months of joblessness, part-time status and occupational mismatch during the first 4 years in Canada. While this is not direct evidence of catch-up among discriminated groups, or even of discrimination against unobservables, it does point to how early discriminatory practices can leave scarring effects on future immigrant earnings. There is a possibility that long-term earnings will be just as discriminatory on unobservables as they were in the initial 5 years since migration. However, recent evidence by Banerjee, Hou, Reitz & Zhang (2021) indicates that the requirement of educational credential assessment in the immigrant selection process positively affects early employment rates and earnings with little longer term effect. I did not take up this issue in more detail because credential assessment services are used predominantly in the initial years since arrival and are unlikely to have any impact on earnings if they were used after those initial years.

The findings of this paper have important policy implications. In the model, it is shown that the empirical regularities are generated when the noise factor (i.e., λ) is sufficiently large and research spending per worker is increasing in the share of immigrants (i.e., $dr(M, v, f)/dM > 0$). It says that as the share of immigrants increases, credential assessors must incur a larger cost of gathering the information about the source country to assess immigrants ability. This makes credential assessment a very difficult task and simply expanding the service may not increase knowledge about immigrant ability. Instead, there needs to be greater government involvement to address these issues, either through funding or improving collaboration across the settlement sector. Given what is known about credential assessment services in Canada, there are many knowledge gaps that could be addressed by existing service provision. Three areas that credential assessment services could expand further with government assistance are: (1) gathering information about the selective-ness of the source country institute that immigrants completed their highest level of education in, (2) accurately measuring the soft skills that immigrants bring with them, and (3) building a Competency Framework linking employers' skill needs with what is currently possessed by candidates. All of the three recommendations are expected to better align immigrant entry earnings with their true ability because of a better market signal and greater recognition of individual ability. The first recommendation has very little precedent but can go a long way towards increasing knowledge about immigrants' ability. Credential assessment services could partner with alumni groups in diaspora communities to gain a better understanding of how education institutes are ranked relative to others in the source country. The second recommendation has become an area of increasing debate among settlement service providers in Canada. Although there is no agreed upon way to measure soft skills, there have been several

attempts to do so, such as reference letters from previous employers in the source country and micro-credentialing. Although soft skills should not be mistaken for ability or talent, they are strongly positively correlated. In a similar way, the competencies possessed by new immigrants are also hidden from employers, which are also positively correlated with ability. The final recommendation is a work-in-progress by Employment and Social Development Canada to build a Competency Framework to connect the existing Skill and Competencies Taxonomy with occupations in Canada (Gyarmati, Lane, & Murray, 2020; Employment and Social Development Canada, 2020). The Competency Framework can also be used to identify soft skill gaps that new immigrants could address through training, apprenticeship, volunteering or internships.

5. Conclusion

In this research paper, I provided evidence that the returns to ability vary across source country groups, and this is probably associated with information gaps that exist between employers' beliefs about immigrant workers' ability and immigrant workers' true ability. The uneven variance in earnings given similar variances in ability is an indication of statistically discriminated source country groups. I hypothesize that contextual or specific information about immigrants and their source country is gathered by a credential assessment service provider. However, there is some information that remains undiscovered and appears as random noise. The presence of random noise in researching the source country where new immigrants come from is associated with a consistent information gap, increasing variance in earnings and decreasing variations in signalled ability, which is a feature of statistically discriminated groups.

I provide empirical evidence from the 2016 Canadian Census of Population that source country-specific variance in entry earnings, variance in ability as measured by the residuals of a Mincerian regression model and source country group size are endogenously related to each other. I show that the share of immigrants from a source country is negatively related to variance in entry earnings and positively related to variance in ability. I build a theoretical model to explain the main features of this empirical regularity with a framework that includes a credential assessment organization and immigration from South to the North.

Credential assessment is an essential service to reduce information gaps that exist between employers and immigrant workers. While assessors do not reveal an immigrant worker's true ability completely without error, they supply contextual and/or specific information about the worker and their source country. The credential assessor invests in researching the source country at a per worker rate. In this way, the source country group size provides feedback in equilibrium by conveying relevant information to the employer through research undertaken by the credential assessor, but also increases the marginal cost of hiring immigrant workers. But even with a significant amount of spending or effort into researching the source country there is still some unexplained random noise that cannot be uncovered by the credential assessor. This noise positively effects the variance in signalled ability and total immigration but has a negative effect on variance in entry earnings. The empirical regularities that were observed in the 2016 Canadian

Census of Population are only generated when potential migration to the North is of low ability and the credential assessor faces sufficient difficulty in learning about the source country.

Notes on contributor

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References

- Allen, J. P., & Turner, E. (1996). Spatial pattern of immigrant assimilation. *Professional Geographer*, 48(2), 140–155.
- Altonji, J. G., & Pierret, C. R. (2001). Employer learning and statistical discrimination. *The Quarterly Journal of Economics*, 116(1), 313–350. Obtained from
- Arrow, K. J. (1998). What has economics to say about racial discrimination? *Journal of Economic Perspectives*, 12(2), 91–100.
- Autor, D. (2004). Labor market intermediation: What it is, why it is growing, and where it is going. NBER, NBER Reporter: Research Summary. Obtained from: <https://www.nber.org/reporter/fall04/autor.html>NBER .
- Autor, D. (2008). The economics of labor market intermediation: An analytic framework. NBER, Working Paper Number 14348.
- Baker, M., & Benjamin, D. (1994). The performance of immigrants on the Canadian labor market. *Journal of Labor Economics*, 12(13), 369–405.
- Banerjee, R., Hou, F., Reitz, J. G., & Zhang, T. (2021). Evaluating foreign skills: Effects of credential assessment on skilled immigrants' labour market performance in Canada. *Canadian Public Policy*, 47(3), 358–372.
- Bartel, J. (2018). Teaching soft skills for employability. *TESL Canada Journal*, 35(1), 78–92.
- Borjas, G. J. (1987). Self-selection and the earnings of immigrants. *American Economic Review*, 77(4), 531–553.
- Borjas, G. J., & Bratsberg, B. (1996). Who leaves? The outmigration of the foreign-born. *Review of Economics and Statistics*, 78(1), 165–176.
- Borjas, G. J., Kauppinen, I., & Poutvaara, P. (2018). Self-selection of emigrants: Theory and evidence on stochastic dominance in observable and unobservable characteristics. *The Economic Journal*. doi:10.1111/econj.12585
- Canada. (2020). Educational credential assessment (ECA) for express entry: What it is. Obtained from: <https://www.canada.ca/en/immigration-refugees-citizenship/services/immigrate-canada/express-entry/documents/education-assessed.html>Website.

- Chiquiar, D., & Hanson, G. H. (2005). International migration, self-selection, and the distribution of wages: Evidence from Mexico and the United States. *Journal of Political Economy*, 113(2), 239–281.
- Chiswick, B. R., & Miller, P. W. (2005). Do enclaves matter in immigrant adjustment? *City & Community*, 4(1), 5–35.
- Cobb-Clark, D. (1993). Immigrant selectivity and wage: The evidence for women. *American Economic Review*, 83(4), 986–993.
- Damm, A. P. (2009). Ethnic enclaves and immigrant labor market outcomes: Quasi-experimental evidence. *Journal of Labor Economics*, 27(2), 281–314.
- Dostie, B., & Leger, P. T. (2009). Self-selection in migration and returns to unobservables. *Journal of Population Economics*, 22(4), 1005–1024.
- Edin, P.-A., Fredriksson, P., & Aslund, O. (2003). Ethnic enclaves and the economic success of immigrants: Evidence from a natural experiment. *The Quarterly Journal of Economics*, 118(1), 329–357.
- Employment and Social Development Canada. (2020). Skills and competencies taxonomy. *Canada.ca*, Obtained from: <https://noc.esdc.gc.ca/SkillsTaxonomy/SkillsTaxonomyWelcomeWebsite>.
- Fang, H., & Moro, A. (2010). Theories of statistical discrimination and affirmative action. NBER, Working Paper Number 15860.
- Farmer, A., & Terrell, D. (1996). Discrimination, bayesian updating of employer beliefs, and human capital accumulation. *Economic Inquiry*, 34(2), 204–219.
- Frenette, M., & Morissette, R. (2003). Will they ever converge? Earnings of immigrant and Canadian-born workers over the last two decades. *Business and Labour Market Analysis Division*, Statistics Canada Analytical Studies Branch Research Paper Series (October 2003).
- Grant, M. L. (1999). Evidence of new immigrant assimilation in Canada. *The Canadian Journal of Economics*, 32(4), 930–955.
- Grant, M. (2016). Aligning skills development with labour market need. Ottawa: Conference board of canada. Obtained from: https://www.conferenceboard.ca/temp/77e4dff4-7c0d-4334-997b-1b6eb008ac7c/7926_AligningSkills_RPT.pdfReport.
- Green, D. A., & Worswick, C. (2011). Immigrant earnings profiles in the presence of human capital investment: Measuring cohort and macro effects. *Labour Economics*, 19(2), 241–259.
- Grogger, J., & Hanson, G. H. (2011). Income maximization and the selection and sorting of international migrants. *Journal of Development Economics*, 95(1), 42–57.
- Gyarmati, D., Lane, J., & Murray, S. (2020). *Competency Frameworks and Canada's Essential Skills* November 2020 (Toronto: Diversity Institute). file:///C:/Users/steim/Downloads/Competency-Frameworks-PPF-Nov2020-EN%20(1).pdf.
- Heckman, J. J., & Kautz, T. (2012). Hard evidence on soft skills. *Labour Economics*, 19(4), 451–464.
- Hensvik, L., & Skans, O. N. (2016). Social networks, employee selection, and labor market outcomes. *Journal of Labor Economics*, 34(4), 825–867.
- Hou, F., & Picot, G. (2016). . *Changing Immigrant Characteristics and Entry Earnings* 11F0019M — No. 374 (Ottawa: Statistics Canada). <https://www150.statcan.gc.ca/n1/en/pub/11f0019m/11f0019m2016374-eng.pdf?st=Ar67KSvv>.
- Ioannides, Y. M., & Loury, L. D. (2004). Job informations, networks, neighbourhood effects, and inequality. *Journal of Economic Literature*, 42(4), 1056–1093.
- Lai, D. W. L., Shankar, J., & Khalema, E. (2017). Unspoken skills and tactics: Essentials for immigrant professionals in integration to workplace culture. *International Migration & Integration*, 18(3), 937–959.
- Lazear, E. P. (2017). Why are some immigrant groups more successful than others? NBER, Working Paper Number 23548.
- OECD. (2019). *International migration outlook 2019*. Paris: Author. doi:10.1787/c3e35eec-en
- Phelps, E. S. (1972). The statistical theory of racism and sexism. *The American Economic Review*, 62(4), 659–661.
- Portes, A. (1998). Social capital: Its origins and applications in modern sociology. *Annual Review of Sociology*, 24, 1–24.

- Warman, C. (2007). Ethnic enclaves and immigrant earnings growth. *The Canadian Journal of Economics*, 40(2), 401–422.
- World Education Services (2022). About WES credential evaluations. Obtained from: <https://www.wes.org/ca/about-wes-credential-evaluation/Website>.
- Xie, Y., & Gough, M. (2011). Ethnic enclaves and the earnings of immigrants. *Demography*, 48(4), 1293–1315.
- Zhang, T., & Banerjee, R. (2021). Bridges or barriers? The relationship between immigrants' early labor market adversities and long-term earnings. *International Migration Review*, 1–32. doi:10.1177/01979183211000286

A Appendix

Implicitly differentiate equation (6) in terms of M gives the general function in terms of dr/dm as

$$\frac{dr}{dM} = -\frac{\frac{1}{2M} \times G(\lambda, r) + \frac{re'(r)\lambda}{M}}{\frac{fM}{v} - \frac{1}{2} \times G_r(\lambda, r) + (e'(r) + re''(r))\lambda} \quad (28)$$

where $r = r(\lambda; M, v, f)$, $G(\lambda, r) = 1 - (e(r) + \lambda)^2 - 2re(r)e'(r)$ and $G_r(\lambda, r) = -2(e(r) + \lambda)e'(r) - 2re(r)e''(r) - 2e(r)e'(r) - 2re'(r)^2$. The sign of $G(\lambda, r)$ and $G_r(\lambda, r)$ is given by

$$G(\lambda, r) \begin{cases} > 0 & \text{if } \lambda < \sqrt{1 - 2re(r)e'(r)} - e(r) \\ = 0 & \text{if } \lambda = \sqrt{1 - 2re(r)e'(r)} - e(r) \\ < 0 & \text{if } \lambda > \sqrt{1 - 2re(r)e'(r)} - e(r), \end{cases} \quad (29)$$

$$G_r(\lambda, r) \begin{cases} > 0 & \text{if } \lambda < -e(r) \left(2 + r + r \frac{e''(r)}{e'(r)} \right) \\ = 0 & \text{if } \lambda = -e(r) \left(2 + r + r \frac{e''(r)}{e'(r)} \right) \\ < 0 & \text{if } \lambda > -e(r) \left(2 + r + r \frac{e''(r)}{e'(r)} \right). \end{cases} \quad (30)$$

where $-e(r)(2 + r + re''(r)/e'(r)) < 0$. Given different λ , equation (28) is either strictly positive, zero or strictly negative. More concisely,

$$\frac{dr}{dM} \begin{cases} > 0 & \text{if } \lambda > \sqrt{1 - 2re(r)e'(r)} - e(r) \text{ and } \lambda > -e(r) \left(2 + r + r \frac{e''(r)}{e'(r)} \right), \\ = 0 & \text{if } \lambda = \sqrt{1 - 2re(r)e'(r)} - e(r), \\ < 0 & \text{if } \lambda < \sqrt{1 - 2re(r)e'(r)} - e(r) \text{ and } \lambda > -e(r) \left(2 + r + r \frac{e''(r)}{e'(r)} \right), \end{cases} \quad (31)$$

The next item to derive is the $dM/d\text{Var}[\lambda]$ from the total migration equation $M = P \times (1 - T(\bar{\theta}_2))$ given by,

$$\begin{aligned} \frac{dM}{d\text{Var}[\lambda]} &= -PT'(\bar{\theta}_2) \times \frac{\partial \bar{\theta}_2}{\partial \text{Var}[\lambda]} \\ &= -PT'(\bar{\theta}_2) \times \frac{1}{\text{Var}[A]} \left(\left(A + \frac{fr(M, v, f)^2 M}{\alpha} \right) \times \frac{d\text{Var}[\theta_2]}{d\text{Var}[\lambda]} \right) \end{aligned}$$

$$\begin{aligned}
& + \frac{dM}{d\text{Var}[\lambda]} \times \frac{fr(M, v, f)}{\alpha} \text{Var}[\theta_2] \left(2M \times \frac{dr(M, v, f)}{dM} + r(M, v, f) \right) - \mu \frac{d\text{Var}[e_2]}{d\text{Var}[\lambda]} \Big) \\
& \quad \stackrel{\dagger}{=} -PT'(\bar{\theta}_2) \times \frac{1}{\text{Var}[A]} \left(\left(A + \frac{fr(M, v, f)^2 M}{\alpha} \right) \times \frac{d\text{Var}[\theta_2]}{d\text{Var}[\lambda]} \right) \\
& + \frac{dM}{d\text{Var}[\lambda]} \times \frac{fr(M, v, f)}{\alpha} \text{Var}[\theta_2] \left(2M \times \frac{dr(M, v, f)}{dM} + r(M, v, f) \right) - \mu \frac{d\text{Var}[\theta_2]}{d\text{Var}[\lambda]} \Big) \\
& \quad = \frac{-PT'(\bar{\theta}_2) \times \frac{1}{\text{Var}[A]} \times \frac{d\text{Var}[\theta_2]}{d\text{Var}[\lambda]} \left(A - \mu + \frac{fr(M, v, f)^2 M}{\alpha} \right)}{\ddagger \ 1 + PT'(\bar{\theta}_2) \times \frac{1}{\text{Var}[A]} \times \frac{fr(M, v, f)}{\alpha} \text{Var}[\theta_2] \left(2M \times \frac{dr(M, v, f)}{dM} + r(M, v, f) \right)}
\end{aligned}$$

where \dagger uses the fact that $d\text{Var}[\theta_2]/d\text{Var}[\lambda] = d\text{Var}[e_2]/d\text{Var}[\lambda]$ given by equation (23). And \ddagger rearranges the equation in terms of $dM/d\text{Var}[\lambda]$.