The Influence of Measurement Error and Unobserved Heterogeneity in Estimating Immigrant Returns to Foreign and Host-Country Sources of Human Capital*

Mikal Skuterud† and Mingcui Su‡

May 2010

Abstract

Studies which estimate separate returns to foreign and host-country sources of human capital have burgeoned in the immigration literature in recent years. In estimating separate returns, analysts are typically forced to make strong assumptions about the timing and exogeneity of human capital investments. Using a particularly rich longitudinal Canadian data source, we consider to what extent the findings of the Canadian literature may be driven by biases arising from errors in measuring foreign and host-country sources of human capital and the endogeneity of post-migration schooling and work experience. Our main finding is that the results of the current literature by and large do not appear to be driven by the assumptions needed to estimate separate returns using the standard data sources available.

Keywords: Immigrant workers; wage differentials; human capital.
JEL Classification: J61, J31, J24.

*We would like to thank Pierre Brochu, Jenny Hunt, Peter Kuhn, Chris Worswick, and seminar participants at the University of Melbourne, the University of Sydney, Australian National University, the 2008 Canadian Economics Association Meetings, and the 2008 Research Data Centre (RDC) Conference held at the University of Ottawa for valuable comments on the paper. Skuterud acknowledges financial support from the Social Science and Humanities Research Council of Canada (No. 410-2006-1968).

†Corresponding author: Assistant Professor, Department of Economics, University of Waterloo, 200 University Avenue West, Waterloo, Ontario, Canada, N2L 3G1; skuterud@uwaterloo.ca

‡Doctoral candidate, Economics Department, University of Waterloo; m3su@uwaterlo.ca.

1 Introduction

In the textbook model of immigrant wage assimilation immigrants experience wage disparities on arrival in a host country, relative to similarly aged and educated native-born workers, but with time since migration the gaps close. In his seminal study of immigrant earnings, Chiswick (1978) argued that this pattern arises from discounting by host-country employers of foreign sources of human capital combined with immigrant accumulation of host-country-specific knowledge and skills following migration. To capture these ideas empirically, Chiswick began by positing a process generating wage outcomes for immigrants with separate returns to foreign and host-country sources of training, though this is not what he estimated. Instead, he imposed parameter restrictions on the data generating process (DGP) he had in mind, which amounted to allowing an intercept shift for immigrants – to capture the discounting of their foreign human capital – and estimating a quadratic return to an immigrant's years since migration (YSM) – to capture the assimilation process. This approach spawned a large literature, which has come to cover many countries (see Borjas 1999 for a review).

From a policy perspective, however, direct evidence on the differential returns to foreign and host-country sources of human capital, provides a much richer set of insights than does an overall return to YSM. For a country such as Canada, struggling to address a deterioration in the labour market performance of more recent immigrant arrival cohorts (Aydemir and Skuterud 2005), these insights are invaluable. For example, the potential dependence of immigrant wages at entry and subsequent wage growth on the schooling and work experience immigrants bring with them directly informs the criteria which the government uses to select immigrants. Their decision in 2008, for example, to increase the value of Canadian work experience in their selection criteria appears to have been, in large part, motivated by growing evidence of a significant disparity between immigrant returns to foreign and host-country work experience. Evidence on the relative wage returns to host-country schooling and experience, on the other hand, informs the efficacy of alternative immigrant settlement policies, such as Canada's Enhanced Language Training programs introduced in 2004 to provide occupation-specific language training to recent immigrants.

To directly estimate returns to foreign and host-country sources of schooling and experience we need measures of where immigrants' years of schooling and work experience were obtained. Unfortunately, the source country of schooling is typically unobserved in available data sources, while work experience is nearly always measured as a residual given a worker's

age and years of schooling. We are aware of no study using direct information on the source country of immigrants' work experience and four studies using direct information on the source of schooling in the literature estimating separate foreign and host-country human capital returns (Borjas 1982; Kossoudji 1989; Alboim, Finnie and Meng 2005; and Ferrer, Green and Riddell 2006).[1] However, in all four cases, the data come from single cross-sectional surveys, so that they are unable to empirically distinguish the effects of time-since-arrival from cohort effects. Instead, studies estimating separate returns in a complete assimilation model with cohort effects, which have burgeoned in Canada over the past decade, have distinguished foreign from host-country sources by assuming all schooling is strictly continuous from age 5 and one year of labour market experience is accumulated in every year after schooling is complete (Stewart and Hyclak 1985; Friedberg 2000; Schaafsma and Sweetman 2001; Bratsberg and Ragan 2002; Green and Worswick 2002; Aydemir and Skuterud 2005, 2008; and Ferrer and Riddell 2008). But to the extent that immigrants with foreign work experience return to school or experience periods of nonemployment following migration, this approach introduces measurement error, the consequences of which are far from straightforward. Moreover, though never explicitly acknowledged in the literature (to our knowledge), the key advantage of the YSM approach to modeling immigrant wage outcomes (besides its limited data requirements) is that conditional on arrival cohort, and ignoring compositional effects in pseudo-panel data due to outmigration or age at migration effects, YSM is exogenous in the sense that it captures an aging process that is not a choice variable. The decision of whether to begin accumulating work experience or host-country schooling following migration might, in contrast, be highly correlated with immigrant wage levels or anticipated future wage growth, thereby complicating inferences regarding wage assimilation. Just as the current literature has tended to overlook the consequences of measurement error, we are aware of no attempt in the literature estimating separate foreign/host-country returns to address the potential endogeneity of the post-migration work/schooling decision.

Using a particularly rich Canadian data source – the Survey of Labour and Income Dynamics (SLID) – which identifies the age of school completion and when full-time work

[1] We are also aware of three additional studies comparing host-country and foreign schooling returns using direct information on the source of schooling, but in each case the analysis is narrower than the average population returns of interest in our paper (Wiers-Jenssen and Try (2005) compare Norwegian nationals studying abroad to Norwegians with host-country credentials; Clark and Jaeger (2006) compare GED returns between U.S. immigrants and natives; and Hartog and Zorlu (2009) look at returns to foreign education among Dutch refugees.) There is also a literature concerned with the determinants of post-migration schooling that uses direct measures of host-country schooling (Chiswick and Miller 1994; Khan 1997; Hum and Simpson 2003; Cobb-Clark, Connolly and Worswick 2005; Van Tubergen and Werfhorst 2007).

began, and is longitudinal allowing us to control for individual fixed effects, we examine to what extent the results of the current literature may be driven by biases arising from measurement error and the endogeneity of post-migration human capital investments. We are particularly interested in the sensitivity of two key findings on which the current literature is almost universally consistent: (i) essentially no return to foreign work experience; and (ii) a modest advantage in the return to host-country over foreign schooling. Assuming these findings have played some role in motivating recent changes in Canadian immigration policy, which seems likely, we think this sensitivity analysis is needed.

Our main finding is that the estimates in the current literature by and large do not appear to be driven by biases arising from either the assumptions necessary to distinguish foreign from host-country human capital or from unobserved heterogeneity. Using our more accurate measures of foreign and host-country human capital, we obtain somewhat larger, and in some cases statistically significant, returns to foreign work experience, though they remain substantially smaller than the returns to host-country experience for either immigrants or natives. Controlling for individual fixed effects in order to account for both the possible endogeneity of schooling and work experience and errors in distinguishing the foreign and host-country quantities of these variables (since within-panel changes in schooling and experience are necessarily host-country) does even less to influence the estimated returns to foreign experience. As for education returns, we continue to find relatively modest differences in immigrant returns to foreign and host-country schooling using our improved measures. Furthermore, adding fixed effects, if anything, suggests even smaller advantages of host-country over foreign schooling for immigrants.

An important advantage of estimating foreign and host-country returns is that entry effects and subsequent wage growth depend directly on the stocks of foreign human capital immigrants bring and their post-migration schooling and work decisions. Not only does this serve to control for age at migration, thereby overcoming a source of bias inherent in the YSM approach, but it also offers a much richer set of counterfactual predictions to identify what types of immigrants and post-migration behaviour produce better wage outcomes. Consistent with results in Green and Worswick (2002) and Aydemir and Skuterud (2005), after accounting for measurement errors and unobserved heterogeneity we continue to find that immigrants with more foreign experience not only start at lower initial wages (relative to a comparably aged native), but also experience lower subsequent wage growth. In fact, controlling for individual fixed effect makes the latter result even stronger. In contrast, we find little evidence that foreign schooling either lowers relative wage outcomes at entry or

affects subsequent wage growth. These results provide valuable insights to inform immigrant selection and settlement policy.

The remainder of the paper is organized as follows. In the following section we briefly make the case for the "separate returns model" over the more standard YSM approach to modeling relative immigrant wage outcomes. We then consider the potential consequences of measurement error and unobserved heterogeneity that arise in estimating separate returns using standard data sources. In the fourth section we describe our data, our approach to distinguishing foreign from host-country sources of schooling and experience, and the specifications we estimate. Section 5 presents the results. We conclude by summarizing our main findings.

2 The Missing Parameters Problem

We have argued above that estimating separate foreign and host-country returns offers policymakers a much richer set of policy inferences to guide immigrant selection and settlement policy. In addition, by conditioning on years of foreign schooling and work experience the model implicitly controls for age at migration, thereby overcoming a shortcoming implicit in the standard YSM approach that predominates the literature. Notwithstanding these advantages, however, in our view the more compelling reason for preferring the separate returns model lies in the potential of the YSM model to produce misleading inferences regarding the capacity of immigrant wage outcomes to assimilate to those of their native-born counterparts in a world with separate foreign and host-country returns.

To see the nature of the bias inherent in the YSM approach, assume for the sake of simplicity that the true (latent) data generating process (DGP) determining wage outcomes in the population of immigrants and natives is given by:

$$w_i = \alpha_0 + \alpha_1 exph_i + \alpha_2 expf_i + \varepsilon_i \tag{2.1}$$

where $exph_i$ and $expf_i$ are years of host-country and foreign experience, respectively; $\alpha_1 > \alpha_2$; $cov(exph_i, expf_i) < 0$ in the immigrant population; and ε_i is some random influence. Do immigrants assimilate in this world? Since immigrants and natives share a constant linear return to host-country experience, the answer is no. But consider what happens if we estimate the basic YSM model found in Chiswick's (1978) seminal paper, which ignoring schooling returns (as well as any year or cohort effects) is simply given by:

$$w_i = \beta_0 + \beta_1 exp_i + m_i \cdot (\beta_2 + \beta_3 ysm_i) + e_i \tag{2.2}$$

where m_i is an immigrant dummy variable; $exp_i = exph_i + expf_i$; $ysm_i = exph_i$; and $\beta_3 > 0$ is evidence of assimilation. Given the DGP in (2.1), it is straightforward to show that the probability limit of estimated assimilation is:

$$\text{plim } \hat{\beta}_3 = (\alpha_1 - \hat{\beta}_1) + \frac{(\alpha_2 - \hat{\beta}_1)\text{cov}(exph_i, expf_i)}{\text{var}(exph_i)} \tag{2.3}$$

which is necessarily positive, implying discrimination when in fact there is none (see Appendix). Borjas (1999, p.1721) and Friedberg (2000, footnote 16) claim that the correct interpretation of the positive return to YSM in estimating (2.2) is, holding total experience constant, immigrants with less of the foreign variety face a relative wage advantage. The result in (2.3) reveals that the estimated YSM return, in fact, depends not just on the relative advantage of host-country experience, but also on the correlation in the data between host-country and foreign experience. Given a large enough positive correlation, the estimated return could, in fact, imply *dissimilation*, even if host-country experience is more valued.[2] But since individuals (or at least their working careers) are finite lived, the correlation will tend to be negative leading us to infer assimilation when in fact there is no assimilation in the actual data.

The nature of the bias in (2.3) is essentially a missing parameters problem. This can be overcome in this case by adding a separate experience return for immigrants, that is by estimating the extended YSM model:

$$w_i = \beta_0 + \beta_1 exp_i + m_i \cdot (\beta_2 + \beta_3 exp_i + \beta_4 ysm_i) + e_i. \tag{2.4}$$

where now immigrants assimilate to natives if $\beta_3 + \beta_4 > 0$. Given the data come from the DGP in (2.2), this produces $\hat{\beta}_1 = \alpha_1$; $\hat{\beta}_3 = \alpha_2 - \alpha_1$; and $\hat{\beta}_4 = \alpha_1 - \alpha_2$, which now correctly implies no assimilation (since $\hat{\beta}_3 + \hat{\beta}_4 = 0$).[3] But estimated assimilation from this extended YSM model is again potentially biased if the process determining wage outcomes in the labour market also depends on unequal returns to host-country and foreign schooling. To see this, suppose the DGP is given by:

$$w_i = \alpha_0 + \alpha_1 exph_i + \alpha_2 sh_i + \alpha_3 expf_i + \alpha_4 sf_i + \varepsilon_i \tag{2.5}$$

[2]The bias is a bit more complicated than equation (2.3) suggests since $\hat{\beta}_1$ itself depends on the sample moments of the distribution. Setting $\alpha_1 = 0.05$; $\alpha_2 = 0.01$; $\bar{m} = 0.2$; $\overline{exph}_i = 17$; $\overline{expf}_i = 6$; $\text{var}(exph_i) = 64$; and $\text{var}(expf_i) = 25$ in a Monte Carlo simulation, $\hat{\beta}_3$ becomes positive as $\text{corr}(exph_i, expf_i) > 0.1$. All of our analytical results in this section and the next have been confirmed by simulations. The programming code for these are available upon request.

[3]To see this simply replace exp_i in (2.5) with $exph_i + expf_i$ and ysm_i with $exph_i$.

where sh_i and sf_i are host-country and foreign years of schooling respectively, and we estimate:

$$w_i = \beta_0 + \beta_1 exp_i + \beta_2 s_i + m_i \cdot (\beta_3 + \beta_4 exp_i + \beta_5 s_i + \beta_6 ysm_i) + e_i \tag{2.6}$$

where now $ysm_i = exph_i + sh_i$. Again, immigrants do not assimilate in this DGP, since host-country returns are linear and equal for immigrants and natives. But what does estimation of (2.7) imply? It can be shown that in this case $\hat{\beta}_6$ is estimated as a weighted average of the host-country (over foreign) advantage in work experience ($\alpha_1 - \alpha_3$) and schooling ($\alpha_2 - \alpha_4$), where the weighting depends on the relative magnitudes of var($exph_i + expf_i$) and var($sh_i + sf_i$), as well as the covariances of $exph_i$, sh_i, $expf_i$, and sf_i (see Appendix). What does this imply for estimates of assimilation? Suppose, for example, that the advantage of host-country sources is larger in schooling than experience ($\alpha_2 - \alpha_4 > \alpha_1 - \alpha_3$) and var($s_i$) is large relative to var(exp_i). Then the estimate of β_6 will tend to exceed the estimate of β_4 (in absolute value), implying assimilation relative to natives (assuming the immigrant works following migration), when there is in fact no assimilation in the underlying DGP. In real world data, however, the variance in experience tends to exceed the variance in schooling, so that the estimated return to YSM will be weighted towards the host-country advantage in experience. But because the model does not distinguish whether the immigrant's YSM are spent in work or school, the model's estimates regarding assimilation are potentially misleading.

Again the nature of the bias in the YSM model is essentially a missing parameters problem, which can only be avoided by directly estimating separate host-country and foreign returns to schooling and experience. In this respect, and because separate foreign and host-country returns offer a much richer set of counterfactual predictions to inform immigrant selection and settlement policy, the separate returns model is preferred to the predominant YSM approach. But, of course, there are obstacles to estimating the separate returns model using the standard data sources available, which presumably explains the predominance of YSM models in the literature. In the following section we consider the potential biases introduced in overcoming these obstacles.

3 Potential Biases of the Separate Returns Model

3.1 Measurement error

The practical challenge in estimating separate foreign and host-country returns to schooling and experience is these quantities are typically unobserved in available data sources. As

mentioned earlier, the approach taken in the current literature estimating separate returns is to assume all schooling is strictly continuous from age 5 and one year of labour market experience is accumulated in every year after schooling is completed . One need then only observe three variables: (i) current age; (ii) age at immigration; and (iii) total years of schooling, to uniquely distinguish schooling and experience obtained abroad from that obtained in the host-country.

This set of assumptions introduces three forms of measurement error, the consequences of which are far from straightforward. First, the assumption of strictly continuous schooling implies an individual cannot hold both foreign labour market experience and host-country schooling, that is $expf_i > 0 \Rightarrow sh_i = 0$. To the extent that immigrants with foreign work experience return to school after migrating, host-country schooling will be under measured by exactly the same amount as foreign schooling is over measured. Furthermore, foreign (host-country) potential experience will be over measured (under measured) by that same amount. Second, temporary work permits and student visas make it possible for immigrants to obtain host-country schooling or experience prior to obtaining permanent residence status. The use of age at immigration (or the date that permanent residence status was obtained) instead of age at migration (the date of arrival in the host-country) will have a similar effect as assuming continuous schooling: host-country schooling (potential experience) will be under measured (over measured) by exactly the same amount that foreign schooling (potential experience) is over measured (under measured). Third, potential experience may be a poor measure of actual labour market experience. The difference is likely to be particularly important for immigrants whose migration decisions may be motivated by nonemployment or who may experience periods of nonemployment following migration.

Analytically it is difficult to say much about the nature of the biases arising from these measurement errors. To the extent that the errors are correlated with the true values of the observables or with unobservables, this is particularly the case. Assuming that the measurement error that results from using potential instead of actual experience is purely random, we know that the estimated experience returns will tend to be attenuated (note that this does not depend on the mean of the measurement error being zero). To the extent that this error affects foreign experience measures more than host-country experience, this could account for the particularly low estimated returns to foreign experience.

The measurement error resulting from assuming strictly continuous schooling and using dates of immigration instead of dates of arrival is, however, more complex. Nonetheless, it is worthwhile considering one especially simple case, which offers a useful insight. Assume

the process generating wage outcomes in the population is given by:

$$w_i = \beta_1 exph_i^* + \beta_2 expf_i^* + \varepsilon_i \tag{3.7}$$

where all variables are now expressed as deviations from their means. It can then be shown that using the observed values $exph_i$ and $expf_i$, where $exph_i = exph_i^* + u_i$; $expf_i = expf_i^* - u_i$; $u_i \sim iid[0, \sigma_u^2]$; $E(u_i \varepsilon_i) = 0$; and $E(expj_i^* \varepsilon_i) = 0$ for $j \epsilon [h, f]$, gives:

$$\text{plim } \hat{\beta} = \beta - [Q^* + \Sigma_{uu}]^{-1} \Sigma_{uu} \beta \tag{3.8}$$

where $\beta = [\beta_1, \beta_2]'$; Q is a 2x2 matrix containing elements $q_{jj}^* = \text{plim}(1/n) \sum expj_i^* expj_i^*$ for $j \epsilon [h, f]$; and $\Sigma_{uu} = \sigma_u^2 ee'$, where $e = [1, -1]$ (see Greene (2008), equation (12-16)). Assuming foreign and host-country experience are uncorrelated ($q_{hf}^* = 0$), this amounts to:

$$\text{plim} \begin{bmatrix} \hat{\beta}_1 \\ \hat{\beta}_2 \end{bmatrix} = \begin{bmatrix} \beta_1 \\ \beta_2 \end{bmatrix} - \frac{\sigma_u^2}{q_{hh}^* q_{ff}^* + \sigma_u^2 (q_{hh}^* + q_{ff}^*)} \begin{bmatrix} (\beta_1 - \beta_2) q_{ff}^* \\ (\beta_2 - \beta_1) q_{hh}^* \end{bmatrix}. \tag{3.9}$$

Hence, to the extent that the true returns to foreign and host-country experience are identical ($\beta_1 = \beta_2$), the measurement error in distinguishing foreign from host-country quantities has no effect on the consistency of the estimator (though it does reduce its efficiency). In fact, this is true even if the measurement error is non-random. The intuition is that the measurement error in the two variables simply cancels out in the error term. Our expectation, however, is that the host-country return dominates ($\beta_1 > \beta_2$), in which case (3.16) implies that the return to foreign (host-country) experience is unambiguously overestimated (underestimated). Measurement error does not then appear responsible for the low estimated returns to foreign experience in the literature. However, this is no longer necessarily true if foreign and host-country experience are negatively correlated ($q_{hf}^* < 0$), as we argued in the previous section they likely are. If $\beta_1 > \beta_2$, $q_{ff}^* > q_{hh}^*$, and q_{hf}^* is sufficiently negative, the measurement error that results from assuming strictly continuous schooling and dates of immigration can simultaneously produce downward biases in the estimated returns to both foreign and host-country experience.[4] The useful insight to take from this, however, is that the consequences of measurement error in the separate returns model may be negligible even if the measurement error is substantial.

3.2 Unobserved heterogeneity

It is widely recognized in the immigrant assimilation literature that non-random outmigration contaminates estimated returns to YSM if immigrant entry cohorts are followed across

[4]This is easiest to show using a Monte Carlo simulation. The programming code are available upon request.

repeated cross-sections of data. There now exist a handful of studies using longitudinal microdata to examine the sensitivity of estimated assimilation rates to compositional changes in immigrant cohorts. Duleep and Regets (1997), Hu (2000), Duleep and Dowhan (2002) and most recently Lubotsky (2007) examine U.S. survey data, in a number of cases combined with Social Security records, while Edin, Lalonde and Åslund (2000) use Swedish Census data matched with tax records, and Hum and Simpson (2004) use the same Canadian longitudinal survey data examined in the present study. With the exception of the papers by Duleep and coauthors, a consistent finding in these studies is substantially lower immigrant wage growth when selective outmigration is accounted for. This is consistent with a higher propensity of outmigration among workers with relatively low earnings (conditional on observables).

To date, all the research using longitudinal data has inferred assimilation from estimated returns to YSM.[5] In directly estimating foreign and host-country returns, we introduce a second channel through which unobserved worker heterogeneity can bias estimates. As noted above, unlike YSM, which is necessarily exogenous (conditional on cohort and ignoring any non-random sample attrition), particular post-migration schooling and experience investments reflect choices made by immigrants (and employers) and are therefore potentially correlated with unobservables. Inferring assimilation from an immigrant's relative return to host-country work experience would be problematic, for example, if immigrants' propensity to accumulate host-country work experience is correlated with their unobserved ability or career motivation. As a result, in estimating separate returns, it is even more critical to in some way account for the unobservable heterogeneity of workers that may, in part, determine wage outcomes. We are not aware of any attempt in the existing literature to do so.

Just as distinguishing post-migration activities complicates the estimation of post-migration wage growth, distinguishing immigrants by their stock of foreign schooling and experience within entry cohorts, complicates the estimation of immigrant entry effects. The reason is, again, that pre-migration human capital investments, or more generally the age when immigrants migrate, reflect choices made by immigrants, and could conceivably be correlated with unobservables. For example, it may be that as adults age their reasons for migrating have increasingly less to do with personal career ambitions and more to do with efforts to leave behind undesirable environments or to improve the lifetime welfare of children. To

[5]Two exceptions are Chiswick, Lee and Miller (2005) and Akresh (2007) in that they distinguish host-country schooling and actual labour market experience. Their samples, however, contain no native-born workers and immigrants are observed in the former case at arrival and 3.5 years later and in the latter case one year following migration. As a result, their inferences regarding immigrants' capacity to obtain comparable wages to natives is severely limited.

the extent that these different motivations lead to different host-country wage outcomes, estimated returns to foreign experience will tend to be biased (and underestimated if career ambitions of migrants tend to decline with age at migration). Nonetheless, from the perspective of a policymaker deciding on the optimal immigrant selection criteria, this is not the return of interest. Regardless of what the low return to foreign experience captures, what matters to the policymaker determining selection criteria is the usefulness of the observable signal in predicting success in the host-country's labour markets. In contrast, in estimating host-country returns what is important is whether influencing the post-migration schooling and work activities of immigrants through settlement policies can be expected to produce better outcomes. Fortunately, because host-country, but not foreign, quantities of schooling and experience are time-varying, controlling for unobserved fixed effects is feasible in the estimation of the host-country, but not foreign, returns.

4 Methods

4.1 The Separate Returns Model

To our knowledge, Stewart and Hyclak (1985) and Kossoudji (1989) are the first studies to estimate a separate returns model of immigrant earnings. Although both papers use a single cross-section of data, subsequent papers have estimated separate returns using repeated cross-sections. In this case, the model can be written:

$$\begin{aligned} w_{it} &= y_t + f_x(exph_{it}) + f_s(sh_{it}) + m_i \cdot [cohort_i + g_{xf}(expf_{it}) + \\ &\quad g_{xh}(exph_{it}) + g_{xhf}(expf_{it} \cdot exph_{it}) + g_{sf}(sf_{it}) + g_{sh}(sh_{it})] + e_{it} \end{aligned} \tag{4.10}$$

where w_{it} is the log hourly wage of worker i observed in year t; y_t is a vector of year dummies; $expf_i$ and $exph_i$ are years of foreign and host-country labour market experience respectively; sf_{it} and sh_{it} are years of foreign and host-country schooling respectively; m_i is an immigrant dummy; $cohort_i$ is a vector of dummies indicating year of migration; and the experience (f_x, g_{xf}, g_{xh}) and schooling (f_s, g_{sf}, g_{sh}) functions are typically taken to be quadratic and linear respectively. If the return to experience is nonlinear, the return to host-country experience must depend on the stock of foreign experience held.[6] The interaction of foreign and host-country experience function (g_{xhf}) captures this dependence.

[6]For example, if the experience profile is quadratic, that is $\beta_1 exp_i + \beta_2 exp_2^2$, and foreign and host-country experience are equivalent, then substituting $exp_i = expf_i + exph_i$ the return to post-migration experience is given by $\beta_1 + 2\beta_2 exph_i + 2\beta_2 expf_i$, where the last term captures the dependence of the host-country return on the stock of foreign experience held.

We begin by estimating (4.10) without individual fixed effects comparing the estimates between between more and less accurate measures of foreign and host-country schooling and experience, in order to gauge the importance of measurement error in driving the results of the existing literature (the alternative variable definitions are described in subsection 4.3 below). Murphy and Welch (1990), and more recently Lemieux (2006), show that the standard quadratic experience profile substantially understates early career wages and overstates mid-career wage growth. In all cases we, therefore, estimate quartic functions in host-country experience (f_x), but quadratic functions in foreign experience (g_{xf}) and immigrant-specific host-country experience (g_{xh}), and linear functions in schooling (f_s, g_{sf} and g_{sh}) and the interaction of foreign and host-country experience (g_{xhf}).

We then extend the separate returns model in equation (4.10) in three ways. First, with information on actual years of work experience we are able to identify idle years, that is time spent outside of school and work. By not controlling for idle years we are assuming that this time has either no direct wage effect, through for example skill atrophy, or that it is uncorrelated with years of schooling and experience. If both assumptions are unsatisfied, the estimated schooling and experience returns will suffer from omitted variable bias. Both assumptions, however, seem problematic, particularly for immigrants who are likely to have higher values of total idle time and are likely to use this in improving language skills and developing social networks. We, therefore, add host-country and foreign years of idle time to the model. Second, the assumption that host-country and foreign schooling are additively separable in producing wage outcomes assumes that there are no complementarities between foreign and host-country schooling. Again, for immigrants this assumption seems unreasonable. Friedberg (2000), for example, argues that immigrants arriving with more schooling may experience more occupational downgrading upon arrival and greater subsequent earnings growth. Using U.S. Census data, Bratsberg and Ragan (2002) find evidence that the return to host-country schooling is increasing in the stock of foreign schooling held. And Ferrer, Green and Riddell (2006) find evidence using Canadian data that the return to foreign experience is decreasing in the quantity of foreign education held. The potential to identify these complementarities is a key advantage of the separate returns model. In order to capture these complementarities, we add interaction terms between foreign and host-country sources of schooling, experience, and idle years.

The final extension we make is to address the possible endogeneity of the post-migration schooling/work decision. If we were only concerned about selective outmigration we could simply condition samples of immigrant cohorts on reaching some level of YSM and examine

wage growth over this period. This is the approach of Edin, Lalonde and Åslund (2000), Hu (2000) and Lubotsky (2007). Due to the short and unbalanced nature of the panels in our data, and our interest in identifying post-migration returns to schooling, experience and idle years, our preferred strategy is to account for individual fixed effects (FE) in estimating the separate returns model. This approach has the advantage that we capture the wage growth of all immigrants and not just immigrants who remain in the host country for some specified duration. To the extent that FE purge the data of correlation between unobserved individual effects and both emigration and changes in post-migration work and schooling decisions, our approach produces consistent estimates of immigrant wage growth conditional on post-migration behaviour. It continues, however, to produce inconsistent estimates if emigration or levels of host-country experience, schooling or idle years are not strictly exogenous (conditional on the FE). This would be the case if, for example, emigration is more likely among workers who correctly anticipate relatively low future wage growth or if the incidence of obtaining additional schooling upon arrival is higher among workers that, even in the absence of additional schooling, would have experienced above average post-migration wage growth.[7]

In adding individual fixed effects to equation (4.10) two complications arise. First, since all the foreign human capital variables are strictly time-invariant, their returns are no longer identified (though the interactions of foreign and host-country variables are). As a result, we can no longer predict an immigrant wage level upon arrival and therefore cannot infer assimilation. Our solution is to identify returns to the time-invariant regressors in a second stage regression, which is estimated at the individual level (see Polachek and Kim 1994 for details). The second stage is estimated by either OLS or GLS exploiting information on the diagonal elements of the residual covariance matrix from the first stage. Second, since the year-to-year change in host-country schooling, experience and idle years must sum to 1 ($\Delta exph_{it} + \Delta sh_{it} + \Delta idleh_{it} = 1$), the year effects, y_t, are no longer identified in the fixed effects estimation. We, therefore, use the annual provincial unemployment rate (and its interaction with the immigrant dummy) to identify period effects.[8]

[7]Two others sources of endogenous selection of concern – besides selective emigration – are non-random sample attrition and selection into wage employment. The latter is more of a problem here than in papers focusing on earnings. In the absence of suitable instruments to identify these selection processes, we are limited to controlling for unobserved FE.

[8]We tried using various detrended unemployment rates in the hope of isolating cyclical fluctuations, but found that since there is a substantial trend in unemployment rates (and our estimated year effects) over our data period, the resulting experience returns appear to overstate wage growth. Our preference is therefore to use unadjusted unemployment rates.

4.2 Data

The Survey of Income and Labour Dynamics (SLID) is a nationally representative longitudinal survey of the Canadian population. An oft-cited limitation of the SLID data is that individuals are followed for only 6 years. The advantage of this short-panel design, however, is that new overlapping panels are sampled every 3 years, thereby substantially increasing the number of immigrants sampled. In constructing our sample, we pool the 4 existing panels collected between 1993 and 2004 (the fourth panel contains only 3 years). When we extract all individuals aged 18-64 with full-time work experience and a valid wage and covariate set we are left with 5,951 immigrants and 55,491 native-born workers who are, on average, observed for 3.7 and 3.9 years, respectively.[9] In order to estimate returns with meangingful precision, we pool men and women. We have tried estimating all specifications separately for men and women and none of our main findings substantively change.

In addition to providing a reasonably large longitudinal sample of immigrants, the SLID questionnaire is exceptionally rich in content, providing three key pieces of information. First, the SLID collects information on total years of schooling separately for elementary and secondary; non-university postsecondary; and university postsecondary, as well as all credentials received and the age when the final non-university and/or university credential was obtained. By comparing the age when credentials were obtained to the age at immigration, we are better able to distinguish foreign from host-country sources of schooling than is possible in the standard data sources available. Of course, data sources with direct information on the source country of schooling now exist, such as the International Adults Literacy Survey (IALS) and the Longitudinal Immigrant Database (IMDB), but these are strictly cross-sectional or do not identify post-migration schooling investments. Second, the SLID identifies the age when full-time work began and the years of actual labour market experience subsequently accumulated. Lastly, the survey collects information on remuneration and hours of work in all jobs over the previous calendar year allowing for the construction of an hourly wage reflecting a weighted average of all paid work done in the reference year. The assimilation patterns we identify are therefore less likely to reflect labour supply adjustments than if earnings data – the usual outcome variable in this literature – were used.

[9] We know from Census data that immigrants comprise roughly 20% of the Canadian population. They are under-represented in the SLID data because they are heavily concentrated in Canada's urban centres where the sampling frame undersamples all individuals. Sampling weights are used, however, throughout the analysis and are pooled and unadjusted just as is typically done when cross-sections of data are pooled. The sample is, therefore, representative of some weighted average of the Canadian populations between 1993 and 2004.

4.3 Variable definitions

In order to obtain evidence on the consequences of measurement error, we begin by considering three alternative definitions of foreign and host-country schooling, which we combine with the implied quantities of foreign and host-country potential experience. We then take our preferred definition of foreign and host-country schooling and combine it with three alternative definitions of foreign and host-country actual experience. This gives us a total of six variable sets to estimate equation (4.10).

As noted above, in the absence of direct information on the source of schooling, the standard approach is to assume strictly continuous schooling. We refer to this approach, which tends to overmeasure (undermeasure) foreign (host-country) schooling, as "left-continuous schooling". Alternatively, we can assume that elementary and secondary school years are again strictly continuous from age 5, but all postsecondary schooling years are strictly continuous up to the age of school completion.[10] We refer to this approach, which tends to over measure (under measure) host-country (foreign) schooling, as "right-continuous schooling". Lastly, we define intermediate values between these two extremes by assuming again that elementary and secondary school years are continuous from age 5, but only the duration of the final educational stint (which we define using information on years of non-university and university schooling and credentials obtained) is continuous up to the age of school completion. All remaining postsecondary school years are instead assumed to be uniformly distributed in the years between the age when elementary or secondary schooling was completed (or when full-time work began) and the age when the final educational stint began. For example, someone with a four-year undergraduate degree who finished high school at age 18 and began a PhD at age 26 would be assigned 0.5 $(4/(26-18))$ years of schooling in each years between age 18 and 26. We refer to this intermediate definition as "uniformly-distributed schooling." Since we believe schooling is not continuous for many individuals, particularly for immigrants, this is our preferred definition of schooling.

Table 1 shows the means of the schooling and potential experience variables. Given our definitions, it is necessarily true at the level of the individual observations, that left-continuous foreign schooling is greater than or equal to uniformly-distributed foreign schooling, which in turn must be at least as large as right-continuous foreign schooling (opposite weak inequalities for host-country schooling). The difference between the two extreme def-

[10]Note that roughly 20% of the sample with postsecondary school years does not have a postsecondary credential. To assure ourselves this is not a peculiarity of the SLID data, we have confirmed this result in Canadian Census data. For these individuals we assume the age of school completion is the minimum of current age and 35.

initions is about 0.7 years for schooling and not much more than 0.6 years for potential experience. The reason is that for the majority of observations the difference between the school completion age and total years of schooling plus 5 is small – less than 3 years for 52.8% of immigrants and 57.8% of natives. Nonetheless, little can be said about the relative estimated returns to these variables. If the advantage in host-country sources is very different in experience than schooling or the measurement error is highly non-random, these small differences could impact estimated returns in a meaningful way.

Less clear is how to split actual years of experience into its foreign and host-country components. Our approach begins by defining "potential working years" as the difference between current age and the age when full-time work began, net of any post-work school years. If actual years of experience equals potential working years, the problem is simple: we assume a single year of experience attained in every year spent outside of school after work began. However, to the extent that actual experience is less than potential working years, it is ambiguous whether the idle years occurred before or after migration. Our approach to this problem is similar to that used in defining the schooling variables. At one extreme we err on the side of overmeasuring (undermeasuring) foreign (host-country) experience by assuming total actual years of experience are continuous from the age when full-time work began. We refer to this as "left-continuous actual experience." At the other extreme we err on the side of overmeasuring (undermeasuring) host-country (foreign) experience by assuming that total actual years of experience are continuous up to the current age. We refer to this as "right-continuous actual experience." Lastly, we define an intermediate case in which total actual years of experience are uniformly distributed between the current age and the age full-time work began. This definition is referred to as "uniformly-distributed actual experience".[11] In all cases we use uniformly-distributed schooling to define foreign and host-country potential working years.

Table 1 shows the means of the actual experience variables. As one might expect, given the challenges that immigrants are likely to experience finding employment in the host-country, idle years are substantially larger for immigrants than natives (6.9 years compared to 4.1).[12] The differences in foreign and host-country quantities between the alternative

[11]Since individuals can accumulate school years while working full time, it is possible actual experience exceeds potential working years. In this case, the difference is assumed to be all foreign, in the left-continuous case, or all host-country, in the right-continuous case. In the case of uniformly-distributed actual experience, no additional assumption is necessary, since the number of years of actual experience accumulated in each calendar year are constant and greater than one.

[12]Note that mean idle years exceed the difference between mean potential and actual experience by a small margin. The reason is idle years are restricted to be non-negative.

variable definitions are, however, once again small – roughly one full year in the case of actual experience and slightly less for potential experience. But again, since little can be said about the relative distribution of measurement error in each variable definition, we have no priors about the relative estimated returns based on the alternative definitions.

The SLID data allow us to produce more accurate measures of foreign/host-country schooling and experience than is possible using the standard data sources available. But some measurement errors almost certainly remain. For example, treating the SLID data as cross-sections, individual-level foreign quantities of schooling and experience are not strictly time-invariant over the panels in our data, which we know they should be (assuming individuals are not working abroad for partial years). In order to make the results comparable to those in the literature, we begin by defining the variables first ignoring the longitudinal dimension of the data. However, when we introduce the individual fixed effects we redefine the variables restricting all changes in schooling, actual experience, and idle years to increase only the host-country quantities. Since the fixed effects model identifies the host-country returns exclusively off these within-panel changes, in the case of the fixed effects estimates all biases arising from errors in distinguishing foreign from host-country quantities are thereby effectively eliminated.

5 Results

Table 2 reports the results from using the three alternative definitions of foreign and host-country schooling and actual labour market experience (first three columns assume potential experience; last three assume uniformly-distributed schooling). The estimates assuming left-continuous schooling are similar to those reported elsewhere and, if anything, tend to be slightly smaller, perhaps reflecting our use of an hourly wage, as opposed to earnings. The return to host-country schooling for both natives and immigrants exceeds the return to foreign schooling, though the differences are small (0.064 and 0.055 respectively, compared to 0.052). The estimated return to foreign experience is very close to zero and statistically insignificant. Also consistent with estimates found elsewhere, the relative host-country experience return for immigrants (the g_{xh} function) is negative, but increasing (it becomes positive at 29 years of host-country experience). This negative return is expected since immigrants, on average, arrive with some foreign experience so their host-country return captures a flatter part of their overall experience profile.

What happens to these estimated returns when we use our more accurate measures of

foreign and host-country schooling? The foreign experience return clearly tends to increase as more schooling is defined as host-country. Comparing the two extreme definitions – left- and right-continuous schooling – the linear term doubles in magnitude and becomes statistically significant. The quadratic term, however, also becomes larger (in absolute value). Twenty years of foreign experience, in the case of right-continuous schooling, implies a 0.1 log point wage increment, compared to 0.05 log points in the case of left-continuous or uniformly-distributed schooling. Measurement error resulting from assuming continuous schooling, therefore, appears to contribute to the low estimated returns to foreign experience in the literature, though even under the most extreme assumptions the return is small. The returns to both foreign and host-country schooling also become larger, though the differences here are also small. Lastly, the immigrant return to host-country experience tends to decrease. The results, overall, suggest that the consequences of assuming strictly continuous schooling in the absence of better data are modest. Why is this true? Across definitions there is a considerable advantage of host-country over foreign sources of experience, implying the difference between β_1 and β_2 in equation (3.9) is substantial. The differences in means across alternative definitions in Table 1, in contrast, appear quite small, suggesting the robustness of the estimates probably has more to do with a small amount of measurement error, than the nature of the measurement error problem.

Replacing the potential experience measures with actual experience, shown in the remaining columns of Table 2, tends to further increase the estimated returns to foreign experience, at least up to 10 years or so. In the left-continuous case, the linear return is now close to 0.02 log points and statistically significant. Nonetheless, in all cases the foreign returns continue to be small relative to the return to host-country experience for either immigrants or natives. As for schooling, using actual experience in all cases tends to decrease the estimated returns and imply an even smaller advantage of host-country over foreign schooling. In the uniformly-distributed case, for example, the immigrant return to foreign schooling is 0.046 log points, compared to 0.048 log points for host-country schooling.

Having estimated the separate returns model, in Figure 1 we compare the implications for assimilation of using the standard and our preferred measures of foreign/host-country schooling and experience (uniformly-distributed schooling and actual experience). In both cases we predict entry log wages for a recent immigrant (arrival cohort 1990-2002) arriving with the sample mean years of foreign schooling (9.77) and work experience (5.98). We then compare subsequent predicted wage growth to a similarly aged native-born worker assuming both accumulate one year of host-country labour market experience in every subsequent

year. Assuming schooling begins at age 5 and no idle years, both representative workers are initially $5 + 9.77 + 5.98 = 20.75$ years of age. To simplify the results, the vertical axis plots the difference between the predicted immigrant and native log wage. The results indicate identical entry effects in the two cases. The only apparent different between the two profiles is subsequent wage growth is slightly higher in the first 10 years following migration using our preferred variable definitions, but then flattens out more quickly. Specifically, using the preferred definitions, the initial gap of 0.29 log points is more than halved after only 8 years, but remains virtually unchanged at 0.09 log points between year 13 and 25. In comparison, using the standard definitions, the initial gap of 0.29 log points is halved within ten years and in the following 10 and 20 years it closes by an additional 0.05 and 0.02 log points, respectively. When one thinks about language acquisition or acculturation processes, this pattern of strong decreasing relative returns to host-experience using our preferred definitions would appear to better capture reality. In this respect, the relative wage profile of the separate returns model seems more reasonable, though the differences are small.[13]

In Table 3 we extend the separate returns model allowing all the host-country returns to depend on the foreign human capital stock and controlling for idle years. To allow for the possibility that the relative returns to foreign and host-country sources of schooling and experience may vary widely across immigrants from different parts of the world, we also fully interact the immigrant-specific component of equation (4.10) with a dummy variable distinguishing immigrants from Canada's traditional immigrant source countries – the U.S., U.K., and Northern, Western and Southern Europe – from those from non-traditional source regions – Eastern Europe, Africa, and Asia. The results from the pooled sample suggest a very small positive return to idle years for immigrants (and natives), whether it is foreign or host-country. This is, however, no longer true when we distinguish between immigrants from traditional and non-traditional source countries. In particular, the return to host-country idle years is significant and close to 0.02 (0.002+0.017) log points for immigrants coming from

[13]A less compelling feature of the preferred definitions is the strong convexity of the profile beginning at about age 46 (though less apparent, this is also a feature of the profile using the standard definitions). What explains it? It turns out both the immigrant and native host-country experience profiles eventually reach a point of sharply decreasing returns, but natives reach the point of decreasing returns earlier than immigrants, resulting in the convexity. When actual years of experience is used, the point of decreasing returns occurs earlier, so the convexity kicks in earlier. Because actual experience levels tend to be lower and our starting point is a native who already has 6 years experience, less than 5% of both the native and immigrant observations have host-country experience beyond the point when the convexity kicks in. By the end of the 35-year period we are essentially making out-of-sample predictions. One would, therefore, not want to give the convexity any economic interpretation.

countries where language and cultural differences are likely greatest. The interactions of host-country idle years with foreign experience and foreign schooling are, however, also more negative. Therefore, for adult immigrants from non-traditional source countries, but not child immigrants, the return to host-country idle years appears to be, if anything, negative.

With few exceptions, the interaction terms in Table 3 suggest modest complementarities between foreign and host-country sources of human capital. In the pooled sample, arriving with additional foreign experience has almost exactly a nil effect on the host-country experience profile. Additional foreign schooling appears to reduce the return to host-country experience, though the effect is again small (but statistically significant). For example, arriving with 16 years of foreign schooling (relative to none) reduces the linear return to host-country experience by only 0.006 log points. We also find little evidence here, for either traditional or non-traditional source country immigrants, that foreign schooling returns are higher for immigrants with more host-country schooling – the interaction of foreign and host-country schooling term is 0.0002 compared to 0.001 in Friedberg (2000, Table 6) using Israeli data. This difference is not explained by our richer information on the source of schooling – we get exactly the same result using the standard variable definitions. One wonders if the difference reflects credential recognition issues, which have over the past decade been the focus of much discussion surrounding Canada's immigrant settlement policies. To the extent that foreign-trained professionals opt to train for entirely new careers following migration in the absence of a system for recognizing foreign training, and the skills involved are not complementary, we would expect this interaction term to be zero.

In Figure 2 we plot predicted log wages separately for natives and immigrants based on the estimates in Table 4. Adding idle years and interaction terms does essentially nothing to change the level or slope of the native wage profile. Distinguishing immigrants from traditional and non-traditional source countries suggests a substantially lower entry wage for non-traditional immigrants – 0.115 log points – primarily reflecting an overall differential (a cohort effect) as opposed to lower returns to foreign schooling or experience. Subsequent wage growth, however, is virtually identical over the following 35-year period for the two immigrant types. Though the sharp change in the slope of the profiles around the tenth year gives the illusion that the traditional-immigrant profile is steeper, the rate of assimilation is at all ages slightly higher for non-traditional immigrants.[14]

[14]It turns out this result is somewhat sensitive to variable definitions. Using standard variable definitions – left-continuous schooling and potential experience – suggests both a lower entry effect for traditional source country immigrants and a higher subsequent assimilation rate. For the sake of brevity we do not show these results. They are, however, available upon request.

In Table 5 we present the FE results. Since we are ultimately interested in the sensitivity of the results to the inclusion of individual fixed effects, we also report estimates from pooled OLS. To capture the main differences, we then predict log wage profiles using exactly the same approach as in Figures 1 and 2, assuming a constant unemployment rate of 7.5% (the mean level in the data). Figure 3 indicates that estimation by FE does little to change the results. In terms of the age-experience simulation (for the sake of brevity we only show the GLS case), the entry effect from FE is 0.229 log points compared to 0.221 from pooled OLS. This is perhaps not surprising, given that entry wages are identified exclusively off time-invariant foreign stocks of human capital, and therefore include all unobserved individual heterogeneity (as argued above, in informing selection policy we do not want to purge entry wages of unobserved heterogeneity). Subsequent relative immigrant wage growth, however, also changes little. Over the full 35-year period, native wages now grow slightly more (0.343 log points compared to 0.327), while immigrant wages grow slightly less (0.631 log points compared to 0.677). As a result, the "average" immigrant considered now reaches wage parity with the comparable native roughly ten years later (age 46, instead of 36).

What explains the fact that our FE estimates do not imply substantially lower immigrant wage growth as the U.S. literature has tended to find (e.g., Lubotsky 2007)? It turns out, it is not because we are identifying wage growth off a return to host-country experience, whereas other studies identify off YSM – we get a similar differences between pooled OLS and FE when we estimate the using either the base or extended YSM model described in Section 2. We can think of two other reasons, however, that may explain the difference. First, it may be that this result is unique to Canada. Indeed, there is reason to believe that the nature of emigration is different in Canada. In particular, immigration to Canada may serve as a stepping stone for onward migration to the U.S.. This onward migration may be most common among highly able, highly motivated workers, so that in the Canadian data, YSM is less positively correlated with high unobserved individual effects. Alternatively, even if the nature of selective emigration is similar in Canada and the U.S., if the propensity to emigrate in both countries is increasing in individuals' post-migration wage growth, then excluding emigrants from the sample, as the existing U.S. studies do will imply lower wage growth. But controlling for individual fixed effects will not. Lower wage growth from longitudinal estimates does not then reflect selective emigration of workers with low wage *levels*, as has been interpreted in these studies.

We have argued that an important advantage of the separate returns model is that it offers a richer set of counterfactual predictions to inform immigrant selection and settlement

policy. In Figures 4 and 5 we perform two such simulations. In Figure 4 we compare predicted log wage profiles for immigrants arriving with 16 years of foreign schooling, but different quantities of foreign experience, and compare to a native with the same total schooling and experience. In Figure 5 we compare host-country wage growth across three immigrants, each arriving with 5 years of foreign experience, but with varying quantities of foreign schooling. In the first case, the immigrant arrives at age 30 with 20 years of schooling and accumulates one year of host-country experience in each subsequent year. In the second case, the immigrant arrives at age 26 with 16 years of schooling, but then completes an additional 4 years of schooling, before beginning to accumulate host-country experience. In the last case, the immigrant arrives with 16 years of foreign schooling, but accumulates 4 idle years before beginning to accumulate host-country experience.[15] These profiles are, again, compared to a similarly-aged native, who initially (age 26) has 16 years of schooling and 5 years experience.

A return to potential foreign work experience close to zero is a standard result in the literature. Though using actual experience increases the return slightly (Table 2), controlling for individual FE does not (Table 5). At least over the first 8 years, the FE foreign experience returns are, if anything, slightly smaller (though still significant). This is captured in Figure 4 in the very modest improvements in entry wage rates across immigrants arriving with very different amounts of work experience. What is arguably more interesting in Figure 4, however, is that not only does additional foreign experience do essentially nothing to improve entry wages, it also appears to reduce subsequent wage growth. For example, over the first 5 years wages grow by 0.264 log points for the immigrant with 5 years foreign experience, compared to 0.254 log points for the immigrant with 15 years of foreign experience. This difference, which is statistically significant, is driven by the negative foreign/host-country experience interaction term. In fact, with enough YSM, the host-country experience return is lower for the immigrant arriving with 15, compared to 5, years of foreign experience, even conditioning on age. As a result, after age 51 the dashed and dotted profiles are diverging.

Recent years have seen a shift in Canadian immigrant selection criteria towards greater emphasis on host-country educational credentials. The evidence in Figure 5 does not suggest that this emphasis is well founded. In particular, providing immigrants with four additional years of schooling (20 instead of 16 years) has almost exactly the same effect on wage levels and wage growth whether the additional four years were obtained in Canada or abroad. It is, of course, possible that the advantage of host-country credentials lies primarily in improving

[15] In all cases we assume that the immigrant has some foreign experience to reflect the reality of the Canadian skilled immigrant selection criteria, which essentially disqualifies applicants with no foreign work experience.

employment prospects, though as long as reservation wages are decreasing in unemployment durations, we would expect this to show up in wage outcomes.

6 Summary

We argue that directly estimating foreign and host-country human capital returns is advantageous in terms of both avoiding biases inherent in the more standard YSM approach and in terms of its policy relevance. The problem with estimating separate returns, however, is twofold. First, unlike YSM models, it requires that the source country of immigrants' schooling and experience be identified in the data, which it is typically not. Second, in distinguishing post-migration schooling and work decisions, the separate returns model introduces an additional source of endogeneity, which complicates inferences made regarding immigrant wage growth and assimilation. We posit that these challenges explain the predominance of the YSM approach in the assimilation literature. The question we ask is how substantial are these potential biases in the Canadian data, where estimation of the separate returns model has become increasingly common in recent years.

Using a particularly rich longitudinal dataset on roughly 6,000 immigrants, we find that that the biases inherent in estimating foreign and host-country returns directly using standard data sources appear modest. In particularly, using more accurate measures of foreign and host-country sources of schooling and experience and controlling for individual fixed effects does little to alter the main findings of the existing Canadian literature. In particular, we continue to find low returns to immigrant foreign experience and little advantage of host-country over foreign schooling returns for immigrants. In addition, we find additional foreign work experience not only does essentially nothing to raise immigrant wage outcomes at entry, but also lowers subsequent returns to host-country work experience. The return to foreign schooling for immigrants from both traditional and non-traditional source countries is, in contrast, virtually identical to their return to host-country schooling, raising questions about recent efforts to attach greater weight to host-country educational credentials in Canadian immigrant selection policy.

APPENDIX

Proof of bias in basic YSM model: As long as $0 < \bar{m} < 1$, we know that $\alpha_2 < \hat{\beta}_1 < \alpha_1$. Given $\hat{\beta}_0$ and $\hat{\beta}_1$, the estimates of β_2 and β_3 can then be thought of as coming from the restricted least squares regression:

$$w_i = \hat{\beta}_0 + \hat{\beta}_1(exph_i + expf_i) + m_i \cdot (\beta_2 + \beta_3 exph_i) + e_i. \tag{6.11}$$

which amounts to estimating the term in parentheses in (2.2) using only the sample of immigrants and the adjusted dependent variable:

$$\tilde{w}_i = (\alpha_0 - \hat{\beta}_0) + (\alpha_1 - \hat{\beta}_1)exph_i + (\alpha_2 - \hat{\beta}_1)expf_i + \varepsilon_i. \tag{6.12}$$

The standard omitted variable bias result then implies the probability limit given in equation (2.3).

Proof of bias in extended YSM model: If $(\alpha_1 - \alpha_3) = (\alpha_2 - \alpha_4) \equiv \theta$, then least squares produces $\hat{\beta}_1 = \alpha_1$; $\hat{\beta}_2 = \alpha_2$; $\hat{\beta}_4 = \hat{\beta}_5 = -\theta$; and $\hat{\beta}_6 = \theta$, and the estimates correctly predict no assimilation (since $\hat{\beta}_4 + \hat{\beta}_6 = 0$ and $\hat{\beta}_5 + \hat{\beta}_6 = 0$). In general, however, $(\alpha_1 - \alpha_3) \neq (\alpha_2 - \alpha_4)$. In this case, $\hat{\beta}_6$ is estimated as a weighted average of the two differences. Defining $\theta_1 \equiv (\alpha_1 - \alpha_3)$ and $\theta_2 \equiv (\alpha_2 - \alpha_4)$, the problem amounts to estimating a single linear return θ when the DGP is given by:

$$y_i = \theta_0 + \theta_1 exp_i + \theta_2 s_i + \mu_i. \tag{6.13}$$

We then know:

$$\text{plim } \hat{\theta} = \frac{\theta_1 \text{var}(exp_i) + \theta_2 \text{var}(s_i) + (\theta_1 + \theta_2)\text{cov}(exp_i, s_i)}{\text{var}(exp_i) + \text{var}(s_i) + 2\text{cov}(exp_i, s_i)} \tag{6.14}$$

which is bounded by θ_1 and θ_2. This tells us that the return to YSM in the unrestricted model is a weighted average of the advantage in host-country sources of schooling and experience (over foreign sources), where the weighting depends on the relative magnitudes of $\text{var}(exph_i + expf_i)$ and $\text{var}(sh_i + sf_i)$, as well as the covariances of $exph_i$, sh_i, $expf_i$, and sf_i. It does not depend on the levels (means) of these variables; this is captured by β_3 in (2.6).

REFERENCES

Akresh, Ilana (2007), "U.S. Immigrants' Labor Market Adjustment: Additional Human Capital Investment and Earnings Growth," *Demography* 44(4): 865-81.

Alboim, Naomi, Ross Finnie , and Ronald Meng (2005), "The Discounting of Immigrants' Skills in Canada," *IRPP Choices* 11(2): 1-26.

Aydemir, Abdurrahman and Mikal Skuterud (2005), "Explaining the Deteriorating Entry Earnings of Canadas Immigrant Cohorts: 1966-2000, *Canadian Journal of Economics* 38(2): 641-71.

Aydemir, Abdurrahman and Mikal Skuterud (2008), "The Immigrant Wage Differential Within And Across Establishments, *Industrial and Labor Relations Review* 61(3): 334-52.

Borjas, George (1982), "The earnings of male hispanic immigrants in the United States," *Industrial and Labor Relations Review* 35(3): 343-53.

Borjas, George (1999), "The Economic Analysis of Immigration." In *Handbook of Labor Economics*, vol. 3A, O. Ashenfelter and D. Card. (eds.), Amsterdam: Elsevier Science.

Bratsberg, Bernt and James Ragan (2002), "The impact of host-country schooling on earnings: a study of male immigrants in the United States," *Journal of Human Resources* 37(1): 63-105.

Chiswick, Barry (1978), "The effect of Americanization of the earnings of foreign-born men," *Journal of Political Economy* 86(5): 897-921.

Chiswick, Barry and Paul Miller (1994), "The determinants of post-immigration investments in education," *Economics of Education Review* 13(2): 163-77.

Chiswick, Barry, Yew Liang Lee and Paul Miller (2005), "Immigrant earnings: a longitudinal analysis," *Review of Income and Wealth* 51(4): 485-503.

Clark, Melissa and David Jaeger (2006), "Natives, the Foreign-born and High School Equivalents: New Evidence on the Returns to the GED," *Journal of Population Economics* 19: 769-93.

Cobb-Clark, Deborah, Marie Connolly and Christopher Worswick (2005), "Post-migration investments in education and job search: a family perspective," *Journal of Population Economics* 18:663-90.

Duleep, Harriet Orcutt and Mark Regets (1997), "Measuring immigrant wage growth using matched CPS files," *Demography* 34(2): 239-49.

Duleep, Harriet Orcutt and Daniel Dowhan (2002), "Insights from longitudinal data on the earnings growth of U.S. foreign-born men," *Demography* 39(3): 485-506.

Edin, Per-Anders, Robert Lalonde and Olof Åslund (2000), "Emigration of immigrants and measures of immigrant assimilation: Evidence from Sweden," *Swedish Economic Policy Review* 7: 163-204.

Ferrer, Ana, David Green and Craig Riddell (2006), "The Effect of Literacy on Immigrant Earnings," *Journal of Human Resources* 41(2): 380-410.

Ferrer, Ana and Craig Riddell (2008), "Education, Credentials, and Immigrant Earnings," *Canadian Journal of Economics* 41(1): 186-216.

Friedberg, Rachel (2000), "You can't take it with you? Immigrant assimilation and the portability of human capital," *Journal of Labor Economics* 18(2): 221-251.

Green, David and Chris Worswick (2002), "Entry Earnings of Immigrant Men in Canada: The Roles of Labour Market Entry Effects and Returns to Foreign Experience," mimeo.

Greene, W.H. (2008), *Econometric Analysis*, 6th edition, Pearson Education: Upper Saddle River, New Jersey.

Hartog, Joop and Aslan Zorlu (2009), "How Important is Homeland Education for Refugees' Economic Position in The Netherlands?" *Journal of Population Economics* 22: 219-46.

Hu, Wei-Yin (2000), "Immigrant Earnings Assimilation: Estimates from Longitudinal Data," *American Economic Review* 90(2): 368-72.

Hum, Derek and Wayne Simpson (2003), "Job-related training activity by immigrants to Canada," *Canadian Public Policy* 29(4): 469-90.

Hum, Derek and Wayne Simpson (2004), "Reinterpreting the performance of immigrant wages from panel data," *Empirical Economics* 29: 129-47.

Khan, Aliya Hashmi (1997), "Post-migration investment in education by immigrants in the United States," *Quarterly Review of Economics and Finance* 37: 285-313.

Kossoudji, Sherry (1989), "Immigrant Worker Assimilation: Is It A Labor Market Phenomenon?" *Journal of Human Resources* 24(3): 494-527.

Lalonde, Robert and Robert Topel (1992), "The assimilation of immigrants in the U.S. labor market," in George Borjas and Richard Freeman, eds., *Immigration and the work force: economic consequences for the United States and source areas* (University of Chicago Press, Chicago, IL), pp.67-92.

Lemieux, Thomas (2006), "The "Mincer Equation" Thirty Years After Schooling, Experience, and Earnings," in Shoshana Grossbard (ed.), *Jacob Mincer: A Pioneer of Modern Labor Economics*," Springer, pp.127-45.

Lubotsky, Darren (2007), "Chutes or Ladders? A Longitudinal Analysis of Immigrant Earnings," *Journal of Political Economy* 115(5): 820-67.

Murphy, Kevin M. and Finis Welch (1990), "Empirical Age-Earnings Profiles," *Journal of Labor Economics*, 8(2): 202-29.

Polachek, Kim and Moon-Kak Kim (1994), "Panel estimates of the gender earnings gap," *Journal of Econometrics* 61:23-42.

Schaafsma, Joseph and Arthur Sweetman (2001), "Immigrant Earnings: Age at Immigration Matters," *Canadian Journal of Economics* 34(4): 1066-99.

Stewart, James and Thomas Hyclak (1984), "An Analysis of the Earnings Profiles of Immigrants," *Review of Economics and Statistics* 66(2): 292-6.

Van Tubergen, Frank and Herman Van De Werfhorst (2007), "Postimmigration investments in education: a study of immigrants in the Netherlands," *Demography* 44(4): 883-98.

Wiers-Jenssen, Jannecke and Sverre Try (2005), "Labour Market Outcomes of Higher Education Undertaken Abroad," *Studies in Higher Education* 30(6): 681-705.