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Gendered Returns to Cognitive Skills in Canada

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Introduction

Much research examines how numerous factors affect earnings differentials, including employment patterns and occupational structures (e.g., Fortin & Lemieux, 2015; Green & Sand, 2015). The term "human capital" is often used to describe a set of factors that generate economic returns. Depending on the study, the measurement of human capital may be captured through proxy indicators (i.e., education level) or more direct assessments (i.e., cognitive skill level). As earnings typically increase at higher levels of these measures, human capital provides an additional explanation for earnings differentials (Hanushek, Schwerdt, Wiederhold & Woessmann, 2015; Harmon, Oosterbeek & Walker, 2003; Hunter & Leiper, 1993; Juhn, Murphy & Pierce, 1993; Schultz, 1960).

Scholars typically study the rate of return to human capital in relation to credentials and years of education. While a culmination of research suggests that one year of education increases earnings by 7–15% (Sweetman, 2002), there is not an equal distribution in returns to human capital across the spectrum of education levels. In Canada, the rate of return to education increased between 1980 and 2006 for all postsecondary graduates (Boudarbat, Lemieux & Riddell, 2010) but decreased for high school graduates (Green & Townsend, 2010). These differential returns likely connect to increasing earnings inequality between low- and high-end occupations during the 1980s and 1990s, a trend Green and Sand (2015) relate to both supply- and demand-side factors, such as regional resource booms and minimum-wage increases in Canada.

Average skill levels generally rise with higher credentials, which suggests overlap in what education and measures of cognitive skills capture — yet skill levels also vary within each education level (Statistics Canada, 2013). The independent association between education and earnings also diminishes when one accounts for individual cognitive skill level (e.g., Hanushek et al., 2015; Heisz, Notten & Situ, 2015). In part, assessment results are influenced by experiences outside of formal education, including the occupational sector of employment, skill utilization at work and workplace training (OECD, 2013b; Statistics Canada, 2013). These and other experiences may increase both cognitive skill level and earning potential.

Returns to human capital also differ by gender. Although the increasing education levels of women in Canada have not necessarily "been met by commensurate increases in earning" (Fortin, Bell & Böhm, 2017, p. 112), the gender earnings gap narrows at higher education levels (Zhao, Ferguson, Dryburgh, Rodriguez & Gibson, 2017). For this reason, returns to human capital — when measured by education level — are typically higher for women (Boudarbat, Lemieux & Riddell, 2010; Migali & Walker, 2017). However, this finding differs by the type of proxy for human capital a researcher uses. In particular, returns to direct assessments of cognitive skill level show either a small gender difference or no difference at all in favor of women (Hu, Daley & Warman, 2019; Truong & Sweetman, 2018). Skill differentials between men and women also have only a marginal contribution to the overall gender earnings gap (Christl & Köppl-Turyna, 2017).

The discrepancy between measures of education and skill in capturing the extent to which returns to human capital differ by gender may be linked to the "sheepskin" effect; that is, an association between education and an economic outcome that can be linked to the power of credentials to signal employability, productivity or another individual attribute that functions above simply time spent in education (Hungerford & Solon, 1987; Ferrer & Riddell, 2002; Park, 1996). Importantly, credentials are much more identifiable than cognitive skill level by employers and may determine access to occupations and jobs that have specific qualification requirements (e.g., teachers and nurses) — although regulatory colleges for regulated professions also play a key role. For this reason, researchers largely find that the sheepskin effect is higher for women, especially for postsecondary credentials (Belman & Heywood, 1991).

Building upon this prior research, this report examines how the wages of workers between the ages of 30 and 59 differ by cogitative skill level in the domains of literacy, numeracy and problem solving in technology-rich environments (PS-TRE) by gender, immigration and Indigenous status in Canada. Although people with higher assessed cognitive skill levels tend to earn more on average, these returns may also differ by sociodemographic factors; that is, individuals with the same skill level earn different amounts in relation to other background characteristics. This study focuses explicitly on the difference between men and women in three sociodemographic groups: 1) foreign-born people (i.e., immigrants), 2) Indigenous peoples, and 3) native-born and non-Indigenous people. Examining the gendered returns to cognitive skills among these three groups makes use of the PIAAC oversampling among immigrants and Indigenous peoples in Canada and is an important extension to previous research that does not examine differences in the rate of return to human capital among different groups of men and women.

This research begins with the following question: "What are the wage returns to literacy, numeracy and problem solving in technology-rich environments in Canada and how do they differ for men and women in each of the three sociodemographic groups?" We then consider how returns to cognitive skills for men and women differ over the distribution of wages. Thus, we ask: "How do the returns to literacy, numeracy and problem solving in technology-rich environments differ across the wage distribution and how do they differ for men and women in each of the three sociodemographic groups?"

Findings

Descriptive Results

The left-hand side of Table 1 provides average assessment scores in literacy, numeracy and PS-TRE among all employed PIAAC participants ages 30 to 59 and for men and women from the three sociodemographic groups of interest. Literacy assessment scores are similar for native-born non-Indigenous men and women, as well as among Indigenous men and women; however, immigrant men have slightly higher literacy scores compared to immigrant women. Average numeracy assessment scores are slightly higher for men across all three groups. PS-TRE assessment scores are higher for native-born non-Indigenous and Indigenous women

compared to their male counterparts, while immigrant men have slightly higher PS-TRE scores compared to immigrant women.

The right-hand side of Table 1 provides a descriptive summary of average wages overall and at each percentile among all employed participants (ages 30 to 59) and for men and women in each of the three sociodemographic groups. For all three groups, mean wages are higher for men compared to women. By gender, mean wages are highest for both native-born non-Indigenous men and women. Typically, the wage gap is smallest at the 5th and 10th percentiles and greatest at the 90th and 95th percentiles — especially when comparing the earnings of native-born non-Indigenous and immigrant men and women. In contrast, a smaller gender wage gap exists among high earning Indigenous men and women.

Table 1: Summary Statistics

	Assessment score			***Wages (Log Wages)***							
	Lit.	Num.	PS-TRE	Mean	5th	10th	25th	50th	75th	90th	95th
All (*N* = 11,020)	278.7	271.7	240.4	27.9 (3.22)	11.1 (2.40)	13.1 (2.57)	17.8 (2.88)	25.0 (3.22)	35.2 (3.56)	45.0 (3.81)	53.4 (3.98)
Native-born, non-Ind. men	285.8	283.7	246.0	31.1 (3.34)	12.5 (2.53)	15.0 (2.71)	20.4 (3.01)	28.9 (3.36)	38.5 (3.65)	49.8 (3.91)	60.1 (4.1)
Native-born, non-Ind. women	285.5	272.3	257.7	26.1 (3.16)	11.1 (2.4)	13.1 (2.57)	17.4 (2.86)	23.4 (3.15)	32.5 (3.48)	42.0 (3.74)	47.4 (3.86)
Indigenous men	270.3	262.1	218.1	28.1 (3.24)	11.0 (2.4)	14.1 (2.65)	19.2 (2.96)	26.0 (3.26)	36.0 (3.58)	43.2 (3.77)	48.8 (3.89)
Indigenous women	272.7	251.8	237.6	23.4 (3.05)	10.1 (2.31)	11.0 (2.4)	14.5 (2.67)	21.4 (3.06)	28.6 (3.35)	38.0 (3.64)	45.0 (3.81)
Immigrant men	264.5	266.4	220.0	28.7 (3.24)	11.6 (2.45)	13.8 (2.62)	18.0 (2.89)	25.0 (3.22)	38.0 (3.64)	48.1 (3.87)	57.2 (4.05)
Immigrant women	257.8	245.8	201.8	23.5 (3.03)	10.3 (2.33)	11.0 (2.40)	14.1 (2.65)	20.0 (3.00)	29.7 (3.39)	40.7 (3.71)	47.0 (3.85)

The weighted descriptive statistics show mean literacy, numeracy and PS-TRE assessment scores and mean wages, as well as wages at each percentile, among: all employed PIAAC participants ages 30–59 in 2012; native-born non-Indigenous people (3,200 men and 3,775 women); Indigenous peoples (922 men and 1,075 women); and immigrants (1,022 men and 1,026 women). Log wages are in parentheses.

OLS Regression Results

Figure 1 illustrates the results of OLS regression analysis that examine the wage returns to literacy, numeracy and PS-TRE skills separately for men and women and across the three sociodemographic groups: immigrants, Indigenous peoples, and native-born non-Indigenous people. There are three model specifications, the baseline model and two full models, each with and without highest education level. Figure 2 (Appendix 1) provides the same results, but with wages log transformed.

The coefficients represent the average wage return at the mean of the wage distribution for each standard deviation increase in assessed literacy, numeracy and PS-TRE scores. For example, in the baseline model in Figure 1 (Appendix 1), native-born non-Indigenous men earn $5.2 more per hour for every standard deviation increase in assessed literacy score. In comparison, native-born non-Indigenous women earn $5.7 more for each standard deviation increase in a model with the same specifications. Additional modelling, available on request, formally tested gender differences in returns to each skill domain through an interaction term. The results section documents when a formal test of the gender difference in returns to skills is statistically significant.

Literacy Skills

The results show that returns to literacy skills are highest in the baseline model, ranging from $5.5 more in average wages (i.e., 0.22 more in log wages) for each standard deviation increase in literacy scores for native-born non-Indigenous women, to a $3.5 increase in wages (i.e., 0.12 more in log wages) for the oversampled Indigenous men. The estimated returns to literacy skills tend to be only partially reduced in the full model without education, but are more substantially reduced in the final model when highest education level is included.

Although the estimated size of the returns to literacy skills are lower in the final models across all sociodemographic groups, scores still have a positive association with wages. After accounting for highest education level, it is again greatest for native-born non-Indigenous women (i.e., $2.4 in wages and 0.10 in log wages) and smallest for Indigenous men (i.e., $2.0 in wages and 0.06 in log wages).

Even though there is a small difference in the point estimates for Indigenous and non-Indigenous men and women, prior Canadian research that examines whether returns to literacy skills differ between these groups finds no statistically significant difference (Hu et al., 2019). When formally testing gender differences, we find only a small log wage difference for native-born non-Indigenous people in favor of women in a full model that does not control for education (β = 0.034, s.e. = 0.06, p<0.05). Once the model includes respondents' highest education level, this gender difference is non-significant.

The difference in returns to literacy skills between the three sociodemographic groups is more pronounced than the gender differences within them. In particular, returns to literacy skills are greatest for immigrant and native-born non-Indigenous individuals across all model specifications, while the rate of return is lowest for Indigenous peoples. Nonetheless, the wide margin of error for the oversampled Indigenous group — as the error bars showing the 95% confidence interval visualize — also suggest greater overall uncertainty in measuring returns to literacy skills for this group.

Numeracy Skills

The results for returns to numeracy skills in the baseline model are similar to literacy, again highest for native-born non-Indigenous women (i.e., $5.7 more in average wages and 0.22 more in log wages for each standard deviation increase in scores) and lowest for Indigenous men (i.e., $3.5 in wages and 0.12 in log wages). Also similar to literacy skills, the estimated returns to numeracy skills are only partially reduced in the full model without the indicator measuring highest education level and more substantially reduced in the full model that includes credential level. These results largely confirm prior research on the returns to numeracy skills in Canada and the extent to which they are reduced in a model that accounts for education level (Hanushek et al., 2015).

As expected, numeracy scores have a positive association with wages across all model specifications and sociodemographic groups. After accounting for respondents' highest education level, it is greatest for the oversampled immigrant men (i.e., $3.3 more in wages and 0.12 more in log wages) and smallest for the oversampled Indigenous men (i.e., $2.0 more in wages and 0.07 more in log wages).

PS-TRE Skills

The results for returns to PS-TRE skills in the baseline model are larger overall compared to the literacy and numeracy domains. In the baseline model in Figure 1 (Appendix 1), returns are highest for native-born non-Indigenous men (i.e., $10.8 more in average wages for each standard deviation increase in scores) and lowest for Indigenous men (i.e., $6.8). However, once wages are log transformed in Figure 2 (Appendix 1), returns are highest for native-born non-Indigenous women (i.e., 0.42 more in log wages) and lowest for Indigenous men (i.e., 0.22 more in log wages), a finding that suggests skew in the untransformed wage data for native-born non-Indigenous men is likely more influential on the regression results than on the results for native-born non-Indigenous women.

The estimated returns to PS-TRE skills are again only partially reduced in the full model without education for all three sociodemographic groups and more greatly reduced in the final model that includes education level. After accounting for highest education level, returns to PS-TRE skills are greatest for oversampled immigrant men (i.e., $6.7 more in wages and 0.20 more in log wages) and smallest for oversampled Indigenous men (i.e., $3.3 more in wages and 0.08 more in log wages). Like returns to the other two skill domains, intragender differences are non-significant across a model specification that formally tests this difference.

As discussed in the introduction, returns to PS-TRE skills can also be estimated without including PIAAC respondents who did not participate in this test. While the results are available upon request, they are not shown in the report as they are similar to the specification that includes all PIAAC participants. For example, in the baseline model, returns to PS-TRE skills (as estimated without including people who did not participate in the test) are again highest for native-born non-Indigenous men (i.e., $11.0 more in wages) and

lowest for Indigenous men (i.e., $7.0 more in wages). In the final model that controls for highest education level, returns are largest for immigrant men (i.e., 6.4 more in log wages) and smallest for Indigenous men and women (i.e., 3.7 more in log wages).

Quantile Regression Results

Figures 3 to 8 (Appendix 1) present the results of quantile regression analyses that examine wage and log wage returns to literacy, numeracy and PS-TRE skills across the earnings distribution (i.e., the 5th, 10th, 25th, 50th, 75th, 90th and 95th quantile) for the same three sociodemographic groups of PIAAC participants: immigrants, Indigenous peoples and native-born non-Indigenous people. Like the OLS regression analysis, three model specifications (e.g., the baseline model and two full models) examine how returns change once additional explanatory variables are included in the model. In the main results section, we focus explicitly on the baseline and full model with education. Because of their similarity with the final model, the results of the full model without education are presented in Appendix 2.

Each plot illustrates the average increase in wages for each standard deviation increase in assessed scores at particular points in the wage distribution. The left-hand side of each figure shows the rate of return as an absolute dollar value, while the right-hand side shows the log return as a percentage changes in wages. For example, in the baseline model, native-born non-Indigenous men at the 5th quantile (i.e., 0.05 on the horizontal axis) earn $1.7 more per hour (i.e., 0.12 more in log wages) for every standard deviation increase in assessed literacy score compared to those at the same quantile of the joint distribution. As estimated in the same model, the separate intercept for native-born non-Indigenous women indicates that they earn, on average, $2.6 (i.e., 0.21 more in log wages) for each standard deviation increase in assessed skill level at the same point in the wage distribution. With no overlap in the confidence intervals, the results suggest that women at the 5th quantile of the wage distribution have a statistically significant higher rate of return than men.

Literacy Skills

In the baseline model measuring untransformed wages in Figure 3 (Appendix 1), returns to literacy skills are smallest at the lower end of the wage distribution (i.e., the 5th and 10th quantiles) for men and women in all three sociodemographic groups. In the lower half of the distribution, returns increase and are also slightly larger for women, typically up to the median (i.e., the 50th quantile). Returns for men and women are similar at the 75th quantile for all three sociodemographic groups; however, at higher percentiles, returns to literacy skills become larger for men compared to their female counterpoints. At the 90th and 95th quantile, the error bars are larger, a finding that suggests greater uncertainty in estimating returns to literacy skills at the high end of the wage distribution.

While the overall trend is similar when the measure of wages is log transformed, for native-born non-Indigenous women, returns are somewhat higher at the lower end of the earnings distribution and decrease

to a larger extent after the median. However, it is important to keep in mind that the percentage of log wage returns is relative to the wage level (e.g., a 5% return among low wage earners is a smaller dollar amount than 5% among higher wage earners). The difference between log and absolute wages may also suggest that the untransformed results for native-born non-Indigenous women are influenced by the skew in the distribution of wages and when it is normalized returns to literacy skill at the lower end of in the distribution increase. Nonetheless, the overall findings between the two specifications is largely the same; that is, the economic incentive for low-wage workers to invest in education and training is not nearly as strong as the incentive for high wage people given the constant rate (%) of return.

Although the overall trends in returns to literacy skills are somewhat similar across all three sociodemographic groups, there are two important differences to note. First, the increase in returns at higher wage quantiles is less pronounced for Indigenous men and women compared to immigrant and native-born non-Indigenous men and women. Second, while returns to literacy skills linearly increase for native-born non-Indigenous men, wage returns plateau and log wage returns decrease for immigrant men after the 75th percentile — although they remain higher at the 75th and 90th percentile compared to native-born non-Indigenous men.

The results change once the analysis includes all control variables, plus respondents' highest credential level. As shown in Figure 4 (Appendix 1), returns diminish at all percentiles, but especially for all women at the high end of the wage distribution and all men and women — other than native-born non-Indigenous women — at the low end of the wage distribution. Immigrant and native-born non-Indigenous men, as well as Indigenous men at the 90th percentile, are still estimated to have sizable returns to literacy skills once education is included in the model. In contrast, women tend to have slightly larger returns at the low end of the wage distribution — a result that follows the same trend as the baseline model.

Numeracy Skills

The quantile regression results for numeracy skills, as illustrated in Figures 5 and 6 (Appendix 1), are similar to returns to literacy skills across all model specifications. In the baseline model, women in all three sociodemographic groups have slightly higher returns to numeracy skills from the 5th to 50th quantile, especially when wages are log transformed, with the gender difference most pronounced for Indigenous peoples at the 25th quantile. After this point, returns to numeracy skills decrease or plateau at higher wage levels for women and are typically larger for men at the 90th and 95th percentile — although the point estimates are similar and the standard error is high, especially for Indigenous men and women, at the 95th percentile.

In Figure 6 (Appendix 1), the results for returns to numeracy skills in the full model are reduced once all control variables and highest credential level is included in the model. For women from all three sociodemographic groups, returns to numeracy skills are somewhat similar across the wage distribution in the full model with education level. At higher wage levels, returns increase for men from all three groups,

especially at the 90th and 95th quantile. Although the error bars are large, returns to numeracy skills in full model with education level included are low for Indigenous men at or below the 25th percentile, while returns decrease for Indigenous women at the 75th percentile and above. Immigrant men at the 25th percentile and below have no to low returns, while those at the 75th percentile and above have larger returns to numeracy skills compared to immigrant women, even when accounting for their education level.

PS-TRE Skills

Unlike the returns to literacy and numeracy skills, there is little to no gender difference in returns to PS-TRE skills across all quantiles. In the baseline model in Figure 7 (Appendix 1), returns typically increase for all three sociodemographic groups from the 5th to the 50th quantile. From the 50th to 75th quantile, returns continue to increase for immigrant and native-born non-Indigenous people, with higher point estimates for men. However, they increase to a smaller extent for Indigenous peoples and even decrease for Indigenous women. Returns to PS-TRE skills are particularly high at the 75th quantile for immigrant men and women, although they plateau or decrease after this point depending on the model specification.

Shown in Figure 8 (Appendix 1), once the results account for control variables and respondents' highest education level, the returns to PS-TRE skills diminish, especially at the lower end of the wage distribution. In this model, returns are still positive and significant for native-born, non-Indigenous men and women across the wage distribution, and higher for men at the 90th and 95th quantile. For Indigenous peoples, once education is included in the model, the standard error increases substantially and the coefficients become largely non-significant — although there are positive and significant returns for Indigenous men and women at the 50th quantile. For the immigrant men and women, those in the 50th quantile or higher have positive returns to PS-TRE skills even when accounting for education, although the error is high at the 90th and 95th quantile.

Conclusion

While prior PIAAC research typically draws attention to how assessed cognitive skill level varies in Canada in relation to age, employment background or other characteristics (e.g., Statistics Canada, 2013), our contribution examines how the skill-wage payoff differs by gender. We examine how returns differ on average and across the wage distribution for men and women in three sociodemographic groups (i.e., immigrants, Indigenous peoples, and native-born non-Indigenous people) in order to answer two primary research questions: 1) What are the wage returns to literacy, numeracy and problem solving in technology-rich environments in Canada and how do they differ for men and women in each of the three sociodemographic groups? 2) How do the returns to literacy, numeracy and problem solving in technology-rich environments differ across the wage distribution and how do they differ for men and women in each of the three sociodemographic groups?

The results show that, on average, returns to wages by assessed numeracy, literacy, and PS-TRE skill scores are similar for men and women in each of the three sociodemographic groups. The results also indicate that respondents' highest education level is clearly a confounding factor and, when included in the regression model, reduces the size of the estimated return to skills. Although smaller in magnitude in this model, positive and significant returns to all three skill domains remain for men and women in all three sociodemographic groups once a model accounts for education level. This finding dovetails with van der Velden and Bijlsma's (2016) study which shows that higher earnings among postsecondary graduates are only partly explained by their higher skill levels; rather, skill and education level have separate but connected associations with wages.

Returns in all three cognitive skill domains grow at higher wage levels, a finding that demonstrates there is a weaker relationship between assessed skills and wages for people at the lower end of the wage distribution. In contrast, literacy, numeracy and PS-TRE skills are rewarded to a greater extent among higher earning men and women from all three sociodemographic groups. Unlike the OLS models, the results also show that returns to literacy and numeracy skills differ by gender at certain points of the wage distribution. In particular, returns are typically higher for women at the 50th quantile and below, and higher for men at the 75th quantile and above. However, there is little to no gender difference in returns to PS-TRE skills across the distribution of earnings.

Although it will be necessary for future research to further explore why the assessed cognitive skill level of men and women at the lower end of the wage distribution has a weaker relationship with wages, our study highlights a key concern in regard to how skills are rewarded in the Canadian labour market and a potential limitation of labour market policy that attempts to alter the skill level of workers without addressing the extent to which these skills are even recognized. This finding likely connects to the extent to which low-wage occupations provide opportunities for skill utilization; for example, prior PIAAC research suggests workers in jobs with greater routinization earn less and have lower assessed skill levels (Marcolin, Miroudot & Squicciarini, 2016).

The results of this study also suggest several avenues for further research. Although the type of skills assessed by PIAAC are intended to be general, information-processing competencies, they may also measure occupation and industry-specific forms of human capital. As suggested by prior research (e.g., Sullivan, 2010), returns to different types of human capital vary considerably by occupation and may explain the small rate of return among low-wage workers. It will also be necessary for future research to directly assess inter-sociodemographic differences in Canada and how returns for men and women differ in regard to other background characteristics. Our research demonstrates that returns to skills are particularly low for Indigenous men compared to both immigrant and native-born non-Indigenous men.

In conclusion, the main findings of this study have the potential to impact the forms of government intervention necessary to alleviate economic and social inequality. We generate insight into how returns to

skills differ by gender — a critical component of equity — and highlight that returns differ only when considering differences across the wage distribution. One of the key results of this study is that it demonstrates returns to literacy, numeracy and PS-TRE skills are particularly low for men and women at the lower end of the wage distribution. While workforce activation policy often targets the skill level of the individual, this key finding highlights that cognitive skills have a weaker or stronger relationship with wages depending on where an individual is located in the earnings distribution. This suggests that policy measures that aim to increase the skill level of individuals in order to support their wage growth are likely to only be successful among individuals who already have access to higher wage employment.

References

Belman, D. & Heywood, J. S. (1991). Sheepskin effects in the returns to education: An examination of women and minorities. *The Review of Economics and Statistics, 73*(4), 720–724.

Bonfanti, S. & Xenogiani, T. (2014). Migrants' skills: Use, mismatch and labour market outcomes–A first exploration of the International Survey of Adult Skills (PIAAC). In *Matching Economic Migration with Labour Market Needs* (pp. 249–312). Paris: OECD Publishing.

Boudarbat, B., Lemieux, T. & Riddell, W. C. (2010). The evolution of the returns to human capital in Canada, 1980–2005. *Canadian Public Policy, 36*(1), 63–89.

Christl, M. & Köppl-Turyna, M. (2017). *Gender wage gap and the role of skills: Evidence from PIAAC dataset* (No. 63). Vienna: GLO Discussion Paper.

Ferrer, A., Green, D. A. & Riddell, W. C. (2006). The effect of literacy on immigrant earnings. *Journal of Human Resources, 41*(2), 380–410.

Ferrer, A. M. & Riddell, W. C. (2002). The role of credentials in the Canadian labour market. *Canadian Journal of Economics, 35*(4), 879–905.

Firpo, S., Fortin, N. M. & Lemieux, T. (2009). Unconditional quantile regressions. *Econometrica, 77*(3), 953–973.

Fortin, N. M. & Lemieux, T. (2015). Changes in wage inequality in Canada: An interprovincial perspective. *Canadian Journal of Economics, 48*(2), 682–713.

Fortin, N. M., Bell, B. & Böhm, M. (2017). Top earnings inequality and the gender pay gap: Canada, Sweden, and the United Kingdom. *Labour Economics, 47*, 107–123.

Green, D. A. & Sand, B. M. (2015). Has the Canadian labour market polarized? *Canadian Journal of Economics, 48*(2), 612–646.

Green, D. A. & Townsend, J. (2010). Understanding the wage patterns of Canadian less skilled workers: The role of implicit contracts. *Canadian Journal of Economics, 43*(1), 373–403.

Gustafsson, J. E. (2016). Lasting effects of quality of schooling: Evidence from PISA and PIAAC. *Intelligence, 57*, 66–72.

Hanushek, E. A., Schwerdt, G., Wiederhold, S. & Woessmann, L. (2015). Returns to skills around the world: Evidence from PIAAC. *European Economic Review*, *73*, 103–130.

Harmon, C., Oosterbeek, H. & Walker, I. (2003). The returns to education: Microeconomics. *Journal of Economic Surveys, 17*(2), 115–156.

Heisz, A., Notten, G. & Situ, J. (2015). The role of skills in understanding low income in Canada. In T. I. Garner & K. S. Short (Eds.), *Measurement of poverty, deprivation, and economic mobility* (pp. 153–184). New York: Emerald.

Hu, M., Daley, A. & Warman, C. (2019). Literacy, numeracy, technology skill, and labour market outcomes among Indigenous Peoples in Canada. *Canadian Public Policy, 45*(1), 48–73.

Hungerford, T. & Solon, G. (1987). Sheepskin effects in the returns to education. *The Review of Economics and Statistics, 69*(1), 175–177.

Hunter, A. A. & Leiper, J. M. (1993). On formal education, skills and earnings: The role of educational certificates in earnings determination. *Canadian Journal of Sociology, 18*(1), 21–42.

Juhn, C., Murphy, K. M. & Pierce, B. (1993). Wage inequality and the rise in returns to skill. *Journal of Political Economy, 101*(3), 410–442.

Liu, Y. & Grusky, D. B. (2013). The payoff to skill in the third industrial revolution. *The American Journal of Sociology, 118*(5), 1330–1374.

Marcolin, L., Miroudot, S. & Squicciarini, M. (2016). *The routine content of occupations: New cross-country measures based on PIAAC* (OECD Trade Policy Papers, No. 188). Paris: OECD Publishing. http://dx.doi.org/10.1787/5jm0mq86fljg-en

Migali, G. & Walker, I. (2017). Estimates of the causal effects of education on earnings over the life cycle with cohort effects and endogenous education. *CESifo Economic Studies, 64*(3), 516–544.

Mincer, J. (1974). *Schooling, experience, and earnings*. New York: Columbia University Press.

OECD. (2013a). *Technical report of the Survey of Adult Skills (PIAAC)*. Paris: OECD Publishing.

OECD. (2013b). *OECD skill outlook 2013: First results from the survey of adults*. Paris: OECD Publishing.

Park, J. H. (1996). Measuring education over time: A comparison of old and new measures of education from the Current Population Survey. *Economics Letters, 50*(3), 425–428.

Pena, A. A. (2016). PIAAC skills and economic inequality. *Journal of Research and Practice for Adult Literacy, Secondary, and Basic Education*, *5*(2), 17–34.

Rindermann, H. (2007). The g-factor of international cognitive ability comparisons: The homogeneity of results in PISA, TIMSS, PIRLS and IQ-tests across nations. *European Journal of Personality, 21*(5), 667–706.

Schultz, T. (1960). Capital formation by education. *The Journal of Political Economy, 68*(6), 571–583.

Smith, W. C. & Fernandez, F. (2017). Education, skills, and wage gaps in Canada and the United States. *International Migration, 55*(3), 57–73.

Statistics Canada. (2013). *Skills in Canada: First results from the programme for the international assessment of adult competencies* (PIAAC). Ottawa: Statistics Canada.

Sullivan, P. (2010). Empirical evidence on occupation and industry specific human capital. *Labour economics, 17*(3), 567–580.

Sweetman, A. (2002). Working smarter: Education and productivity. In A. Sharpe, F. St-Hilaire & K. Banting (Eds.), *The review of economic performance and social progress* (pp. 157–180). Montreal: The Institute for Research on Public Policy.

Truong, N. K. & Sweetman, A. (2018). Basic information and communication technology skills among Canadian immigrants and non-immigrants. *Canadian Public Policy, 44*(S1), S91–S112.

van der Velden, R. & Bijlsma, I. (2016). College wage premiums and skills: A cross-country analysis. *Oxford Review of Economic Policy, 32*(4), 497–513.

Wu, M. L. & Adams, R. J. (2002). Plausible values: Why they are important. Paper presented at the *International Objective Measurement Workshop*, New Orleans, LA.

Zhao, J., Ferguson, S. J., Dryburgh, H., Rodriguez, C. & Gibson, L. (2017). *Does education pay? A comparison of earnings by level of education in Canada and its provinces and territories* (Cat.no. 98-200-X20160024). Ottawa: Statistics Canada.

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