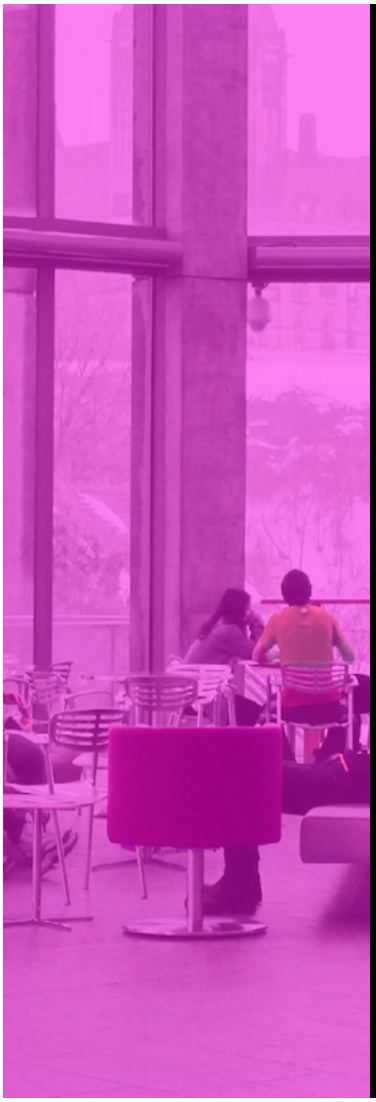
The Conference Board of Canada

In partnership with Future Skills Centre

Valuing Skills in Canada

A Statistical Approach

Impact paper | May 23, 2023



Future Skills Centre

The Future Skills Centre – Centre des Compétences futures (FSC-CCF) is a forward-thinking centre for research and collaboration dedicated to preparing Canadians for employment success. We believe Canadians should feel confident about the skills they have to succeed in a changing workforce. As a pan-Canadian community, we are collaborating to rigorously identify, test, measure, and share innovative approaches to assessing and developing the skills Canadians need to thrive in the days and years ahead.

The Future Skills Centre was founded by a consortium whose members are Toronto Metropolitan University, Blueprint, and The Conference Board of Canada.

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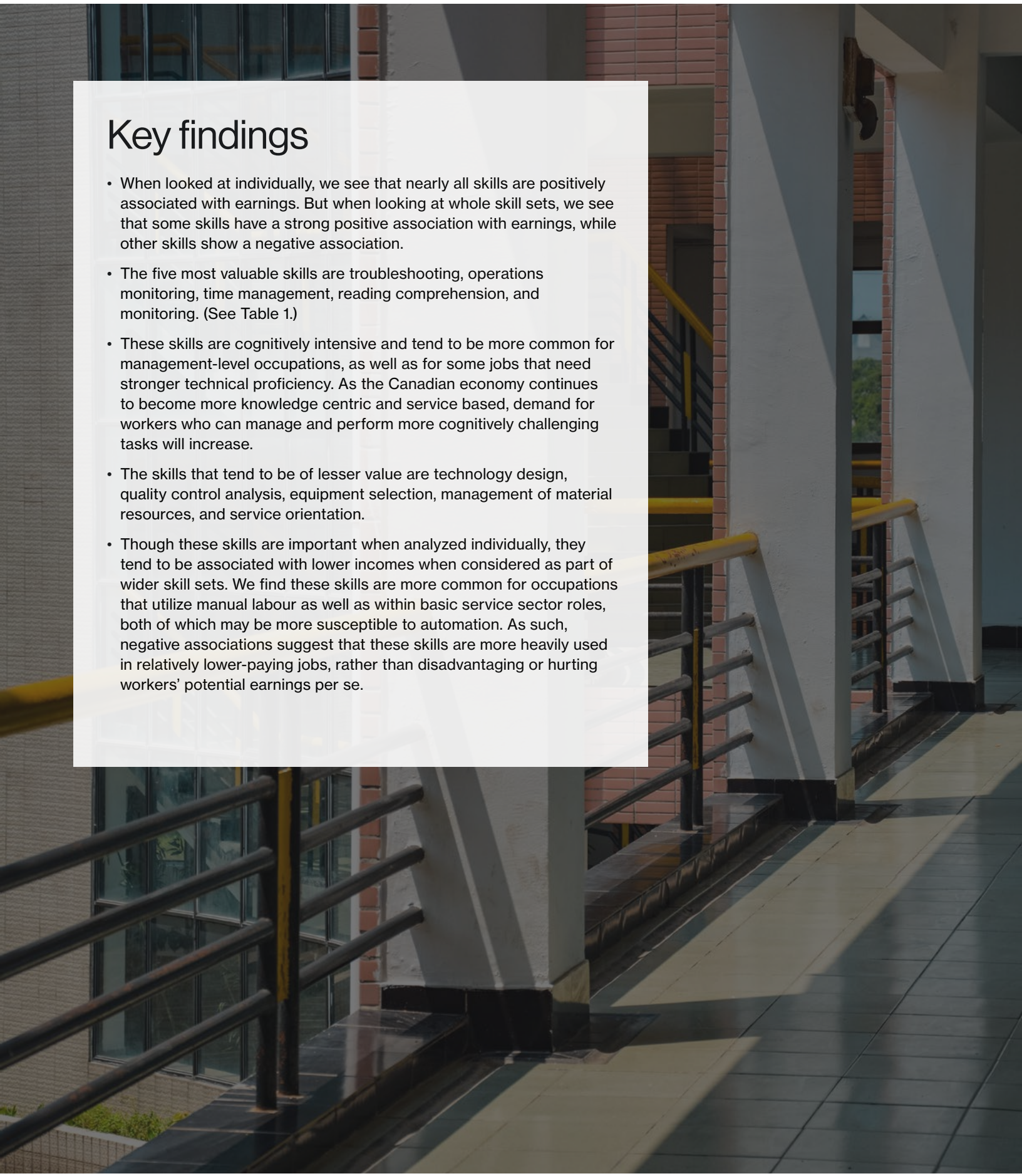


Key findings

- When looked at individually, we see that nearly all skills are positively associated with earnings. But when looking at whole skill sets, we see that some skills have a strong positive association with earnings, while other skills show a negative association.
- The five most valuable skills are troubleshooting, operations monitoring, time management, reading comprehension, and monitoring. (See Table 1.)
- These skills are cognitively intensive and tend to be more common for management-level occupations, as well as for some jobs that need stronger technical proficiency. As the Canadian economy continues to become more knowledge centric and service based, demand for workers who can manage and perform more cognitively challenging tasks will increase.
- The skills that tend to be of lesser value are technology design, quality control analysis, equipment selection, management of material resources, and service orientation.
- Though these skills are important when analyzed individually, they tend to be associated with lower incomes when considered as part of wider skill sets. We find these skills are more common for occupations that utilize manual labour as well as within basic service sector roles, both of which may be more susceptible to automation. As such, negative associations suggest that these skills are more heavily used in relatively lower-paying jobs, rather than disadvantaging or hurting workers' potential earnings per se.

Recommendations

- Screen and hire job candidates based on demonstrated skills rather than education. Employers should focus on what skills a job candidate possesses and place less emphasis on educational attainment measured by schooling years.
- Embed skill development directly into curriculum and classroom instruction. Teachers, school administrators, and educational policy decision-makers should incorporate skill development directly into curricula and educational achievement standards.
- Focus on teaching the most valuable skills. It is not enough to just assert that educators should teach skills; we must also choose which skills should be the focus of instruction. Here we can refer directly to our findings and recommend that the most valued skills should be directly inculcated and measured as part of standard educational instruction.
- There is a need for additional research on skills using more detailed data. We recommend further research using detailed microdata to estimate skill values more precisely. We also recommend that labour market researchers and analysts try to utilize actual skill measures when possible, either in conjunction with or in lieu of educational attainment.

Table 1
The top five most and least valued skills
(Regression coefficients, estimated elasticity)

Skill	Value
Troubleshooting	14
Operations monitoring	12
Time management	12
Reading comprehension	10
Monitoring	9
Technology design	–9%
Equipment selection	–10%
Quality control analysis	–10%
Management of material resources	–11%
Service orientation	–14%

Sources: O*NET; Statistics Canada; The Conference Board of Canada.

Introduction

A key ingredient for a successful and financially rewarding career is having useful and valuable skills that enable people to perform specific jobs. Accordingly, we expect workers with in-demand skills to earn higher wages and salaries, reflecting the need for those skills in the workplace. On the other hand, we also expect lower relative earnings for workers in those jobs that use lesser valued and less in-demand skills.[1]

Apart from affecting earnings, a varied and flexible skill set can also improve someone's hiring prospects and potential job opportunities. Evidence from recent online job postings has shown that "employers are suspending the use of degree completion as a proxy and instead now favor hiring on the basis of demonstrated skills and competencies. This shift to skills-based hiring will open opportunities to a large population of potential employees who in recent years have often been excluded from consideration because of degree inflation."[2] Degree inflation can be defined as "the practice of seeking a candidate with a four-year college degree for a position currently held by someone with a high school diploma or an associate's degree," and is costly for businesses as well as for prospective employees, especially those looking for "middle-skills jobs."[3]

Why are skills important for career success? Skills are "developed capacities that an individual must demonstrate to be effective in a job, role, function, task, or duty."[4] The acquisition and continual refinement of useful skills is an important determinant of labour market outcomes because skills—for individual workers, as well as the whole labour force—are a core component of human capital. The World Bank describes human capital as "the knowledge, *skills*, and health that people accumulate over their lives," and that "more human capital is associated with higher earnings."[5] So developing and strengthening skills feeds into more valuable human capital, which then parlays into higher earnings.

1 We define skill value based on its strength of statistical association to annual income. A strong positive association between a specific skill and relatively higher incomes is construed as being a higher valued skill. Conversely, a strong negative association between a certain skill and relatively lower incomes is regarded as being of lesser value. This interpretation will be echoed throughout the impact paper.

2 Fuller, Langer, and Sigelman, "Skill-Based Hiring Is on the Rise."

3 Fuller and Raman, "Dismissed by Degrees."

4 Employment and Social Development Canada, "Skills and Competencies Taxonomy."

5 Gatti and others, The Human Capital Index.

At the macroeconomic level, a skilled workforce with more human capital is one of the essential drivers of sustained national economic growth.[6] The World Bank notes that higher levels of human capital and skills can enable workers "to realize their potential as productive members of society" (i.e., productive contributions at the societal, macroeconomic level).[7] Fortunately, Canada's workforce is among the most highly educated in the world and continues to attract more human capital by way of targeted immigration policy.[8]

Canadian workers need information to help identity which skills they should develop to increase their chances for financially rewarding careers.[9] Most experts in education, economics, and human resources management agree that continuously refining—and flexibly applying—workplace skills is essential for career success in an increasingly dynamic, competitive, and turbulent labour market. So better understanding of the value associated with specific skills is important for Canadian workers, educators, career advisors, and policy-makers to ensure ongoing labour market vitality and broader macroeconomic strength. Ultimately, we want to identify which skills are associated with higher incomes, and which are of lesser value in terms of job earnings.

To estimate the relative value of skills, we use a popular model that measures wage premiums and discounts owing to different skills or other occupational characteristics. For our purposes, we define skills using the 35 skills described in the U.S. O*NET Content Model. (See Appendix A.) Using this approach we were able to identify the most and least valuable skills in terms of their association with job earnings.[10] Our analysis also shows that some skills—such as persuasion, operations analysis, and management of personnel resources—appear less important in terms of job earnings.[11] (See Chart 1.)

6 Jones, "The Facts of Economic Growth"; Hanushek and Woessmann, "Education, Knowledge Capital, and Economic Growth."

7 The World Bank, "The Human Capital Project."

8 Organisation for Economic Co-operation and Development, "Population With Tertiary Education"; and Kaushal and Lu, "Recent Immigration to Canada and the United States."

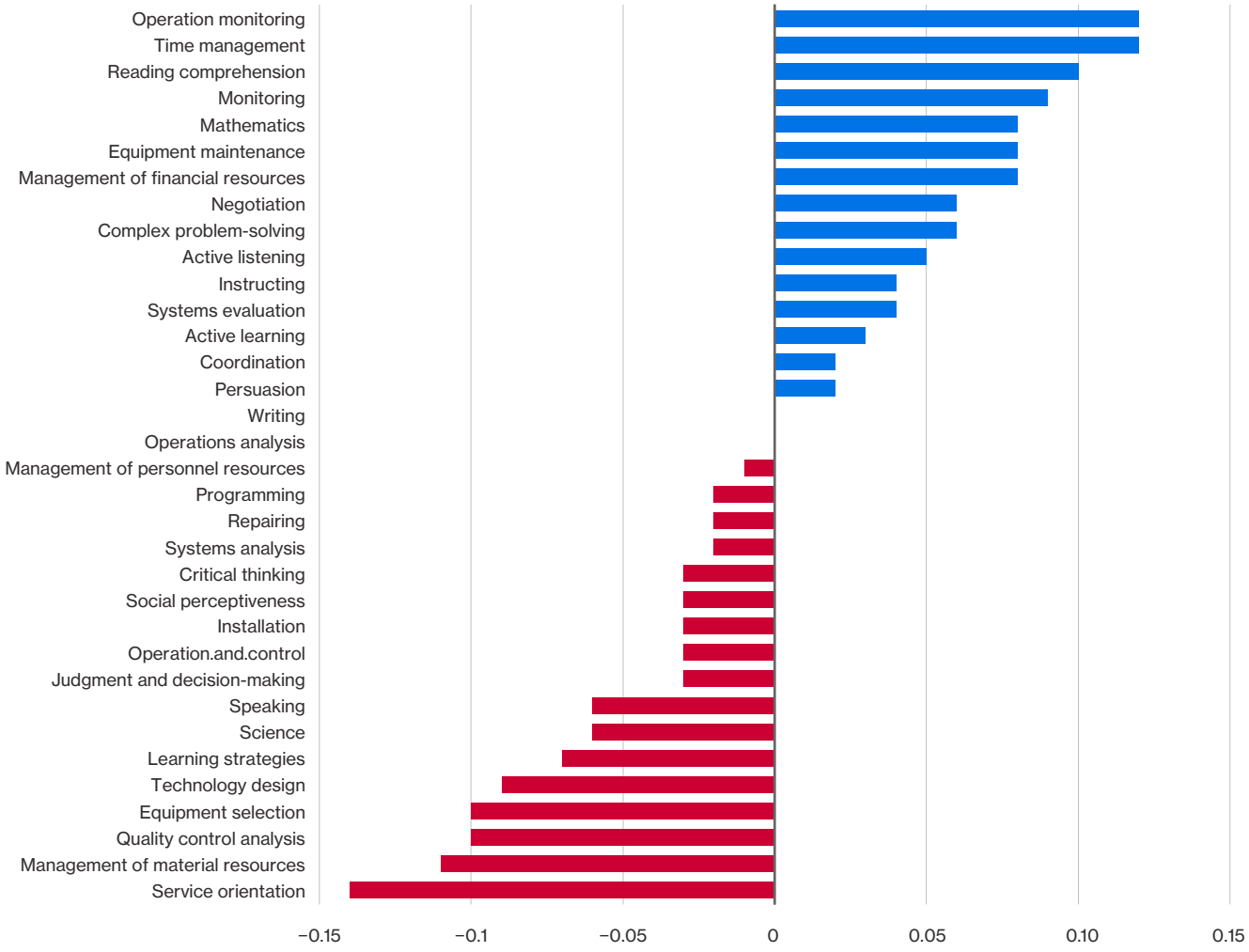
9 Labour Market Information Council, "LMI Most Wanted by Canadians." This article found that information about wages was the most important for several different categories of workers, though "the second most common labour market information need is to know the skill requirements for jobs."

10 The estimated regression coefficients measure the statistical association between a skill and income, holding the effects of other variables constant. When interpreting the results, it is also important to keep in mind that our model does not partial out (exclude) occupation-specific effects. These effects can be large, conditional on an identical set of skills. For instance, a banker and a math teacher both use math intensively but do not receive the same compensation. Because we only have access to skills that vary across occupations but not over time, we were not able to use panel data to account for occupational effects. It is worth noting that the estimated parameters are weighted by occupations instead of population, such that for a same skill level two occupations are weighted the same, even if one accounts for more employment across Canada's labour market.

11 Less important in terms of statistical as well as economic significance.

Chart 1

The relationship between specific skills and income varies widely, both positively and negatively
(regression coefficients, estimated elasticity)



Sources: O*NET; Statistics Canada; The Conference Board of Canada.

The most valuable skills

Troubleshooting

The most valued skill turns out to be troubleshooting, which is associated with a 14 per cent gain in earnings compared with the median income for all occupations. Based on the distribution of troubleshooting skills across the Canadian labour market, we find that higher-paying jobs often require relatively strong troubleshooting, and that sufficient strengthening of this skill can raise income by upwards of 14 per cent.[12]

Troubleshooting is defined as the ability to determine the "causes of operating errors and deciding what to do about it."[13] Some of the occupations that require very high troubleshooting skills include: (1) power system electricians, (2) mechanical engineers, (3) computer network technicians, (4) industrial electricians, and (5) elevator constructors and mechanics.

Being able to identify and solve problems is integral to any decision-making process and becomes more important in proportion to the consequences of any decision. The cross-functional application of troubleshooting means it is part of most occupational skill sets, but its relative importance compared with other skills rises along with the level of managerial or decision-making responsibility. More managerial and decision-making responsibility usually coincides with higher earnings, which is reflected in the value-added by superior troubleshooting skills. As such, troubleshooting is a key skill for managers and supervisors at all levels and across all industries. It also features prominently in technical roles, especially in engineering and mechanics-related jobs.

Operations monitoring

Operations monitoring is the second most valuable skill and sufficient strengthening of this skill is associated with a 12 per cent increase in income. The purpose of operations monitoring is to watch "gauges, dials, or other indicators to make sure a machine is working properly."[14] Based on this description, being highly skilled in operations monitoring implies familiarity and regular usage of various devices, tools, and instruments that require technological knowledge as well as hands-on experience. More detailed illustrations provided by O*NET emphasize the operations management aspect of this skill, especially making sure that automated production processes are being optimized.[15] So jobs that require relatively strong proficiency in operations monitoring have both a technological as well as a managerial component.

There is a preponderance of engineering, mechanics, inspectors, operators, and technician roles among the jobs for which operations monitoring is particularly important. Some examples include: (1) mechanical engineers, (2) power engineers and power systems operators, (3) machining tool operators, industrial instrument technicians and mechanics, and (4) aircraft mechanics and aircraft inspectors. The jobs for which operations monitoring is the absolute most important are air pilots, flight engineers, and flying instructors—where watching airplane "gauges, dials, and other instruments" to ensure that an aircraft is functioning correctly is of immeasurable importance.

12 The phraseology of "relatively strong" and "sufficient strengthening" is used as a qualitative description instead of the more quantitatively technical concept of standard deviation. Standard deviation is a measure of distributional spread and connotes relative positioning within a particular distribution for some variable—in this case, the distribution of specific skills. Throughout this impact paper, we use phrases like relatively strong and sufficient strengthening to denote a one standard deviation increase in that skill.

13 O*NET OnLine, "Browse by Cross-Functional Skills: Troubleshooting."

14 O*NET OnLine, "Browse by Cross-Functional Skills: Operations Monitoring."

15 To illustrate, O*NET describes operations monitoring as managing "feedback control in a processing facility to maintain production flow," or monitoring "machine functions on an automated production line." O*NET OnLine, "Browse by Cross-Functional Skills: Operations Monitoring."

It also makes sense that operations monitoring and troubleshooting are so close to each other in the rankings; these two skills are highly correlated, and both tend to be relatively strong within the wider suite of technically oriented managerial occupations. The same is true for monitoring, which is the fifth most valuable skill based on our estimates. Though monitoring focuses on how well people are performing rather than how machines and instruments are performing, it is a critical skill along with troubleshooting and operations monitoring for numerous technically oriented managerial roles.

Time management

Time management is the third most valuable skill. As proficiency becomes relatively strong in time management, we find that income can increase by up to 12 per cent compared with the median. According to O*NET, it simply means "managing one's own time and the time of others."[16] But being able to efficiently use a limited number of working hours to accomplish goals is an essential part of job performance, while misallocated time can translate into inferior workplace results. Time is a truly scarce resource, so it makes sense to pay a premium for this skill.

More generally, efficient time management and task prioritization benefits workers and organizations via greater productivity, accomplishing more tasks, and reducing workplace stress.[17] Time management can be optimized if workers learn to prioritize and delegate tasks, and avoid procrastination, wasting time, and rework.[18] So we can imagine how important strong time management skills are for all managers. Indeed, some higher-paying jobs that require well-developed time management skills include: (1) senior managers in health, education, social and community services, and membership organizations, (2) managers in healthcare, (3) architecture and science managers, and (4) government managers in economic analysis, policy development, and program administration.

Reading comprehension

Reading comprehension is the fourth most valued skill; sufficient strengthening of this skill is associated with a 10 per cent increase in annual income, compared with the median across all occupations. The importance that strong reading comprehension has on career choices, job opportunities, and lifelong earnings cannot be overstated. Extensive research has shown that literacy level influences numerous micro and macro developmental outcomes, and widespread literacy is one of the key components underlying modern economic development and broad human capital accumulation.[19]

Though basic reading abilities are required for just about every job, higher-paying knowledge workers or managerial jobs require sophisticated comprehension skills—the ability to understand, process, summarize, and extract insights from what is being read. High-level reading comprehension features in numerous liberal arts professions like: (1) university professors and lecturers, (2) senior managers in health, education, social and community services, and membership organizations, (3) economists and economic policy researchers and analysts, and (4) school principals and administrators of elementary and secondary education.

Strong reading comprehension helps workers to be more productive and efficient. It can also help workers learn about and utilize new technologies or tactics, and it can shorten the amount of time it takes to digest and exploit new information. Another important characteristic of high-level reading comprehension is that it cannot be easily replaced by computers and artificial intelligence, making jobs that utilize advanced reading comprehension hard to automate. That implies that developing high-level reading comprehension skills can potentially shield some workers from future automation risks.

16 O*NET OnLine, "Browse by Cross-Functional Skills: Time Management."

17 Price, Carney, and Clews, Time Management.

18 Farnsworth and others, Managing Time in the Workplace.

19 Coulombe, Tremblay, and Marchand, "International Adult Literacy Survey Literacy Scores, Human Capital and Growth Across Fourteen OECD Countries"; and Statistics Canada, "The Contribution of Literacy to Economic Growth and Individuals' Earnings."

Monitoring

Monitoring is the fifth most valuable skill and is associated with a 9 per cent increase in income, compared with the median, as proficiency strengthens. Unlike operations monitoring with its focus on observing how machines are performing, monitoring focuses on observing how people are doing on the job. More precisely, this skill is defined as "monitoring/assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action."[20]

Given the focus on observing how others are doing in the workplace, we would expect that this skill is integral for many managerial or supervisory positions, which helps to explain its relatively high value. Monitoring is a very important part of any large organization's performance management system, and organizational decision-makers must constantly be monitoring and evaluating employee performance. And based on the results from workplace monitoring, decision-makers can ensure that goals are being attained, that employees are being productive, and identify where remedial actions may be needed.

Looking at some of the occupations that require strong monitoring skills, we find an array of managerial roles across numerous industries. In addition, monitoring tends to be especially important in technically oriented occupations. In fact, of the 30 occupations with the highest monitoring skills, 20 of them are managerial or supervisory roles, including coaches and school principals. Some of the best-paying jobs that feature strong monitoring skills include: (1) fire chiefs and senior firefighting officers, (2) banking, credit, and other investment managers, (3) retail and wholesale trade managers, and (4) architecture and science managers. Many of the higher-paying jobs that are characterized by strong monitoring skills are technically oriented, such as: (1) industrial and manufacturing engineers, (2) airline pilots, flight engineers, and flying instructors, and (3) construction managers. To the extent that monitoring skills are important for service sector jobs, it is also mostly at the managerial level for positions like banking, credit, and investment managers, and corporate sales managers.

The least valuable skills

When analyzing the least valued skills, it's important to carefully interpret negative associations. Intuitively, acquiring more of any skill is valuable if we consider each skill in isolation. Our preliminary analysis found that almost all skills are in fact positively associated with income on an individual, skill-by-skill basis. But when the whole skill set is assessed collectively, some skills evidence a negative relationship once all cross-skill effects are incorporated.

Some lower-paying jobs are characterized by the intensive use of a limited number of lesser valued skills. This explains the negative impact of these skills on earnings, compared with other jobs for which these skills are less predominate and used in conjunction with more valuable skills. Without trying to attribute causation, a likely explanation for any negative association is that specializing in certain low

20 O*NET OnLine, "Browse by Basic Skills: Monitoring."

value skills may be detrimental to income, compared with other occupations that are more reliant on a greater number of higher valued skills.

To illustrate, consider a worker with service orientation skills that are twice as strong compared with the average level for this skill across all occupations. Despite being excellent at service orientation, this person could wind up spending their career in a series of relatively low-paying service sector jobs, in which they excel in providing stellar service to their clients but never really get beyond entry-level positions. Even in the client relations field, promising workers need to complement their service orientation skills with troubleshooting or management of human resources skills before moving into higher-paying roles with more responsibility. That means too much honing of certain skills can ultimately detract from incomes if those skills are disproportionately utilized in lower-paying occupations.

Service orientation

We use the example of service orientation because it turns out to be the least valued skill; relatively strong proficiency in service orientation is actually associated with a 14 per cent reduction in annual income.[21] Several of the low-paying jobs that require well-honed service orientation skills include: (1) travel counsellors, (2) retail salespersons, (3) nurse aides, orderlies, and patient service associates, (4) social and community service workers, and (5) coaches. There are some exceptions like corporate sales managers and banking, credit, and other investment managers who require relatively strong service orientation and command high incomes as well. But apart from a few exceptions, most of the jobs that require strong service orientation tend to pay below the median income.

Management of material resources

Management of material resources is the second least valuable skill; as proficiency becomes relatively strong, the associated decline in income is about 11 per cent compared with the median. A possible explanation is that this skill tends to be more important for overseeing manual production processes, which predominate in lower-paying labour-intensive jobs. And though management of material resources is a more specialized and refined skill than brute manual labour, it may be especially important in industries that emphasize manual labour like residential landscaping or home-building and renovation. Another possibility is that management of material resources is a skill that can be partially automated or augmented with modern management control systems, which make workers more productive but also more individually interchangeable.

Some examples of occupations that need strong material resources management skills include: (1) home-building and renovation managers, (2) accommodation service managers, (3) managers in horticulture, (4) restaurant and food service managers, and (5) chefs. However, due to the managerial aspect of this skill we also find some high-paying jobs, such as (1) senior managers in health, education, social and community services, and membership organizations, (2) computer and information systems managers, and (3) school principals and administrators of elementary and secondary education. All of these jobs need strong management of material resources skills as well.

21 Dickerson and Green used a variable called “client communication” to estimate their hedonic wage equation, a construct that resembles “service orientation.” Their analysis similarly found a negative association between client communication and wages. See Dickerson and Green, “The Growth and Valuation of Computing and Other Generic Skills” for more details. The precise statistical interpretation is as follows: The average skill set, with average service orientation, corresponds to the average annual income. Then, for every standard deviation increase in skill orientation, annual income declines by 14 per cent—all relative to averages for income and skill set composition. The interpretation is “ceteris paribus,” so strengthening service orientation alone without concurrent changes in other skills.

Equipment selection and quality control analysis

Equipment selection and quality control analysis are the third and fourth least valuable skills, though the estimates are very close; as proficiency becomes relatively strong in either of these, the associated decline in income is about 10 per cent compared with the median. Equipment selection can be defined as the ability to choose "the kind of tools and equipment needed to do a job"[22] while quality control analysis means "conducting tests and inspections of products, services, or processes to evaluate quality or performance."[23] We can rationalize the negative association we find for both equipment selection and quality control analysis the same way as for management of material resources—namely that these skills are used more heavily in relatively lower-paying jobs that feature labour-intensive or manual production processes.

These two skills may also be relatively susceptible to automation with the help of increasingly sophisticated information systems and data analytics. In fact, both equipment selection and quality control analysis are key skills for the group of occupations that were labelled as "Builders" in a previous Conference Board of Canada issue briefing, which was the group most susceptible to automation risk.[24] Another group of jobs facing serious automation risk are "Doers," for whom equipment selection and quality control analysis are also relatively important skills.

As expected, we find a slew of manual and physically dexterous jobs requiring relatively strong equipment selection skills. Some examples include: (1) appliance servicers and repairers, (2) machining tool operators, (3) film and video camera operators, (4) logging and forestry labourers, and (5) other small engine and small equipment repairers—all of which pay below the median annual income. Similarly, we can identify numerous physically dexterous jobs that must be highly skilled in quality control analysis. Some examples include: (1) machining tool operators, (2) appliance servicers and repairers, and (3) electrical mechanics.

But as with management of material resources, we find that equipment selection is also important for some higher-paying jobs like: (1) industrial electricians, (2) construction millwrights and industrial mechanics, and (3) elevator constructors and mechanics—which are all very specialized technical trades. And there are counter examples of high-paying occupations that require strong quality control skills too, especially engineering jobs like: (1) chemical engineers, (2) mining engineers, (3) geological engineers, and (4) metallurgical and materials engineers. Some other technical roles using machinery and mechanics, such as aircraft mechanics and aircraft inspectors or heavy-duty equipment mechanics, require top-notch quality control skills but tend to pay more than the median income.

22 O*NET OnLine, "Browse by Cross-Functional Skills: Equipment Selection."

23 O*NET OnLine, "Browse by Cross-Functional Skills: Quality Control Analysis."

24 In that issue briefing, the two occupational groups—Builders and Doers—accounted for over 75 per cent of the jobs that were at higher automation risk, as well as having less occupational mobility. For a description of different occupational clusters, see Gabler, "Beyond Blue and White Collar." For more details about which jobs are at greatest risk from automation, see Gretch, *Responding to Automation*.

Technology design

Technology design is the fifth least valuable skill; increasing relative proficiency in this skill is associated with a decline in annual income of 9 per cent. Technology design is defined as the ability to develop and adapt "equipment and technology to serve user needs."[25] In addition to creating or inventing new tools or instruments, the definition also encompasses redesigning or incrementally improving technological devices.

Admittedly, the negative association between technology design and income is hard to rationalize given how important science, technology, engineering, and innovation are for Canada's macroeconomic and labour market prospects. And as we would expect, most of the occupations requiring top-notch technology design skills tend to pay above the median income. When analyzed on its own, the bivariate relationship between technology design and income is in fact positive. However, it is likely that within a multivariate framework any positive association between technology design and income is ultimately being reflected via its correlation with other closely related explanatory variables like troubleshooting, operations monitoring, and equipment maintenance, which all exhibit positive relationships with income.

Conclusion

We can draw some conclusions about the association between skills and job earnings in the Canadian labour market. Foremost, we can confirm that numerous skills are associated with earnings, though the magnitude and significance vary depending on the individual skill. When looked at individually, we see that nearly all skills are positively associated with earnings. But when looking at whole skill sets, we see that some skills have a strong positive association with earnings, while other skills show a negative association. We find that as the importance of certain skills like troubleshooting and service orientation increase, income can income can rise, or fall, by upwards of 14 per cent. So, developing the more valuable skills can potentially lead to better-paying jobs and more lucrative careers. It is also useful to know that too much honing certain skills that potentially pigeonhole workers into lower-paying sectors or occupations, all else being equal, may be associated with lower income.

Most of the higher valued skills are managerially or technically oriented, such as time management, troubleshooting, and operations monitoring. This makes sense as the Canadian economy continues to become more knowledge centric and service based, thereby increasing the demand for workers who can perform more cognitively challenging tasks.[26] To the extent that certain skills are more important or common for managerial or supervisory jobs that are higher paying, it's sensible that those skills would be are (commensurately/correspondingly) more valuable. These types of cognitively intensive and managerially oriented skills may also be harder to fully automate, thereby insulating occupations that are heavily reliant on these skills from potential downward pressure on incomes due to technological innovations. Skills like troubleshooting and efficient time management are not (yet) easily automated.

On the other hand, we find that relatively lower valued skills are more oriented toward the accomplishment of physical tasks. We found that service orientation—though not necessarily physical in nature—is the least valued skill, likely because it is used so heavily in many lower-paying entry-level service sector jobs. We also rationalize that certain skills tend to be more important for industries that emphasize manual labour, even if these skills are more cognitive than physical. Another possibility is that some skills can be partially automated or augmented with information systems that make workers more productive, but also more replaceable. Ultimately, the negative associations suggest that these skills are more heavily used in relatively lower-paying jobs, rather than disadvantaging or hurting workers' potential earnings per se. Some of the negative associations could also be due to the correlations between skills; the underlying positive relationships are instead being reflected in the positive associations exhibited by other skills.

25 O*NET OnLine, "Browse by Cross-Functional Skills: Technology Design."

26 Hanushek and Woessmann, "The Role of Cognitive Skills in Economic Development."

Recommendations

Screen and hire job candidates based on demonstrated skills

Employers should focus on what skills a job candidate possesses and place less emphasis on educational attainment measured by schooling years.[27] Screening job candidates directly for demonstrated competencies like troubleshooting or reading comprehension is more likely to lead to successful hiring than recruiting based on educational attainment. Not all college or university programs confer the same skill sets or knowledge base. The point is even more applicable for workers further along in their careers, whose work experience—and the skills repository built up throughout their careers—is more indicative of employee potential than a general measure of educational attainment.

Embed skill development directly into curriculum and classroom instruction

Teachers, school administrators, and education policy decision-makers should incorporate skill development directly into curricula and educational achievement standards. Of course, developing knowledge of certain subjects, like English or math, coincides with developing literary and numeracy skills. But students are often evaluated on their ability to memorize facts—on timed tests or exams—rather than on an ability to usefully apply skills. From an employer's perspective, knowing that a job candidate completed a philosophy degree is less important than knowing how persuasive they are, if they are astute critical thinkers, and if that persuasiveness and critical thinking confer strong negotiation skills. Educators should set goals that focus on what skills are being developed, alongside the content of whatever subjects are being taught.[28] Educators could also try to devise standardized tests that measure skills like troubleshooting and persuasion based on reliable psychometric evaluation tools.

Focus on teaching the most valuable skills

It is not enough to just assert that educators should teach skills; they also need to choose which skills should be the focus of instruction. Here we can refer directly to our findings and recommend that the most valued skills should be directly taught and measured as part of standard educational instruction. That means that intentional development of troubleshooting, reading comprehension, time management, active learning, and systems evaluation skills should be a basic feature of every educational experience. Educators and curriculum design experts—both in secondary and post-secondary institutions—should develop classroom content specifically meant to hone these higher valued skills.

This recommendation raises a few important questions. Foremost, how can these more important skills be purposefully taught? How can skills like time management, reading comprehension, and troubleshooting be developed *while* students are learning about subjects like biology, history, social studies, or high school mathematics? And then, how will skill development be measured or graded? Educators can readily teach and evaluate some skills like reading comprehension and mathematics, but less tangible skills may prove harder to purposefully develop.

Need for additional research on skills using more detailed data

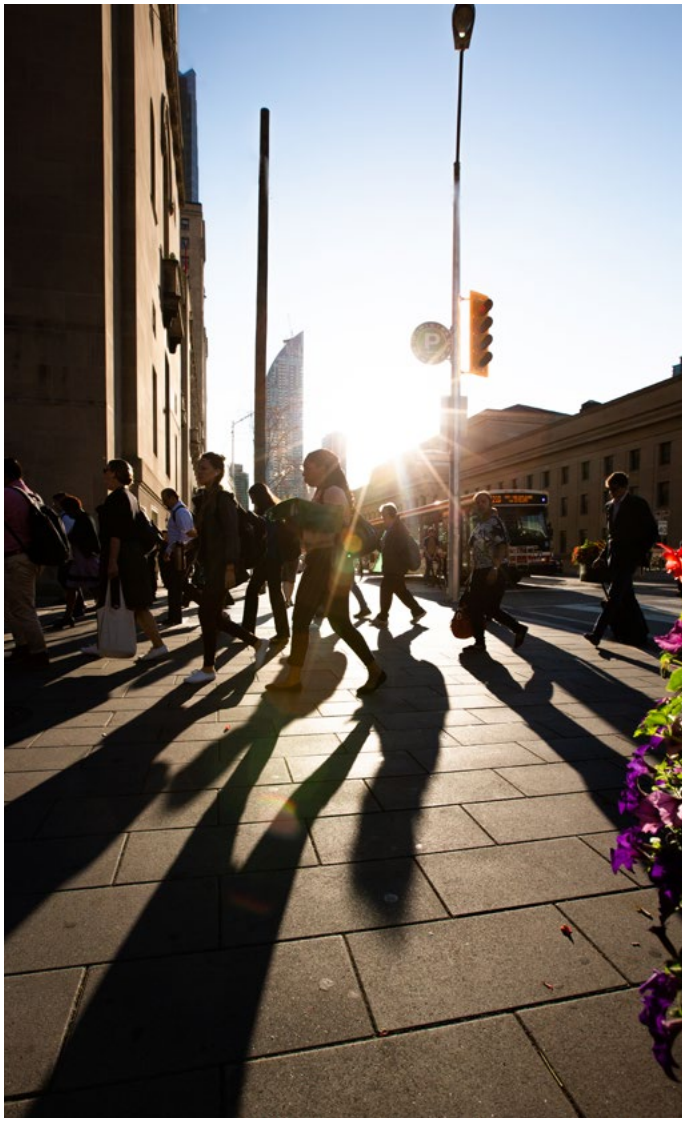
Though we have demonstrated the differential value of various skills, more precise estimates can be obtained using more granular microdata. Using microdata from the Canadian census would allow for weighting by aggregate employment for each occupation, as well as the inclusion of more control variables like geography and age. Analyzing microdata may also help to account for important effects attributable to certain industries or types of occupations and to separate them out from the true underlying relationship between skills and incomes.

27 This suggestion is less applicable to professions and jobs that require extensive domain knowledge, such as lawyers and chartered accountants, where focusing purely on skills is not feasible.

28 A similar recommendation that educators incorporate teaching of "human skills" within standard education curricula was made by Stirrett, "It's Human Skills—Not Technical Skills—That We Need the Most in Today's Work Force."

On a related note, we also recommend that labour market researchers and analysts try to utilize actual skill measures, either in conjunction with educational attainment. As noted earlier, years of schooling cannot attest to the composition or strength of a prospective employee's actual skill set. Microdata can link individual skill sets with exact educational achievements, which can help clarify exactly what skills are being developed in tandem with instruction in specific knowledge areas or disciplines.

Lastly, we estimated a model based on the general assertion that skills and income are related, without theorizing too much about how or why certain skills are more or less important drivers of income. Our main aim was to show that skills are related to income, but without delving deeply into theoretical rationales or prospective causality. As such, this analysis serves as a conversation starter and call for further research into the causal impacts of different skill sets on income.



Appendix A

Methodology and statistical results

For this impact paper, we want to pose and answer a simple question: What is the relationship between skills and income?

We start by compiling data on annual income and skills for each of the 500 occupations listed at the four-digit National Occupation Classification system (NOC) level. Our annual income data comes from the 2016 Canadian census. The skill intensity is derived from the U.S. O*NET classification system which is reconciled to match Canadian occupations. For ease of interpretation all skill variables were standardized to a mean of zero and unit variance, such that results are expressed in standard deviations from the mean. The data is configured this way so the results can be interpreted as the *percentage change in annual income associated with one standard-deviation change in the importance of a specific skill*.[1] All this data was gathered directly from The Conference Board of Canada's OpportuNext database.[2]

It's important to note that different skill sets parlay into different occupations. Conversely, working in different occupations will lead employees to develop and refine different types of skills, or combinations of skills. In this regard, the relationship between skill sets and occupations is a two-way street; honing a particular set of skills prepares workers for certain occupations, while working in those occupations leads to further development or refinement of an employee's skill set. Moreover, there are several other factors unrelated to skill sets that characterize different occupations and hence influence incomes. These factors may include credentialing and licensing requirements, physical safety risks, and broader industry prospects.

Taken together, we recognize that occupational incomes are also influenced by industry-specific or occupation-specific fixed effects. These effects can be important in terms of explaining differential incomes across occupations. However, there is a conceptual circularity when it comes to skill development, occupational choice, and income. Having particular skills is a prerequisite to work in certain occupations; working in an occupation further develops that initial skill set. So, skills influence occupational choices, and occupations in turn influence the further refinement of an employee's skill set. These mutually reinforcing effects make it difficult to disentangle and isolate the separate drivers of income. As such, ascertaining whether occupation-fixed effects, or skill sets, are the latent variable determining income differences resembles the proverbial chicken-or-egg paradox.

To estimate average wage premia or discounts across the labour market owing to different occupational skills, we use a methodology inspired by Dickerson and Green, who estimated a hedonic wage equation using indices for *generic* skills.[3] Hedonic wage equations measure the premia or discounts attributable to any type of job characteristic. A classic version of this model that regresses wages on education level is known as the Mincer equation. Our analysis resembles the Mincer model, but in lieu of education we use job skills importance. A more recent article by Deming also includes a hedonic wage equation that measures the relationship between earnings and *social* skills.[4]

1 Within an occupation's otherwise unchanged skill set. The correct interpretation of that relationship depends on how the dependent and independent variables are both measured. For this analysis, all the results have the following interpretation: every one standard deviation change in importance for a particular skill is associated with an "X" per cent change in annual income, all else being equal.

2 The Conference Board of Canada, "OpportuNext."

3 Dickerson and Green, "The Growth and Valuation of Computing and Other Generic Skills." A common approach for assessing how job characteristics relate to earnings is to estimate a hedonic wage equation. Hedonic wage equations can be used to estimate wage premiums and discounts that accrue to any measurable job attributes. For example, it is possible to estimate wage premiums that compensate for physically risky jobs, or premiums that accrue to investments in education. This latter example is called the Mincer equation, a foundational model in applied labour economics that estimates the wage premia to sequentially higher levels of schooling. See Mincer, "Education, Experience and the Distribution of Earnings and Employment." Different versions of the Mincer model have been "widely used as a vehicle for estimating 'returns' to schooling quality, for measuring the impact of work experience on male–female wage gaps, and as a basis for economic studies of returns to education in developing countries." See Heckman, Lochner, and Todd, "Earnings Functions, Rates of Return and Treatment Effects," 311.

4 Deming, "The Growing Importance of Social Skills in the Labor Market"; and Deming, "Automation and the Growing Importance of Social Skills in the Labor Market."

We first estimate simple linear regressions for each individual skill to assess the marginal impact, or how each one relates to income when looked at independently. The purpose is to show that most skills have a positive statistical relationship with earnings when looked at individually. Indeed, the estimates confirm that most skills are positively related to earnings when considered individually. However, these regression parameters mis-estimate the true relationships between each individual skill and earnings—partly due to the omission of other important variables that help to explain how skill sets affect earnings. Though we don't use or rely on these simple regression estimates to make inferences about valuations, they confirm that most individual skills are inherently valuable.

We then estimate several multivariate regression models using all 35 O*NET skills as explanatory variables,[5] as well as several controls for gender, minority status, and completion of high school education. The dependent variable is annual income. All the results discussed in the main body of this impact paper are based on Model 4, which includes all the control variables and has the highest adjusted R-squared. We judged that Model 4 provides the most explanatory power, both economically and statistically.

A drawback of analyzing all 35 skills jointly in one regression model is that the estimated coefficients cannot be interpreted independently from the other coefficients. In addition, the strong correlations among certain skill intensities imply that some parameters will lose some statistical or economic importance. However, the advantage of using a multivariate analysis is the ability to compare different skills within a single, stand-alone statistical framework. A general form of the model on which our results are based is provided in Equation 1. The resulting parameter estimates provide a measure of the differential premia or discounts associated with each skill, within a broader skill set.

Annual income data is logged in the regression, so the model is log-linear with explanatory variables standardized to have zero mean and unit variance. Specifying a hedonic wage equation in such fashion offers a convenient interpretation for the results—the parameter estimate measures the percentage change in annual income associated with a one standard deviation increment in skill importance.[6]

The full results from the multivariate analysis are provided in Table 1. A detailed explanation and interpretation of these results was covered in the main body of this impact paper. We can also note that the goodness of fit, or the adjusted R-squared, indicates that 60 per cent to 70 per cent of the variation in annual income can be explained by the collective suite of 35 skills.

Equation 1

An equation for measuring the relationship between skills and income

$$\log(y_i) = \beta_0 + \sum_{i=1}^{35}(\beta_i \times x_i) + \sum_{j=0}^{3}(\theta_j \times z_j) + \varepsilon_i \; ; \; \forall x, z \in X, Z$$

Where x_i are the skills (1–35), and z_j are controls. This equation can also be written in matrix notation as:

$$\log(y_i) = \boldsymbol{X}'\beta + \boldsymbol{Z}'\theta + \varepsilon_i$$

5 According to O*NET, its "Content Model is the conceptual foundation of O*NET. The Content Model provides a framework that identifies the most important types of information about work and integrates them into a theoretically and empirically sound system." See O*NET OnLine, "The O*NET Content Model" for more details on each component of the model.

6 A similar log-linear specification with standardized regressors was used in Dickerson and Green, "The Growth and Valuation of Computing and Other Generic Skills."

Appendix A Table 1

Statistical results for models 1–4

	Model 1	Model 2	Model 3	Model 4
Intercept	10.82***	10.82***	10.82***	10.82***
	(0.01)	(0.01)	(0.01)	(0.01)
Reading comprehension	0.20**	0.13*	0.1	0.1
	(0.06)	(0.06)	(0.06)	(0.06)
Active listening	0.07	0.03	0.05	0.05
	(0.06)	(0.05)	(0.05)	(0.05)
Writing	–0.02	–0.06	0	0
	(0.06)	(0.05)	(0.05)	(0.05)
Speaking	–0.09	–0.05	–0.06	–0.06
	(0.07)	(0.06)	(0.06)	(0.06)
Mathematics	0.09**	0.10***	0.08**	0.08**
	(0.03)	(0.03)	(0.03)	(0.03)
Science	–0.04	–0.07*	–0.06*	–0.06*
	(0.03)	(0.03)	(0.03)	(0.03)
Critical thinking	–0.01	–0.01	–0.03	–0.03
	(0.06)	(0.05)	(0.05)	(0.05)
Active learning	0.11	0.03	0.03	0.03
	(0.06)	(0.05)	(0.05)	(0.05)
Learning strategies	–0.12*	–0.11*	–0.07	–0.07
	(0.05)	(0.05)	(0.04)	(0.05)
Monitoring	0.04	0.05	0.09*	0.09*
	(0.04)	(0.04)	(0.04)	(0.04)
Social perceptiveness	–0.03	–0.03	–0.03	–0.03
	(0.05)	(0.04)	(0.04)	(0.04)
Coordination	0.04	0.07*	0.02	0.02
	(0.04)	(0.03)	(0.03)	(0.03)
Persuasion	–0.01	0.03	0.02	0.02
	(0.06)	(0.05)	(0.05)	(0.05)
Negotiation	0.06	0.10*	0.06	0.06
	(0.05)	(0.05)	(0.05)	(0.05)
Instructing	0.06	0.04	0.04	0.04
	(0.05)	(0.05)	(0.04)	(0.04)
Service orientation	–0.15***	–0.22***	–0.14***	–0.14***
	(0.04)	(0.04)	(0.03)	(0.03)
Complex problem–solving	0.07	0.11*	0.06	0.06
	(0.06)	(0.05)	(0.05)	(0.05)
Operations analysis	0.03	0.01	0	0
	(0.03)	(0.03)	(0.03)	(0.03)
Technology design	–0.05	–0.08**	–0.09***	–0.09***
	(0.03)	(0.03)	(0.03)	(0.03)

(continued ...)

Appendix A Table 1 (cont'd)

Statistical results for models 1–4

	Model 1	Model 2	Model 3	Model 4
Equipment selection	–0.09	–0.11*	–0.10*	–0.10*
	(0.05)	(0.04)	(0.04)	(0.04)
Installation	0.01	–0.02	–0.03	–0.03
	(0.03)	(0.02)	(0.02)	(0.02)
Programming	–0.03	–0.02	–0.02	–0.02
	(0.03)	(0.02)	(0.02)	(0.02)
Operation monitoring	0.04	0.09	0.12**	0.12**
	(0.05)	(0.05)	(0.05)	(0.05)
Operation and control	0.05	0.04	–0.03	–0.03
	(0.05)	(0.04)	(0.04)	(0.04)
Equipment maintenance	–0.04	0.03	0.08	0.08
	(0.1)	(0.09)	(0.09)	(0.09)
Troubleshooting	0.21**	0.19***	0.14*	0.14*
	(0.06)	(0.06)	(0.05)	(0.05)
Repairing	0.1	0.06	–0.02	–0.02
	(0.1)	(0.09)	(0.08)	(0.08)
Quality control analysis	–0.11*	–0.11**	–0.10**	–0.10**
	(0.04)	(0.04)	(0.04)	(0.04)
Judgment and decision–making	–0.01	–0.04	–0.03	–0.03
	(0.06)	(0.06)	(0.05)	(0.05)
Systems analysis	–0.01	–0.03	–0.02	–0.02
	(0.06)	(0.06)	(0.05)	(0.05)
Systems evaluation	0.1	0.09	0.04	0.04
	(0.07)	(0.06)	(0.06)	(0.06)
Time management	0.13**	0.12**	0.12**	0.12**
	(0.05)	(0.05)	(0.04)	(0.04)
Management of financial resources	0.01	0.05	0.08	0.08
	(0.06)	(0.05)	(0.05)	(0.05)
Management of material resources	–0.11*	–0.11*	–0.11*	–0.11*
	(0.05)	(0.05)	(0.05)	(0.05)
Management of personnel resources	0	0.01	–0.01	–0.01
	(0.05)	(0.05)	(0.05)	(0.05)
Less than high school		–0.27***	–0.29***	–0.29***
		(0.03)	(0.03)	(0.03)
Female			–0.18***	–0.18***
			(0.02)	(0.02)
Minority employment				0
				(0.02)
Adjusted R–squared	0.61	0.67	0.71	0.71

Note: All continuous predictors are mean-centred and scaled by one standard deviation, standard errors in parentheses. ***p < 0.001; **p < 0.01; *p < 0.05.
Sources: O*NET OnLine; Statistics Canada; Conference Board of Canada.

Appendix B

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