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by Hassan Faryaar

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Research article

Workforce aging and labour productivity

By Hassan Faryaar

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Abstract

Background: Canada's population, and consequently its workforce, is aging. While older workers bring valuable experience to firms, they may be less familiar with new technologies and more likely to face chronic health conditions, which can pose challenges for employers. This paper examines the impacts of aging on labour productivity using firm-level measures of workforce aging constructed by Statistics Canada.

Data and methods: This study uses measures of worker age and firm characteristics from the Canadian Employer–Employee Dynamics Database and the National Accounts Longitudinal Microdata File, both maintained by Statistics Canada. It then employs multiple regression analysis to examine the relationship between workforce aging and labour productivity at the firm and industry levels.

Results: The study finds that the labour productivity of firms increases with average worker age, peaking in the 40s, before declining slightly thereafter. The impact of workforce aging on labour productivity varies across the analyzed industries; the construction sector is most affected, while the finance and insurance sector is the least affected.

Interpretation: Given the productivity–age relationship, continued workforce aging is likely to place increasing downward pressure on labour productivity in the coming years, potentially further slowing already weak productivity growth rates.

Author

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What is already known on this subject?

- Some studies based on aggregate data show that, on average, older workers tend to have lower productivity than younger workers, and that labour-force aging is associated with slower productivity growth.
- Other studies using sample-based firm-level data find that productivity generally increases with worker age up to mid-career and then declines at older ages.

What does this study add?

- This study is the first to examine workforce aging and labour productivity at the firm level using data covering the universe of Canadian firms, providing a comprehensive and inclusive perspective.
- The most recent study in the literature based on sample firm-level evidence for Canada dates back to the mid-2000s, despite substantial shifts in workforce age composition over the past two decades. This study uses the most up-to-date data available, covering the period up to 2022.
- The study finds that firms' labour productivity increases with the average age of workers, peaking at middle age before declining thereafter. It also shows that the relationship between productivity and age varies across industries.

Introduction

The Canadian population is aging. In the last two decades, the average age of Canadians has risen by over four years, from 37.5 in 2001 to 41.7 in 2021 (Statistics Canada, 2021). Additionally, the demographic composition of the population has shifted significantly. Those aged 55 and older rose from constituting 22.0% of the population in 2001 to 32.3% in 2022 (Statistics Canada, 2025). Notably, in 2023, the population of individuals aged 65 and older surpassed that of people younger than 18 years for the first time in history (Statistics Canada, 2024, February 21).

Aging can influence an economy through two channels: a higher dependency ratio, measured by the proportion of retirees to workers, and workforce aging (Aiyar et al., 2016). The first channel leads to a lower gross domestic product (GDP) per capita (Persson, 2002; Bloom et al., 2000) as older individuals tend to be out of the labour force. The second channel, i.e., workforce aging, may affect the labour productivity of firms if there is any relationship between the workforce's age and its productivity. For example, Maestas et al. (2023) find that two-thirds of the decline in GDP caused by population aging in the United States was attributable to slower labour productivity.

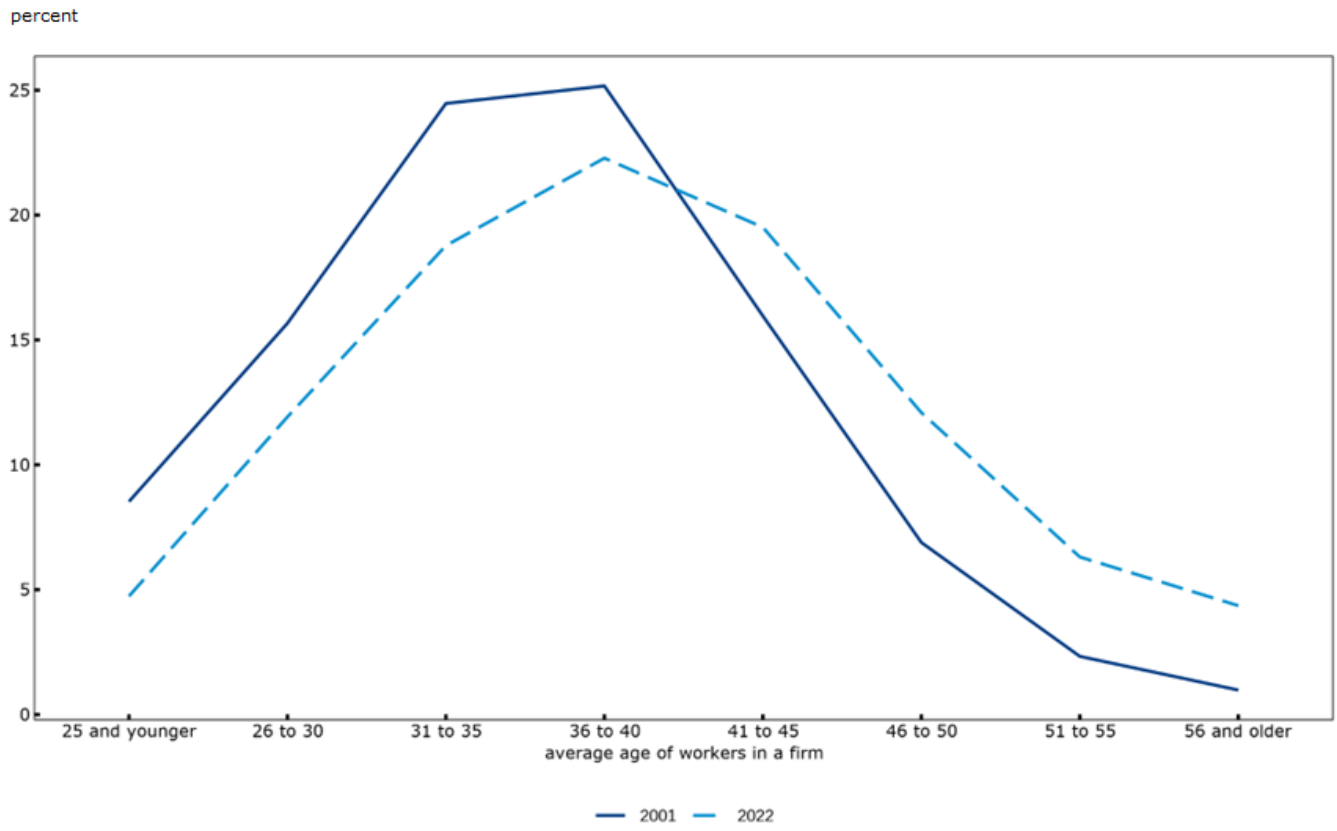
Similar to the Canadian population, the demographic of the Canadian workforce has also been trending older over the past two decades.

Faryaar (2026) measures the firm-level distribution of workforce age and finds that the distribution of firms' average worker age shifted significantly toward older, and at the same time the share of workers aged 55 and older within firms doubled from 2001 to 2022.

Chart 1 shows the distribution of firms by the average age of their workers. The vertical axis reports the percentage of firms in each age category, while the horizontal axis shows the average worker age within a firm. The solid line represents the distribution in 2001, and the dashed line represents the distribution

in 2022. For example, in 2001, firms with an average worker age of 46 to 50 represent 6.9% of total firms, a share that rose to 12.1% in 2022. Comparing the two distributions reveals a clear shift over the study period. The proportion of firms with an average worker age above 40 increased by 16.1 percentage points—from 26.2% in 2001 to 42.3% in 2022—highlighting the ongoing aging of the Canadian workforce. The study also finds that the share of workers aged 55 and older within firms has doubled, rising from 9.3% in 2001 to 18.8% in 2022 (Chart 2).[1]

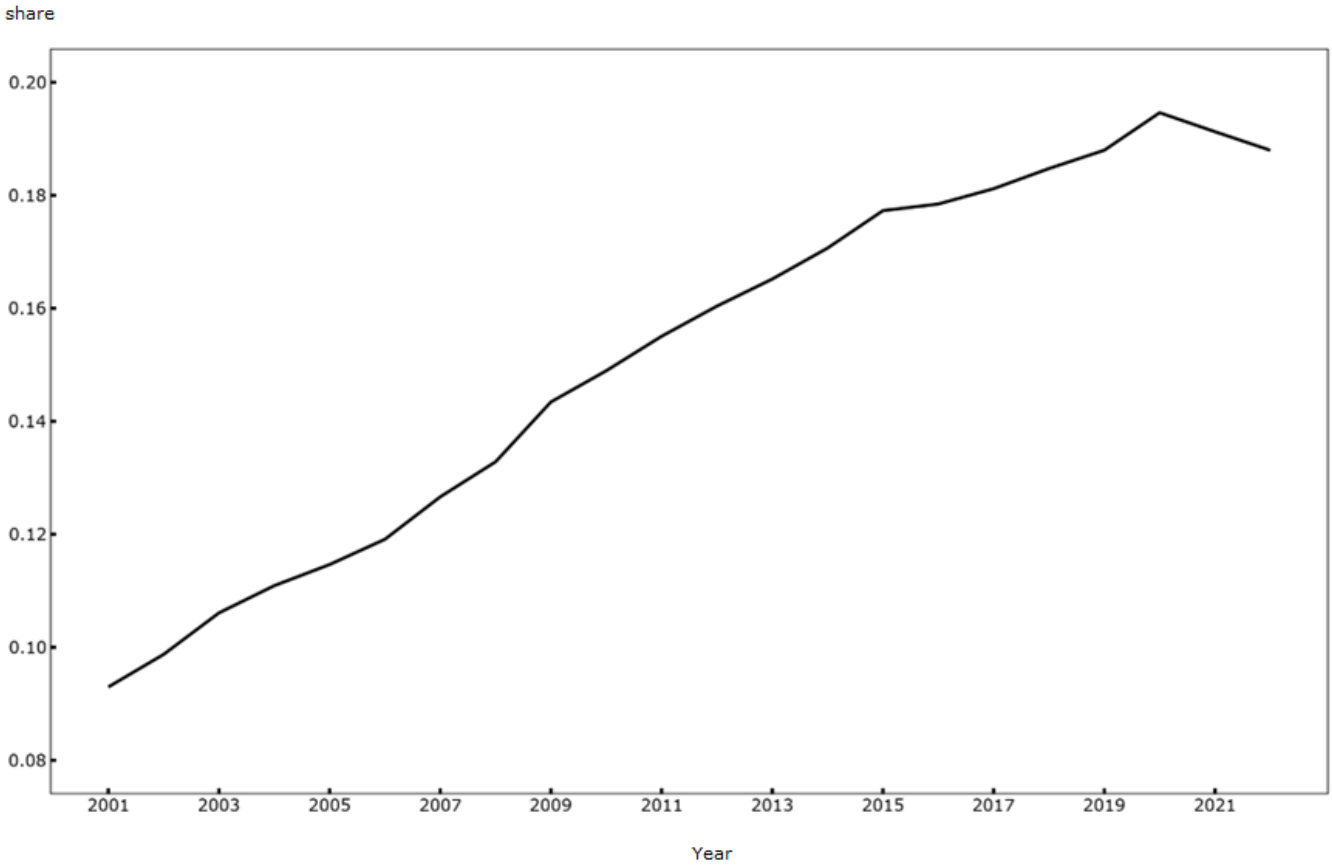
Chart 1
Workforce age distribution at the firm level



Notes: Very small firms, with three or fewer workers, are excluded from the sample because of potential outlier effects. The vertical axis shows the percentage of total firms, while the horizontal axis displays the average age of workers in a firm, grouped into eight categories.
Source: Faryaar (2026), Statistics Canada.

1. Although workforce aging is primarily driven by population aging, the shift toward an older workforce can also be partly attributable to policy changes—such as the elimination of mandatory retirement in some provinces during the mid to late 2000s (Morris & Dostie, 2024) and the introduction of income tax incentives aimed at encouraging older individuals to remain in the labour market (Lacroix & Michaud, 2024; Milligan & Schirle, 2024). For more discussion, see Shannon and Grierson (2004).

Chart 2
Share of workers aged 55 and older across firms



Note: To obtain the annual average across all firms, the share of workers aged 55 and older in a firm is weighted by its employment size in each year.
Source: Faryaar (2026), Statistics Canada.

While older workers bring valuable experience that can enhance their labour productivity (Disney, 1996), they often have less familiarity with new technologies, essential for improving productivity. For example, Aksoy et al. (2019) show that the share of young workers in Organisation for Economic Co-operation and Development (OECD) countries influences the innovation process positively, and a population distribution trending older leads to a decline in innovation activity. They also find that a demographic structure with more older workers (in particular, the 50-to-59 age group) has a strong negative impact on the total number of patent applications. Meyer (2009) finds that German firms with a higher share of older workers are less likely to adopt new technologies in the information and communications technology (ICT) sector if the workplace organization is not managed well. Moreover, older workers are more likely to face health challenges that could hinder their productivity. For instance, Polanco et al. (2024) state that chronic conditions among individuals aged 50 to 65 in European countries lead to people decreasing their working hours, resulting in productivity losses.

The literature on workforce aging presents mixed evidence regarding its impact on productivity. For example, using the Workplace and Employee Survey (1999 to 2005), Dostie (2011) finds that productivity and wages in Canada follow a concave pattern with respect to workers' age. Similarly, Feyrer (2008) uses a cross-country dataset to show that total factor productivity peaks among workers aged 40 to 49. Tang and Macleod (2006), using Canadian aggregate data from 1981 to 2001 across provinces, find that older workers are less productive than younger ones and that labour force aging has a negative impact on productivity growth. Fukao et al. (2023) report that the productivity of Japanese firms follows an

inverted-U shape with respect to average worker age, peaking in the mid-40s. More recently, Guénette and Shao (2025) use a cross-country dataset and state that productivity contributions vary across age groups, with individuals aged 40 to 49 being the most productive. Additionally, Hernæs et al. (2023), using Norwegian data, suggest that raising the retirement age and increasing the share of older workers (aged 63 to 67) results in higher total wage expenses for firms while having only a small positive impact on labour productivity in the short term. The authors caution that such policies may also lead to higher unemployment among younger workers, particularly those younger than 30.

Similar inverted-U patterns are observed in studies of individual productivity. For example, Jones (2010) finds that the output of Nobel Prize winners peaks in their late 30s, while Feyrer (2008) notes that the median age of inventors at the time of patent grant is around 48.

Conversely, some studies argue that productivity either increases monotonically or remains stable with age. Aubert and Crépon (2007) find that productivity rises until ages 40 to 45 and then stabilizes. Göbel and Zwick (2009) report no significant decline in productivity until age 60. Börsch-Supan and Weiss (2016), analyzing data from German car assembly plants, find no evidence of declining productivity up to age 60. Mahlberg et al. (2013) identify a negative correlation between the proportion of younger workers and firm productivity but no such correlation for older workers. Their study also finds no evidence of overpayment among older employees.

This paper uses firm-level measures of workforce aging constructed by Statistics Canada, as described by Faryaar (2026), and examines the relationship between workforce aging and labour productivity (hereafter referred to as productivity).

The paper contributes to the literature in two key ways. First, it is the first study to use Canadian firm-level data encompassing all firms to examine the age–productivity relationship. Second, it employs a more recent dataset that coincides with a period of sluggish productivity growth in the Canadian economy. Understanding any potential negative relationship between workforce aging and productivity is particularly important for the last two decades, given Canada's persistent productivity slowdown since 2001 (Gu & Willox, 2023).

It is important to note that assessing the impact of workforce age on labour productivity is challenging because of the highly individual and sector-specific nature of productivity. Productivity is a complex and multidimensional concept that varies depending on the job. It is also influenced by a wide range of characteristics, including communication skills, information processing speed, physical strength, health, self-discipline, flexibility, administrative and strategic abilities, mathematical proficiency, motivation, education, energy, and job experience (van Ours & Stoeldraijer, 2011). Many of these factors are not directly observable by researchers. Consequently, the results presented in this paper should be interpreted as reflecting the productivity of an average worker at the firm level, rather than capturing individual-level productivity effects.

The remainder of the paper is organized as follows: Section 2 describes the methodology and data, Section 3 explains the results at the aggregate and industry levels, Section 4 explores some robustness checks, and Section 5 concludes the study.

Methodology and data

This paper assumes that value added per unit of labour in a firm is correlated with its human capital, proxied by the average age of workers. Then, the following fixed effects model is applied to study the relationship between the average age of workers in a firm and its labour productivity:

$$q_{it} = \beta_i + \sum_{d=1}^{d=8} \beta_d avg\_age\_dummy_{it,d} + \beta_1 k + \mathrm{X}'\boldsymbol{\beta} + \beta_t + \epsilon_{it}, \quad (1)$$

where q_{it} is the log of labour productivity of firm i in year t. The term β_i represents a time-invariant firm fixed effect, and $avg\_age\_dummy_{it,d}$ is a dummy variable based on the average age of workers in firm i in year t. To capture potential non-linearity in the relationship between age and productivity, the average age of workers is classified into eight groups: 25 and younger (baseline or reference group), 26 to 30, 31 to 35, 36 to 40, 41 to 45, 46 to 50, 51 to 55, and 56 and older. For example, if the average age of workers in firm i in 2010 is 37, then $avg\_age\_dummy_{i2010,4}$ (corresponding to the 36-to-40 age group) is set to 1 for that firm-year. The value of the dummy variable changes as the firm's average workforce age moves across age groups over the study period.

The variable k is the capital intensity (measured as the log of capital per unit of labour). The vector X' includes control variables such as the share of women workers, the share of immigrant workers, firm age, firm size, industry, and province or territory. β_t captures year fixed effects, and ϵ_{it} is the error term. All nominal variables are deflated using industry-level deflators with two-digit North American Industry Classification System (NAICS) codes. The study covers the period from 2001 to 2022.

Labour productivity is calculated by dividing a firm's value added by its number of employees. Firm size is based on the number of workers and categorized into three groups: small firms (5 to 99 employees), medium firms (100 to 499 employees) and large firms (500 or more employees). Data on firm characteristics—including value added, total revenue, capital, total expenses, wages, depreciation, number of workers, total hours worked, firm age, industry, and province or region of operation—are obtained from the National Accounts Longitudinal Microdata File.

Data on employee characteristics—such as age; average age; the shares of young, middle-aged and senior workers; and the share of women workers—are obtained from the Canadian Employer–Employee Dynamics Database. Information on the number of immigrant workers is drawn from the Longitudinal Immigration Database. The three databases are then linked using the enterprise identification numbers of firms.

The model estimation may be subject to endogeneity if more productive firms tend to hire employees in specific age groups or adjust their workforce composition in response to productivity shocks (Aubert & Crépon, 2007). To address this concern, the study generates lagged age-dummy variables, using one-year lags of the average age variable. This approach relies on the assumption that a firm's current productivity does not influence the choice of age composition of its workforce in previous years. While these instruments may not be particularly strong, they represent the best available option to the author that can mitigate the potential endogeneity problem.

As noted earlier, workforce age is measured by the average age of workers in a firm. Very small firms can act as outliers if their average age deviates significantly from the rest of the sample. To address this issue, the analysis excludes firms with fewer than five employees.

To determine an appropriate cut-off point, the analysis compares age distributions using a higher cut-off: firms with more than 10 employees. When the cut-off is increased to 10 employees, the difference in the oldest category—defined as the share of firms with an average worker age of 56 and older—narrows. However, the overall distribution and its shifts over the study period remain largely consistent across both thresholds. To preserve as many observations as possible, the paper adopts the lower threshold of excluding firms with fewer than five employees. It also conducts robustness analyses comparing small firms with medium- and large-sized firms to assess whether workforce aging affects these groups differently. For more details on how the distribution of average worker age varies across firms by size, industry and region, see Faryaar (2026).

The model above examines how the average worker age across firms affects labour productivity. Because the analysis controls for a range of firm characteristics, the results provide a meaningful assessment of the relationship between a firm's average worker age and its labour productivity. However, the average may not fully capture the underlying age distribution, particularly when that distribution is skewed within a firm. As a robustness check, this paper also applies the model proposed by Hellerstein et al. (1999), which assumes that output is a function of different labour types, here defined by age groups. Under the assumptions that worker types are perfectly substitutable and that each worker has the same marginal product across firms, firm productivity can be expressed as a function of these age groups. Given these assumptions, and after manipulating a Cobb–Douglas production function, the following model can be derived:[2]

$$q_{it} = \alpha_i + \alpha_1 \frac{L_{Mit}}{L_{Yit}} + \alpha_2 \frac{L_{Oit}}{L_{Yit}} + \alpha_3 k_{it} + \mathrm{X}'\boldsymbol{\beta} + \alpha_t + \varepsilon_{it}, \qquad (2)$$

where q_{it} is the log of labour productivity of firm i in year t; α_i is a time-invariant firm fixed effect; and L_{Yit}, L_{Mit} and L_{Oit} are the number of younger (16 to 34), middle-aged (35 to 54) and older (55 and older) workers of firm i in year t, respectively. Variable k_{it} is capital intensity, calculated as capital stock per unit of labour in a firm. For the rest of the variables in the model, X' is the vector of control variables as already specified in Equation (1), α_t represents year fixed effects and ε_{it} is the error term. As in Equation (1), the sample includes all firms except those with fewer than five employees, and the study covers the period from 2000 to 2022.

Results

The average age of workers and labour productivity

Table 1 and Chart 3 present the fixed effects model estimates for all firms, excluding those with fewer than five employees, as specified in Equation (1). Chart 3a reports the regression results for the baseline model in which average worker age is defined using a one-year lag, while Chart 3b compares these results with the specification that uses contemporaneous (no-lag) worker age. Labour productivity, shown on the y-axis, is measured relative to the baseline group—firms with an average worker age of 25 years and younger. The x-axis displays the average-worker-age categories, beginning with 25 years and younger, increasing in five-year intervals, and ending with the final category of 56 years and older.

2. For the derivation steps of the model proposed by Hellerstein et al. (1999), which is widely used in the literature, see Dostie (2011). However, in this paper, the author does not rely exclusively on the restrictive assumptions underlying the Hellerstein et al. (1999) and instead adopts Equation (1) as the baseline model.

Table 1
Average worker age and labour productivity

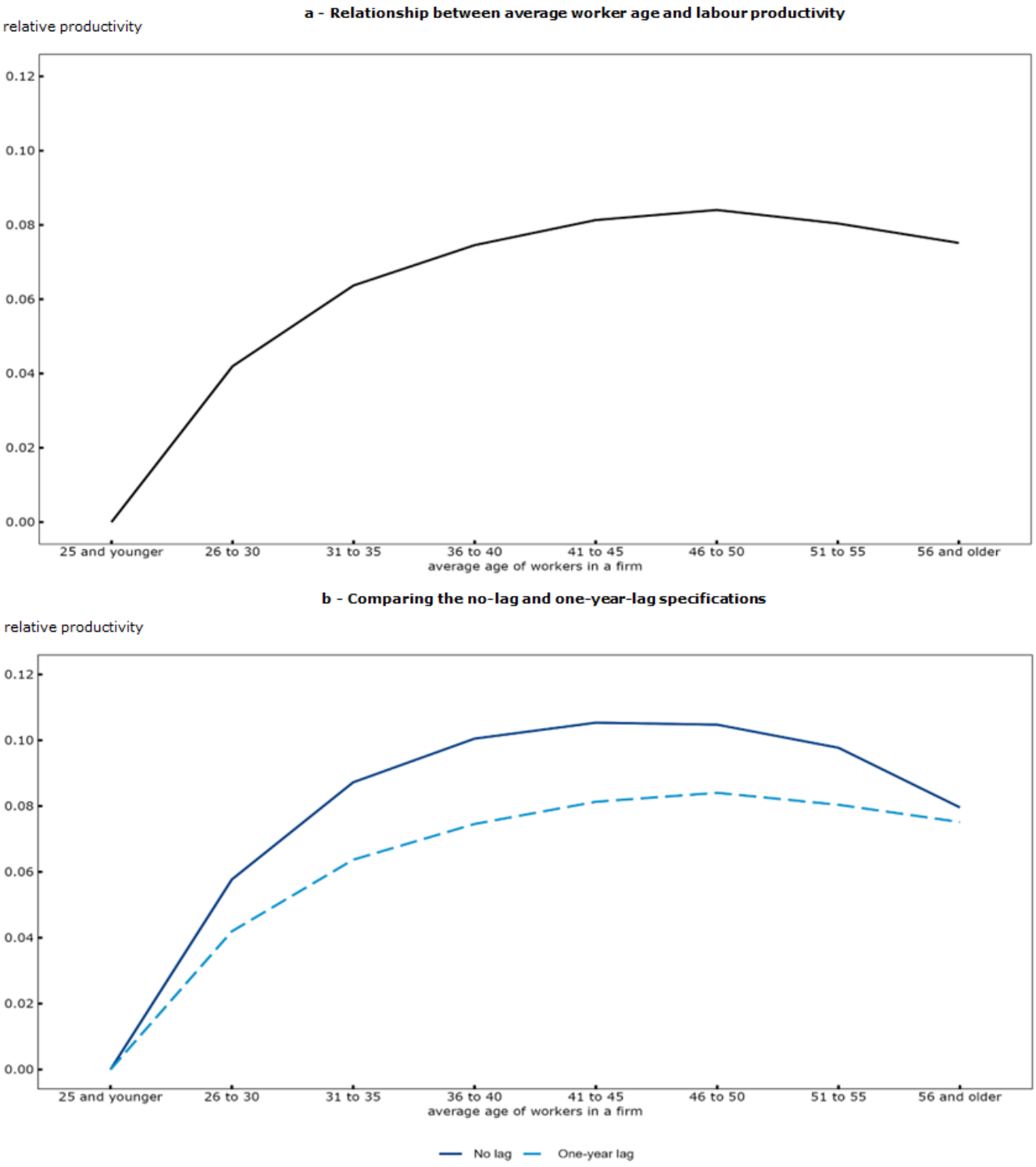
	One-year lag			No lag		
Labour productivity (log)	**Coefficient**	**Robust standard error**	**P-value**	**Coefficient**	**Robust standard error**	**P-value**
Age category (ref.: 25 and younger)						
26 to 30	0.042	0.002	0.000	0.058	0.002	0.000
31 to 35	0.064	0.002	0.000	0.087	0.002	0.000
36 to 40	0.075	0.002	0.000	0.100	0.002	0.000
41 to 45	0.081	0.002	0.000	0.105	0.002	0.000
46 to 50	0.084	0.002	0.000	0.105	0.002	0.000
51 to 55	0.080	0.003	0.000	0.098	0.003	0.000
56 and older	0.075	0.004	0.000	0.080	0.004	0.000
Capital intensity (log)	0.170	0.001	0.000	0.175	0.001	0.000
Women share	-0.141	0.003	0.000	-0.146	0.003	0.000
Immigrant share	-0.010	0.004	0.010	-0.013	0.004	0.000
Internationally owned firm (ref.: Canadian-resident-owned firm)	0.030	0.006	0.000	0.041	0.006	0.000
Employment size (ref.: fewer than 100 employees)						
100 to 499 employees	-0.011	0.003	0	-0.007	0.002	0.006
500 or more employees	-0.079	0.01	0	-0.078	0.01	0
Firm age (ref.: less than 5 years)						
5 to 9 years	-0.013	0.001	0	-0.016	0.001	0
10 to 19 years	-0.03	0.001	0	-0.035	0.001	0
20 years or more	-0.031	0.002	0	-0.036	0.002	0
Industry control	Yes	...	...	Yes	...	...
Province or region control	Yes	...	...	Yes	...	...
Year control	Yes	...	...	Yes	...	...
Constant term	8.95	0.013	0	8.905	0.013	0
Number of observations	7,165,684		...	7,762,907	...	...
Within (overall) R-squared	0.0645 (0.1568)		...	0.0672 (0.1557)	...	...

... not applicable

Notes: Firms with fewer than five employees are excluded from the sample. In the last row, the numbers in parentheses refer to the overall R-squared value.

Source: Author's calculations using microdata.

Chart 3
Average workforce age and labour productivity



Notes: Chart 3a shows the relationship between average worker age and labour productivity, where average age is computed using a one-year lag of worker age. Chart 3b compares the no-lag and one-year-lag specifications. The one-year lag is constructed using workers' ages from the firm's previous year. Firms with fewer than five employees are excluded from the sample.
Source: Author's calculations using microdata.

Overall, the results indicate that productivity increases with average worker age and peaks at 41 to 50 years, before declining slightly. For the baseline model, i.e., the model with a one-year lag, labour productivity peaks from ages 46 to 50 before declining slightly. Firms with peak labour productivity are 8.8% more productive than baseline firms with an average worker age of 25 and younger, while they are 1.0% more productive than firms with an average worker age of 56 and older.[3] The results are statistically significant at the 1% level.

Chart 3b compares the no-lag specification with the one-year-lag results. Overall, the pattern remains broadly consistent; however, under the no-lag specification, labour productivity peaks in the 41-to-45 age category and lies above the corresponding estimates from the one-year-lag model. In this case, firms in the peak category are approximately 11.1% more productive than the reference group and about 2.8% more productive than firms in the oldest category, those with an average worker age of 56 and older.

The findings of this paper align with those of several other studies in the literature that indicate an inverted-U-shaped relationship between workforce age and productivity. For instance, using the Workplace and Employee Survey from 1999 to 2005, Dostie (2011) demonstrates that productivity and wages in Canada follow a concave pattern with respect to workers' age. The study finds that productivity is highest among workers aged 35 to 55 and declines thereafter. Similarly, Feyrer (2008) uses a cross-country dataset to show that total factor productivity peaks in the 40-to-49 age group. Fukao et al. (2023) also find that the productivity of Japanese firms follows an inverted-U shape with respect to workforce age, increasing with the average age of workers, peaking in the mid-40s and then declining. In a recent work, Guénette and Shao (2025) use a cross-country dataset to examine the impact of the age distribution of the working-age population and the old-age dependency ratio on aggregate productivity. Their findings reveal that productivity contributions vary across age groups, with individuals aged 40 to 49 being the most productive.

The current study also finds that, regardless of the model specification, labour productivity increases with the log of capital intensity, while it decreases with the share of women and immigrant workers.

Additionally, the analysis shows that labour productivity increases with capital intensity. Internationally owned firms exhibit higher labour productivity than domestic firms, i.e., those owned by Canadian residents. Labour productivity declines with the share of women and immigrant employees, although the latter effect is not statistically significant in the baseline model. The negative coefficient on employment size suggests decreasing returns to scale on average, though this relationship is not always statistically significant. Finally, the results indicate that older firms, on average, tend to have lower labour productivity; however, robustness checks reveal that this pattern holds only among small firms.

Workforce age and productivity, industry level

The effects of an aging workforce on labour productivity can vary by the composition of occupations. For some roles, such as managers, researchers and professors, productivity may improve with age. By contrast, in physically demanding occupations, such as skilled trades in the construction sector, labour productivity tends to decline as workers age (Aiyar et al., 2016). Research also suggests that older workers tend to experience sharper declines in productivity in roles that require problem solving, rapid learning and speed compared with those where experience and verbal skills are more critical (Skirbekk, 2003).

3. The dependent variable, i.e., labour productivity, is in the natural log form. So, to interpret the results, the paper takes the exponential of the coefficients in each age group and then compares them.

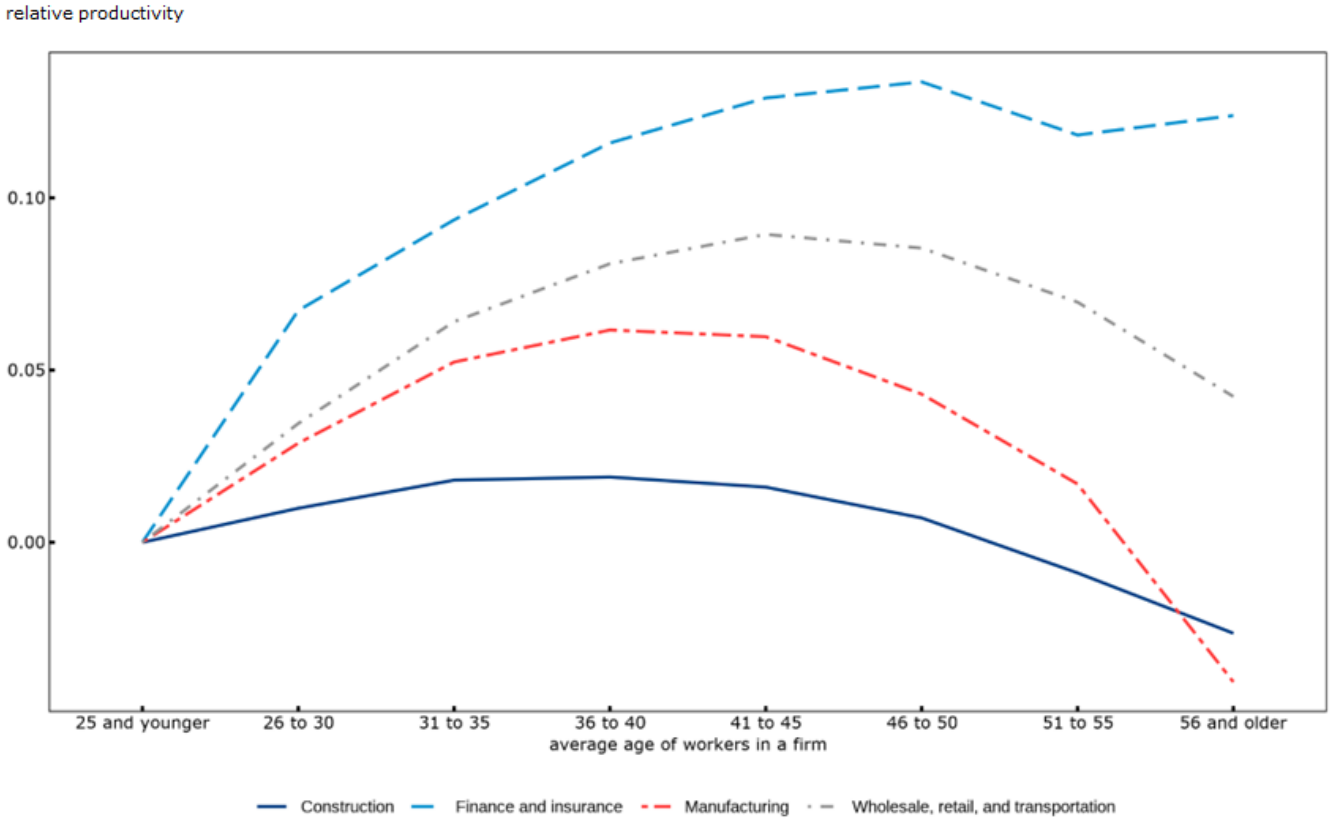
Although the current study does not have access to occupation data, it examines the impact of an aging workforce on labour productivity across major industries that may differ in occupational composition.[4] For the industry-level analysis, the study focuses on a group of selected sectors. Based on two-digit NAICS codes, the study focuses on the following four sector groups:

1. construction (NAICS 23)
2. manufacturing (NAICS 31, 32 and 33)
3. wholesale trade, retail trade, and transportation and warehousing (NAICS 41, 44, 45, 48 and 49)
4. finance and insurance (NAICS 52).

Chart 4 and Table 2 present the industry-level results for the baseline model, i.e., when the average-worker-age categories are calculated using a one-year lag. The findings indicate that labour productivity in the construction, manufacturing, and trade and transportation sectors follows an inverted-U-shaped pattern. In the construction sector (solid blue line), labour productivity peaks earlier than in other sectors, at an average worker age of 36 to 40 years. Additionally, the age–productivity curve for the construction sector lies below those of other sectors, indicating a smaller productivity gap between peak-performing workers and the reference group (firms with an average worker age of 25 years and younger). This pattern likely reflects the physical demands of construction work or early career specialization in the sector. As a result, experience may play a smaller role in enhancing productivity, or the gains from experience among older workers may be partially offset by a decline in physical capabilities. For example, in the construction sector, firms with the peak-performing workers are 1.9% more productive than firms in the baseline group, compared with 6.4% in manufacturing, and 9.4% in trade and transportation.

4. Although the distribution of occupations across industries is different, the industry-level results cannot be attributed to differences in labour productivity across various occupations, because certain roles, like administrative and management positions, are common across all industries.

Chart 4
Workforce age and labour productivity, industry level



Notes: The sectors are combined based on two-digit North American Industry Classification System (NAICS) codes. The manufacturing sector includes NAICS 31, 32 and 33. Wholesale, retail and transportation includes wholesale trade (NAICS 41), retail trade (NAICS 44 and 45), and transportation and warehousing (NAICS 48 and 49).
Source: Author's calculations using microdata.

Table 2
Workforce age and labour productivity, industry level

	Construction			Manufacturing			Wholesale, retail and transportation			Finance and insurance		
Labour productivity (log)	Coefficient	Robust standard error	P-value	Coefficient	Robust standard error	P-value	Coefficient	Robust standard error	P-value	Coefficient	Robust standard error	P-value
Age category (ref.: 25 and younger)												
26 to 30	0.010	0.005	0.038	0.029	0.010	0.003	0.034	0.004	0.000	0.067	0.029	0.021
31 to 35	0.018	0.005	0.000	0.052	0.010	0.000	0.064	0.004	0.000	0.094	0.030	0.002
36 to 40	0.019	0.005	0.000	0.062	0.011	0.000	0.081	0.004	0.000	0.116	0.031	0.000
41 to 45	0.016	0.005	0.004	0.060	0.011	0.000	0.089	0.004	0.000	0.129	0.031	0.000
46 to 50	0.007	0.006	0.231	0.043	0.011	0.000	0.085	0.005	0.000	0.134	0.032	0.000
51 to 55	-0.009	0.007	0.212	0.017	0.012	0.157	0.070	0.005	0.000	0.118	0.033	0.000
56 and older	-0.026	0.010	0.010	-0.041	0.014	0.005	0.042	0.007	0.000	0.124	0.036	0.001
Capital intensity (log)	0.175	0.002	0.000	0.145	0.003	0.000	0.164	0.002	0.000	0.152	0.006	0.000
Women share	-0.268	0.010	0.000	-0.151	0.012	0.000	-0.125	0.006	0.000	-0.101	0.024	0.000
Immigrant share	0.001	0.011	0.944	-0.012	0.013	0.374	-0.014	0.008	0.093	-0.068	0.011	0.033
Internationally owned firm (ref.: Canadian-resident-owned firm)	-0.026	0.038	0.499	0.014	0.011	0.207	-0.015	0.011	0.167	0.020	0.037	0.582
Employment size (ref.: fewer than 100 employees)												
100 to 499 employees	0.070	0.006	0.000	0.020	0.006	0.001	-0.021	0.005	0.000	-0.059	0.021	0.005
500 or more employees	0.177	0.028	0.000	0.005	0.018	0.800	-0.139	0.020	0.000	-0.250	0.068	0.000
Firm age (ref.: less than 5 years)												
5 to 9 years	-0.034	0.002	0.000	0.009	0.003	0.004	-0.001	0.002	0.454	-0.008	0.006	0.204
10 to 19 years	-0.036	0.003	0.000	0.015	0.004	0.000	-0.011	0.002	0.000	-0.015	0.008	0.066
20 years or more	-0.024	0.004	0.000	0.017	0.005	0.001	-0.011	0.003	0.000	-0.037	0.011	0.001
Province or region control	Yes	...	...	Yes	...	...	Yes	...	...	Yes	...	...
Year control	Yes	...	...	Yes	...	...	Yes	...	...	Yes	...	...
Constant term	9.545	0.034	0.000	9.263	0.043	0.000	9.007	0.019	0.000	9.622	0.078	0.000
Number of observations	1,029,000	...	...	626,000	...	...	1,815,000	...	...	149,000	...	...
Within (overall) R-squared	0.075 (0.112)	...	...	0.057 (0.151)	...	...	0.073 (0.183)	...	...	0.086 (0.121)	...	...

... not applicable

Notes: Firms with fewer than five employees are excluded from the sample. In the last row, the numbers in parentheses refer to the overall R-squared value. The sectors are combined based on two-digit North American Industry Classification System (NAICS) codes. The manufacturing sector includes NAICS 31, 32 and 33. Wholesale, retail and transportation includes wholesale trade (NAICS 41), retail trade (NAICS 44 and 45), and transportation and warehousing (NAICS 48 and 49).

Source: Author's calculations using microdata.

In the manufacturing sector, labour productivity increases with the average age of workers, peaking around 36 to 40 years before declining. The decline in productivity among firms with older workers on average, similar to that observed in the construction sector, may also be attributable to the physical demands of manufacturing jobs. For the construction and manufacturing sectors, the labour productivity of firms with an average worker age of 56 and older is lower than that of firms in the baseline group.

Labour productivity in the grouped sectors of wholesale trade, retail trade, and transportation and warehousing peaks around ages 41 to 45, then it gradually declines. The productivity of firms in the oldest category is still significantly higher than that of firms in the baseline group. This pattern suggests that experience plays a significant role in these sectors and that aging has a less negative effect on productivity than in the construction and manufacturing sectors.

By contrast, the finance and insurance sector exhibits a different pattern than the rest of the studied sectors. The results also indicate that the finance and insurance sector has substantially larger robust standard errors than the other sectors examined in this study (see Table 2). Consequently, greater caution is warranted when interpreting these estimates.[5]

A notable distinction in the labour market across these sectors lies in the role of physical strength and interactive, analytical and technological skills in production processes. Sectors such as construction and manufacturing tend to rely more heavily on physical strength compared with finance and insurance. As workers age, a decline in physical strength may negatively affect labour productivity in physically demanding industries, as illustrated in Chart 4. Moreover, experience is likely to play a smaller role because of early career specialization in these sectors.

By contrast, the finance and insurance sector places greater emphasis on interactive, analytical and technological skills. Interactive abilities—such as communication and collaboration—tend to remain relatively stable over a worker's lifetime, and productivity in tasks requiring these skills can even improve with age as experience accumulates (Autor et al., 2003; Skirbekk, 2003). Cognitive and analytical skills may also develop with age and experience. Conversely, technological skills—often more prevalent among younger workers—are also critical in these sectors. Therefore, if labour productivity does not decline with age in the finance and insurance sector, this suggests that the benefits of interactive and analytical abilities outweigh the potential disadvantages associated with declining technological skills during the study period.

The impact of an aging workforce on technology adoption is not necessarily negative and depends largely on management practices. For example, studies suggest that effective collaboration between younger and older workers can enhance firms' ability to adopt new technologies. For example, Meyer (2009) finds that while a high proportion of older workers may hinder technology adoption in ICT firms in Germany, companies that promote teamwork or adopt flatter organizational structures are more likely to embrace new technologies—even when they have a larger share of older employees.

It should be noted that although the age-category coefficients are significant at the 1% level in most industry specifications, this pattern does not hold for the construction sector. In this sector, the coefficients for the 46-to-50 and 51-to-55 age groups are not significant even at the 10% level, and those for the 26-to-30 and 56-and-older age groups are not significant at the 1% level. One possible explanation is the relatively smaller variability in average worker age among construction firms compared with firms in other

5. As a robustness check, the study combines the finance and insurance sector with related sectors—real estate and rental and leasing; management of companies and enterprises; professional, scientific and technical services; and information and cultural industries. In this broader grouping, labour productivity increases monotonically with the average age of workers, showing no evidence of an inverted-U or concave relationship. The robust standard errors also decline under this combined specification, further strengthening the stability of the estimates.

sectors. For example, Faryaar (2026) shows that, from 2001 to 2022, the distribution of average worker age in the construction sector experienced smaller shifts than in the other sectors analyzed in the study.

Regarding other variables, the industry-level results are generally consistent with the overall findings, with some exceptions: firm age and employment size. While the overall results show a small but negative relationship between firm age and labour productivity, the industry-level analysis reveals more mixed patterns. In the construction and manufacturing sectors, labour productivity follows a U-shaped pattern with respect to firm age. It declines until firms reach the established stage (10 to 19 years), then increases thereafter. By contrast, in the manufacturing sector, labour productivity increases steadily with firm age on average. For the remaining sectors, the results show a negative association between firm age and labour productivity; however, this relationship is not statistically significant in the finance and insurance sector.

Regarding employment size, the results show a positive relationship between employment size and labour productivity in the construction sector, a U-shaped relationship in the manufacturing sector, and a negative relationship in the remaining sectors. The study also finds no statistically significant difference in labour productivity between firms owned internationally and those owned by Canadian residents.

Robustness checks

An alternative model

In this subsection, the paper performs several robustness checks. First, it estimates an alternative model, presented as Equation (2), which is based on the specification introduced by Hellerstein et al. (1999). The model estimates how different categories of workers—such as categories based on age groups—affect marginal products and therefore firm productivity.

Although the model relies on assumptions that may not always hold in practice, it remains widely used in empirical research because it allows productivity to be decomposed across worker types. In the context of this paper, its key advantage is that it captures the within-firm distribution of worker ages rather than relying solely on a single summary measure, such as the firm's average worker age.

The result shows that labour productivity follows a concave age–productivity profile in the specification corresponding to Equation (2). Productivity rises as the workforce shifts from younger workers (16 to 34) to middle-aged workers (35 to 54), but it falls as the share of older workers (55 and older) increases relative to younger workers. This pattern implies that productivity reaches its peak at some point within the middle-age range. Consistent with the baseline model in Equation (1), firms with an average worker age of 46 to 50 exhibit the highest levels of labour productivity. The estimates for the remaining variables, as reported in Table 3, are also broadly consistent with the baseline model.

Table 3
Workforce age and labour productivity, a robustness check

Labour productivity (log)	Coefficient	Robust standard error	P-value
Middle-aged to young	0.004	0.000	0.000
Old to young	-0.004	0.000	0.000
Capital intensity (log)	0.177	0.001	0.000
Women share	-0.143	0.003	0.000
Immigrant share	0.000	0.004	0.925
Internationally owned firm (ref.: Canadian-resident-owned firm)	0.030	0.006	0.000
Employment size (ref.: fewer than 100 employees)			
100 to 499 employees	-0.005	0.002	0.042
500 or more employees	-0.067	0.009	0.000
Firm age (ref.: less than 5 years)			
5 to 9 years	-0.013	0.001	0.000
10 to 19 years	-0.030	0.001	0.000
20 years or more	-0.031	0.002	0.000
Industry control	Yes	...	
Province or region control	Yes	...	
Year control	Yes	...	
Constant term	8.948	0.013	0.000
Number of observations	7,392,610	...	
Within (overall) R-squared	0.067 (0.141)	...	

... not applicable

Notes: Firms with fewer than five employees are excluded from the sample. In the last row, the number in parentheses refers to the overall R-squared value.

Source: Author's calculations using microdata.

Revenue-based productivity

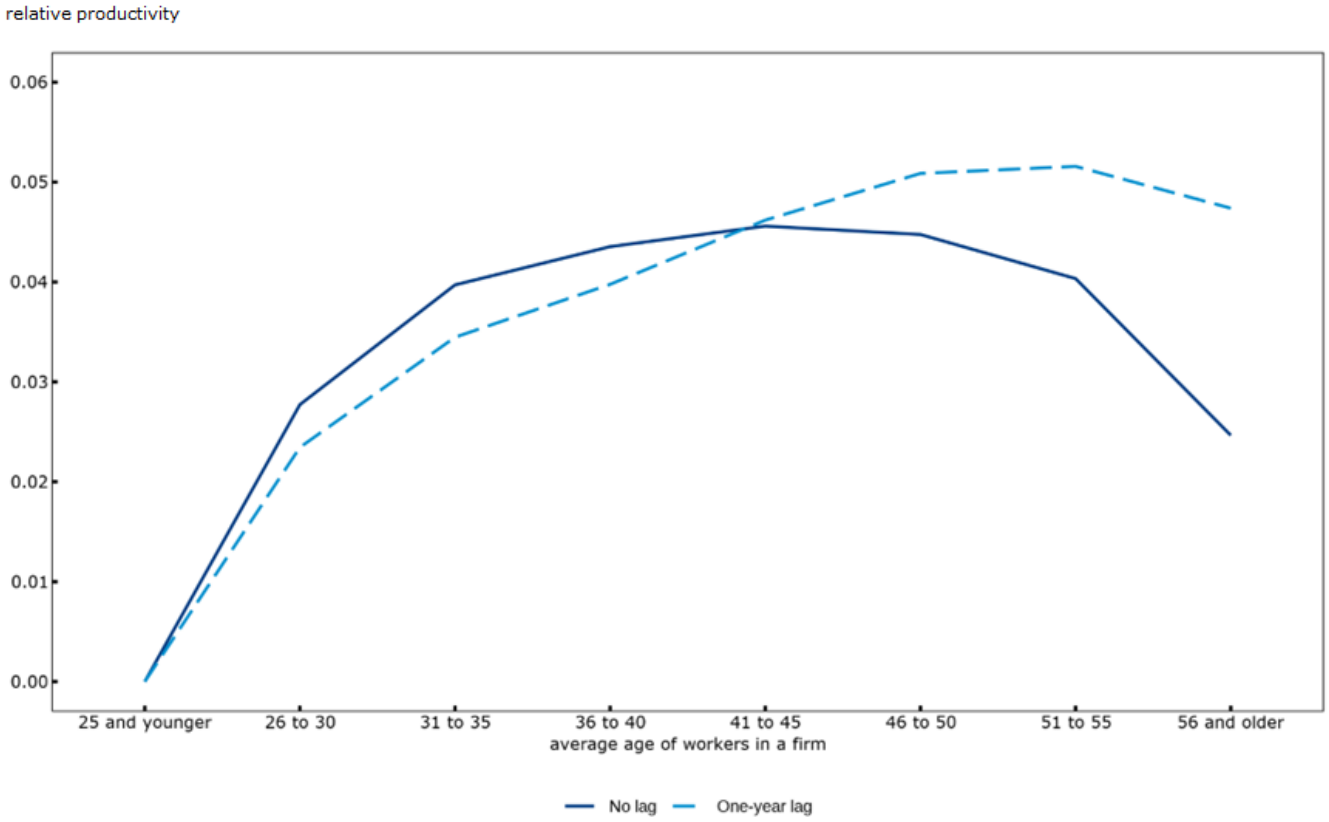
For the baseline specification, labour productivity is defined using value added, but firm-level value-added measures can be noisy depending on how they are calculated at the firm level. As a robustness check, the analysis also constructs an alternative measure of labour productivity based on deflated revenue per employee and examines the relationship between average worker age and productivity.

Using revenue-based productivity is not ideal in settings where intermediate input costs make up a large share of total expenses, since revenue may overstate the contribution of labour and capital. Even so, it remains a widely used proxy in the empirical literature and serves as a useful complement to value-added

productivity, allowing the paper to test whether the main results are sensitive to the choice of productivity measure.

The results, as shown in Chart 5 and Table 4, indicate that labour productivity is still concave in average worker age, regardless of whether output is measured by value added or revenue. However, the differences in labour productivity across age groups have narrowed.

Chart 5
Average worker age and labour productivity



Notes: As in the baseline model, firms with fewer than five workers are excluded from the sample. Productivity refers to revenue-based labour productivity.
Source: Author's calculations using microdata.

Table 4
Workforce age and labour productivity, revenue-based labour productivity

	One-year lag			No lag		
Labour productivity (log)	**Coefficient**	**Robust standard error**	**P-value**	**Coefficient**	**Robust standard error**	**P-value**
Age category (ref.: 25 and younger)						
26 to 30	0.023	0.002	0.000	0.028	0.002	0.000
31 to 35	0.034	0.002	0.000	0.040	0.002	0.000
36 to 40	0.040	0.002	0.000	0.044	0.002	0.000
41 to 45	0.046	0.002	0.000	0.046	0.002	0.000
46 to 50	0.051	0.002	0.000	0.045	0.002	0.000
51 to 55	0.052	0.003	0.000	0.040	0.003	0.000
56 and older	0.047	0.003	0.000	0.025	0.004	0.000
Capital intensity (log K/L)	0.235	0.001	0.000	0.249	0.001	0.000
Women share	-0.061	0.003	0.000	-0.060	0.003	0.000
Immigrant share	0.001	0.004	0.729	0.002	0.004	0.638
Internationally owned firm (ref.: Canadian-resident-owned firm)	0.100	0.007	0.000	0.112	0.007	0.000
Employment size (ref.: fewer than 100 employees)						
100 to 499 employees	-0.050	0.003	0.000	-0.050	0.003	0.000
500 or more employees	-0.155	0.011	0.000	-0.162	0.011	0.000
Firm age (ref.: less than 5 years)						
5 to 9 years	-0.033	0.001	0.000	-0.045	0.001	0.000
10 to 19 years	-0.060	0.001	0.000	-0.072	0.001	0.000
20 years or more	-0.062	0.002	0.000	-0.068	0.002	0.000
Industry control	Yes	...		Yes	...	
Province or region control	Yes	...		Yes	...	
Year control	Yes	...		Yes	...	
Constant term	9.391	0.016	0.000	9.260	0.016	0.000
Number of observations	7,159,000	...		7,785,000	...	
Within (overall) R-squared	0.122 (0.118)	...		0.135 (0.116)	...	

... not applicable

Notes: Firms with fewer than five employees are excluded from the sample. In the last row, the numbers in parentheses refer to the overall R-squared value.

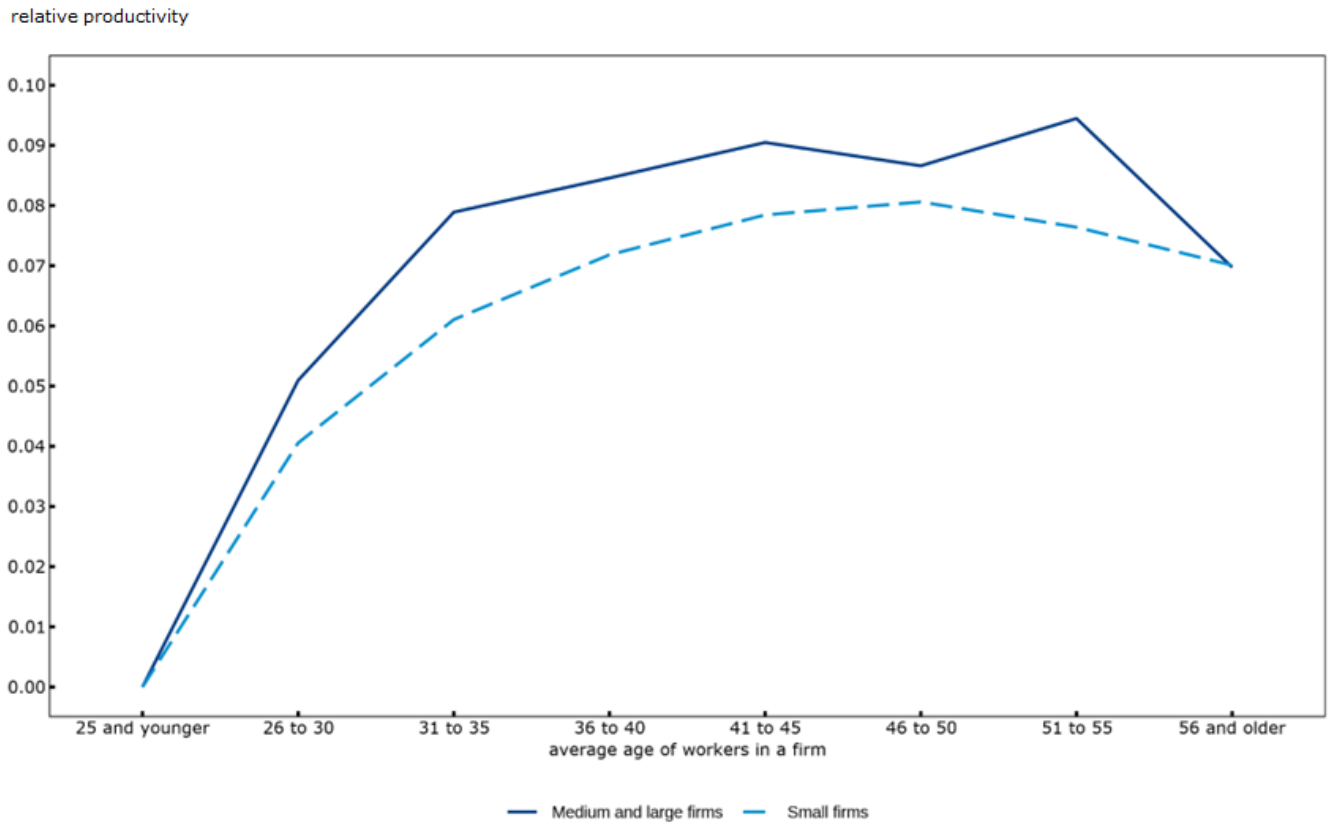
Source: Author's calculations using microdata.

Small firms versus medium and large firms

As noted earlier, workforce age is measured by the average age of workers in a firm. Very small firms can act as outliers if their average age deviates significantly from the rest of the sample. To address this issue, the analysis focuses only on firms with at least five employees. As an additional robustness check, the study also provides separate analyses for small versus medium and large firms.

Chart 6 and Table 5 present the results. Overall, the findings are very similar across specifications, except that the robust standard errors for the oldest age category are considerably larger for medium and large firms compared with those for small firms, and the corresponding coefficient is not statistically significant at the 5% level. One possible explanation is the lower variability in average worker age among medium and large firms with an average worker age above 50. For example, Faryaar (2026) shows that the distribution of average worker age is more centralized around 35 to 45 in medium and large firms than in small firms. Also, in medium and large firms, changes in the age distribution are not noticeable among firms with an average worker age older than 50, whereas in small firms, shifts occur more uniformly across the entire distribution.

Chart 6
Average worker age and labour productivity, small firms versus medium and large firms



Source: Author's calculations using microdata.

Table 5
Workforce age and labour productivity, small firms versus medium and large firms

	Small firms (5 to 99 employees)			Medium and large firms (100 or more employees)		
Labour productivity (log)	Coefficient	Robust standard error	P-value	Coefficient	Robust standard error	P-value
Age category (ref.: 25 and younger)						
26 to 30	0.041	0.002	0.000	0.051	0.006	0.000
31 to 35	0.061	0.002	0.000	0.079	0.008	0.000
36 to 40	0.072	0.002	0.000	0.085	0.009	0.000
41 to 45	0.078	0.002	0.000	0.090	0.010	0.000
46 to 50	0.081	0.002	0.000	0.087	0.011	0.000
51 to 55	0.076	0.003	0.000	0.094	0.018	0.000
56 and older	0.070	0.004	0.000	0.070	0.039	0.070
Capital intensity (log)	0.173	0.001	0.000	0.141	0.005	0.000
Women share	-0.140	0.003	0.000	-0.168	0.025	0.000
Immigrant share	-0.007	0.004	0.088	-0.050	0.024	0.037
Internationally owned firm (ref.: Canadian-resident-owned firm)	0.055	0.009	0.000	-0.014	0.009	0.106
Firm age (ref.: less than 5 years)						
5 to 9 years	-0.015	0.001	0.000	0.004	0.003	0.195
10 to 19 years	-0.033	0.001	0.000	0.014	0.004	0.001
20 years or more	-0.035	0.002	0.000	0.017	0.005	0.001
Industry control	Yes	...		Yes	...	
Province or region control	Yes	...		Yes	...	
Year control	Yes	...		Yes	...	
Constant term	8.936	0.014	0.000	9.224	0.059	0.000
Number of observations	6,741,070	...		424,614	...	
Within (overall) R-squared	0.064 (0.150)	...		0.066 (0.251)	...	

... not applicable

Notes: Firms with fewer than five employees are excluded from the sample. In the last row, the numbers in parentheses refer to the overall R-squared value.

Source: Author's calculations using microdata.

Conclusion

In the last two decades, the average age of Canadians has risen by more than four years. Similarly, the demographic composition of the Canadian workforce is shifting toward older workers. While older workers bring valuable capabilities, such as experience and soft skills, that can boost labour productivity, they may lag behind younger workers in areas like technological skills or be more vulnerable to chronic health conditions.

This paper examines the relationship between workforce aging and labour productivity. The findings indicate that, on average, firms exhibit a concave age–productivity profile: productivity increases with the average age of workers, reaches its peak in the mid to late 40s and then gradually declines. However, depending on the model specification, the post-peak decline in labour productivity at the economy-wide level may be relatively modest.

Across industries, the age–productivity relationship varies considerably. For instance, in the finance and insurance sector, productivity increases with the average worker age and peaks in the late 40s and then shows only a modest decline. By contrast, in the construction and manufacturing sectors, productivity reaches its peak in the late 30s and declines more sharply thereafter. In these two sectors, firms with an average worker age of 56 and older tend to have lower labour productivity than firms in the reference group, those with an average worker age of 25 and younger.

While population aging poses challenges, it also creates important economic opportunities when supported by appropriate policies. For example, the OECD (2020) demonstrates that with the right government and employer actions, an aging workforce can significantly boost future GDP per capita. The report shows that aging becomes an economic asset when policies foster multigenerational workplaces, requiring employers to adopt age-inclusive practices in recruitment, retention, training and retirement transitions. It also emphasizes that expanding lifelong learning is essential to sustain productivity as workers age. Moreover, healthy working conditions and flexible arrangements help older workers remain engaged and enhance team performance through experience-driven complementarities.

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