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Powering Progress: Toward a Better Understanding of Canada's Green Economy

by Peter Foltin, Bassirou Gueye and Jiang Li

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Abstract

Despite Canada’s ambitious climate goals and the global transition toward more sustainable economic development models, empirical evidence on how the green transition affects Canada’s productivity growth is limited because of a lack of comprehensive data. This study fills this gap in two steps. First, it constructs a first-of-its-kind measure of green intensity at the detailed industry level by synthesizing multidimensional data, including information on green outputs and processes. Second, it investigates productivity dynamics by decomposing productivity growth using this newly developed green index. The paper finds that high green-intensity industries are concentrated in professional, scientific and technical services; construction; and agriculture, forestry, fishing and hunting. They maintain substantial productivity advantages of 50% to 60% over those in low green-intensity industries. They also demonstrated superior economic resilience during the COVID-19 pandemic. Moreover, the drivers of productivity growth vary across greener industries, with the service sector relying more heavily on market dynamism and reallocation and the goods sector relying more on within-firm improvements. Overall, this study offers a comprehensive measurement framework for policy makers to understand the implications of the green transition.

Keywords: Green economy, productivity, Porter hypothesis, environmental policy, industrial policy, Canada, green intensity index, firm performance.

1 Introduction

Canada stands at a pivotal crossroads in the global green transition. As a resource-rich nation with 14.6% of its 2021 gross domestic product (GDP) tied to natural resource extraction, energy production and related industries—the highest share in the G7 and more than double that of France, the United Kingdom and the United States (Organisation for Economic Co-operation and Development [OECD] 2025)—Canada faces unique challenges as it seeks to balance economic growth with ambitious climate and sustainability goals. The imperative to decarbonize to meet net zero targets, against the backdrop of accelerating climate change impacts (World Meteorological Organization 2021) and shifting international trade and investment patterns (Airaudo et al. 2025), has led to calls for a comprehensive measure of the performance of the industries most involved in Canada's progress toward a more environmentally friendly economy.

Existing metrics have been typically developed around single dimensions, providing important but incomplete snapshots. For example, Statistics Canada's Environmental and Clean Technology Products Economic Account (ECTPEA) measures the contribution of the production of environmental and clean technology (ECT) goods and services[1] to the economy, providing information related to output, employment and other economic variables, but lacking productivity metrics. Occupation-based methods, as developed by Vona et al. (2019) and applied by organizations such as the OECD, ECO Canada, and Employment and Social Development Canada (OECD 2023; Laing et al. 2025), identify green jobs through task analysis[2] and estimate that these jobs are equivalent to about 2% to 4% of Canadian employment. Meanwhile, business surveys, like the Survey of Innovation and Business Strategy, reveal significant sectoral variations in clean technology adoption, ranging from 3.6% in the finance and insurance sector to 33.5% in the utilities sector, with traditionally polluting industries showing strong adoption rates. A holistic framework that integrates granular data on output, employment and technology adoption would better enable policy makers and stakeholders to assess progress, identify gaps and design targeted interventions that support sustainable economic transformation.

This paper takes several steps in that direction by developing a novel and comprehensive index at the four-digit North American Industry Classification System (NAICS) level that captures output, process and employment activities related to reducing environmental impact, remediating environmental degradation and preserving ecosystems, hereafter referred to as green activities.[3] This approach integrates multiple dimensions of green activities, including output-based industrial categorizations, occupational green task intensity, environmental goods exports and firm-level investment in capital associated with clean technologies, into a three-tier composite measure—low, medium and high—that reflects the spectrum of intensity of green activity across all industries. It is important to note that by this definition, the absence of green activity within a firm, an industry or a sector does not imply it is harming the environment; this merely indicates that it is not positively affecting environmental outcomes.

1. They are defined as any process, product or service that reduces environmental impacts through any of the following three strategies: environmental protection activities that prevent, reduce or eliminate pollution or any other degradation of the environment; resource management activities that result in the more efficient use of natural resources, thus safeguarding against their depletion; and the use of goods that have been adapted to be significantly less energy or resource intensive than the industry standard. For more information, see Statistics Canada (2024).
2. Green jobs are positions that involve green tasks—i.e., tasks that contribute to the conservation, preservation or restoration of the environment (Government of Canada, n.d.).
3. This term is broadly compatible with concepts such as environmental and clean products and services, clean technologies, and green jobs. However, the way this concept is operationalized may not perfectly overlap with these precisely defined terms. More details will be presented in Section 3 on what will be considered green activities in this paper and how the green-intensity measure will be applied.

This study finds that industries with high green intensity are concentrated in professional, scientific and technical services; construction; and agriculture, forestry, fishing and hunting. From 2016 to 2022, high green-intensity industries maintained a significant productivity advantage, with productivity levels 10% to 20% above those of medium green-intensity industries and 50% to 60% above those of low green-intensity industries. Even at a more aggregated sectoral level (two-digit NAICS code), this productivity premium persisted—five of seven sectors with high green-intensity industries experienced superior productivity performance. Furthermore, industries with high green intensity showed signs of being more economically dynamic and resilient, posting higher productivity growth rates from 2016 to 2022 and experiencing smaller post-pandemic productivity declines than firms in medium and low green-intensity industries. Finally, productivity growth of greener industries relied more heavily on dynamic market processes in the service sector, compared with within-firm improvements, which were more prominent in the goods sector. These findings contribute to the growing body of evidence that environmental sustainability and economic performance are not competing objectives but complementary imperatives for long-term prosperity. Moreover, the varying drivers of productivity growth between the goods and service sectors underscore the potential need for tailored policy design aimed at fostering a green economy.

The remainder of this paper is organized as follows. Section 2 reviews the relevant literature. Section 3 outlines data sources and the development of the industry-level green intensity index. Section 4 presents the empirical analysis, including descriptive statistics and the results from a productivity decomposition framework. Section 5 concludes with key findings, limitations and future research directions.

2 Literature review

This section reviews and synthesizes recent literature on the interplay between environmental performance and economic outcomes, particularly in the Canadian context.

The transition toward a green economy has become a central focus for policy makers worldwide as the effects of climate change intensify and the need for sustainable development grows. The costs of climate change can be direct—extreme temperatures have been associated with productivity losses in Canadian manufacturing (Kabore and Rivers 2023), on top of the costs of flooding (Bemrose and Macdonald 2022) and wildfires (Brown and Brown 2025)—and diverse. For example, these impacts translate into operational disruptions, supply chain vulnerabilities and increasing regulatory pressures for businesses (United Nations Environment Programme Finance Initiative 2023). Without significant mitigation efforts, these costs are projected to escalate, potentially reaching 5% to 6% of GDP annually by mid-century (Canadian Climate Institute 2022). The burden extends beyond climate change itself, with air pollution linked to lower productivity; notably, as much as one-third of labour productivity growth in Europe from 2011 to 2022 has been attributed to improvements in air quality (Dechezleprêtre and Vienne 2025).

Contrary to traditional assumptions about inevitable trade-offs between environmental and economic prosperity (Porter 1991), recent literature increasingly points to potential alignment. The Porter hypothesis suggests that well-designed environmental regulations can stimulate innovation and efficiency improvements and, ultimately, enhance competitiveness (Porter and van der Linde 1995).

Recent empirical evidence supports this view across various contexts, though it also highlights that such benefits are not uniformly experienced across all firms or industries. For example, De Lyon and Dechezleprêtre (2025) show that the most productive firms also tend to be far less carbon intensive, and significant productivity and carbon-efficiency gains could be had if laggard firms adopted the technology and processes of leading firms. The productivity premium observed in carbon-efficient firms indicates potential economy-wide gains from the broader adoption of sustainable practices. Najjar and Cherniwchan (2021) show that among Canadian manufacturers, air quality standards often do not bind for the most productive firms, and that aggregate productivity improves as more polluting firms exit. Research by Hottenrott et al. (2016) shows that for German manufacturers, the adoption of greenhouse gas abatement technologies did not negatively affect productivity, as long as these technological changes were accompanied by broader organizational adjustments. Furthermore, Albrizio et al. (2014), in an OECD working paper, report that increasingly stringent environmental policies across OECD countries have had little impact on aggregate productivity. However, their findings also suggest that more technologically advanced industries and frontier firms have enjoyed modest productivity gains, while less productive firms often experienced declines. Similarly, Commins et al. (2011) found that while energy taxes and the European Union Emissions Trading System had a positive overall impact on multifactor productivity, the magnitude of this effect varied by industry. Finally, the seminal paper by Berman and Bui (2001) observed that oil refineries in the Los Angeles Air Basin achieved greater productivity gains compared with their less-regulated counterparts, demonstrating that even stringent environmental policies can coincide with productivity growth in heavily polluting sectors. This growing body of evidence suggests that sustainability and profitability can be mutually reinforcing objectives.

The ECT sector has shown notable economic progress in Canada, contributing 3.0% to Canada's GDP in 2023 (Statistics Canada 2024). From 2012 to 2021, the ECT sector's real GDP expanded by 21%, outpacing the broader economy's growth rate of 15% (Jiang 2023). ECT exports also grew faster than total exports; this export growth was primarily driven by increased shipments of ECT goods, whereas ECT service exports represented a smaller share (Jiang 2023). Furthermore, when comparing clean technology-supported firms with those engaged in other business innovation and growth support (BIGS) program streams from 2016 to 2023, ECT firms were found to be smaller, newer and typically employed a more highly educated workforce (Carta and Demers 2023). Notably, ECT-supported firms outperformed other BIGS participants, particularly in productivity growth: from 2018 to 2021, the median increase in productivity among firms receiving clean tech support was $14,300 per employee, compared with $13,500 among all other BIGS recipients. Beyond firms participating in the production of ECT goods and services, Canadian industries have become more energy efficient. From 2009 to 2022 real GDP grew by 33.1%, while energy use grew 8.2% (Daraji and Li 2025).

These findings highlight that green activities, including clean technology adoption, may simultaneously address climate change concerns and enhance economic competitiveness.

3 Data sources and development

This paper leverages a variety of data—existing indicators of green activity employed in this paper and Statistics Canada's administrative datasets—to capture the level of green activity across the economy. They are synthesized into a three-tiered index where industries are sorted into low, medium and high green-intensity groups. This section provides an overview of the data sources and the development of such an index.

3.1 Data sources

3.1.1 Green activities

Four sets of indicators from Statistics Canada and other sources are considered, shedding light on green activities related to the production of goods and services, the adoption and maintenance of capital and technology, and the intensity of green tasks across industries.

Green goods and services

In 2012, the U.S. Bureau of Labor Statistics produced a list of industries with green goods and services (GGSs), where GGSs were broadly defined as any product or service that benefits the environment or conserves natural resources.[4] This list, prepared at the six-digit NAICS level, recognized 325 national industries as potentially producing GGSs. This list was cross walked with the 2022 Canadian NAICS, resulting in 244 industries linked to GGSs.[5] GGSs were further categorized into the following five categories:

- **renewable:** the production and management of electricity, heat or fuel generated from renewable sources such as wind, solar and biomass
- **efficiency:** products and services that improve energy efficiency
- **remediation:** the reduction and removal of greenhouse gases and pollution more broadly
- **conservation:** products and services that conserve natural resources
- **compliance:** the enforcement and creation of public awareness of environmental issues and regulations (including education and training related to clean technologies and environmentally friendly practices).

Green intensity of employment

Adapting the methodology of Vona et al. (2019) to the Canadian context, Employment and Social Development Canada developed a green-intensity measure of employment at the five-digit National Occupational Classification level (Laing et al. 2025). A total of 91 such occupations were identified as green jobs or, specifically, as having green tasks. Table 1 lists the 10 most green-intensive occupations. Several, including aerospace and civil engineers, are associated with the professional, scientific and technical services sector, while occupations such as plumbers and roofers and shinglers are associated with the construction sector. This is because green tasks are related to both output (that is, GGSs) and tasks related to improving the environmental efficacy of processes.

Table 1
Top 10 occupations by green task intensity

Occupation title	Green task intensity
	number
Aerospace engineers	0.46
Civil engineers	0.45
Meteorologists and climatologists	0.43
Utilities managers	0.40
Urban and land use planners	0.36
Plumbers	0.34
Geoscientists and oceanographers	0.33
Roofers and shinglers	0.30
Mechanical engineers	0.28
Architects	0.27

Source: Employment and Social Development Canada's calculation using the O*NET occupational database.

4. This definition is conceptually compatible with ECT goods and services but, having been developed separately, is not identical in scope or practice. Further, the process to identify GGSs was intended to create a universe of national industries (six-digit NAICS level) that encompasses output-based green activity. As such, even if an industry is flagged with GGSs, no individual firm within that national industry may necessarily be producing them.
5. The extensive documentation on the NAICS concordance is available on the Statistics Canada and U.S. Census websites. There were 245 national industries in the 2012 and 2017 NAICS.

Green intensity of investment

The T2 Schedule 8, which is filed by incorporated businesses as part of their corporate income tax return, provides firm-level data on capital asset acquisitions and depreciation claims through Canada's capital cost allowance (CCA) system. The following CCA classes are related to clean technologies and are leveraged to produce a green capital investment indicator:[6] **CCA classes 43.1 and 43.2** (clean energy generation and energy conservation equipment); **CCA classes 54, 55 and 56** (zero-emission vehicles); and **CCA Class 57** (carbon capture technology).

Environmental exports

Statistics Canada's Trade by Exporter Characteristics (TEC) microdata file records firm-level customs transactions by Harmonized System (HS) commodity. Transactions are then matched to the list of environmental goods associated with the Environmental Goods Agreement (EGA).[7] This list identified 265 six-digit HS environmental goods—mostly specialized manufactured products—being considered for preferential tariffs (see Table A.2 for examples).[8]

3.1.2 Firm characteristics and performance

The National Accounts Longitudinal Microdata File (NALMF) is a firm-level dataset covering all firms in Canada that file a T2 Corporation Income Tax Return, T4 Statement of Remuneration Paid, payroll deduction remittance, or goods and services tax or harmonized sales tax. The file provides consistent and detailed firm-level data on core economic indicators, including value added, employment, productivity, investment, capital assets, research and development expenditures, firm age, industry, and production location.

3.2 Data development

This subsection documents how industrial green intensity is constructed. It is worth noting that industries engaged in multiple green activities may register a higher intensity measure—reflecting their multidimensional activities—than those active only in a single dimension.

3.2.1 Green indicators

Before creating a composite measure of green intensity, eight indicators were created using the data sources outlined in the previous subsection. Six are output-based and two are process-based, with the focus restricted to the business sector.[9] The indicators include:

- five categories derived from the GGS dataset: **renewable**, **efficiency**, **remediation**, **conservation** and **compliance**
- **green intensity of employment**

6. The distinction between "clean technologies" and "green capital" reflects the fact that clean technologies involve a specific taxonomy developed in part to support the Clean Technology Data Strategy. In contrast, this paper applies the CCA class structure to leverage firm-level microdata. While there is considerable conceptual overlap, the two definitions do not coincide completely.
7. In 2014, Canada began negotiations with several members of the World Trade Organization, including China and the United States, to develop a new EGA. The intended goal was to reduce or eliminate tariffs on a broad range of goods that help address environmental challenges, such as renewable energy generation, improved energy efficiency and environmental remediation. While a final agreement was never reached, the process produced the list of environmental goods.
8. See World Trade Organization (n.d.) for more information on the negotiations around the EGA. Environmental goods identified through the process of negotiations with international peers do not fully encompass the definition of ECT products and services used in the ECTPEA.
9. The public sector, which includes educational services, health care and social assistance, public administration, and the central bank, is excluded from the study.

- **industry share of green investment**
- **share of green exports by industry**.

The unit of analysis is industries defined at the four-digit NAICS level, as this is the most granular level feasible based on data availability.

Green goods and services

The five categories of GGSs are used to construct indicators at the four-digit NAICS level by taking an employment-weighted average of all employer businesses at that level of industrial aggregation. In doing so, each four-digit NAICS industry is assigned a score from 0 to 1. A score of 0 indicates that none of the firms within that industry fall within a six-digit NAICS industry that may have GGSs, while a score of 1 indicates that all firms are within national industries that may have GGSs. As the average is employment weighted, industries with greater employment are favoured in the measure. This measure is maximalist by design, as a score of 1 still does not guarantee that a particular firm actually produces GGSs.

Green intensity of employment

Green tasks are related to the production of GGSs and the performance and maintenance of green processes. The green intensity of an occupation can be interpreted as the proportion of time, on average, spent on green-related tasks. Therefore, the measure of green intensity of employment takes the average of the green intensity of occupations weighted by occupational employment at the industry level. As green tasks can take place in the production of GGSs, clean technology adoption and maintenance services, they tend to be concentrated in sectors such as professional, scientific and technical services; utilities; and construction. They also tend to be concentrated in more polluting sectors like mining, quarrying, and oil and gas extraction.

Industry share of green investment

The industry share of green investment is calculated from the CCA in the T2 Schedule 8. Several CCA classes are associated with clean technologies, such as clean energy generation and energy conservation equipment (classes 43.1 and 43.2), zero-emission vehicles (classes 54, 55 and 56), and carbon capture technology (Class 57). Using these classifications, a green capital investment indicator is constructed by calculating each industry’s share of total investment attributable to these classes of assets. Firms involved in energy-intensive or polluting activities have the most incentive to invest in green capital, and so this measure captures efforts involved in greening the economy.

Green intensity of exports

Combining environmental goods in exports from the EGA and the TEC, the green intensity of exports is constructed as the proportion of exports at the four-digit NAICS level, by value, that were identified as environmental goods by the EGA. Reflecting the fact that most identified goods are manufactured products, over three-quarters of environmental goods exports are from the manufacturing sector.

3.2.2 An index of green intensity

To help synthesize all eight indicators into a single index, the study employs a principal factor analysis. Let the factor analysis find q common latent factors ($q < 8$ in this case) to linearly reconstruct the original indicators:

$$X_j = a_{j1}F_1 + \ldots + a_{jq}F_q + u_j, j = 1,2,\ldots,8,$$

where X_j is the normalized value of the j th indicator; a_{jk} is the factor loading, or weight of factor k on indicator j ; F_k is the latent factor; and u_j is the j th indicator's unique factor, which is similar to a residual. Because only the indicator is fixed, a specific method must be selected to estimate the other variables. This study uses the principal component method and the Kaiser criterion for factor selection, which selects eigenvectors with eigenvalues greater than 1, as this threshold represents the information accounted for by an average single item (Kaiser 1960). Once the factor loadings are estimated, a varimax rotation is then applied to improve interpretability (Kaiser 1958).

The results of the factor analysis inform which variables are most closely aligned and the degree to which factors can explain the variation observed in the data. Table 2 summarizes the results of the factor analysis on the eight indicators. It reports only variables with factor loadings above 0.4, grouping them into three factors as retained for index construction.

Table 2
Results of factor analysis

Indicator	Factor 1	Factor 2	Factor 3
Renewable		††	
Efficiency	††		
Remediation	††		
Conservation		††	
Compliance			†
Green investment			††
Green task intensity	††		
Green exports	††		

† indicates a factor loading near 0.4
†† indicates a factor loading well above 0.4
Source: Authors' calculations using Statistics Canada's T2 Schedule 8, Trade by Exporter Characteristics and National Accounts Longitudinal Microdata File datasets; the U.S. Bureau of Labor Statistics' green goods and services classification; and Employment and Social Development Canada's special tabulation on green intensity by industry.

Table 2 shows that each of the eight indicators loads heavily on one of the three factors, with decreasing explanatory power, highlighting different underlying factors that explain the green economy. Factor 1 has a significant bearing on efficiency, remediation, green exports and green intensity of employment, establishing a clear alignment between green tasks and these GGSs. Factor 2 loads renewable and remediation goods and services, suggesting a different segment of the green economy. Finally, Factor 3 loads green investment and, to a lesser extent, compliance. As expected, green investment is mostly orthogonal to the other indicators, capturing the importance of green investment to firms not involved in green production. Industries with compliance-related GGSs typically do not have other kinds of GGSs. Therefore, compliance is loaded weakly on the third factor.

Following these results, including the factor loadings and the explained variation of each factor, a score for each industry is created by combining the indicators as follows:

$$Score_i = \sum_{q=1}^{3} \tilde{\lambda}_q \left(\tilde{a}_{1q} * x_{1i} + \ldots + \tilde{a}_{8q} * x_{8i} \right),$$

where $\tilde{\lambda}_q$ is the normalized eigenvalue of factor q , x_{ji} is industry i 's realized value for indicator j , and $\tilde{a}_{jq}$ is the normalized factor loading for factor q and indicator j if the factor loading a_{jq} is greater than 0.4 and 0 otherwise. Given the results from Table 2, which shows that each indicator significantly loads on one factor, this process creates the following weights for each indicator, summarized in Table 3.

Table 3
Weights to create a score at the four-digit level of the North American Industry Classification System

Indicator	Standardized weight
	number
Renewable	0.146
Efficiency	0.130
Remediation	0.094
Conservation	0.156
Compliance	0.076
Green investment	0.166
Green task intensity	0.125
Green exports	0.107

Source: Authors' calculations using Statistics Canada's T2 Schedule 8, Trade by Exporter Characteristics and National Accounts Longitudinal Microdata File datasets; the U.S. Bureau of Labor Statistics' green goods and services classification; and Employment and Social Development Canada's special tabulation on green intensity by industry.

These weights show the relative importance of each indicator. While GGS-related measures make up the bulk of the index, green investment represents the largest single weight. The results also demonstrate that overperformance in any one indicator is unlikely to greatly affect an industry's overall score. Instead, a strong performance in several categories is needed to achieve a high score. Implicitly, this means that this measure of green intensity tends to favour a broad range of green activities over a singular focus on a particular indicator, although not absolutely.

Once each industry is assigned a score, all 285 four-digit NAICS industries are then sorted into three categories by two thresholds:[10] high green intensity, medium green intensity and low green intensity. The results of this process are summarized in Table 4. Among these industries, 6.7% are categorized as high green intensity.

Table 4
Distribution of industries across green-intensity levels

Green intensity index	Count	Proportion (percent)
High	19	6.7
Medium	94	33.0
Low	172	60.4

Source: Authors' calculations using Statistics Canada's T2 Schedule 8, Trade by Exporter Characteristics and National Accounts Longitudinal Microdata File datasets; the U.S. Bureau of Labor Statistics' green goods and services classification; and Employment and Social Development Canada's special tabulation on green intensity by industry.

3.2.3 Understanding the green intensity index

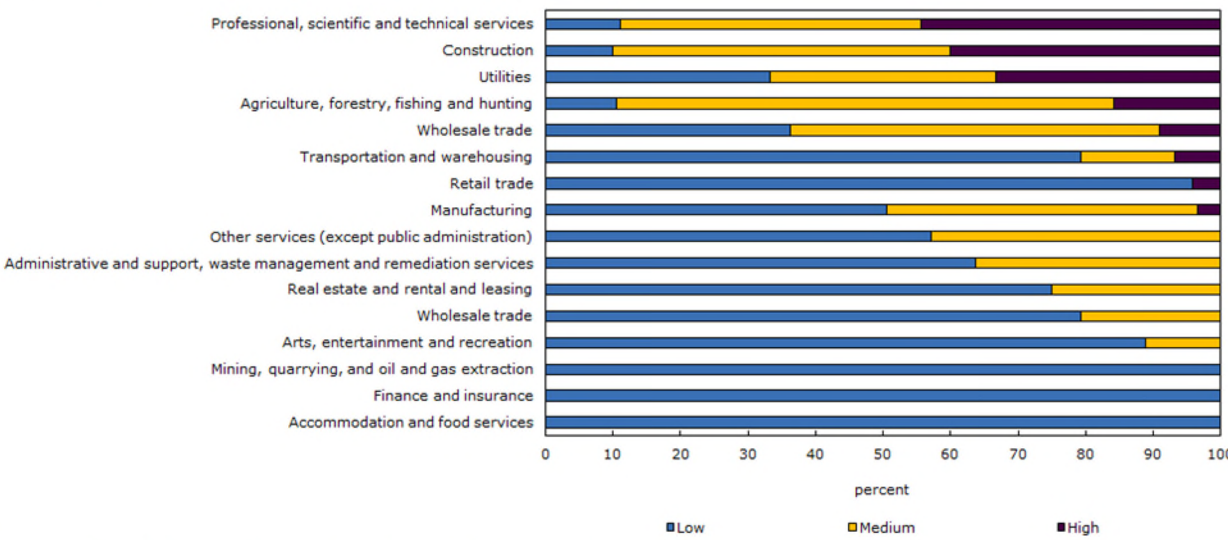
Chart 1 shows how four-digit industries are distributed across the green-intensity categories within sectors. Low green-intensity industries are concentrated in sectors related to natural resource extraction, pipelines, metalwork-related manufacturing, and accommodation and food services. Medium green-intensity industries are found in sectors such as agriculture, forestry, fishing and hunting; information and cultural industries; manufacturing; and other services (except public administration). High green-intensity industries, making up roughly 15% of total real GDP, are most common in sectors such as professional, scientific and technical services; construction; and utilities. However, they also appear in agriculture, forestry, fishing and hunting; information and cultural industries; transportation and warehousing; retail trade; and manufacturing. This demonstrates that green activities are distributed across the economy and that the green intensity

10. These thresholds are determined by sorting industries by their green score and finding the largest gaps between adjacent entries. The gaps represent breaks in the pattern of the values of the indicators for industries of similar rank.

index captures these activities in both the goods-producing sector and the service-providing sector of the economy.

The weights presented in Table 3 also help explain the results in Chart 1. About 70% of the index is made up of output-based measures, mostly through the GGS-derived indicators, but it is also influenced by the export of environmental goods. Given the similar nature of such measures on ECT goods and services, the index overlaps in green activities also identified in the ECTPEA. By including measures related to process, such as green investment and green intensity of employment, the index brings in other industries with high green intensity. For example, strong green investment, particularly in zero-emission vehicles, drives the inclusion of automobile dealers (NAICS 4411) and urban transit systems (NAICS 4851) in the high green-intensity category. This highlights an important nuance of the green intensity index developed in the current paper: industries most intensely participating in improving environmentally friendly processes can be just as important in the green transition as those engaged directly in producing goods and services.

Chart 1
Distribution of industries by green-intensity level and sector



Source: Authors' calculation from the National Accounts Longitudinal Microdata File.

4 Empirical results

With the composite indicator of green intensity developed at the four-digit NAICS industry level, firms in the NALMF can then be grouped according to the green intensity of their industry. This concordance also enables an investigation into how productivity dynamics differ across sectors of varying green intensity. Crucially, the structure of the NALMF allows for tracking firm-level performance over time and, as such, supports a detailed decomposition of aggregate productivity growth into within-firm, between-firm and net entry effects.

4.1 Descriptive statistics

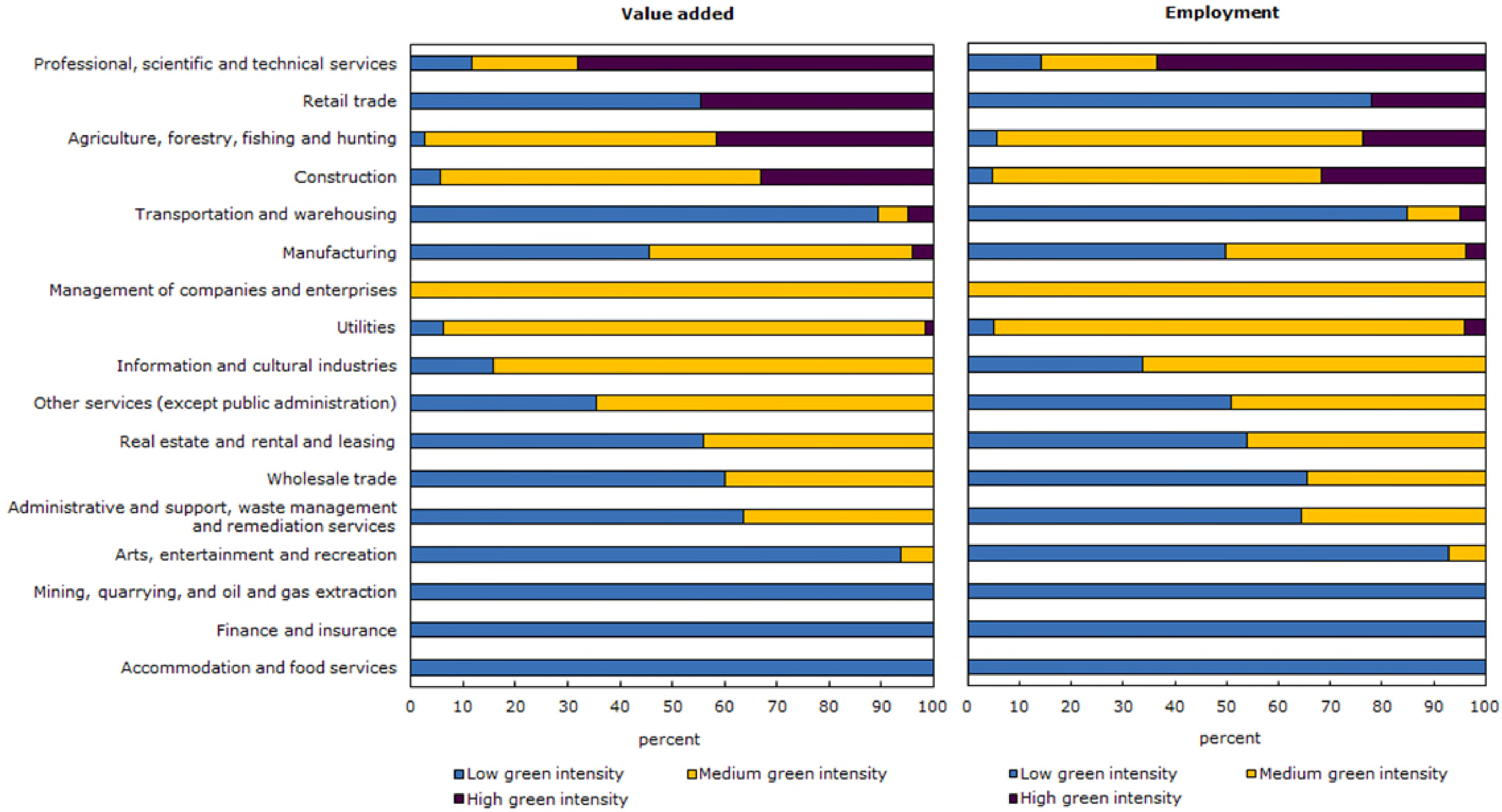
Chart 2 presents a detailed breakdown of the value-added and employment shares across two-digit NAICS sectors, categorized by the level of green intensity of their component four-digit industries. The relative productivity can also be inferred by the ratio of these shares.

As noted in Chart 1, eight sectors include high green-intensity industries. In agriculture, forestry, fishing and hunting, 41.7% of value added and 23.6% of employment come from high green-intensity industries, and the relative productivity is especially high, suggesting that high green-intensity industries in this sector generate much more value per worker (Chart 2). Similarly, in professional, scientific and technical services, high green-intensity industries generate 68.2% of value added and 63.4% of employment. High green-intensity industries in the construction, manufacturing and retail trade sectors also have relative productivity greater than 1.

In contrast, sectors such as utilities and transportation and warehousing have a relative productivity below 1 in their high green-intensity industries. In terms of output and employment, the utilities sector is dominated by electric power generation, transmission and distribution (NAICS 2211), which rates as a medium green-intensity industry, as this category includes renewable and fossil fuel-based forms of energy production.

Some sectors have a high prevalence of low or medium green-intensity industries. Low green-intensity industries make up sectors such as mining, quarrying, and oil and gas extraction; accommodation and food services; and finance and insurance. While the mining, quarrying and oil and gas extraction sector is associated with activities that are damaging to the environment, the accommodation and food services and the finance and insurance sectors are not necessarily so. The prevalence of low green-intensity industries within these sectors reflects relatively low levels of green activity within constituent industries and does not equate to environmental harm or negative environmental effects.

Chart 2
Distribution of value added (left) and employment (right) by green-intensity level and sector, 2022



Source: Authors' calculation from the National Accounts Longitudinal Microdata File.

4.2 Productivity analysis

With distributional statistics by sector and green intensity, this subsection turns to differences in labour productivity between intensity groups. By comparing average productivity levels over time, it assesses whether firms in high green-intensity industries outperform others and to what extent these gaps have changed.

For each tier of green intensity—low, medium and high—aggregate labour productivity is the sum of productivity of firms, weighted by their shares of employment. At the firm level, value added is the sum of the payroll, net income before taxes and extraordinary items, and CCA. Industry-specific deflators are used to convert nominal value added into real terms. This measure reflects the economic value generated by the firm relative to its workforce size:

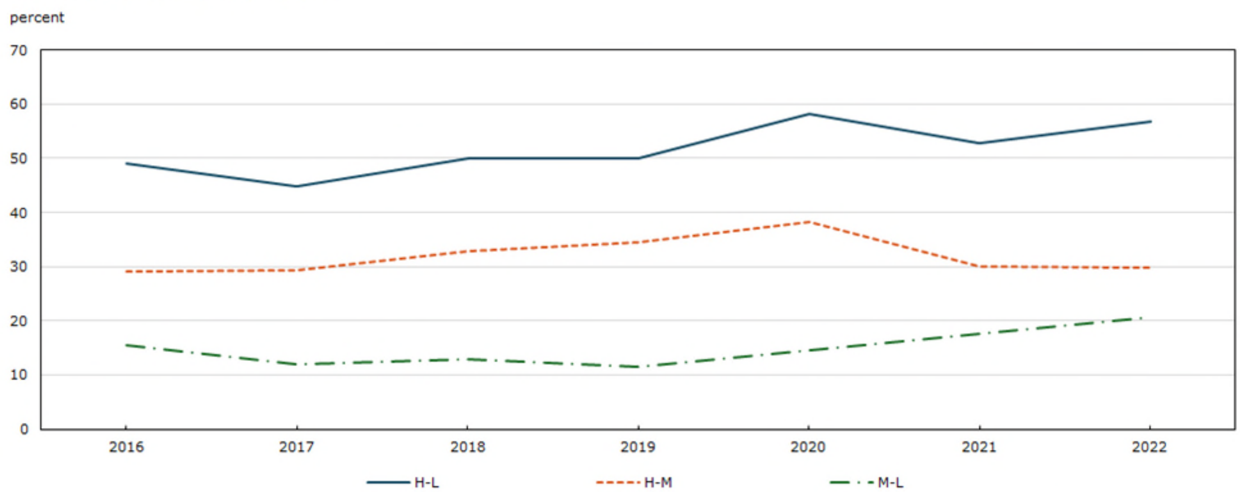
$$P^t = \sum_i s_i^t \, p_i^t \, ,$$

where s_i^t is the share of firm i in employment at time t, and p_i^t represents the firm's labour productivity.

4.2.1 Productivity gaps

Chart 3 shows how labour productivity compares across green-intensity groups. The differences are reported as percentages, using firms in the least green group as a benchmark. Overall, the data show that firms in greener sectors consistently perform better in terms of value added per worker.

Chart 3
Labour productivity gap by year



Notes: H-L denotes the productivity gap (in percentage) between high and low green-intensity industries. M-L denotes the gap between medium and low green-intensity industries. H-M denotes the gap between high and medium green-intensity industries.
Source: Authors' calculation from the National Accounts Longitudinal Microdata File.

The productivity gap between firms in high and low green-intensity industries (H-L) averaged 51.7% over the 2016-to-2022 period, ranging from 44.8% to 58.3%. This suggests that firms in high green-intensity industries consistently generated over 50% more output per worker than those in low green-intensity industries.

The productivity gap between medium and low green-intensity industries (M-L) was more stable, around 29.1%, but peaked in 2020 at 38.3%. Despite year-to-year variations, this smaller and less volatile gap suggests that firms in medium green-intensity industries maintained a relatively consistent comparative advantage in productivity over firms in low green-intensity industries throughout the period.

The productivity gap between high and medium green-intensity industries (H-M) increased over time, rising from 15.5% in 2016 to 20.7% in 2022. This upward trend, combined with a relatively stable M-L gap, indicates that since 2020, the widening productivity gap between H-L firms has been primarily driven by the H-M gap.

The persistent, and in some cases widening, productivity gaps across green-intensity groups underscore the importance of environmental orientation as a driver of firm performance. These descriptive findings motivate the decomposition analysis that follows, which will assess whether these gaps are driven by within-firm improvements, reallocation effects or firm turnover.

4.2.2 Productivity decomposition

The decomposition framework developed by Griliches and Regev (1995) is used to analyze productivity growth. This method attributes changes in aggregate productivity to four components: within-firm productivity change, between-firm employment reallocation, and the contributions of firm entry and exit. The approach has been widely applied, including in the Canadian context by Baldwin and Gu (2008), who used it to study firm turnover and productivity growth in the retail trade sector.

The change in aggregate productivity between two periods is decomposed as:

$$\Delta P_s = \underbrace{\sum\nolimits_{i\in C_s} \overline{s}_{is}\Delta p_{is}}_{Within_s} + \underbrace{\sum\nolimits_{i\in C_s} \Delta s_{is}\left(\overline{p}_{is} - \overline{P_s}\right)}_{Between_s} + \underbrace{\sum\nolimits_{i\in E_s} s_{is}^{t}\left(p_{is}^{t} - \overline{P_s}\right) - \sum\nolimits_{i\in X_s} s_{is}^{t-k}\left(p_{is}^{t-k} - \overline{P_s}\right)}_{Net\ Entry_s = Entry_s - Exit_s},$$

where C_s, E_s and X denote the sets of continuing (incumbent), entering and exiting firms, respectively, within green intensity group s. The term $\overline{P_s}$ represents the average productivity of group s, while $\overline{s}_{is}$ and $\overline{p}_{is}$ denote firm-level averages across the two periods.

The first term measures the within-firm effect, or the contribution of productivity changes among continuing firms to aggregate productivity growth. This reflects improvements or declines in firm-level efficiency. The second term captures the between-firm effect, which is typically interpreted as the contribution from the reallocation of employment among continuing firms. It indicates whether resources have shifted toward more or less productive firms over time. The third and fourth terms reflect the role of firm turnover, measuring the contribution of entering and exiting firms, respectively. Together, these last two terms capture the net effect of firm turnover on aggregate productivity.

In this decomposition, the contribution of entering and exiting firms is evaluated relative to the average productivity level of incumbent firms across all green-intensity groups. Entering firms contribute positively to productivity growth if they are more productive than the average incumbent (positive entry effect). Conversely, the contribution of exiting firms is positive when they are less productive than the group average at the time of their exit. The combined effect of the between-firm, entry and exit terms thus reflects the role of market selection and reallocation in shaping productivity outcomes over time (Baldwin and Gu 2008).

Stronger growth for firms in high green-intensity industries from 2016 to 2022

The results are presented in Table 5. At the aggregate level, labour productivity grew by 12.8% over the six-year period from 2016 to 2022, with 9.6 percentage points attributed to within-firm improvement, 2.0 percentage points to reallocation among incumbents and 1.3 percentage points to net entry. Labour productivity also increased across all green-intensity groups, though the sources and magnitudes of such growth varied. Firms in high green-intensity industries recorded the largest productivity growth, at 15.8%, compared with 13.0% for those in low green-intensity industries and 11.7% for those in medium green-intensity industries.

Table 5
Decomposition of labour productivity growth

Sector	Within-firm effect	Between-firm effect	Net entry	Entry	Exit	Total
		percentage points				percent
2016 to 2022						
All sectors						
Green-intensity level						
Low	9.2	3.6	0.1	-7.8	7.9	13.0
Medium	11.3	-1.1	1.5	-2.7	4.2	11.7
High	5.7	5.5	4.6	-3.0	7.6	15.8
All levels	**9.6**	**2.0**	**1.3**	**-5.3**	**6.6**	**12.8**
2021 to 2022						
All sectors						
Green-intensity level						
Low	-9.4	-2.1	-0.4	-1.7	1.2	-11.9
Medium	-6.1	-0.5	-1.3	-1.3	-0.1	-8.0
High	-3.9	0.7	0.2	-1.1	1.3	-3.1
All levels	**-7.5**	**-1.3**	**-0.8**	**-1.5**	**0.7**	**-9.5**

Source: Authors' calculation from the National Accounts Longitudinal Microdata File.

In the low green-intensity group, most of the productivity growth came from within-firm improvements (9.2 percentage points) and reallocation (3.6 percentage points). The positive contribution to productivity growth implied by the exit of less productive firms (7.9 percentage points) was offset by the entry of less productive firms (-7.8 percentage points). The medium green-intensity group showed the most sizable within-firm growth (11.3 percentage points) but a limited reallocation effect (-1.1 percentage points) and a modest net entry effect (1.5 percentage points).

The productivity growth was more balanced within the high green-intensity group, which posted positive within-firm growth (5.7 percentage points), a positive reallocation effect (5.5 percentage points) and the highest net entry contribution (4.6 percentage points). The net entry reflects that the positive exit effect (7.6 percentage points) offset the negative entry effect (-3.0 percentage points), suggesting that within high green-intensity industries, productivity gains are driven more by the exit of less productive firms than by the entry of new ones.

Broad-based declines in productivity from 2021 to 2022

During the early recovery from the COVID-19 pandemic, labour productivity declined across all green-intensity groups (Table 5). The overall productivity fell by 9.5%, with the largest contribution coming from within-firm productivity declines (-7.5 percentage points). The between-firm reallocation of employment toward less productive firms contributed 1.3 percentage points of decline. Net entry of firms with less productivity, compared with an average incumbent, accounted for 0.8 percentage points of decrease.

Across firms, those in low green-intensity industries experienced the largest productivity drop (-11.9%), followed by firms in the medium (-8.0%) and high (-3.1%) green-intensity groups. The decline in the low green-intensity group was primarily driven by within-firm productivity decreases (-9.4 percentage points), with modest contributions from reallocation (-2.1 percentage points) and, to a lesser degree, net entry (-0.4 percentage points). In contrast, the high green-intensity group was the only group to post a positive reallocation effect (0.7 percentage points) and a slightly positive net entry effect (0.2 percentage points), highlighting its economic resilience through reallocation and market dynamics.

4.2.3 Distinguishing “greenness” from sector composition

One important question arises: is the productivity advantage observed among greener industries unique to the “greenness” defined by this paper? Or is it potentially driven by its concentration in the service sector, which is typically more knowledge intensive? To address this, the decomposition was separately carried out for service-providing and for goods-producing industries. The results are summarized in Table 6.

Table 6
Decomposition of labour productivity growth, goods versus service sectors

Sector	Within-firm effect	Between-firm effect	Net entry	Entry	Exit	Total
		percentage points				percent
2016 to 2022						
Services						
Green-intensity level						
Low	11.6	5.3	1.9	-6.4	8.3	18.8
Medium	13.3	0.0	8.7	5.8	2.9	22.0
High	-0.5	7.8	5.3	-2.3	7.5	12.6
All levels	**10.9**	**3.7**	**4.9**	**-1.7**	**6.6**	**19.5**
Goods						
Green-intensity level						
Low	-5.9	0.2	2.5	2.8	-0.3	-3.2
Medium	8.2	-1.7	-2.1	-4.4	2.3	4.4
High	17.5	0.7	4.3	-3.5	7.8	22.4
All levels	**3.9**	**-0.7**	**0.4**	**-1.5**	**2.0**	**3.6**
2021 to 2022						
Services						
Green-intensity level						
Low	-7.0	-1.7	1.4	-0.3	1.7	-7.4
Medium	-6.6	-1.1	3.0	3.4	-0.5	-4.7
High	-4.8	1.1	1.1	-0.2	1.3	-2.7
All levels	**-6.6**	**-1.4**	**1.8**	**1.0**	**0.8**	**-6.2**
Goods						
Green-intensity level						
Low	-19.7	-2.4	-2.4	-1.3	-1.1	-24.5
Medium	-5.6	0.2	0.4	-1.1	1.6	-5.0
High	-3.6	0.0	-1.7	-2.5	0.7	-5.4
All levels	**-11.2**	**-1.0**	**-0.9**	**-1.3**	**0.3**	**-13.1**

Source: Authors’ calculation from the National Accounts Longitudinal Microdata File.

Comparing results in tables 5 and 6 reveals that greenness is not just a proxy for sectoral makeup. For both sectors, within-firm improvement was the main driver for productivity growth during the 2016-to-2022 period, followed by net entry and between-firm reallocation. Furthermore, at the onset of the pandemic, the decline in net entry from the goods sector largely underpinned the overall outcome, in contrast to a rise in market dynamics in the service sector.

Important differences also emerge between the goods and service sectors by green-intensity level. In the service sector, high green-intensity industries were more resilient during the pandemic shock, posting the smallest productivity decline (-2.7%), compared with the medium (-4.7%) and low (-7.4%) intensity groups. This resilience was not driven by improvements within firms, but rather by resource reallocation toward more productive firms and exits of less productive ones. Over the longer period from 2016 to 2022, productivity gains in services were strongest in the medium green-intensity group (22.0%), reflecting a surge of productive entrants, while high green-intensity services grew modestly (12.6%), relying more on market reallocation. This shows that in services, the green premium is associated with dynamic market adjustments rather than consistent within-firm improvements.

By contrast, in the goods-producing sector, the green premium is somewhat clearer. From 2016 to 2022, productivity in high green-intensity goods industries rose by 22.4%, driven primarily by within-firm growth (17.5 percentage points) and supported by positive exit dynamics. Goods industries with medium green intensity grew modestly (4.4%), while those with low green intensity declined (-3.2%). During the pandemic, goods industries overall posted sharp productivity losses, but the smallest decline was again observed in medium (-5.0%) and high (-5.4%) green-intensity industries, while low-intensity goods industries contracted sharply (-24.5%). This suggests that in the goods sector, greener industries are not only more resilient but also better able to sustain long-term productivity growth through within-firm improvement.

These findings are broadly consistent with the theoretical and empirical literature discussed in sections 1 and 2. The observed productivity advantage among firms in the high green-intensity industries, in terms of higher average labour productivity and greater resilience during the pandemic downturn, aligns with the view that environmental orientation can complement, rather than slow, firm performance. The decomposition results further support this interpretation, showing that productivity growth in the high green-intensity group reflects a balance among within-firm improvements, between-firm reallocation and net entry effects. The results also demonstrate that greenness matters beyond sector composition. In services, the productivity advantage comes from reallocation and market resilience, while in goods-producing industries it comes from sustained within-firm improvements. Taken together, these results highlight that greener industries may be better positioned to drive and sustain productivity growth over time.

4.2.4 Understanding growth drivers across green industries

High green-intensity industries recorded the strongest overall productivity growth, yet lower within-firm contributions, compared with less green industries. At first glance, this may appear contradictory: should the industries most engaged in the green transition also demonstrate strong within-firm improvements, instead of relying more heavily on market dynamics?

It turns out that this pattern is not unique to green industries. Canadian studies have shown that the sources of productivity growth differ sharply by sector. For example, in the retail trade sector, almost 70% of labour productivity growth from 1984 to 1998 came from net entry and reallocation, while the within-firm component was small and sometimes negative (Baldwin and Gu 2008). Productivity gains in that sector reflected the rise of new entrants and technology-enabled firms displacing less productive incumbents. By contrast, Canadian manufacturing saw a substantial within-firm improvement from 1973 to 1997, accounting for 40% to 100% of productivity growth, while net entry contributed to a smaller share (Baldwin and Gu 2003).

The results presented herein align closely with this distinction. In goods-producing and high green-intensity industries, productivity growth primarily driven by within-firm improvements is possibly reflective of higher capital intensity and firm-level investment in specialized green equipment and technologies. In services, by contrast, high green-intensity industries exhibit limited within-firm growth but strong contributions from reallocation and turnover, mirroring the experience of the retail sector. The findings that greener industries show overall higher productivity growth with lower within-firm contributions therefore reflect the growth drivers of the green economy leaning more heavily on services.

These findings have important implications. First, Greener industries may grow in a different way, gaining productivity not just from improvements within individual firms, but more from dynamic changes across the broader market. Second, policies aimed at greening the economy should consider different instruments for different sectors. For goods-producing green industries, supporting capital deepening and technology adoption may be key to sustaining firm-level productivity gains. For service-based green industries, by contrast, productivity growth depends more on maintaining a dynamic, competitive environment that allows efficient firms to expand, less productive ones to exit, and knowledge and practices to spread across firms.

5 Discussion

Despite the importance of understanding the green transition in Canada, existing metrics have been typically developed around single dimensions, providing important but incomplete snapshots. This paper develops a first-of-its-kind composite index of green intensity at the four-digit NAICS level, combining multidimensional indicators that reflect green activities related to output, technology adoption and employment. Principal component-based factor analysis was used to synthesize these indicators into a single score for each industry.

Using this composite index, the paper finds firms in the most green-intensive industries to be concentrated in professional, scientific and technical services and construction, reflecting the knowledge-intensive nature of the green transition. While most of the economy's value added and employment are within low and medium green intensity, five of eight sectors with high green-intensity industries derive a disproportionate share of their value added from those industries. Overall, the distribution of green intensity across the economy is highly uneven, indicating that efforts to increase green activity should consider the unique characteristics and current status of each sector.

The productivity decomposition analysis reveals that firms in high green-intensity industries not only maintain superior performance levels but also exhibit greater economic resilience. The analysis from 2016 to 2022 shows the largest productivity gains occurring in the high green-intensity group. The strongest productivity growth within the high green-intensity group came from industries in the goods-producing sector and was driven by high within-firm productivity growth, suggesting the importance of capital deepening for these industries. The gains for high green-intensity industries within the service sector were more balanced, with productivity improvements driven primarily by the reallocation of employment toward more productive firms and by business turnover. This suggests that these industries rely more heavily on market dynamics for productivity growth. During the pandemic-related productivity decline in 2021 and 2022, these industries experienced the smallest productivity drop (-3.1%) while demonstrating positive reallocation and net entry effects, across those in the goods and the service sectors. These findings further confirm that firms in more green-intensive industries are better positioned to adapt to economic shocks and maintain competitive advantages during times of uncertainty.

Overall, the study challenges the traditional assumption of environmental–economic trade-offs and demonstrates that greening the economy not only supports environmental goals but can also drive stronger economic growth. The comprehensive measurement framework developed in this study also offers a valuable tool for policy makers seeking to understand and promote the green economy transition, with implications extending beyond Canada's borders for countries weighing the costs and benefits of environmental protection.

While this analysis represents a step forward in understanding the structure of the green economy, several limitations remain. For example, the current green intensity index is based on 2022 data and applied retroactively using a fixed concordance across the years. While allowing for consistency in classification, it may limit the ability to capture changes in green activity over time. Similarly, the index does not represent firm-level variation in green activities and, by aggregating at the industry level, may miss standout high green-intensity firms. Future work should aim to address these limitations, including integrating the time-varying nature of the green transition, constructing a more granular index at the firm level, and accounting for additional data sources to better capture environmentally friendly innovation and technology adoption.

6 Annex: Indicators of green activity

Green intensity of employment

Table A.1 lists the top 10 sectors in 2023 by green intensity of employment. Given the heavy representation of occupations related to engineering and science, the professional, scientific and technical services sector leads all others in terms of green intensity of employment. The utilities and construction sectors are also in the top 10. The high scores for the mining, quarrying, and oil and gas extraction sector and the transportation and warehousing sector reflect the role of tasks related to green processes and remediation in sectors traditionally considered highly polluting.

Table A.1
Top 10 sectors by green intensity of employment, 2023

Sector	Green task intensity (percent)
54 Professional, scientific and technical services	7.0
22 Utilities	4.5
52 Finance and insurance	4.5
51 Information and cultural industries	4.0
21 Mining, quarrying, and oil and gas extraction	3.8
91 Public administration	3.6
23 Construction	3.0
48-49 Transportation and warehousing	3.0
31-33 Manufacturing	2.8
41 Wholesale trade	2.5

Source: Employment and Social Development Canada's calculation using the O*NET occupational database and custom tabulations from Statistics Canada's Labour Force Survey.

World Trade Organization's list of environmental goods

Goods associated with 265 six-digit Harmonized System (HS) codes were identified as environmental goods through the negotiations for the Environmental Goods Agreement. Because the list of environmental goods identifies goods using the 2012 vintage of the HS, this paper uses a conversion table published by the United Nations to identify environmental goods using the latest 2022 vintage. Table A.2 provides a brief sample of environmental goods and their description from the HS.

Table A.2
Examples of identified environmental goods

Harmonized System code	Description
8481.80	Taps, cocks, valves and similar appliances for pipes, boiler shells, tanks, vats or the like, including pressure-reducing valves and thermostatically controlled valves: - Other appliances
7308.90	Structures and parts of structures of iron or steel; plates, rods, angles, shapes, sections, tubes and the like, prepared for use in structures, of iron or steel: - Other
8501.52	Electric motors and generators (excluding generating sets): Other AC motors, multi-phase: Of an output exceeding 750 W but not exceeding 75 kW
4401	Fuel wood, in logs, in billets, in twigs, or in similar forms; wood in chips or particles; sawdust and wood waste and scrap, whether or not agglomerated in logs, briquettes, pellets or similar forms: - Other

Source: World Customs Organization.

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