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Economic factors and the changing size distribution of breweries in Canada: 2011-2025

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Abstract

In this paper we examine the association between economic factors and the size distribution of breweries in Canada between 2011 and 2025. Using Statistics Canada's grouped employment data, we first estimate Gini indices of brewery size inequality based on the Ortega et al. and Rohde functional forms of the Lorenz curve. We then examine the association between economic factors and the estimated Gini indices of the size distribution of breweries. Our empirical results, which are robust with respect to the choice of Lorenz curve functional form, reveal a significant general decrease in the degree of inequality in the size distribution of breweries over the 15-year period considered, which is consistent with the rapid growth in the number of small craft breweries in the Canadian beer sector. We also find that the decrease in brewery size inequality is largely explained by the growth in incomes.

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1. Introduction

The existence of many papers examining the size distribution of firms across a wide range of industries and countries (e.g., Cabral and Mata, 2003; Caputo, 2007; Angelini and Generale, 2008; Cefis et al., 2009; Cirillo, 2009; Ashenfelter et al., 2015) highlights the widespread interest in understanding how firms vary in size across different economic contexts.

The strong interest in firm size distribution can be attributed to several factors. For example, a disproportionately high prevalence of very small firms relative to medium and large firms can affect employment, competition, and innovation, among other outcomes. A balanced mix of firms of different sizes can create opportunities for smaller firms to stimulate local economic activity across sectors, while larger firms may be more actively engaged in international trade. Information on firm size distribution is also valuable for developing government policies related to taxation, subsidies, and regulations for different categories of firms.

From a theoretical perspective, knowledge of firm size distribution can help explain how firms evolve and how different distributions emerge (e.g., Gibrat, 1931; Lucas, 1978; Coad, 2009; Fiori, 2020). For example, under Gibrat's (1931) law of proportionate effect, whereby firm growth is independent of firm size, the resulting size distribution is log-normal under certain assumptions.

From an empirical perspective, firm size has been linked to a wide range of economic phenomena, including productivity and economic growth (e.g., Pagano and Schivardi, 2003; Silveira, 2022), innovation (e.g., Ettlie and Rubenstein, 1987), profitability (e.g., Amato and Wilder, 1985; Amato and Amato, 2004), and ownership structure (e.g., Csabay and Stehlikova, 2020), among others. Similarly, it is important to undertake empirical investigations into the determinants of changes in the size distribution of firms.

There are two major empirical approaches to studying the size distribution of firms. The first approach (e.g., Cirillo, 2009; Cyr et al., 2014) involves fitting a specific statistical distribution to an appropriate measure of firm size, such as the number of employees or output. This approach is feasible only when data on firm size measures are available at the individual firm level. However, when data are available only in grouped form, as is often the case, Lorenz curves can be used to model the size distribution. Originally introduced by Lorenz (1905), Lorenz curves are graphical representations of inequality that can be used to assess changes in firm size distributions over time.

Despite the widespread use of Lorenz curves for analyzing income and wealth distributions (e.g., Lorenz, 1905; Ogwang and Rao, 1996, 2000; Krause, 2014; De Mesnard, 2022; Sarabia et al., 2025), our comprehensive review of the literature suggests that these curves have rarely been applied to the study of firm size distributions. The fact that every probability distribution has an associated Lorenz curve representation (e.g., Gastwirth, 1972; De Mesnard, 2022) makes the Lorenz curve a credible and flexible tool for analyzing firm size distributions.

From a policy perspective, it is important to identify the factors that explain changes in the size distribution of firms. In this regard, our review of the literature reveals relatively few studies that examine the determinants of firm size distribution in general, and brewery size distribution in particular.

The objective of this paper is therefore to address this gap by examining the factors that explain changes in the size distribution of breweries in Canada between 2011 and 2025, with a particular focus on economic factors, using Lorenz curves and the associated Gini indices.

Our choice of Lorenz curves for the empirical analysis is motivated by the fact that data on brewery size in Canada, measured by the number of employees, are available only in grouped form. In addition, Lorenz curves provide estimates of the Gini index, a widely accepted quantitative measure of inequality. Our approach is also consistent with earlier studies that used Gini indices to assess firm size inequality in other industries (e.g., Fedderke and Naumann, 2011; Guo et al., 2013; Gao et al., 2015).

Our analysis proceeds in two stages. In the first stage, we employ the Lorenz curve models proposed by Ortega et al. (1991) and Rohde (2009) to estimate the relevant Gini indices associated with brewery size inequality over the 15-year period from 2011 to 2025. In the second stage, we use regression analysis to examine the economic determinants of changes in inequality in the brewery size distribution over the same period.

Our empirical results reveal a general downward trend in the Gini index of inequality in the size distribution of Canadian breweries over the 15-year period examined (2011–2025). We also find a significant negative relationship between the Gini index of inequality in brewery size distribution and real Gross National Income (GNI) per capita. As discussed below, these findings suggest that the proliferation of microbreweries in Canada has been partly driven by rising incomes.

The remainder of the paper is organized as follows. Section 2 describes the salient features of the Canadian beer industry. Section 3 provides an overview of Lorenz curves in the context of firm size distribution analysis. Section 4 outlines the methodology and data used in the study. Section 5 presents and discusses the empirical results. Finally, Section 6 provides the conclusions.

2. Overview of the beer industry

The relative resilience of beer consumption to economic cycles (e.g., Freeman, 2001; Sadik-Zada and Niklas, 2021) makes the beer industry an interesting context for examining long-term trends and structural change. During its early development, the industry became increasingly concentrated as firms expanded through a combination of increasing returns to scale in production and pecuniary economies. Many firms also pursued mergers to achieve these efficiencies.

The literature examining the advantages and disadvantages of industry consolidation is extensive (e.g., Horowitz and Horowitz, 1969; Larue et al., 1996; Cefis et al., 2009; Horvath et al., 2001; Ashenfelter et al., 2015; Blundell and Wilson, 2023). For example, Ashenfelter et al. argue that firms advocating horizontal mergers often claim that such mergers will lower prices for consumers. However, reduced competition may create incentives to increase prices, potentially outweighing any cost reductions resulting from consolidation. Blundell and Wilson (2023) further examine the non-price effects of horizontal mergers in the beer industry, particularly with respect to product variety.

In many countries, the beer industry has undergone significant structural transformation as craft beer has gained popularity and market share in a manner like boutique wines. This trend, which began in the United States during the 1970s, has since spread to many European and Asian markets (Kleban and Nickerson, 2012; Smith et al., 2017; Garavaglia and Swinnen, 2018; Fastigi et al., 2018; Miller et al., 2019; Cabras et al., 2023). Canada has experienced a similar development (Chittley, 2014; Lamertz et al., 2016; Weersink et al., 2018; Stiff and Smetanin, 2022).

Although overall beer consumption in Canada has declined slightly in recent years, the number of craft breweries has continued to increase. In addition, an exploratory analysis of Google Trends data (https://trends.google.com/trends/) reveals a general upward trend in the Google Search Intensity Index for the combined terms "craft breweries" and "craft beer" in Canada since 2004, when such data first became available. This trend signifies a growing public interest in the craft beer industry.

Surprisingly, the beer industry has received less scholarly attention than the wine industry, despite both sectors exhibiting similar patterns of smaller firms entering the market. While numerous studies have explored the historical development of craft beer, research specifically focused on the size distribution of breweries remains relatively limited. Nevertheless, several studies help explain why craft beer has been able to gain market share. For example, Murray and O'Neill (2012, p. 900) surveyed 25,000 craft beer enthusiasts to analyze their demographics, spending habits, and restaurant selection criteria. They found that approximately 42 percent of respondents were between the ages of 35 and 49, while 80 percent reported relatively high family incomes and higher levels of education (p. 903). Their findings suggest that income growth may be an important driver of the proliferation of craft breweries.

Other research highlights how craft breweries have successfully occupied market niches that were neglected because of the homogenization of beer products by large breweries (Withers, 2017; Elzinga et al., 2015). In addition, several studies emphasize the importance of craft beer in tourism, drawing parallels with wine tourism, which has long supported the boutique wine sector (e.g., Plummer et al., 2005; Pechlaner et al., 2009; Kraftchick et al., 2014; Weersink et al., 2018; Miller et al., 2019; Gajic et al., 2021; Dunn and Wickham, 2021).

In response to declining market share, large breweries have adopted strategies like those used by major wineries. Just as large wine producers have introduced boutique wine labels, many major breweries have launched their own craft beer brands to remain competitive (Caputo, 2007).

3. Overview of the estimated Lorenz curves

A Lorenz curve is a valuable graphical tool for analyzing grouped data. Although Lorenz curves have traditionally been used to study income and wealth distributions, they can also be adapted to analyze the distribution of firm sizes. Clear expositions of Lorenz curves and their applications are provided by Sitthiyot and Holasut (2020, 2021). One of the principal strengths of Lorenz curves is that they yield the Gini index, a widely used numerical measure for assessing inequality in any variable of interest, whether income, wealth, or firm size.

Following the standard approach used in Lorenz curve analyses of income and wealth distributions (e.g., Ogwang and Rao, 1996, 2000; Krause, 2014), a Lorenz curve for firm size distribution is constructed by plotting the cumulative proportion of firms on the horizontal axis, with firms ranked from smallest to largest, against the corresponding cumulative proportion of the firm size measure on the vertical axis.

There are two main reasons why Lorenz curves are particularly well suited for analyzing firm size distributions. First, as noted earlier, Lorenz curves can be conveniently constructed using grouped data. Second, they provide estimates of the Gini index, a widely accepted numerical measure of the degree of firm size inequality.

Mathematically, a Lorenz curve for firm size distribution takes the generic form $y = L(p), 0 \leq p \leq 1; 0 \leq y \leq 1$, where p is the cumulative proportion of firms (ranked from smallest to largest as explained above) and y is the corresponding cumulative proportion of employees (or another appropriate measure of firm size). A legitimate Lorenz curve must satisfy the boundary conditions $L(0)=0$ (i.e., the smallest 0 percent of firms employ 0 percent of employees) and $L(1)=1$ (i.e., the smallest 100 percent of firms employ 100 percent of employees). A legitimate Lorenz curve must also be convex and monotonically increasing and therefore must satisfy the conditions $\frac{dL(p)}{dp} \geq 0$ and $\frac{d^2L(p)}{dp^2} \geq 0$. The perfect equality line is the diagonal line connecting the two boundary points, points (i.e., $L(0) = 0$ and $L(1) = 1$) on a Lorenz curve.

The Gini index of a legitimate Lorenz curve $y = L(p), 0 \leq p \leq 1; 0 \leq y \leq 1$ is given by the formula $G = 1 - \left\{2 \int_0^1 L(p)dp\right\}$. When all firms are equal in size, the Gini index attains its minimum value of zero. In contrast, when a single firm accounts for all employment, the Gini index attains its maximum value of one. The farther the Lorenz curve deviates from the perfect equality line, the more unequal the firm size distribution becomes and the closer the Gini index approaches its maximum value.

In this paper, our empirical analysis is based on the popular and parsimonious Lorenz curve functional forms proposed by Ortega et al. (1991) and Rohde (2009), both of which satisfy all the desirable properties of a legitimate Lorenz curve under the appropriate parameter restrictions stated below. Our selection of these two functional forms was also motivated by the need to conserve degrees of freedom for reliable Nonlinear Least Squares (NLS) estimation of their parameters, given the limited number of observed points on the Lorenz curves.

The functional form of the two-parameter Lorenz curve proposed by Ortega et al. (1991) is:

$$y = p^{\alpha}\left(1 - (1-p)^{\beta}\right), \alpha \geq 0, 0 \leq \beta \leq 1 \quad (1)$$

where p is the cumulative proportion of firms and y is the cumulative proportion of employees, as defined above.

The Gini index for the Ortega et al. (1991) Lorenz curve depicted in Equation (1) is given by

$$G = \frac{(\alpha-1)}{(\alpha+1)} + 2B(1+\alpha, 1+\beta) \quad (2)$$

where $B(1+\alpha, 1+\beta)$ denotes the usual beta function with parameters $(1+\alpha, 1+\beta)$.

The functional form of the one-parameter Lorenz curve proposed by Rohde (2009) is:

$$y = p\left(\frac{\alpha-1}{\alpha-p}\right), \alpha > 1 \quad (3)$$

The Gini index for the Rohde (2009) Lorenz curve depicted in Equation (3) is given by

$$G = 1 - 2(\alpha - 1)[\alpha \ln(\alpha) - \alpha ln(\alpha - 1) - 1] \quad (4)$$

4. Methodology and Data

Our analysis of trends in brewery size inequality in Canada is based on the number of employees as the measure of brewery size. Our preference for using the number of employees as a measure of firm size is motivated by two main considerations. First, the number of employees is a simple, transparent, and widely used indicator not only of the size of a firm's workforce, but also of its resource capacity and economic impact. Second, reliable data on the number of employees are more readily available than data on alternative measures of brewery size, such as output, sales volume, or asset size.

We obtained the employment data used in this analysis from various releases of the *Canadian Business Counts with Employees*, published by Statistics Canada (available at https://www150.statcan.gc.ca). Given our focus on the size distribution of breweries, we use data corresponding to the North American Industry Classification System (NAICS) Code 312120, which specifically pertains to breweries. Statistics Canada reports brewery size distribution data twice annually, for June and December. For consistency, we use only the December figures for each year.

Ideally, we would have examined trends in brewery size distribution beginning in 1985, when only ten breweries were recorded in Canada. However, insufficient data on employee counts across all relevant firm size categories for the earlier years limited our analysis to the 15-year period from 2011 to 2025.

Table 1 presents the size distribution of breweries in Canada over this 15-year period, using the number of employees as the measure of firm size. One notable feature of the data is the substantial increase in the number of breweries from 157 in 2011 to more than eight hundred by the early 2020s.

To examine changes in brewery size inequality over time, we use the data reported in Table 1 to construct observed points on the Lorenz curve for each year in Canada. Each observed point (*x, y*) indicates that the smallest *x* percent of firms employ *y* percent of total employees, as explained in Section 3 above.

We use NLS to fit both the Ortega et al. and Rohde Lorenz curve functional forms to the data for each year. We then calculate the Gini measure of brewery size inequality for the fitted Lorenz curves using the relevant formulas presented in Section 3.

Table 1: Classification of breweries in Canada by size (2011-2025)*

Year	Brewery size classification (Number of employees)								
	1-4	5-9	10-19	20-49	50-99	100-199	200-499	≥500	Total
2011	45	38	25	29	6	6	4	4	157
2012	49	32	36	29	9	10	4	3	172
2013	68	38	39	36	12	10	5	3	211
2014	75	47	46	42	15	11	5	4	245
2015	82	61	62	66	18	14	5	5	313
2016	94	76	97	85	27	15	6	2	402
2017	114	99	134	105	33	20	5	2	512
2018	153	136	143	134	43	21	5	2	637
2019	173	155	187	171	38	22	7	2	755
2020	182	169	204	192	36	21	9	2	815
2021	157	190	208	264	38	21	9	3	830
2022	161	175	222	246	48	16	9	4	881
2023	152	180	234	248	58	21	9	4	906
2024	142	179	238	240	62	22	12	2	897
2025	148	143	243	222	78	23	7	4	868

*Source: Statistics Canada: *Canadian Business Counts with Employees*, various December releases. North American Industry Classification System (NAICS) Code 312120. The data are available at https://www150.statcan.gc.ca.

5. Empirical Results

5.1 Evolution of the size distribution of breweries

Table 2 presents the estimated parameters and Gini indices for the Ortega et al. (1991) and Rohde (2009) Lorenz curves for Canada. Three features of the table are particularly noteworthy. First, the estimated parameters for both Lorenz curve models satisfy all the required conditions for a valid Lorenz curve in each of the 15 years examined. Second, the estimated Gini indices derived from the two models are very similar, even though the Ortega et al. model contains two parameters whereas the Rohde model contains only one. Third, the reported Gini estimates reveal consistently high levels of inequality in the size distribution of Canadian breweries, with Gini index values exceeding 0.6 in all 15 years studied (2011–2025), regardless of the Lorenz curve model used.

Two additional aspects of Table 2 are also noteworthy. First, the general decline in the Gini values over time suggests that the corresponding Lorenz curves shifted progressively closer to the perfect equality line. Second, the Gini estimates obtained in this study are similar in magnitude, and in many cases lower, than those reported by Fedderke and Naumann (2011) for the South African manufacturing sector, which were based on ungrouped firm level data.

Table 2: Estimates of Lorenz curves and the Gini indices for breweries size inequality in Canada (2011-2025)*

Year	Ortega et al. (1991)			Rohde (2009)	
	α	β	Gini	α	Gini
2011	4.40861	0.343215	0.8077	1.05539	0.7662
2012	3.78995	0.385865	0.7747	1.06693	0.7384
2013	4.80090	0.416270	0.7953	1.06472	0.7435
2014	3.37096	0.359711	0.7698	1.06459	0.7438
2015	2.52040	0.345773	0.7402	1.06920	0.7333
2016	1.96228	0.392812	0.6845	1.09239	0.6862
2017	1.62485	0.390792	0.6607	1.10227	0.6685
2018	1.61861	0.405203	0.6522	1.08600	0.6983
2019	1.63645	0.420140	0.6457	1.06670	0.6610
2020	1.62783	0.422555	0.6437	1.10634	0.6616
2021	0.983461	0.374190	0.6112	1.10120	0.6704
2022	1.24340	0.413732	0.6129	1.11147	0.6531
2023	1.18197	0.404112	0.6125	1.11363	0.6528
2024	1.28801	0.419209	0.6141	1.11865	0.6417
2025	1.25812	0.426792	0.6066	1.12840	0.6270

* The Ortega et al. (1991) Lorenz curve is given by the formula $y = p^{\alpha}\left(1-(1-p)^{\beta}\right)$, $\alpha \geq 0$, $0 \leq \beta \leq 1$, where p is the cumulative proportion of firms and y is the cumulative proportion of employees as noted above. The Gini index corresponding to the Ortega et al. Lorenz curve is given by the formula $G = \frac{(\alpha-1)}{(\alpha+1)} + 2B(1+\alpha, 1+\beta)$, where $B(1+\alpha, 1+\beta)$ denotes the usual beta function with parameters $(1+\alpha, 1+\beta)$. The Rohde (2009) Lorenz curve is given by the formula $y = p\left(\frac{\alpha-1}{\alpha-p}\right)$, $\alpha > 1$. The Gini index corresponding to the Rohde Lorenz curve is given by the formula $G = 1 - 2(\alpha-1)[\alpha \ln(\alpha) - \alpha ln(\alpha-1) - 1]$.

5.2 Determinants of the evolution of the size distribution of breweries

Having identified a downward trend in the level of inequality in the brewery size distribution in Canada over the 2011–2025 period, we proceeded to examine the determinants of this trend by regressing the Gini measure of inequality on Gross National Income (GNI) per capita (in thousands of constant 2015 dollars), a widely accepted indicator of overall economic health. In doing so, we recognize that inequality in the brewery size distribution may also be influenced by a complex combination of factors, including policy changes, economic shocks, demographic shifts, and firm entry and exit dynamics. However, to conserve degrees of freedom, given the relatively small sample size used for estimation, and to maintain a focus on economic determinants, we included the total labor force participation rate (ages 15–64; %) as the only additional independent variable. Data for both real GNI per capita and the labor force participation rate were obtained from the World Bank's *World Development Indicators* (WDI) database.

The regression results for the Ortega et al. and Rohde models are reported in Table 3. Two features of the table are particularly noteworthy. First, both parsimonious regression models pass the RESET test for correct model specification, when the conventional 5 percent level of significance is used. Second, the results for both models reveal a significant negative relationship

between the Gini index of brewery size inequality and real GNI per capita at the conventional 5 percent level of significance. These findings are consistent with earlier literature suggesting that the proliferation of microbreweries may be partly explained by rising incomes. For example, as noted earlier, Murray and O'Neill (2012) found a disproportionately high representation of higher income individuals among the craft beer drinking population they considered.

Conceptually, the negative relationship between the Gini index of brewery size inequality and real GNI per capita in Canada is consistent with expectations. A sustained disproportionate increase in the number of craft breweries relative to larger breweries, driven by stronger consumer preferences for craft beer associated with rising incomes, would be expected to reduce inequality in brewery size distribution over time.

Table 3: Regression of the Gini indices on economic variables (2011-2025)*

Dependent variable: Gini index for brewery size inequality	Intercept	Real GNI per capita	Labor force participation rate	R^2	SER	RESET
Ortega et al. (1991)	-0.1910 (0.7872)	-0.0360 (0.0044)	0.0381 (0.0022)	0.76	0.0401	1.9797 (0.1890)
Rohde (2009)	-0.0605 (0.8932)	-0.0192 (0.0015)	0.0247 (0.0020)	0.71	0.0256	1.1324 (0.3600)

*p-values in parentheses; N=15 for both the Ortega et al. and Rohde regressions; SER denotes standard error of the regression; RESET is the usual Ramsey's Regression Specification Error test with the squares and cubes of the predicted Gini index included as additional independent variables.

6. Conclusions

In this paper, we examined changes in the Gini index of inequality in the size distribution of breweries in Canada using grouped employment data spanning the period from 2011 to 2025. To conduct the analysis, we employed two widely used Lorenz curve models proposed by Ortega et al. (1991) and Rohde (2009). To the best of our knowledge, this is the first study to use Lorenz curves to investigate changes in firm size inequality within the beer industry.

Our findings reveal a downward trend in inequality in the size distribution of Canadian breweries over the 2011–2025 period, a result that is consistent with the rapid growth of small craft breweries across the country. We also find a significant relationship between real GNI per capita and the Gini index measure of brewery size inequality. These findings underscore the importance of economic factors in explaining changes in the size distribution of breweries in Canada.

This paper represents an important first step in the quantitative assessment of firm size inequality within the context of the rapidly evolving craft beer industry. Future research using a longer time horizon for Lorenz curve analysis would provide sufficient time series data to support more comprehensive analyses of the evolution of brewery size inequality in Canada. Such analyses

could incorporate a broader range of explanatory factors, including policy changes, economic shocks, demographic shifts, and firm entry and exit dynamics. In addition, future studies should consider alternative measures of brewery size, such as output, sales volume, and asset size, should the necessary data become available.

It would also be valuable to apply the Lorenz curve approach used in this paper to other Canadian alcoholic beverage industries, such as wineries and distilleries, to facilitate cross-industry comparisons of firm size inequality. Similarly, the approach could be extended to analyze the evolution of firm size inequality in alcoholic beverage industries in other countries.

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