

Size and Productivity in the Canadian Food Processing Industry

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1 What Is the Issue?

The manufacturing industry is an important sector for the Canadian economy. Manufacturing contributes approximately \$174 billion to Canada's GDP, which is equivalent to more than 10% of Canada's GDP ([Statistics Canada, 2019](#)). In addition, the manufacturing industry accounts for 68% of Canada's total merchandise exports. Within the manufacturing industry, food manufacturing is the largest manufacturing employer and also the second largest manufacturing industry in terms of the value of production ([Agriculture and Agri-Food Canada, 2016](#)). Figure 1 show that food processing accounted for 15.6% of employment in manufacturing sector in 2019. However, Canadian food manufacturing sector saw a significant drop in its competitiveness compared to other developed countries from 2000 onward, in particular the United States, primarily due to a lack of investment in R&D, the appreciation of the Canadian dollar, smaller production scale, and labour shortage ([George Morris Centre, 2012](#)). This brief examines the relationships between size and productivity in the context of the Canadian food manufacturing and manufacturing. Previous studies suggest that productivity varies across firms of different size and firm size is positively correlated with productivity. For example, [Leung, Meh, and Terajima \(2008\)](#) note that there is a positive relationship between firm size and productivity in Canada's manufacturing and non-manufacturing sectors. In this study, we specifically focus on the size-productivity relationship in the food processing industry. In this study, we assess whether plant size is linked to productivity. The size distribution of firms in food processing sector is a matter of considerable importance for economics and public policy. Interest in it, however, has been hampered by the lack of sufficiently detailed publicly available data.

2 What Did the Study Find?

Employment and firm size: Table 1 presents total private sector employment by industrial sector and business size. In 2017, for manufacturing sector, 50.1% of the businesses are small, 34.82% are medium-sized and 15.1% are large.

Table 2 presents plant size distribution for manufacturing, food manufacturing, and its sub-sectors. [Agriculture and Agri-Food Canada \(2016\)](#) states that "90% of establishments have less than 100 employees, 9% have between 100 and 500 employees, while only 1% of establishments have more than 500 employees" in the food and beverage processing sector. In Table 2, large plants only account for slightly over 1%, while small plants constitute nearly 90% of the establishments in food manufacturing. As with food manufacturing, manufacturing is also dominated by a disproportionate number of small plants. Less than 1% of the observations are large plants, whereas 91.6% are small. Similar evidence is found for the sub-sectors. Five out of nine sub-sectors have less than 1% of large plants. In particular, animal food manufacturing is completely made up of small and medium-size plants. Based on the table 2, it is can be said that plant size distribution for all the sectors is right-skewed, implying that the mean size is smaller than the median size. The right-skewed plant size distribution is supported by a large body of literature. This is consistent with Gibrat's Law, which states that firm size has log-normal distribution with a few large firms and a long, thin tail of small and nearly-equal-size firms ([Kwoka Jr, 1982](#)).

There are a number of factors affect size distribution - e.g., features of the industry, technology development, financial structure, etc. One of the factors contributing to the skewed size distribution is financial constraints. Under most circumstances, small firms have more difficulty accessing formal

Table 1: Total private sector employment by industrial sector and business size, 2017

	Small		Medium		Large		Total
	Thousands	%	Thousands	%	Thousands	%	
Goods-Producing Sector	1,891.40	62.1	783.7	25.7	369.6	12.1	3,044.80
Agriculture	101.3	90.9	9.4	8.4	0.8	0.7	111.5
Resources	142.1	50.7	66.9	23.9	71.5	25.5	280.6
Utilities	6.8	44.9	3.8	25.4	4.5	29.7	15.1
Construction	821.3	82.1	133.4	13.3	45.6	4.6	1,000.30
Manufacturing	819.9	50.1	570.2	34.8	247.2	15.1	1,637.30
Service-Producing Sector	6,404.40	72.4	1,587.70	17.9	858.7	9.7	8,850.70
Wholesale and retail trade	1,949.80	77.3	469.9	18.6	102.5	4.1	2,522.20
Transportation and warehousing	350.8	57.8	160.8	26.5	95.5	15.7	607.1
Finance, insurance, real estate and leasing	551.7	61.5	182.8	20.4	163.1	18.2	897.6
Professional, scientific and technical services	670.5	68.3	211.1	21.5	99.9	10.2	981.5
Business, building and other support services	416.1	73.8	109.1	19.3	38.8	6.9	564
Educational services	65.1	61.6	17.8	16.8	22.7	21.5	105.6
Health care and social assistance	537.1	55.7	194.7	20.2	232.4	24.1	964.2
Information, culture and recreation	344.8	64.1	115.5	21.5	77.4	14.4	537.6
Accommodation and food services	1,007.00	90.5	84.9	7.6	20.7	1.9	1,112.50
Other services (except public administration)	511.6	91.6	41.1	7.4	5.8	1	558.5
Total	8,295.80	69.7	2,371.40	19.9	1,228.30	10.3	11,895.50

Source: Statistics Canada: <https://www.ic.gc.ca/eic/site/061.nsf/eng/h03090.html#point1> – 1. Resources :
Forestry, fishing, mining, quarrying, and oil and gas extraction; Small = 1 – 99 employees; medium =
100 – 499 employees; and large = 500 + employees.

sources of external finance, such as bank loans. According to [Beck and Demircuc-Kunt \(2006\)](#), large firms finance growth with bank finance 13% more than small firms do. On the other hand, financial structure for small firms primarily consists of informal sources of finance, including moneylenders of family and friends. [Cabral and Mata \(2003\)](#) found direct evidence that financing constraints to some degree results in increased skewness in the size distribution. Another determinant of firm size distribution is age. [Cabral and Mata \(2003\)](#) notes that firm size distribution becomes symmetric as firms age. Specifically, the size distribution for young firms are concentrated on the lower tail and much more skewed compared to the overall firm size distribution. As firms get older, the distribution moves to the right tail and the degree of skewness reduces gradually.

Table 3 show business survival by business size. The values in table 2 indicate that larger businesses have higher survival rate than smaller businesses.

Productivity dispersion exists in the industry: We find the evidence of the existence of heterogeneity in plant productivity levels, even within narrowly defined industries such as four-digit NAICS. In this study, we examined the 75th-25th and the 90th-10th ratios. These ratios are used to give information about by how much a plant located at the upper tail of the productivity distribution is more productive than on at the lower tail of the productivity distribution. We find productivity dispersion across the industries. For instance, in Canadian manufacturing, a plant at the top 75% of the productivity distribution produces almost twice as much output using the same inputs as one at the bottom 25%. A even large productivity dispersion is found in Canadian food manufacturing with a plant at the top 75% makes more than 4 times more output than a plant at the bottom 25%. Similar evidence is found with the sub-sectors as well.

Productivity is persistent over time: We find that food processing plants' productivity is directly linked to their productivity in the previous period of time. A possible explanation for productivity persistence is that plants are heterogeneous in terms of investment-decision making. For example, those plants that choose not to invest in R&D will continue to use the same old technologies. Furthermore, there is nearly no incentive for food manufacturers to upgrade their technologies mainly due to the fact that they primarily produce non-patent-protected products (e.g., sugar, vegetables, and fruits).

Larger food processing plants tend to be more productive than small and medium-size food processing plants: We divide food processing plants into three categories based on the number of employees: small, medium, and large. According to the definitions proposed by [Leung, Rispoli, and Gibson \(2011\)](#) in the Canadian context, small plants are defined as plants with less than 100 employees;

Table 2: Plant Size Distribution for Manufacturing, Food Manufacturing, and its Sub-sectors

Industry	Observation #	Small	Medium	Large
Manufacturing	471,953	432,309 (91.60%)	35,991 (7.63%)	3,653 (0.77%)
Food Manufacturing	47,582	41,513 (87.25%)	5,446 (11.40%)	623 (1.35%)
Animal Food	5,086	4,959 (97.50%)	127 (2.50%)	0 (0%)
Grain and Oilseeds	1,511	1,327 (87.82%)	165 (10.92%)	19 (1.26%)
Sugar	1,868	1,559 (83.45%)	253 (13.54%)	56 (3.01%)
Fruit and Vegetables	3,385	2,779 (82.10%)	527 (15.57%)	79 (2.33%)
Dairy	3,811	3,187 (83.63%)	587 (15.40%)	37 (0.97%)
Meat	7,102	5,571 (78.44%)	1,268 (17.85%)	263 (3.71%)
Seafood	5,382	4,338 (80.60%)	991 (18.41%)	53 (0.98%)
Bakery	14,293	13,300 (93.05%)	922 (6.45%)	71 (0.5%)
Other	5,144	4,493 (87.44%)	606 (11.78%)	45 (0.78%)

Notes: Percent probabilities in parenthesis; Rounded to 2 decimal places.

Small: < 100 employees; Medium: 100 to 499 employees; Large: \geq 500 employees.

Table 3: Survival rate by initial business size for Canadian in Goods-producing sector and Service-producing sector

Number of years since the company's entry	1–4 employees	5–19 employees	20–49 employees	50–99 employees
T 0	100.00%	100.00%	100.00%	100.00%
T+1	92.10%	96.80%	98.10%	98.10%
T+2	81.80%	88.30%	91.10%	92.40%
T+3	73.60%	80.00%	83.40%	85.60%
T+4	66.30%	72.70%	77.10%	78.70%
T+5	60.50%	66.40%	72.50%	73.20%
T+6	55.90%	61.70%	68.60%	70.10%
T+7	51.90%	57.10%	64.10%	66.30%
T+8	48.30%	53.30%	60.60%	62.30%
T+9	45.20%	49.80%	56.30%	59.20%
T+10	42.40%	46.80%	53.00%	55.40%

Source: Statistics Canada: <https://www.ic.gc.ca/eic/site/061.nsf/eng/h03090.htmlpoint1> – 1

medium plants' employee number ranges from 100 to 500; large plants are those plants with more than 500 employees. We find that productivity is positively correlated with plant size, meaning that large plants are more productive than small and medium plants. Also, given that plant size is not restricted to be measured by the number of employees, we also use plants' sales to proxy for plant size and the conclusion is robust to the selection of size measurements.

3 How was the Study Conducted?

Our analysis is conducted based on a plant-level data set from the Annual Survey of Manufacturing and Logging Industries (ASML), covering the period from 2000 to 2011. We examined the relationships between size and productivity in the Canadian food processing industry. First, we use the Akerberg-Caves-Frazer translog production approach to estimate productivity for each food processing plant included in our sample. Second, using the productivity estimates obtained from the first step, fixed effects regressions are employed to determine whether plant size has an impact on plant's productivity.

References

- Agriculture and Agri-Food Canada. 2016. "Overview of the Food and Beverage Processing Industry." <http://www.agr.gc.ca/eng/industry-markets-and-trade/canadian-agri-food-sector-intelligence/processed-food-and-beverages/overview-of-the-food-and-beverage-processing-industry/?id=1174563085690>, Accessed: 2019-11-07.
- Beck, T., and A. Demircuc-Kunt. 2006. "Small and medium-size enterprises: Access to finance as a growth constraint." *Journal of Banking & finance* 30:2931–2943.
- Cabral, L., and J. Mata. 2003. "On the evolution of the firm size distribution: Facts and theory." *American economic review* 93:1075–1090.
- George Morris Centre. 2012. "Improving Productivity in Canada's Food Processing Sector through Greater Scale." Working paper, Institute for Competitiveness & Prosperity, February.
- Kwoka Jr, J.E. 1982. "Regularity and diversity in firm size distributions in US industries." *Journal of Economics and Business* 34:391–395.
- Leung, D., C. Meh, and Y. Terajima. 2008. "Firm size and productivity." Working paper, Bank of Canada Working Paper.
- Leung, D., L. Rispoli, and B. Gibson. 2011. "Small, medium-sized and large business in the Canadian economy: measuring their contribution to gross domestic product in 2005."
- Statistics Canada. 2019. "Canadian manufacturing sector gateway." <https://www.ic.gc.ca/eic/site/mfg-fab.nsf/eng/home>, Assessed: 2019-11-07.

Appendix

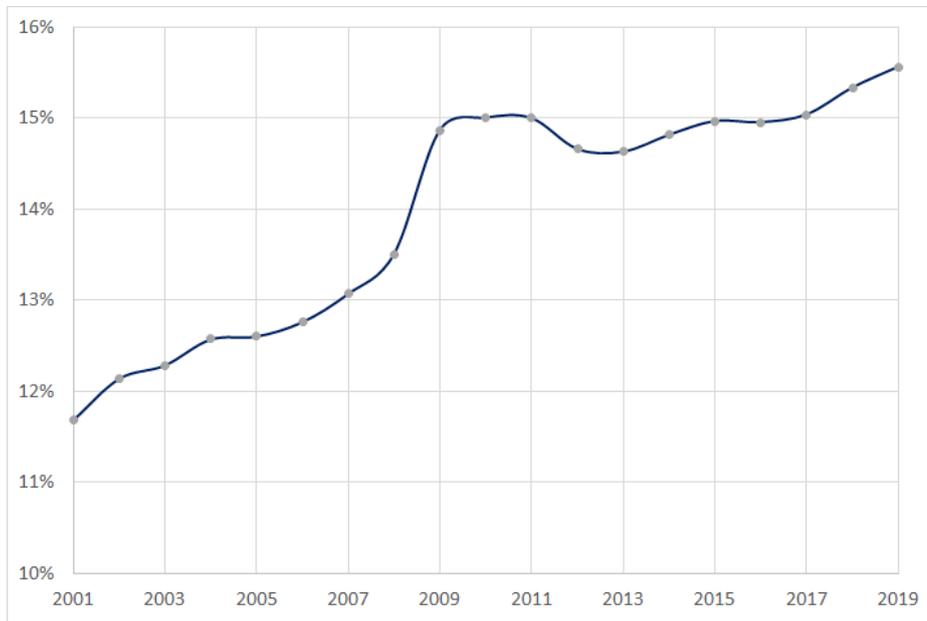


Figure 1: Share of food manufacturing in employment in manufacturing sector
 Source: Statistics Canada. Table 14-10-0202-01 Employment by industry, annual DOI:
<https://doi.org/10.25318/1410020201-eng>