

Financing Innovation in the Canadian Food Manufacturing Sector

Getu Hailu

Department of Food, Agricultural and Resource Economics
University of Guelph¹

July 27, 2021

¹**Disclaimer:** Some of the works in this presentation were conducted while the author was a Special Advisor to AAFC. Any views expressed are those of the author and don't represent the views of AAFC the author is affiliated with.

Access to Finance, Competition, Innovation, and Exporting in the Canadian Food Processing Sector

Getu Hailu*

Deepananda Herath†

July 27, 2021

Abstract

This paper examines the relationship between access to finance and innovation in Canada's food processing sector. The paper uses a recent survey of innovations in food manufacturing in Canada. We find that firms with access to finance for innovation, that received government supports, large, spend large money on innovation activities are more likely to introduce innovations. The results have implications for policies targeted at enhancing R&D and innovation in food processing sector.

Keyword: Innovation, Finance, Exporting, Food Manufacturing

Why Food Manufacturing?

	Employment			Revenue		
Year	2001	2010	2019	2001	2010	2019
Food processing	12%	15%	16%	11%	16%	15%
Beverage	2%	2%	3%	2%	2%	2%
Petroleum	1%	1%	1%	6%	13%	11%
Transportation equipment	12%	11%	13%	23%	16%	19%

- One of the largest manufacturing industries
- Processes 70% of the food Canadians buy
- Very resilient during the Great Recession /pandemic

Outline

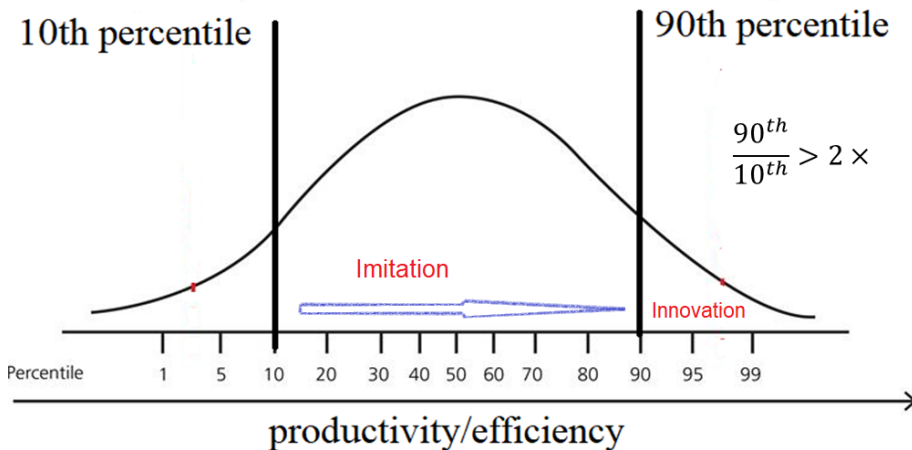
- 1 Overview
- 2 Literature
- 3 Data
- 4 Estimation Strategy
- 5 Results
- 6 Summary



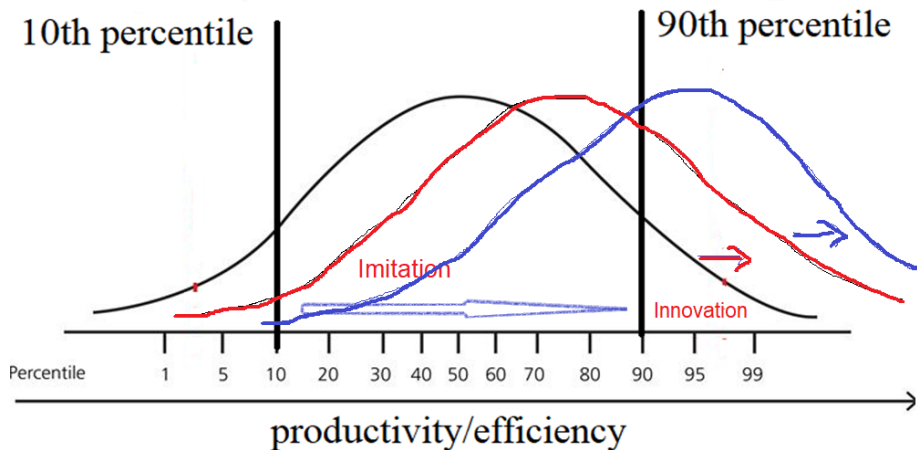
- **Innovation**: introduction of new/improved products, processes, organization structures, marketing systems
- **Financial constraints**: Difficulty in accessing external finance for investment or growth.

- The growth rate of output:
 - ① Rate of growth of the technology
 - ② Replication of existing technologies (Schultz 1956, 1962)
 - Expansion in capital
 - Expansion in labour force (population growth)
- Substantial productivity improvements for the crops and livestock sectors in Canada (Gray and Weseen, 2007; Veeman and Gray, 2009).

Considerable Inter-decile Productivity Dispersion for Food Manufacturing and its Sub-sectors



Considerable Inter-decile Productivity Dispersion for Food Manufacturing and its Sub-sectors



Considerable Inter-decile Productivity Dispersion for Food Manufacturing and its Sub-sectors

Year	311	3111	3112	3113	3114	3115	3116	3117	3118	3119
2000	3.16	4.83	5.65	4.03	4.83	6.00	4.05	2.11	2.40	3.34
2001	3.31	4.71	5.62	4.10	4.72	6.16	4.06	1.93	2.58	3.59
2002	3.20	4.51	6.31	3.64	4.84	5.61	3.54	1.65	2.30	3.18
2003	3.20	4.67	6.30	3.83	4.71	5.76	3.45	1.77	2.38	2.83
2004	3.41	4.89	5.75	4.13	4.56	5.87	3.33	2.34	2.88	3.37
2005	3.44	5.00	5.55	4.17	4.65	5.73	3.37	2.61	3.03	3.39
2006	3.51	4.96	5.38	4.66	4.75	5.86	3.34	2.39	3.13	3.18
2007	3.53	5.09	5.43	4.07	4.80	5.61	3.59	2.25	3.06	3.22
2008	3.42	4.45	6.03	4.00	4.86	5.74	3.66	2.23	3.01	2.98
2009	3.41	4.33	5.93	3.62	4.79	5.84	3.72	2.35	3.09	2.99
2010	3.50	4.68	5.52	3.65	4.88	5.56	4.05	2.24	3.19	2.79
2011	3.49	4.73	5.56	3.62	5.13	5.81	4.01	2.33	3.15	2.71
Average	3.46	4.76	5.83	4.09	4.94	5.87	5.81	2.15	2.92	3.13

Note: 3111= Animal food manufacturing; 3112= Grain and oilseed milling; 3113= Sugar and confectionery product manufacturing; 3114= Fruit and vegetable preserving and specialty food manufacturing; 3115= Dairy product manufacturing; 3116= Meat product manufacturing; 3117= Seafood product preparation and packaging; 3118= Bakeries and tortilla manufacturing; 3119= Other food manufacturing.

What Explains Heterogeneity in Productivity?

Internal factors

- 1 Managerial practices/talent
- 2 Quality of labour and capital
- 3 IT and R&D
- 4 Learning-by-doing
- 5 Product innovation
- 6 Firm structure decisions

External Factors

- 1 Productivity spillovers
- 2 Competition/Darwinian selection (both intra-market and through trade)
- 3 Regulatory environment
- 4 Input market flexibility

Syverson (2011)

Endogenous Economic Growth and Innovation - Creative Destruction

- Value of innovation

$$= \frac{Rent}{interest} \quad (1)$$

- Growth will mainly come from new entrants (Aghion and Howitt, 1992)

$$= \frac{Rent}{interest + prob(new > 0)} \quad (2)$$

- In Aghion and Howitt (1992), growth rate is the product of spillover effect (γ) (Romer, 1986) and business stealing effect (δ) (Tirole, 1988)

$$= \gamma \times \delta \quad (3)$$

- Social planners care about how much spillover is created
 - If spillover (γ) is too little, society should spend less on R&D.
 - If spillover (γ) is too much, society should spend more on R&D.

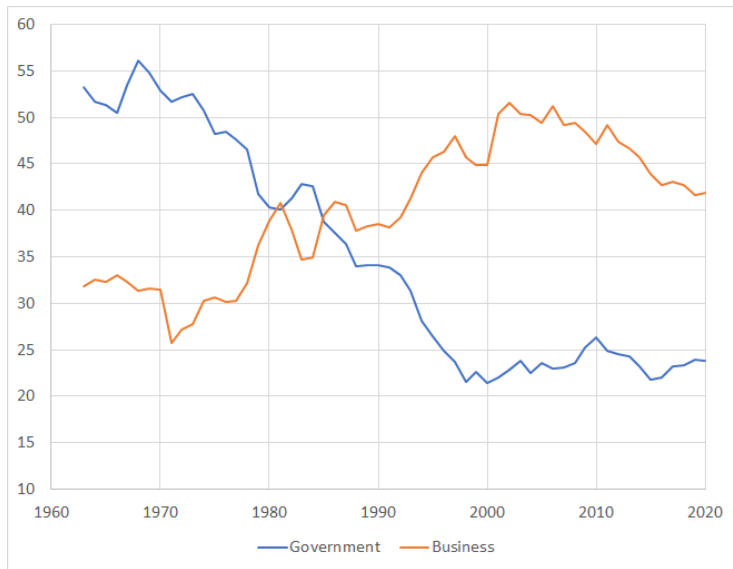
The Barton Report - Advisory Council on Economic Growth - 2017

- Unlocking innovation to drive productivity and help new companies scale up more rapidly

Innovation is key in the policy frameworks

- Agricultural Policy Framework (2003-2008)
 - Focus: science and innovation
 - Outcome: improve competitiveness and profitability
- Growing Forward: (2008-2013)
 - Focus: innovation
 - Outcome: ensure productivity, profitability, competitiveness
- Growing Forward 2: (2013-2018)
 - Focus: innovation
 - Outcome: long-term profitability and competitiveness
- Canadian Agricultural Partnership (2018-2023)
 - Focus: science, research and innovation
 - Outcome: increase competitiveness, productivity, profitability

Share of Gross domestic expenditures on R&D



Establishments reporting high impact of obstacles to innovation, (fiscal years 2016 to 2018)

Obstacles	<i>Innovating</i>	<i>non-innovating</i>
Shortages of skilled workers	43.5	23.3
Lack of internally generated cash flow	34.6	17.1
Long gestation period of innovation	26.5	5.1
Insufficient flexibility in regulations	21.9	11.9
Lack of external equity funding	21.1	9.6
Lack of debt financing	17.4	8.3
Lack of idea champions	12.1	6.9

Establishments that used government programs to help mitigate specific obstacles to innovation, (fiscal years 2016 to 2018)

Obstacles	%
Lack of internally generated cash flow	33.0
Shortages of skilled workers	23.6
Lack of external equity funding	16.0
Lack of debt financing	13.9
Long gestation period of innovation	11.7
Lack of marketing capability	11.7
Insufficient flexibility in regulations/policies	8.7

Financing of Innovation

- R&D is susceptible to financing constraints (Brown, Martinsson, and Petersen, 2012).
- The diffusion² of new innovation requires significant financial commitments.

²Diffusion refers to the process or rate of technology spread)

Modigliani-Miller (1959, 1961, 1963) Proposition

- Firm's financing policy is irrelevant.
 - The choice between retained earnings and new share issues as sources of investment finance is irrelevant
 - Debt policy irrelevant ($i_t = r_t$)
 - The value of a firm is unaffected by how that firm is financed.
- Financial and production decisions are independent

Modigliani-Miller (1959, 1961, 1963) Proposition

Assumes an efficient financial market, absence of

- taxes,
- bankruptcy/distress costs,
- agency costs and
- asymmetric information

The Trade-Off Theory of Leverage

- Debt financing less attractive in the presence of bankruptcy costs (-)
- Debt financing is more attractive in the presence of tax advantages (+)

A Financial "Pecking Order" (Myers and Majluf 1984)

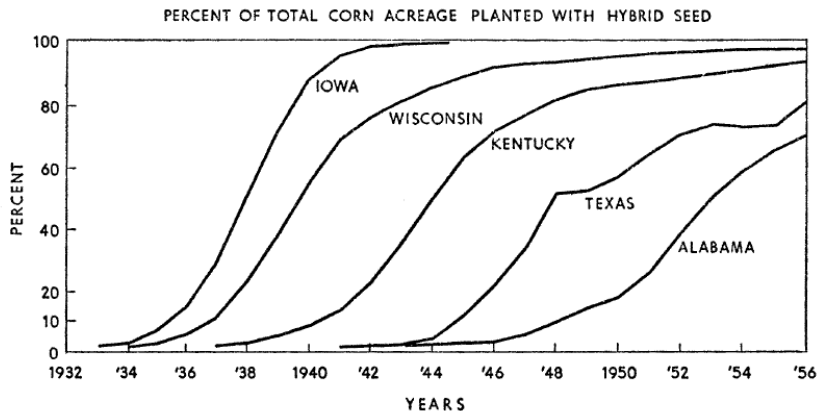
- Hierarchy of costs associated with different sources of investment finance.
 - internal funds,
 - debt and
 - new equity.
- The firm's financial policy may play a key role in the investment decision - i.e., financial and investment decisions are dependent

Market Failure for R&D

- Asymmetric information problems

Literature - Agricultural Innovation

- Hybrid Corn: An Exploration in the Economics of Technological Change (Griliches, 1957).



- Advanced Technology in the Canadian Food Processing Industry (Baldwin, West, and Sabourin, 1999);
- The Nature and Extent of Innovation in the Canadian Food Processing Industry (Bonti-Ankomah, 2006).
- Understanding the financing of innovation and commercialization (Herath, Cranfield, and Henson, 2010)

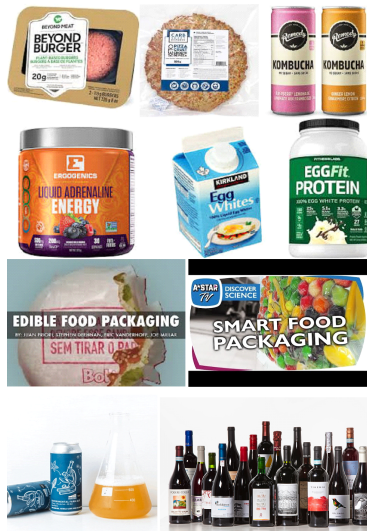
- The relative rate of major inventions is higher in small firms (Akcigit and Kerr, 2018);
- Small firms are more financially constrained (Gopinath et al., 2017).
- Young firms are more financially constrained (Dinlersoz et al., 2019)

- Does access to external finance matter?

- Innovation in the Food Processing Industry Survey 2018.
- Food Manufacturing with at least one employee and one million dollars in revenue
- The data were collected through an electronic questionnaire (Feb 27 - June 3, 2019)
- 2,217 food processing establishment 74.5% response rate)
- Four Categories of innovation.
 - Process
 - Product
 - Organization
 - Marketing

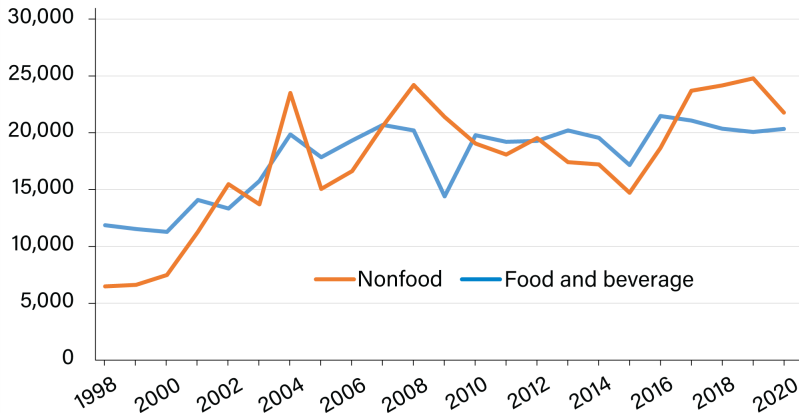
Food & Beverage Innovation Taxonomy

- food safety and preservation,
- food quality,
- convenience,
- nutritional value,
- food materials,
- health
- productivity/production costs,
- packaging
- plant-based
- ...



New product introductions of consumer packaged goods, 1998–2020

The number of new food and beverage products saw substantial decreases followed by proportional rebounds in 2010 and 2016, and had a relatively smooth decline between 2016 and 2019 before increasing slightly in 2020



Source: Prepared by USDA, Economic Research Service, using data from Mintel's Global New Product Database (Mintel GNPD).

Data as of May 2021.

- Probit

$$u^* = \beta_0 + \beta_1 Fin + \beta_2 R\&D + \beta_3 Gov + X'\beta + \delta_p + \delta_s + \epsilon \quad (4)$$

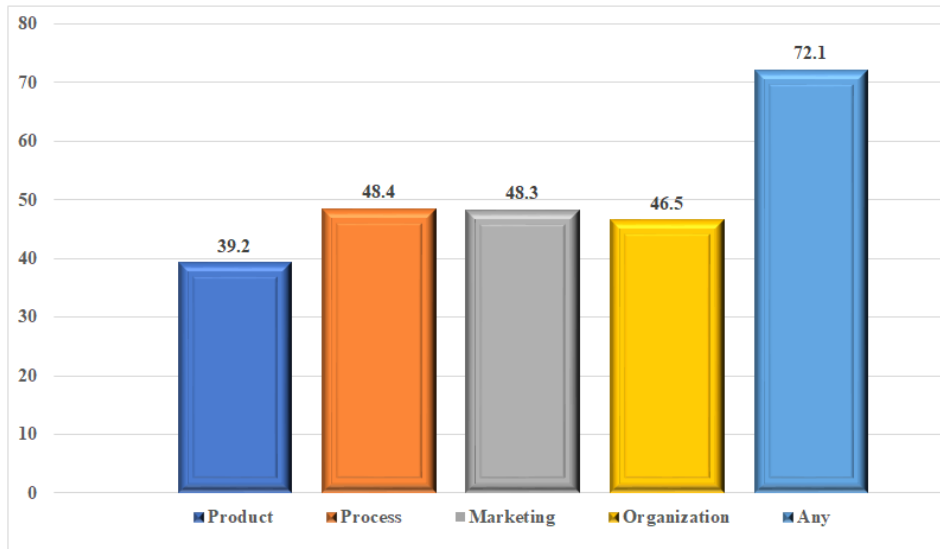
- where

- Fin := financial constraints
- Gov := Government support
- X := size, export, labour, competition, spending

- Multivariate Probit

- Joint decisions and complementarity

Adoption of Innovation by Type



Prevalence of innovation by size (%)

Size	<i>Product</i>	<i>Process</i>	<i>Mrkt</i>	<i>Org</i>	<i>No</i>
<100 Employees	36.9	45.2	48.4	44.4	29.1
100-249 Employees	44.5	58.6	45.1	52.3	23.6
250+ Employees	54.5	64.3	54.6	58.5	23.2
Total	39.2	48.4	48.3	46.5	27.9

Prevalence of innovation by industry (%)

Industry	Product	Process	Mrkt	Org	No
Animal Food Manufacturing	24.7	37.0	42.4	33.6	41.4
Grain and Oilseed Milling	29.4	57.4	49.1	51.7	21.9
Sugar and Confectionary	51.5	59.1	66.6	59.1	12.0
Fruit and vegetable	53.5	68.4	52.6	53.0	13.2
Dairy Product	50.4	53.1	57.4	48.7	19.6
Animal Slaughtering	18.6	39.3	36.6	29.4	46.1
Rendering and Meat Processing	43.3	49.9	46.5	44.8	31.3
Poultry Processing	29.7	33.1	33.1	38.8	44.2
Seafood Product	17.3	41.3	26.6	30.5	43.6
Bakeries and Tortilla	42.7	44.7	54.3	50.3	25.0
Other Food Manufacturing	48.2	54.7	51.8	55.7	20.7

Prevalence of innovation by region (%)

Region	<i>Product</i>	<i>Process</i>	<i>Mrkt</i>	<i>Org</i>	<i>No</i>
Atlantic	23.4	39.3	32.5	31.5	44.1
Quebec	42.0	48.8	50.5	47.9	26.4
Ontario	42.9	51.1	48.8	48.6	25.7
Prairies	24.8	47.2	47.7	42.5	31.5
Alberta	35.4	46.8	53.6	47.7	27.6
BC and Territories	43.9	48.0	50.8	49.6	23.9

Innovation expenditure as a share of total expenditure (%)

Employees	None	up to 1%	2% to 5%	6% to 10%	11% or more
<100	28.8	31.1	27.1	8.3	4.7
100-249	25.2	28.2	31.8	8.3	6.5
250+	20.6	29.9	33.3	9.4	6.8
Total	27.8	30.6	28.2	8.4	5.1

Establishments reporting high impact of obstacles to innovation, (fiscal years 2016 to 2018) (%)

Obstacles: Lack of ...	Product or process Innovating	Non-innovating
Internal cash flow	34.6	17.1
External equity funding	21.1	9.6
Debt financing	17.4	8.3

Use of government programs to support innovation activities by size (fiscal years 2016 to 2018)) (%)

Employment size class	%
<100 Employees	21.1
100-249 Employees	38.4
250+ Employees	45.5
Total	25.2

Importance of government support to innovation by source, (fiscal years 2016 to 2018) (%)

Sources of support	High	Low	NA
R&D tax incentives	53.1	29.1	17.8
Government R&D grants	46.4	28.8	24.8
Government financing support	42.7	28.7	28.6
Training and hiring programs	35.4	34.4	30.2
Government research facilities	27.3	38.7	33.9
Other government programs	27.3	32.6	40.1
Export development assistance	26.3	32.9	40.8
Government procurement	12.3	39.8	47.9
Incubator & accelerator programs	12.1	38.5	49.4

Main source of capital raised, (fiscal years 2016 to 2018) (%)

Source of financing	%
Banks, cooperatives and credit unions	35.8
Government sources	23.5
Canadian based venture capital	10.5
Other	8.6
Angel investors, family or friends	4.1
Other foreign based venture capital	2.4

Reasons for refusing or limiting funding for innovation by lender, (fiscal years 2016 to 2018), (fiscal years 2016 to 2018) (%)

Reasons	%
Failed to meet lending criteria	9.4
Other	6.3
Capital not available due to market conditions	6.1
Further development or proof of concept required	5.5
Lender does not fund development projects	3.8
Lack of long term strategic planning	1.8
Lack of evidence to support projections	1.8
Lack of marketing analysis	1.6
Lack of intellectual property	0.5

Establishments that attempted to raise capital specifically for innovation by size, (fiscal years 2016 to 2018) (%)

Employment size class	Attempt to Raise	Successful in Raising
<100 Employees	11.9	58.0
100-249 Employees	13.2	71.5
250+ Employees	11.5	81.5
Total	12.0	61.6

Average Marginal Effects of the Probit Model

	Process	Product	Org'l	Market	Any
Finance	0.126***	0.0751	0.136***	0.191***	0.209***
Export	0.018	0.086***	0.017	0.00627	0.020
R & D	0.046	0.153***	0.0832**	0.0288	0.098***
Gov't	0.115***	0.068**	0.078**	-0.0106	0.096***
Small	-0.121***	-0.097**	-0.100**	-0.0704	0.00568
Medium	-0.061	-0.109**	-0.079	-0.106*	0.020
Spending					
Up to 1%	0.200***	0.226***	0.162***	0.253***	0.211***
2% to 5%	0.348***	0.309***	0.296***	0.389***	0.371***
6% to 10%	0.450***	0.392***	0.362***	0.415***	0.472***
11% or more	0.629***	0.404***	0.396***	0.413***	0.401***
Observations	1558	1556	1551	1556	1540

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Multivariate Probit - Joint Decisions

Correlation matrix				
	Process	Product	Orgaization	Marketing
Process	1.00	0.486*** (10.42)	0.522*** (12.08)	0.391*** (8.11)
Product		1.00	0.336*** (6.57)	0.335*** (6.47)
Organizational			1.00	0.537*** (13.02)
Marketing				1.00

Process Innovations and the Probability of Cost Savings

	(1)	(2)	(3)	(4)
Improved Methods	0.0829* (1.68)			0.109** (2.20)
Improved Logistics		0.0314 (0.73)		0.0164 (0.38)
Maintenance Systems			0.105** (2.55)	0.120*** (2.87)
Government Support	0.0766* (1.75)	0.0773* (1.77)	0.0725* (1.68)	0.0655 (1.52)
Small	-0.185*** (-2.70)	-0.186*** (-2.70)	-0.181** (-2.58)	-0.175** (-2.50)
Medium	-0.0806 (-1.04)	-0.0865 (-1.11)	-0.0869 (-1.11)	-0.0746 (-0.95)
Observations	759	759	759	759

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Summary of Key Findings

- 72% the firms adopted at least one type of innovation.
- Exporting
- Access to finance
- R&D investment
- Government support

- Better understanding of cross-sectional heterogeneity in adoption.
- The identification of potential adopters of innovation allow targeted interventions.
 - Access to finance, firm size, spending on innovation, R&D
- The importance of government subsidy programs.
- Age- and size-based subsidies or R&D support.
- Challenge to uncover causal effects and mechanisms that enhance innovation.

What is next

- Link the innovation data to business data.
- Strengthen the role University-Government partnership plays
 - Both parties, the Government and the University get value out of the partnership.
 - Engage passionate people in building a successful partnership.
 - Government funding uncertainty.
 - Basic research and applied research.
 - Joint webinar throughout the year.
 - Identify data gap and improve access to public data.

Acknowledgements



OMAFRA



Statistics
Canada

Statistique
Canada



Agriculture and
Agri-Food Canada

Bibliography I

- Aghion, P., and P. Howitt. 1992. "A model of growth through creative destruction." *Econometrica* 60:323–351.
- Akcigit, U., and W.R. Kerr. 2018. "Growth through heterogeneous innovations." *Journal of Political Economy* 126:1374–1443.
- Baldwin, J.R., D. West, and D. Sabourin. 1999. *Advanced technology in the Canadian food processing industry*. 88, Statistics Canada.
- Bonti-Ankomah, S. 2006. "The Nature and Extent of Innovation in the Canadian Food Processing Industry." Working paper.
- Brown, J.R., G. Martinsson, and B.C. Petersen. 2012. "Do financing constraints matter for R&D?" *European Economic Review* 56:1512–1529.
- Dinlersoz, E., [U+FFFD]Kalemli-Özcan, H. Hyatt, and V. Penciakova. 2019. "Leverage over the firm life cycle, firm growth, and aggregate fluctuations.", pp. .
- Gopinath, G., Ş. Kalemli-Özcan, L. Karabarbounis, and C. Villegas-Sanchez. 2017. "Capital allocation and productivity in South Europe." *The Quarterly Journal of Economics* 132:1915–1967.
- Gray, R., and S. Weseen. 2007. *The Economic Rationale for Public Agricultural Research in Canada*. Citeseer.
- Griliches, Z. 1957. "Hybrid corn: An exploration in the economics of technological change." *Econometrica, Journal of the Econometric Society*, pp. 501–522.
- Herath, D., J. Cranfield, and S. Henson. 2010. "Understanding the financing of innovation and commercialization: the case of the Canadian functional food and nutraceutical sector." *Applied Economics* 42:2667–2682.
- Romer, P.M. 1986. "Increasing returns and long-run growth." *Journal of political economy* 94:1002–1037.
- Syversen, C. 2011. "What determines productivity?" *Journal of Economic literature* 49:326–65.
- Tirole, J. 1988. *The theory of industrial organization*. MIT press.
- Veeman, T.S., and R. Gray. 2009. "Agricultural production and productivity in Canada." *Choices* 24.