Complementarities of Business Innovation and Growth Support (BIGS) Programs Supporting Small and Medium-Sized Enterprises

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OBJECTIVES

- Enhance understanding of the synergies among heterogenous program streams within the BIGS initiative, aiming to bolster support for Small and Medium-sized Enterprises (SMEs).
- Investigate the potential complementarity across various program streams, aiming to identify opportunities for enhanced efficiency and effectiveness in supporting SMEs.
- Quantitatively assess the causal impact of federal innovation programs on the performance metrics and outcomes of SMEs, thereby informing evidence-based policymaking and program optimization efforts.

RESEARCH QUESTIONS

- Which BIGS program streams were most frequently utilized by SMEs in the manufacturing and Professional service industries?
- What are frequent patterns or co-occurrences observed from SMEs behavior?
- What is the causal impact of different combinations of BIGS program streams on SME economic performance? Does the complementarity affect the coherence of the programming suite?

ECONOMETRIC METHODOLOGY

Difference-in-Differences with Multiple Periods

- **Diff-in-diff with Multiple Periods:** Since our treated firms can receive the treatment in different years in a staggered fashion, we follow the specification in Callaway and Sant'Anna (2021):

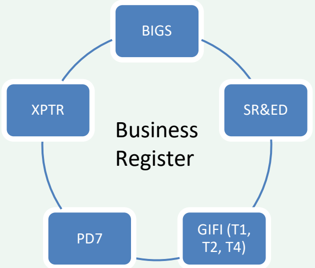
$$ATT(g,t) = E[Y_t - Y_{g-1} | X, G=g] - E[Y_t - Y_{g-1} | X, C=1]$$

$$\theta S(g) = \frac{1}{T-g+1} \sum_{t=2}^{T} 1\{g \le t\} \cdot ATT(g,t)$$

$$\theta_S^0 = \sum_{g=2}^{T} \theta S(g) P(G=g)$$

DATA SOURCE

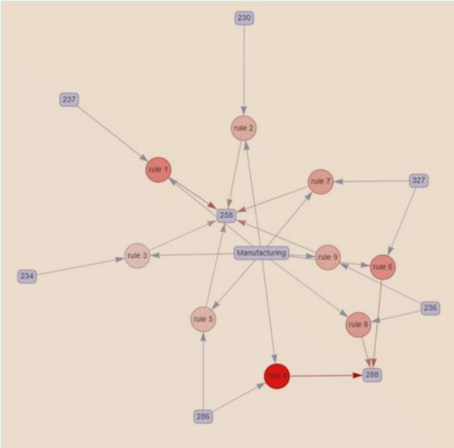
Business Linkable File Environment



MACHINE LEARNING METHODOLOGY

- **Association Rule Mining (ARM)** was introduced by Agrawal et al. (1993) to investigate the purchase tendencies of customers since then it has been applied in many other domains.
- It is commonly used for the determination of hidden patterns and relationships between the variables in datasets and the dependencies among these variables.
- The rules are defined and presented in the form of "X→Y", where X is antecedent, and Y is consequent. The statement is often read as if X then Y.
- While generating association rules, support, confidence, and lift are the thresholds used to identify the most robust rules.
- **Network analysis** provides a framework for investigating synergies among heterogenous program streams within the entire BIGS universe.

Top 9 rules for SMEs in manufacturing ▸



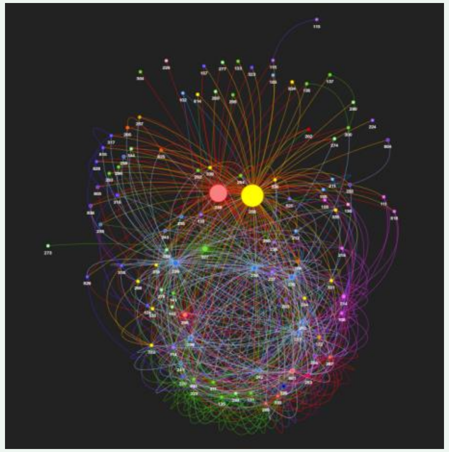
KEY FINDINGS

1. Benefits of Using Multiple BIGS Programs:
- Firms that utilized multiple BIGS programs compared to single users experienced higher economic performance across various metrics, including sales, labor productivity, revenue, R&D, and exports.

2. Impact of Trade Export Programs:
- There is an additional impact on sales and exportation when firms use Trade Commissioner Service program in conjunction with CANEXPORT program. This finding indicates that the combination of BIGS trade export programs enhances SMEs' ability to increase sales and expand into international markets.

3. R&D Performance
- In the manufacturing sector, the combination of MITACS and IRAP programs resulted in a higher increase in R&D performance compared to using either program individually.
- Similarly, in the professional service industry, pairing IRAP with the Experience Award program led to a greater increase in R&D performance compared to using those programs alone.

▼ SMEs BIGS program stream Network



The Differential Impact of BIGS Programs on Beneficiary Enterprises' R&D Spending

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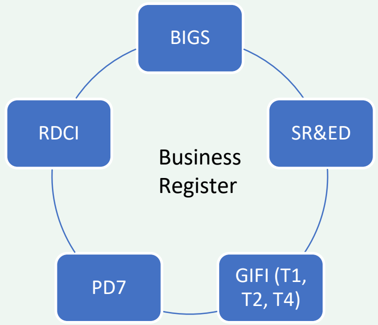
RESEARCH QUESTIONS

1. To what extent do public subsidies incentivize private Research and Development (R&D) investment among for-profit firms in Canada?
2. How do direct subsidies provided through initiatives like BIGS and indirect approaches such as tax credits complement each other in stimulating private R&D investment within the Canadian context?
3. What is the relative importance of advisory services compared to direct financial support mechanisms in influencing private R&D spending in Canada? Do firms that utilize a combination of advisory services and financial support exhibit higher levels of R&D investment compared to those relying solely on one type of support?
4. Does the overall effect of government support on private R&D investment obscure variations in the impact of these programs across different sizes of enterprises, age categories, industrial sectors, and other relevant demographics? How do these heterogeneous effects manifest, and what are the underlying drivers?

DATA SOURCE

- BIGs microdata linked to the Business Linkable File Environment (B-LFE)
- Annual Survey of Research and Development in Canadian Industry (RDCI)
- Scientific Research and Experimental Development (SR&ED)



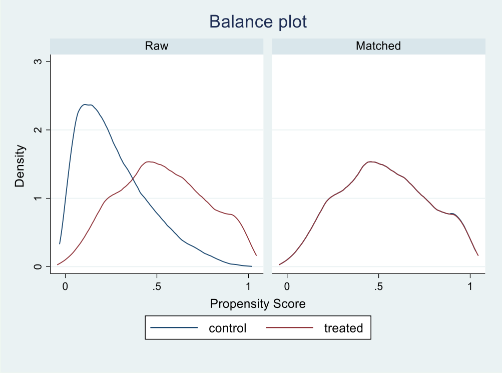
METHODOLOGY

- Propensity Score Matching used to estimate the impact of BIGS support on Firm's R&D spendings
- **Treated group:** Received BIGS support in three consecutive years, 2018-19, 2019-20, 2020-21
- **Control group:** Never received any form of BIGS support in the same periods

Propensity scores are based on the probability of receiving the treatment:

$$\Pr(S=1|Z=z)=\Phi(Z'\beta)$$

Results of treatment effect via Propensity Score Matching



MAIN FINDINGS (PHASE I)

- Propensity Score Matching (PSM) models demonstrate that both direct funding through BIGS and indirect support via tax incentives stimulate private R&D investment. **Direct funding** and **fiscal incentives** are complementary in providing firms with a more comprehensive and impactful approach to fostering innovation.
- The study also finds that **advisory services** are as important as providing financial support in increasing business-funded R&D.
- On average, the impact of BIGS support on private R&D investment is strong for small- and medium-sized enterprises (SMEs), and for young enterprises less than ten years old.
- Government subsidies play a crucial role in supporting R&D investments in capital-intensive sectors (manufacturing) and knowledge-intensive sectors (professional, scientific, and technical services).

Impact of BIGS programs on private R&D investment by type of intervention

Treatment effect Models	Overall impact	BIGS beneficiaries received tax credits and BIGS continuously in three years	Firms continuously received advisory services and other type of support in the past three years	Firms received advisory services and other type of support at least once in the past three years	Firms received other type of support but NO advisory support	Treatment effect for smaller and younger firms
ATET	0.472***	0.499***	0.641***	0.559***	0.310***	0.797***
	-0.0627	-0.0496	-0.0698	-0.0647	-0.0894	-0.0763
Observations	6,772	6,084	5,832	6,570	4,526	2,371

Impact of BIGS programs on private R&D investment across top three industries

Treatment effect Models	Overall impact	Treatment effect for firms in Professional, Scientific and Technical Services	Treatment effect for wholesale Trade and Retail Trade	Treatment effect for firms in Manufacturing	Treatment effect for firms in Manufacturing with export	Treatment effect for older firms in Manufacturing
ATET	0.472***	0.505***	0.529***	0.267***	0.425***	0.470***
	-0.0627	-0.0385	-0.0707	-0.078	-0.0615	-0.126
Observations	6,772	2,272	2,253	511	1,638	1,214

Assessing the Impact of Business Innovation and Growth Support (BIGS) Programs Delivered through Consortium Projects

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OBJECTIVES

- To comprehensively analyze the objectives and mechanisms of various BIGS programs aimed at fostering collaboration, with a focus on identifying patterns and dynamics within and across different program streams.
- To evaluate the effectiveness and impact of collaboration facilitated by BIGS programs on the economic and innovation performance of participating enterprises.
- To assess the extent to which the outcomes of collaborative initiatives within BIGS programs vary across enterprises of different sizes, industries, and organizational characteristics, with the aim of identifying factors that contribute to differential impacts.

DATA SOURCE

- A unique dataset is created by connecting BIGS data with the General Index of Financial Information (GIFI) and Scientific Research and Experimental Development (SR&ED) databases through the Statistics Canada's Business Linkable File Environment (B-LFE) for the period from 2014 to 2021.

METHODOLOGY

- Using various lenses, such as degree of involvement in collaboration, enterprise size, enterprise age, industrial sector, country of origin, and spatial distribution of the consortia participating enterprises to portray the patterns and dynamics of consortium related program streams.
- Applying Propensity Score Method (PSM) to compares the performance of treated firms (BIGS firms in the consortium) with non-treated firms (BIGS firms not in a consortium) to access the impact of the consortium participation.

$$\Pr(y = 1) = \frac{e^{\beta' x}}{1 + e^{\beta' x}} \qquad E(\alpha_{TT}) = E(Y^T|S = 1, X) - E(Y^C|S| = 0\ X)$$

MAIN FINDINGS (PHASE I)

- During the period from 2014-15 to 2021-22, approximately 15,870 unique enterprises received $3.46 billion in total, through 24,100 unique consortium projects to foster collaboration.
- Majority of enterprises in consortium projects are for-profit (84%); non-profit and post-secondary institutions account for 12% and 4%, respectively.
- Natural Sciences and Engineering Research Council of Canada (NSERC) and Innovation, Science and Economic Development (ISED) Canada delivered 97% of consortium projects.
- 90% for-profit enterprises in consortium-projects located in urban areas.

Figure 1 Comparative Distribution of Firms in Consortium Projects versus Non-Consortium Projects by Age Category

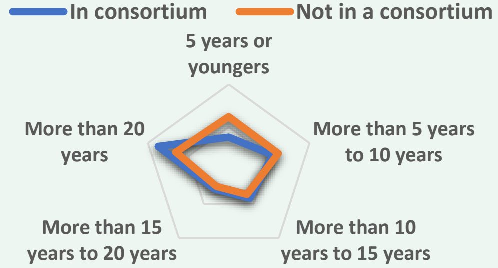

Figure 3 Comparative Distribution of Firms in Consortium Projects versus Non-Consortium Projects by Country of Control

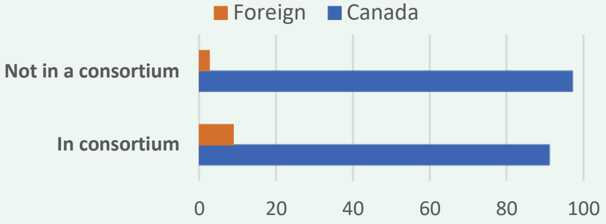

Figure 2 Comparative Distribution of Firms in Consortium Projects versus Non-Consortium Projects by Employment Size

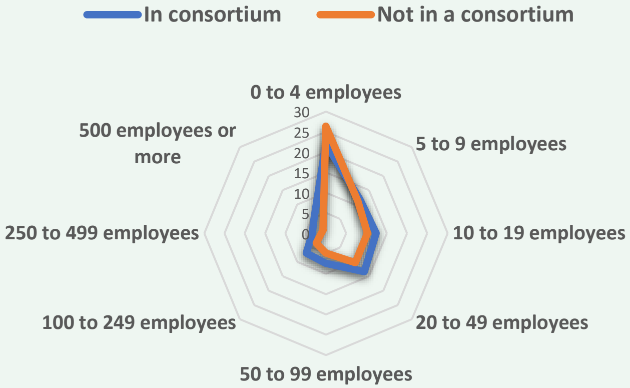

Figure 4 Total Value of Support and Number of Enterprises Supported through Consortium Projects, 2014-2021