



Scale-ups and Canada's Innovation Policy Suite: Usage and Impacts

SEMINAR

SEPTEMBER 21, 2023

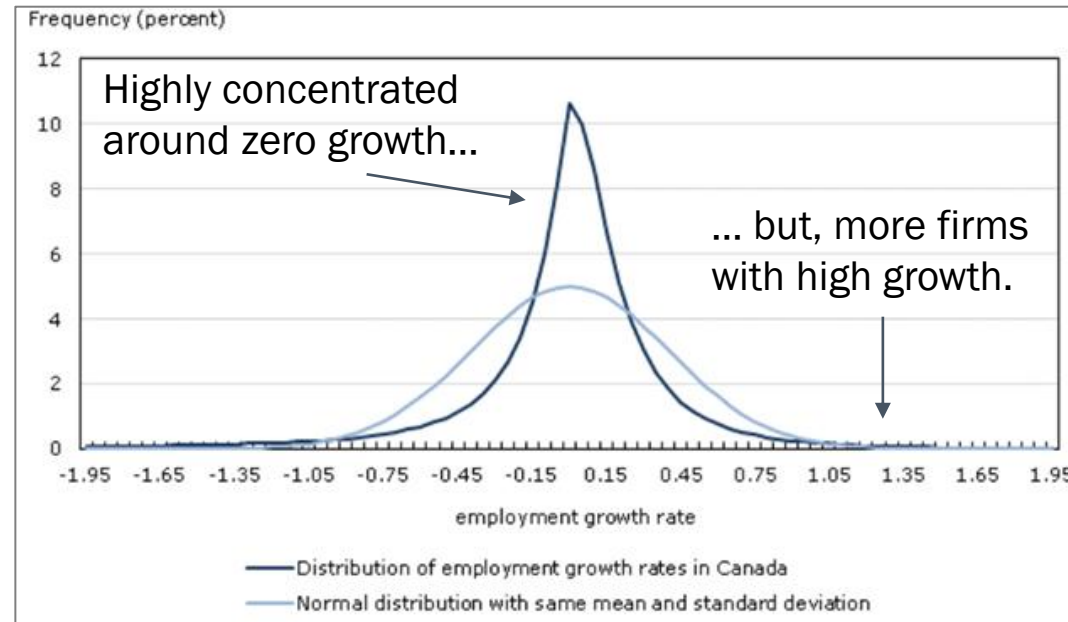
- **Steven Denney** (*University of Vienna & Munk School of Global Affairs and Public Policy*)
- **Ryan Kelly** (*Innovation, Science and Economic Development*)
- **David Wolfe** (*Innovation Policy Lab, Munk School of Global Affairs and Public Policy*)

The views and opinions expressed in this paper are those of the authors alone and do not represent the views or opinions of the Department of Innovation, Science and Economic Development, the Department of Finance or of the Government of Canada.

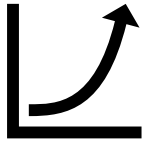
Introduction and Motivation

Problem: understanding small set of high-performing firms that drive growth

Employment growth distribution (2000-2009),
compared to normal distribution



The pivotal role of scale-ups in Canada



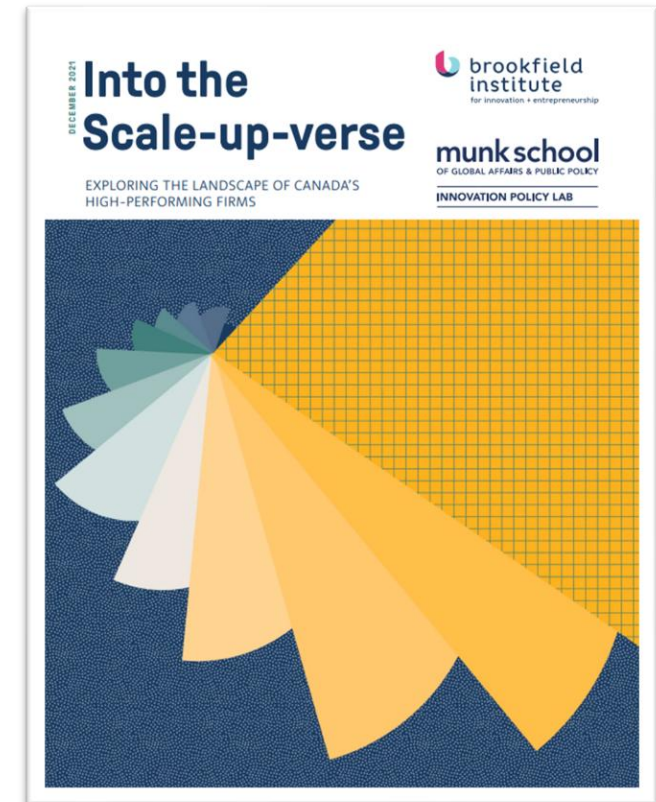
Rare but impactful

- Between <1% to 8% of firms depending on the definition
- Achieve higher employment levels & pay higher wages
- Higher average productivity growth



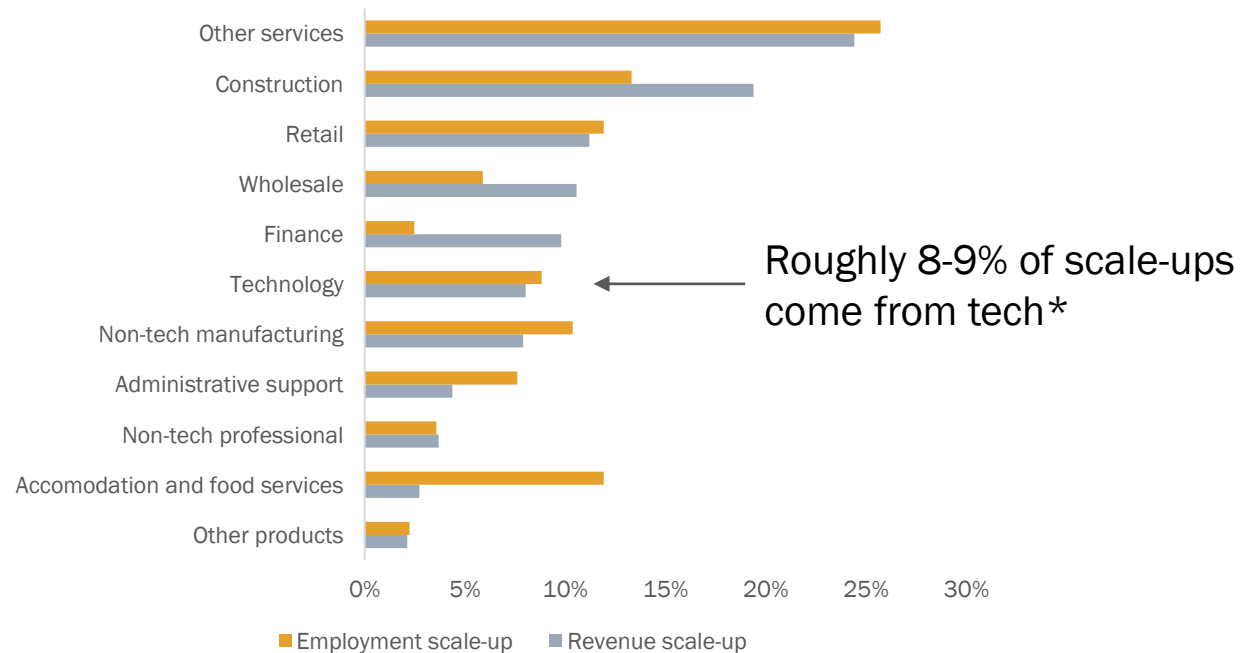
Export & R&D

- Up to 10X more likely to export.
- Up to 8X more likely to conduct R&D
- Downward trend in the share of scale-ups performing R&D



Scaling not limited to tech-based industries

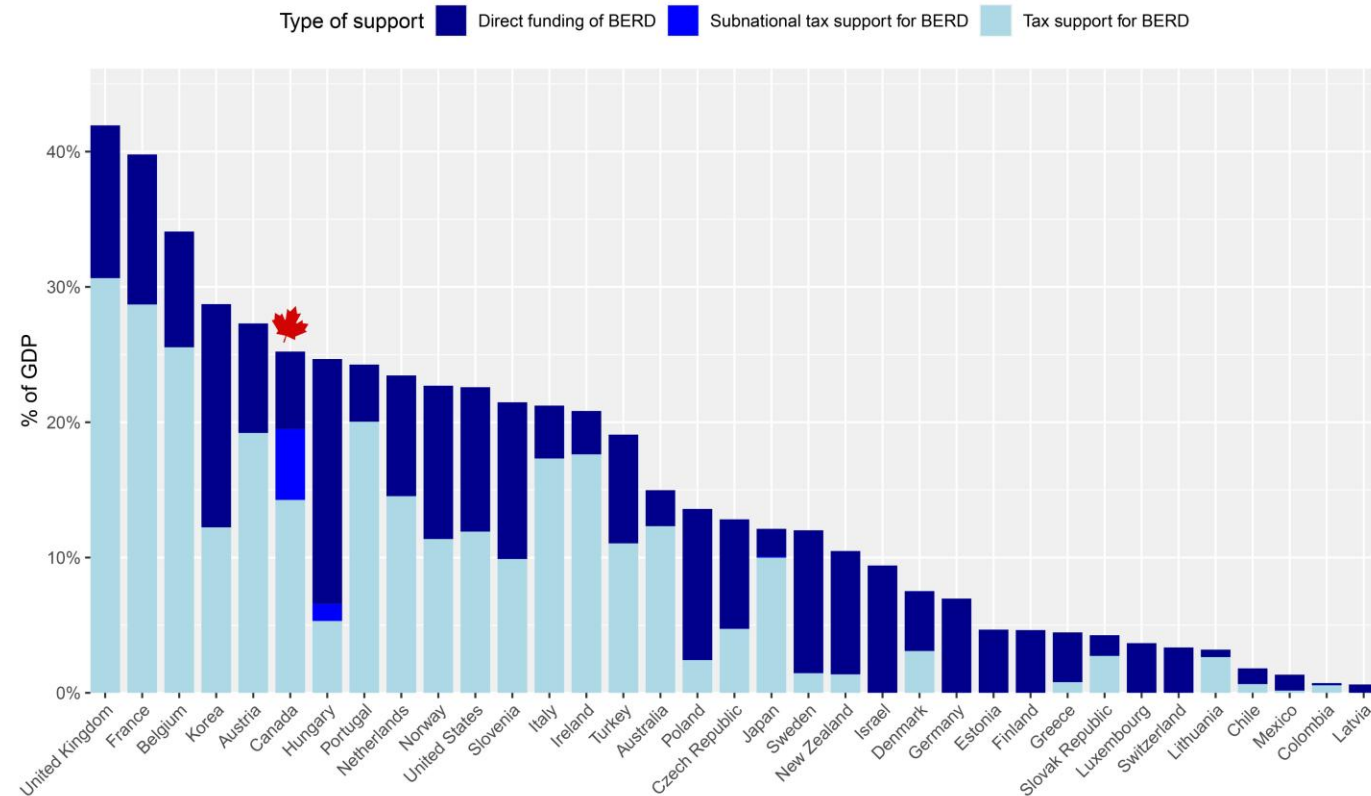
Share of overall scale-ups by industry
by scale-up definition (2016)



*Tech industry includes 4-digit NAICS that have 3X the average concentration of tech workers. These industries include: 2211, 3333, 3341-46, 3353, 3364, 4173, 4861-2, 5112, 5122, 5152, 5171-2, 5174, 5179, 5182, 5211, 5261, 5413, 5415, 5417, 8112.



Government funding and tax support for BERD



- OECD 2019

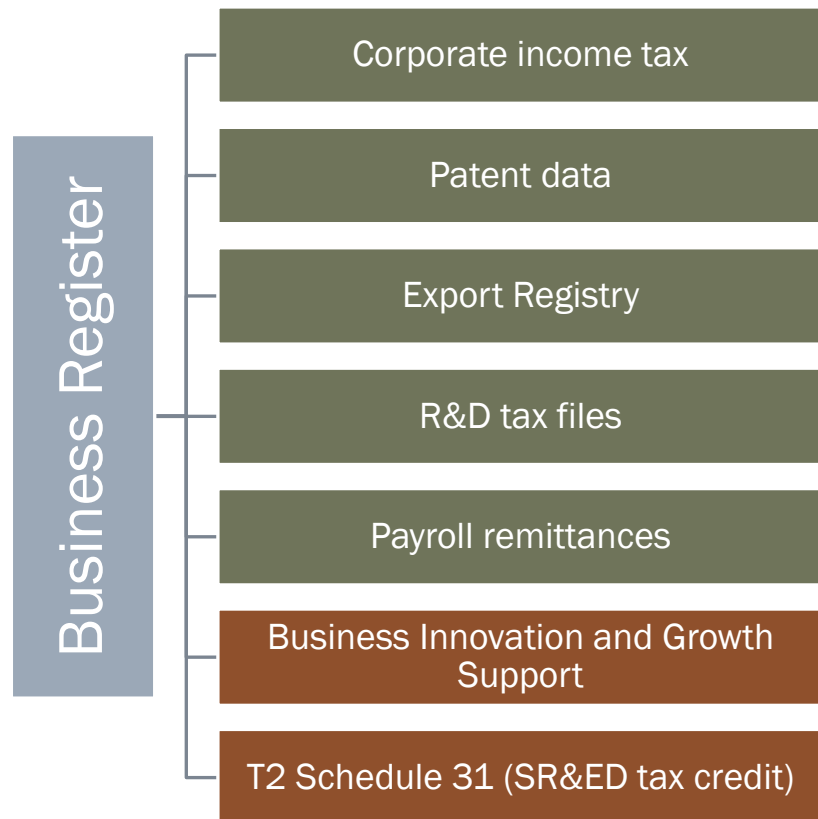
The availability of BIGS data allows for new policy-relevant questions

Current questions for the **scale-up universe**:

- Who receives direct support?
- How much support do firms receive, and from which programs?
- When are firms getting support – is it before/after scaling?
- What is the impact of direct support on firm behavior?

Data and Definitions

Statistics Canada Administrative Data



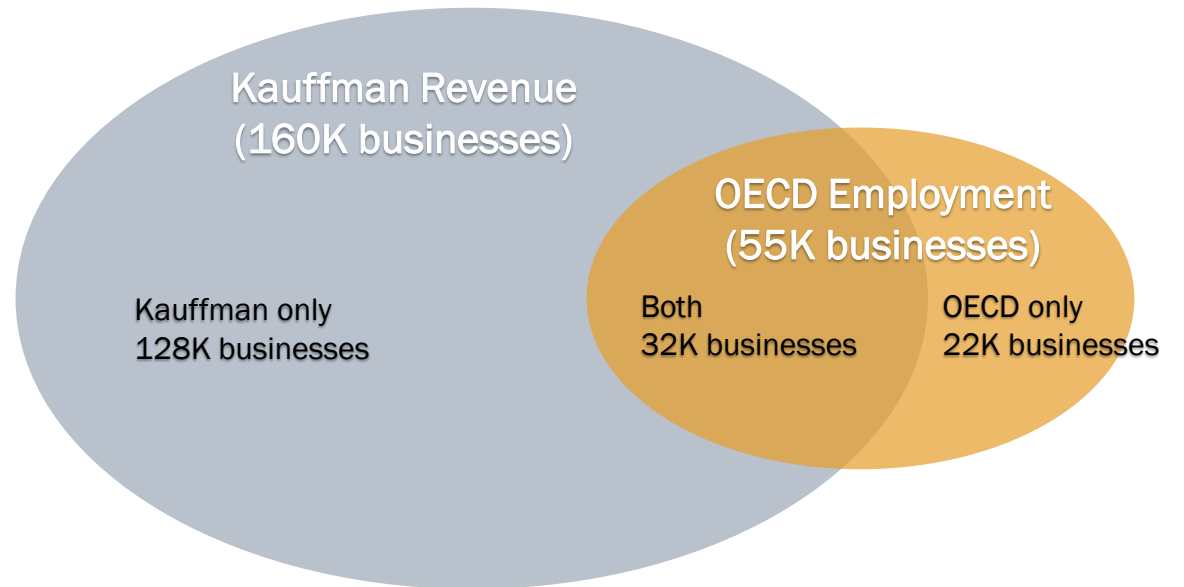
Data links BIGS program data and SR&ED ITC files to key administrative data sources covering growth, patenting, exporting, R&D performance.

Population includes all BIGS program recipients from 2007-19, and all businesses that achieve scale-up status (either employment or revenue).

Scale-up Definitions Used

Dimension of Growth	Firm population	Definition
Revenue (output of production)	All firms	Kauffman Revenue Scale-up <= 20% year-on-year growth in revenue over three years <= \$2 million in revenue at the end of the measurement year
Employment (input to production)	Established firms	OECD Employment Scale-up Average of at least 20% year-on-year growth in employment for three consecutive years At least 10 employees at the beginning of the growth period

Scale-ups 2010-19 cohort
by scale-up definition

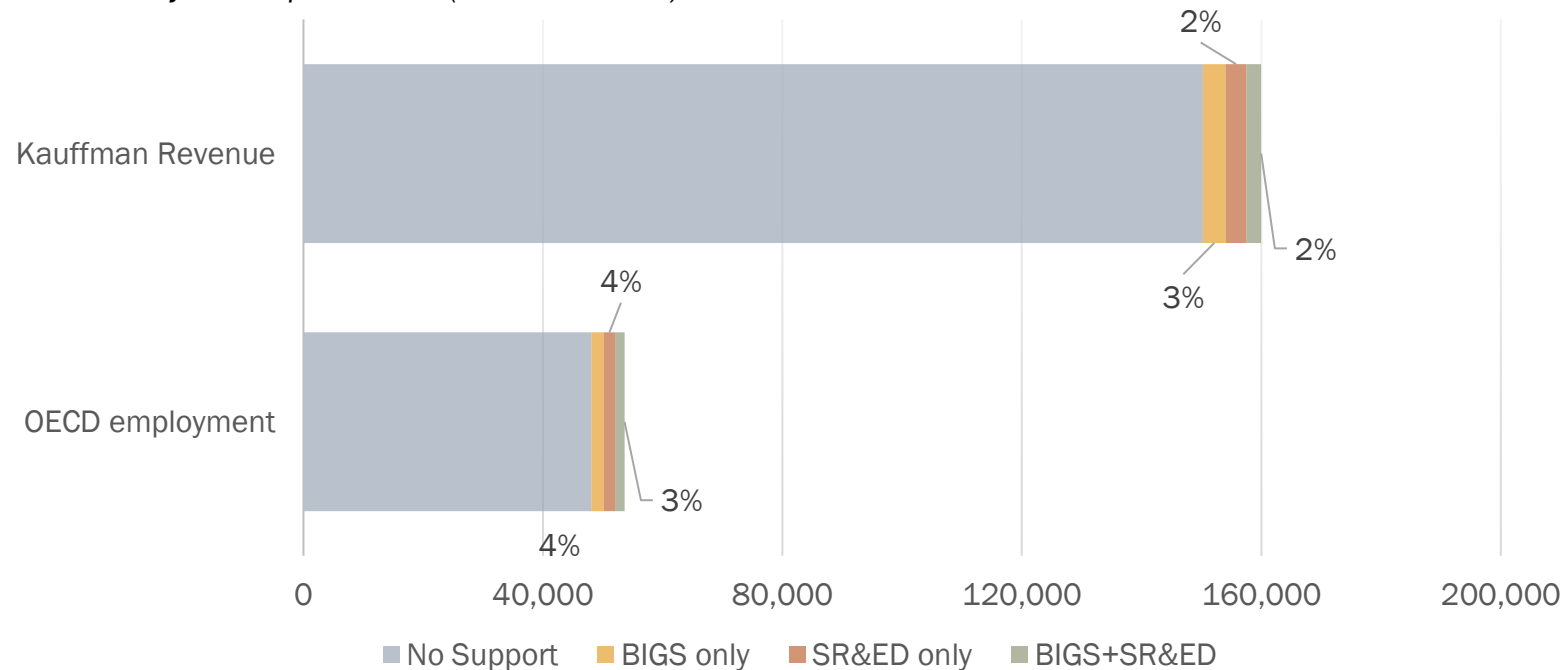


Findings

Majority of scale-ups don't receive BIGS or SR&ED support

Support Status of Scale-ups in 2019

Counts by scale-up definition (2010-19 cohort)



Focus on businesses that achieve scale at some point during 2010-19.

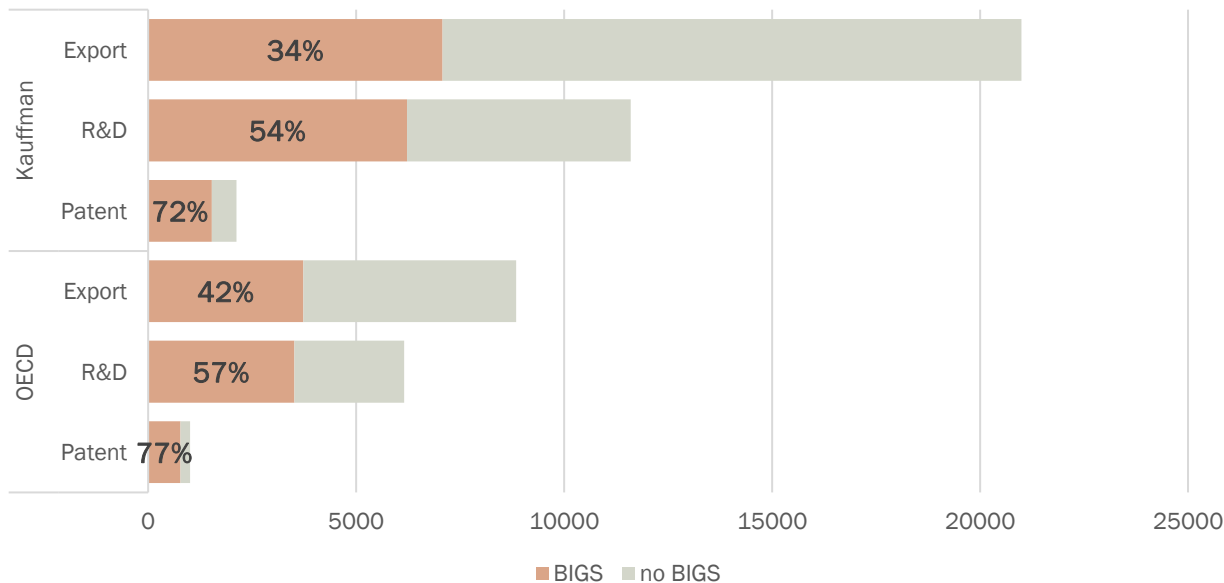
Depending on the definition Between 7-11% received support in 2019.

- Note: following a cohort of 2012-15 scale-ups and evaluating over full BIGS sample (i.e., 2007-2019) % of supported scale-ups goes up to 15-23%.

However, high percentage of exporting, R&D performing or patenting scalers get BIGS support...

Export, R&D and Patenting Scale-ups by BIGS support status*

Counts by scale-up definition (2010-15 cohort)



BIGS coverage higher in the manufacturing sector.

- 52-56% of exporting scale-ups
- 61-63% of R&D performing scale-ups
- 82-85% of patenting scale-ups

And, higher among larger scale-ups (i.e., those with 100+ employees)

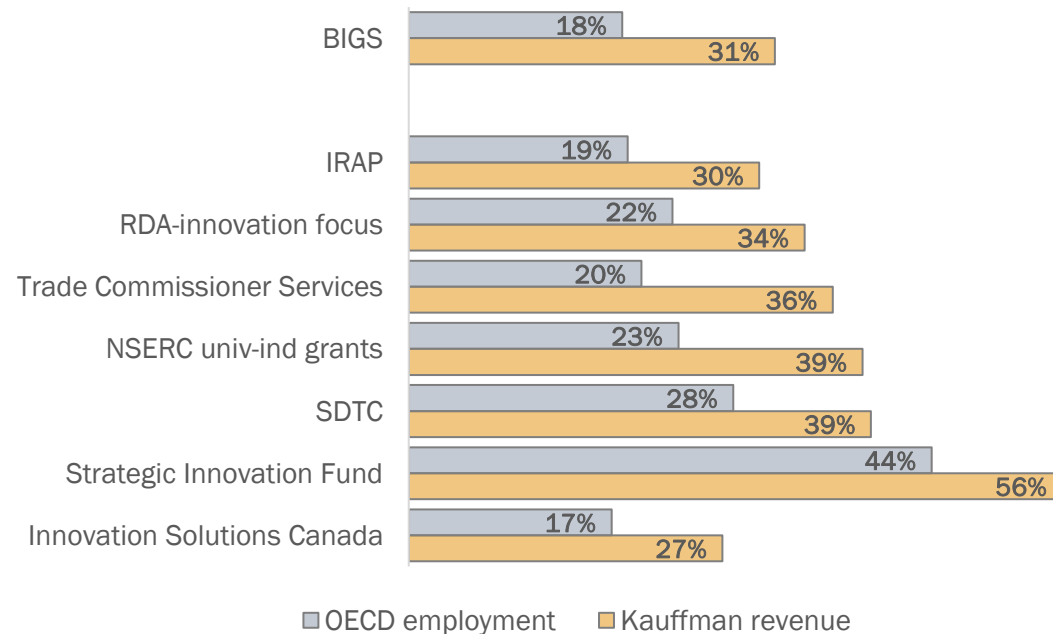
- 54-57% of exporting scale-ups
- 69-70% of R&D performing scale-ups
- 85-86% of patenting scale-ups

*BIGS support received at any point during 2007-19; Exporter or R&D performer if the business had R&D expenditures or exports at any point 2007-19; Patenting if business applied for a patent 2007-2015.

...And, a high percentage of BIGS recipients have scaled

Percentage of 2019 BIGS recipients that achieved scale-up status prior to support

by scale-up definition (2010-19)



Between ~20-30% of BIGS recipients had at least one instance of scaling depending on the definition

A higher percentage of recipients are scalers in more targeted programs, e.g., SDTC, SIF.

Coverage and intensity of BIGS support to scale-ups varies by program

IRAP and TCS are the most commonly leveraged programs by scale-ups, but involve less financial support than other more targeted programs (e.g., SIF)

Value of Support going to Scale-ups in 2019

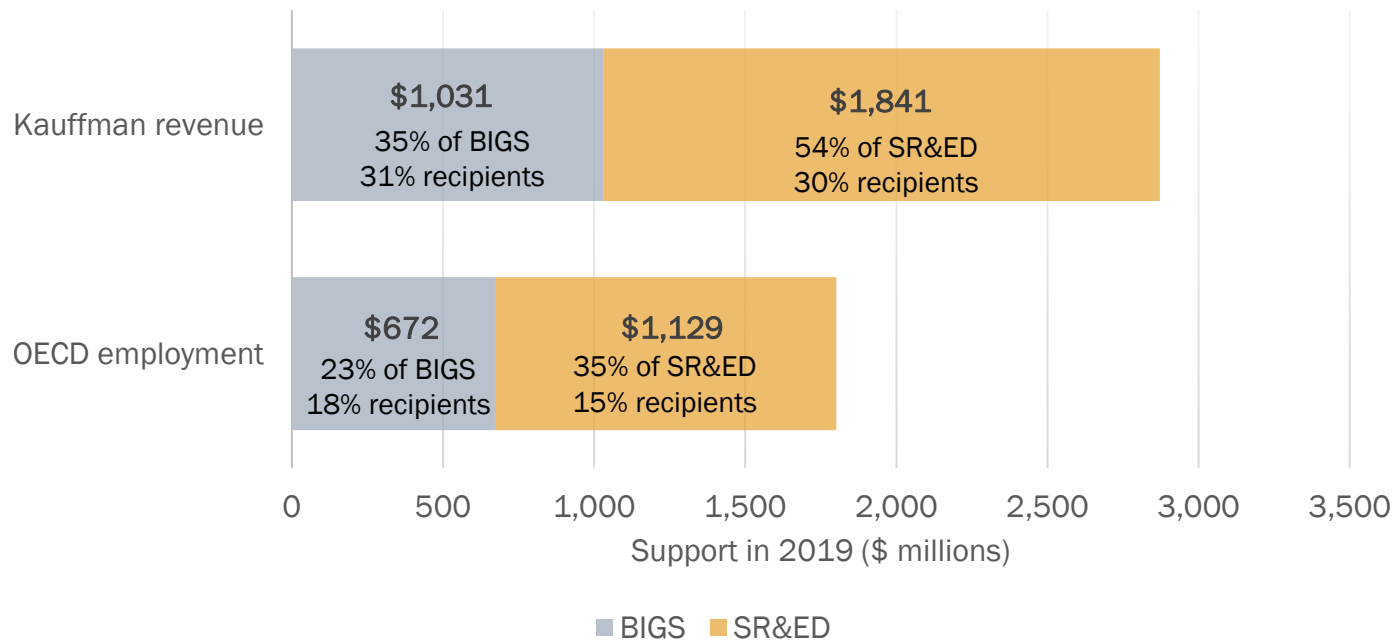
By scale-up definition (2010-19 cohort)

	OECD Employment Scale-ups			Kauffman Revenue Scale-ups		
	Recipients	Value (\$)	Avg Value (\$)	Recipients	Value (\$)	Avg Value (\$)
IRAP	1,340	106,000,000	79,000	2,145	150,000,000	70,000
RDA-innovation focus	500	223,000,000	446,000	750	302,000,000	403,000
Trade Commissioner Services	1,740	N/A	N/A	3,170	N/A	N/A
Other programs	1,785	343,000,000	192,000	2,870	579,000,000	202,000
SDTC	40	40,000,000	1,000,000	55	61,000,000	1,109,000
Strategic Innovation Fund	20	65,000,000	3,250,000	25	111,000,000	4,440,000
Innovation Solutions Canada	25	8,000,000	320,000	40	11,000,000	275,000
 BIGS	 3,675	 672,000,000	 183,000	 6,300	 1,031,000,000	 164,000
SR&ED	3,465	1,129,000,000	326,000	5,925	1,841,000,000	311,000

Supported scale-ups punch above their weight in BIGS/SR&ED \$\$

Value of Support going to Scale-ups in 2019

By scale-up definition (2010-19 cohort)



Businesses scaling at some point in the last ten years received a significant percentage of overall 2019 support.

Scale-ups received nearly twice as much support from SR&ED compared to BIGS.

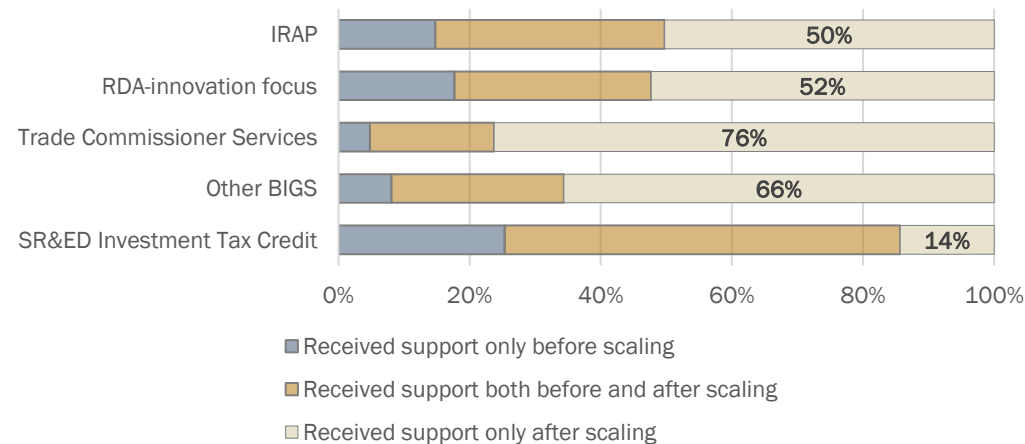
For most supported scale-ups, BIGS came only after initial scaling

More than half of scale-up recipients received support from BIGS only after scaling

In contrast, the majority (86%) of SR&ED supported scale-ups received support prior to scaling.

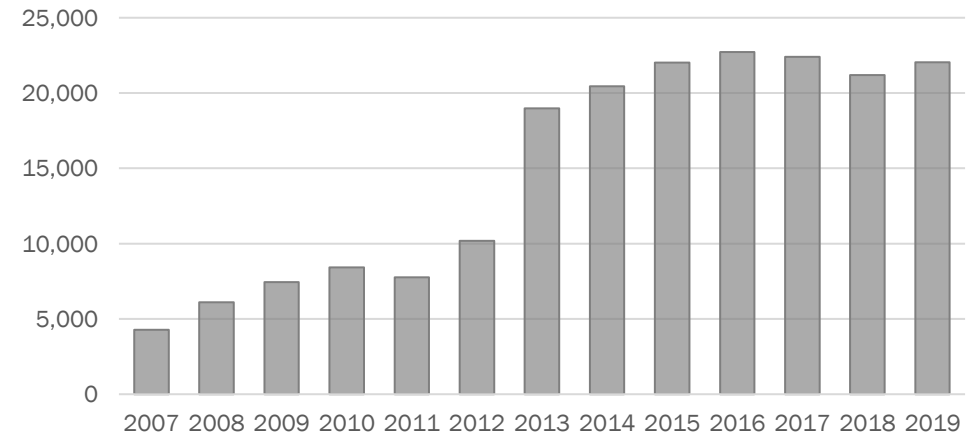
Distribution of scale-ups by timing of support

OECD employment scale-up (2012-15 cohort)



This stark difference is at least partially an artifact of the expansion of BIGS, which touched more businesses from 2013 onwards.

Count of BIGS Recipients

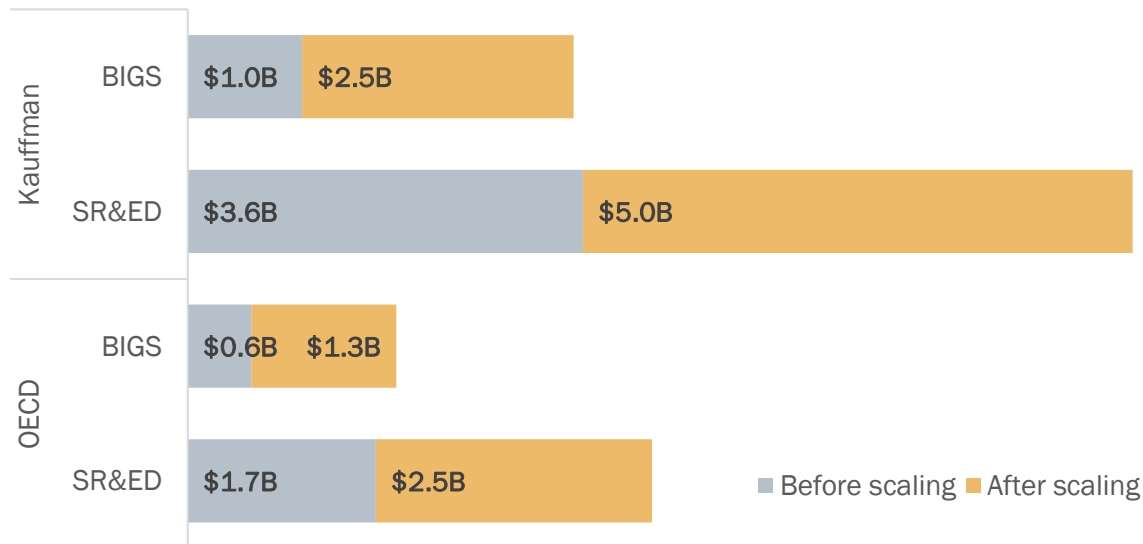


Value of support weighted towards post-scaling for both BIGS and SR&ED

Total Value of support over 2007-19 by timing
relative to initial scaling
2012-15 scale-up cohort

% of support
after scaling

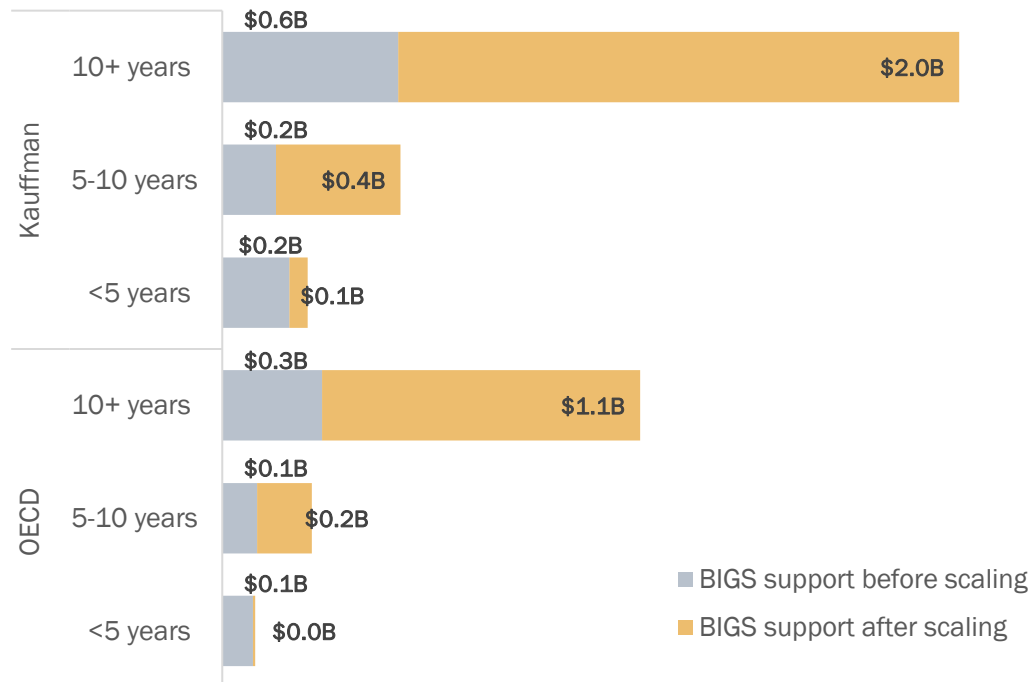
While most **SR&ED scale-ups** received some support prior to scaling, most of their received support came **after** they first scaled.



Most scalers are mature when they scale-up, and receive most of the BIGS support after scaling

Total Value of BIGS support over 2007-19 by timing relative to initial scaling

By age at initial scaling (2012-15 scale-up cohort)



Roughly 60% of scale-ups first achieved scale at 10+ years.

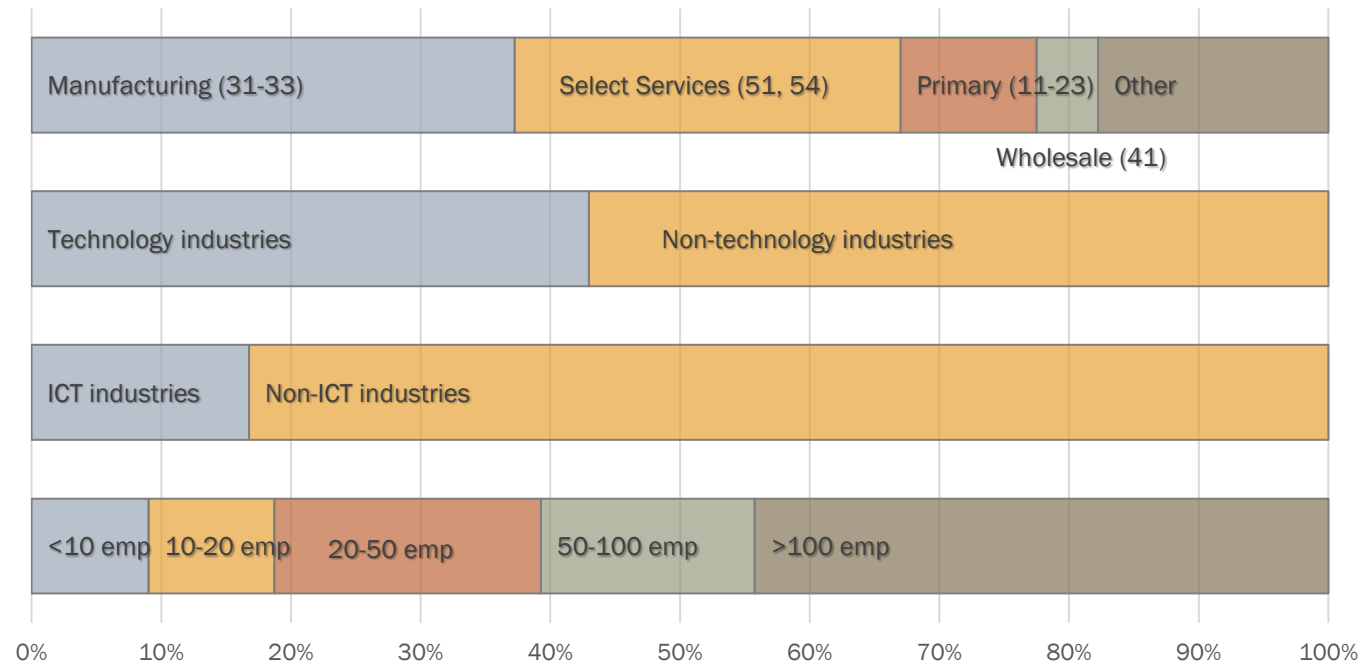
Half of mature scale-ups (scaling at 10+ years) getting BIGS received support only after scaling.

Between 55-60% of the value of BIGS support going to scale-ups went to mature scale-ups after scaling.

Value of support concentrated in the Manufacturing sector and among larger businesses

Distribution of Value of BIGS Support to Scale-ups in 2019

Kauffman revenue scale-ups (2010-19)



Roughly 70% of BIGS value going to scale-ups is in Manufacturing, information/cultural, or professional services

More than 40% directed towards technology based industries; 17% towards ICT industries

Roughly 60% of BIGS value going to scale-ups goes to businesses with 50 or more employees

*Tech industry includes 4-digit NAICS that have 3X the average concentration of tech workers. These industries include: 2211, 3333, 3341-46, 3353, 3364, 4173, 4861-2, 5112, 5122, 5152, 5171-2, 5174, 5179, 5182, 5211, 5261, 5413, 5415, 5417, 8112.

Econometric results

Estimating impacts of BIGS on businesses post-scaling performance

Treatment group: Businesses receiving first round of BIGS in 2012-14 that achieved scale-up status prior to support.

Use propensity score matching to select controls among non-supported scale-up population:

- Nearest neighbour matching with replacement; include caliper to drop poor matches.
- Exact match on years since scaling, in addition to matching on previous employment/revenue growth

By limiting both treatment and control to scale-ups (i.e., high-performing, market validated businesses), we help mitigate unobserved differences in firm quality.

Estimate Propensity Score from Logistic Model
 $\Pr(\text{Support}_{i,t} = 1) = \alpha_c + \alpha_t + \beta X_{it} + \varepsilon_{it}$

Controls ($X_{i,t}$) include:

- Previous growth 3yrs (employment/revenue);
- R&D performer (dummy)
- R&D expenditures
- Exporter (dummy)
- Exports
- Size (employment/revenue);
- Average wages
- Age;
- NAICS 3-digit industry
- Years since scaling (exact match)

Control groups balanced across several key covariates

		OECD employment scale-ups					Kauffman Revenue scale-ups				
		Any BIGS	IRAP	RDA Innovation	TCS	NSERC	Any BIGS	IRAP	RDA Innovation	TCS	NSERC
Before matching	Employment	***	***	**	***	***	***	***	***	***	***
	Revenue	***	***	***	***	***	***	***	**	***	***
	Average wages	***	***	***	***	***	***	***	***	***	***
	Age	***	**		***		***	***		***	
	R&D performer (dummy)	***	***	***	***	***	***	***	***	***	***
	R&D expenditures	***	***	***	***	***	***	***	***	***	***
	Exports	***	***	***	***	***	***	***	***	***	***
	Employment growth (past 3 years)	***	***	*	***	*	***	***	***	***	***
	Revenue growth (past 3 years)	***	***	*	***	*	***	***		***	
	Years since scaling				***		***			***	
	Propensity score	***	***	***	***	***	***	***	***	***	***
After matching	Employment				**						
	Revenue				**						
	Average wages	**		**	*					**	
	Age										
	R&D performer (dummy)										
	R&D expenditures				**		***			***	
	Exports				*						
	Employment growth (past 3 years)		*		**						
	Revenue growth (past 3 years)									*	*
	Years since scaling (exact match)										
	Propensity score										

Kolmogorov-Smirnov equality of distribution tests; *** P<0.01; ** P<0.05; * P<0.1

BIGS associated with positive impacts on growth

Results show BIGS support is associated with faster growth, and higher rates of subsequent scaling periods.

- Estimates show average growth premium over 5 years post treatment.

Given some covariates we were unable to balance fully, we use a Fixed Effects model to estimate the impacts.

$$Y_{it} = \alpha_i + \delta_t + \beta X_{it} + \theta Treat_{it} + \epsilon_{it}$$

Controls ($X_{i,t}$) include:

- R&D performer; Exporter; Patent holder
- Industry year cross-products
- SR&ED support

Treatment Effects

By program aggregate and scale-up definition (2012-14) scale-up cohorts

	Employment	Revenue	Scaling incidence
<i>OECD employment</i>			
Any BIGS	10% ***	17% ***	5% ***
IRAP	9% ***	15% ***	3%
RDA innovation	21% ***	26% ***	8% *
TCS	14% ***	24% ***	6% ***
NSERC	22% ***	34% ***	8% **
<i>Kauffman revenue</i>			
Any BIGS	14% ***	20% ***	4% ***
IRAP	14% ***	18% ***	4% ***
RDA innovation	16% ***	20% ***	10% **
TCS	14% ***	23% ***	5% ***
NSERC	20% ***	27% ***	5% **

Each cell represents a Fixed Effects model estimate of the corresponding program aggregate treatment effect for either OECD employment scale-ups or Kauffman Revenue Scale-ups. Each model includes controls for R&D performers, exporters, patent holders, industry-year cross products and SR&ED support. Treatment control pair observations are included from t -5 to t+5. Standard errors clustered at the firm level.

*** P<0.01; ** P<0.05; * P<0.1

BIGS support leads to higher wages, R&D and exports

Despite impacts on other performance variables, impact on labour productivity not statistically significant.

- Lack of impact could be related to growing pains.

Individual program impacts show similar results across the board.

- While supports and target populations may differ across programs, the overall impacts of \$1 support could be similar.
- Could also be related to high overlap among the programs (particularly large among the scale-up population).

Treatment Effects

By program aggregate and scale-up definition (2012-14) scale-up cohorts

	Average wages	R&D expenditures	R&D incidence	Exports	Export incidence	Sales per employee
<i>OECD employment</i>						
Any BIGS	2% *	15% ***	5% ***	17% **	4% ***	2%
IRAP	4% ***	15% ***	7% ***	6%	5% ***	0%
RDA innovation	4%	13%	0%	46%	6% **	-6%
TCS	3% ***	12% ***	6% ***	12% *	7% ***	4%
NSERC	-2%	13% **	3%	24%	6% ***	-9%
<i>Kauffman revenue</i>						
Any BIGS	3% ***	14% ***	5% ***	12% **	5% ***	1%
IRAP	3% **	13% ***	5% ***	4%	5% ***	0%
RDA innovation	5% **	16% *	1%	41% **	4% *	-11% *
TCS	3% ***	14% ***	5% ***	14% ***	5% ***	3%
NSERC	2%	20% ***	7% ***	21% *	7% ***	3%

Each cell represents a Fixed Effects model estimate of the corresponding program aggregate treatment effect for either OECD employment scale-ups or Kauffman Revenue Scale-ups. Each model includes controls for R&D performers, exporters, patent holders, industry-year cross products and SR&ED support. Treatment control pair observations are included from t -5 to t+5. Standard errors clustered at the firm level.

*** P<0.01; ** P<0.05; * P<0.1

BIGS support leads to higher wages, R&D and exports

Despite impacts on other performance variables, impact on labour productivity not statistically significant.

- Lack of impact could be related to growing pains.

Individual program impacts show similar results across the board.

- While supports and target populations may differ across programs, the overall impacts of \$1 support could be similar.
- Could also be related to high overlap among the programs (particularly large among the scale-up population).

Treatment Effects

By program aggregate and scale-up definition (2012-14) scale-up cohorts

	Average wages	R&D expenditures	R&D incidence	Exports	Export incidence	Sales per employee
<i>OECD employment</i>						
Any BIGS	2% *	15% ***	5% ***	17% **	4% ***	2%
IRAP	4% ***	15% ***	7% ***	6%	5% ***	0%
RDA innovation	4%	13%	0%	46%	6% **	-6%
TCS	3% ***	12% ***	6% ***	12% *	7% ***	4%
NSERC	-2%	13% **	3%	24%	6% ***	-9%
<i>Kauffman revenue</i>						
Any BIGS	3% ***	14% ***	5% ***	12% **	5% ***	1%
IRAP	3% **	13% ***	5% ***	4%	5% ***	0%
RDA innovation	5% **	16% *	1%	41% **	4% *	-11% *
TCS	3% ***	14% ***	5% ***	14% ***	5% ***	3%
NSERC	2%	20% ***	7% ***	21% *	7% ***	3%

Each cell represents a Fixed Effects model estimate of the corresponding program aggregate treatment effect for either OECD employment scale-ups or Kauffman Revenue Scale-ups. Each model includes controls for R&D performers, exporters, patent holders, industry-year cross products and SR&ED support. Treatment control pair observations are included from t -5 to t+5. Standard errors clustered at the firm level.

*** P<0.01; ** P<0.05; * P<0.1

Conclusions

Many scale-ups do not receive support, but more innovative scale-ups do (i.e., exporters, R&D spenders or patenting firms).

Much of the government support comes after initial scaling:

- Selection by programs (i.e., selecting businesses with proven track records)
- Selection by businesses (i.e., better-managed businesses more effective)

Results show positive impacts (growth, R&D, exporting) on supported scalers and continuous scaling. However, support was not associated with increased labour productivity in the near-term.

Policy Implications

Winners pick government

Key question: what kinds of firms tend to make use of government programs to enhance technological and innovative capabilities?

- “Our results confirm that, in contrast to those who maintain governments ‘can’t pick winners’, winning firms are much more effective at choosing to participate in government-based innovation programs than are ‘losers’”. (Levitte, Gertler and Wolfe 2003).
- “Scale-up entrepreneurs prefer a more active role of the government in the form of demand-side, direct, and targeted innovation instruments. [Our] findings... provide a more nuanced understanding of the innovation policy landscape and the preferences of technology scale-up firms” (Denney, Southin and Wolfe 2023)

Should innovation support programs target scale-up firms?

Scale-up firms look to government for demand-side, direct and targeted innovation support

- Results confirm that direct and targeted BIGS support programs produce results for scale-up firms
- Should scale-ups be targeted more generally in BIGS funding programs?
- How will the Canada Innovation Authority advance this agenda?

What is striking about policy findings is impact of BIGS support for scale-ups R&D, sales and exports

- Should enhanced focus on sales and exports be key criteria for allocating BIGS funding?
- Would confirm a key argument that G/A has been making for several years.

How could Canada's private sector fund R&D to bring it to OECD average?

Current R&D Status: Canadian BERD is 0.93% while average OECD BERD is more than double at 1.99%

- Canadian BERD expenditures are \$23.9B -- to meet OECD average must increase to \$51.2B (\$27.2B higher per year)
- Incremental business R&D/Innovation funding must be sourced primarily from corporate revenues which must come primarily from increased exports because of the relative size of Canada's domestic market
- Innovative firms spend about 3.5% of revenues on R&D although certain sectors spend more
- Therefore, innovative firms would need to increase revenues by \$777B per year to be able to finance incremental R&D/Innovation activity of \$27.2B per year
- Because of the relative size of Canada's domestic market, exporting firms would need to increase exports by over 80% from \$936B (in 2022) to \$1,713B annually to generate sufficient revenues to fund the targeted R&D spending level

- David Watters, Global Advantage

Policy Implications: Canada's private sector funding R&D

- An enhanced R&D strategy must be an export strategy
- Growth in Schumpeterian industries requires an effective export strategy (Richard Harris 1985)
- But, in which countries are the export markets located? What incremental Canadian goods and services would be bought? What public infrastructure is available in Canada today (hard and soft) to support and de-risk such large new export sales?

What is missing?

BIGS data provides great preliminary insights into the impact of federal business and innovation support funding on the performance of scale-up firms

BUT our analysis is missing crucial pieces needed for a full assessment:

- Impact of demand-side policies – procurement data is available in BIGS, but its effects doesn show up clearly in the present analysis
- This piece of the puzzle needs further exploration
- Impact of support from BDC and EDC
 - These agencies are crucial for understanding the impact of federal support on the export performance of innovative Canadian scale-ups
 - We need the data for crown agencies added to BIGs to undertake a full assessment of export effects

Still lots to do on the research agenda!