

Public Entrepreneurial Finance around the Globe

Jessica Bai, Shai Bernstein, Abhishek Dev, and Josh Lerner
Harvard University and Yale University

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Introduction

- The financing of early-stage ventures contributes to innovation and economic growth:
 - Solow 1957.
- Venture capitalists do so, but face limits in their ability:
 - Focus on a narrow band of technologies,
 - Intense cyclical availability in capital availability, and
 - Fundraising challenges.
 - Lerner and Nanda 2020.
- Government investments have long been prescribed by economists as a solution to market failures:
 - Here, innovative spillovers from new businesses and increasing returns associated with the formation of entrepreneurial clusters:
 - Acs and Audretsch 1988; Glaeser, Kerr, and Kerr 2015.

Introduction (2)

- Argument depends on government officials not pursuing private benefits rather than social welfare:
 - Shleifer and Vishny 1998.
- Moreover, government officials may not have needed skills:
 - Selecting and monitoring start-ups require significant expertise:
 - Gompers and Lerner 1999; Kaplan and Stromberg 2003.
 - VC frequently make decisions based on “soft information”:
 - Kaplan and Stromberg 2004; Bernstein, Giroud, and Townsend 2016; etc.
 - These may be difficult for public officials to duplicate.

Why might government programs may benefit from private entrepreneurial finance?

- To encourage entrepreneurial finance, the government should be willing to contribute capital with an eye to maximizing important externalities that may not be internalized by private capital providers:
 - Griliches 1992; Bloom, Schankerman, and Van Reenen 2013.
- Moreover, highly effective governments can anticipate these problems and collaborate with private capital markets to address them:
 - Acemoglu and Robinson 2013.
- Will formalize with a simple model and empirical analysis:
 - Difference from voluminous literature on program-level impacts:
 - Babina et al. 2020; Bronzini and Iachini 2014; Fei 2018; Howell 2017; Kisseleva 2020; Le and Jaffe 2017; Myers and Lanahan 2022; Pless 2020; Santoleri et al. 2020

Our theoretical approach

- Construct a simple conceptual framework.
- Builds on Lach, Neeman, and Schankerman (2020), who study government loans for R&D startups.
- We extend their work by focusing on the interaction of public and private sector investments in early-stage ventures.

Set-up

Entrepreneurs:

- Risky projects with probability of success p , private returns $R > 1$, and externality σ .
- p is common knowledge, but externality σ is unobserved.
- Limited internal funds to finance themselves.
- Cost of project is common knowledge and normalized to 1.

Venture capitalists:

- Provide capital in return for equity stake that is realized if project succeeds.
- Increase success probability of the project (value-add) by $\beta = \frac{1}{\gamma} + \delta$, where:
 $\gamma > 0$ is search costs and $\delta > 1 - \frac{1}{\gamma}$ is VC effectiveness.
- VCs do not internalize externalities.

Set-up (2)

Government:

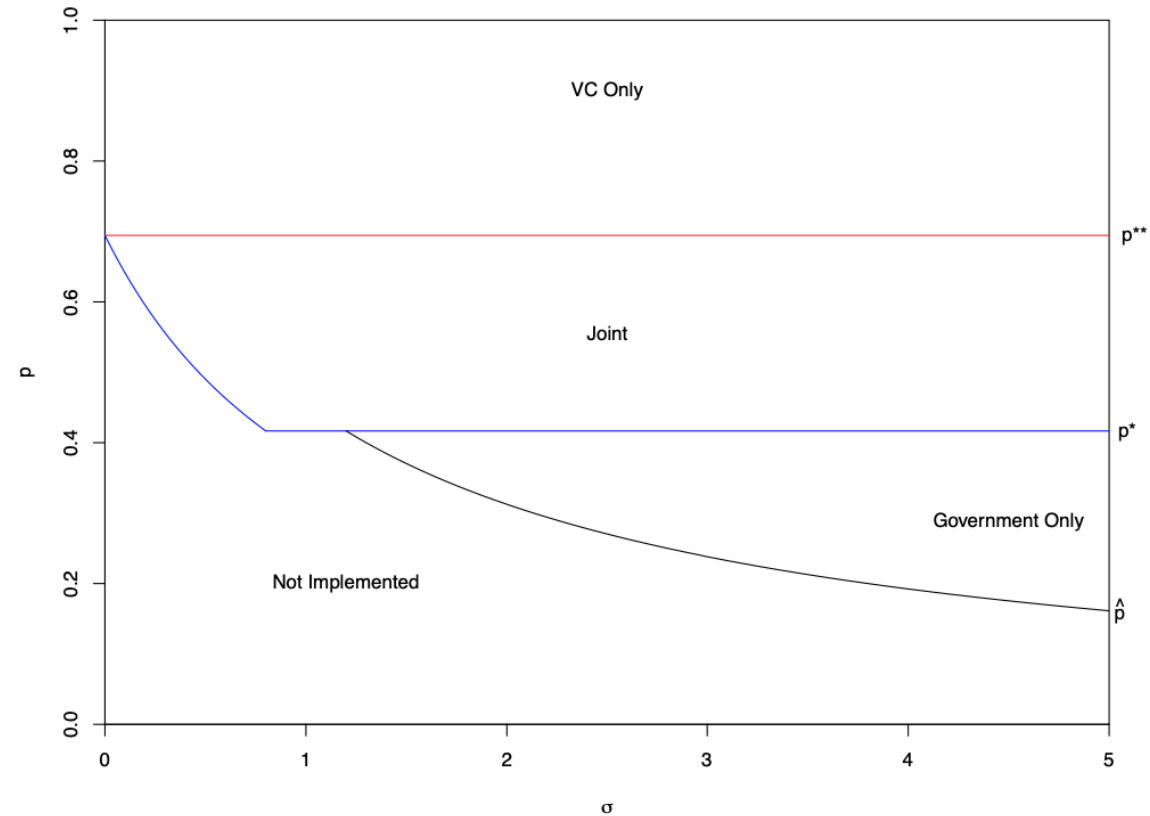
- Risk neutral and observes unbiased signal of the project's externality σ .
- Only party that internalizes social externalities.
- Objective is to maximize social welfare without financing projects that would receive support from private markets anyway.
- Government can either fund projects on its own (in return for equity stake), or split the investment with VC investors.
- We also examine cases where government officials extract private benefits *PB* from investing.

Modeling co-investment

- Government can induce private investor participation in riskier but high-externalities projects by offering co-investment scheme:
 - VC contributes an equal portion of the funds, but gets disproportionately higher equity compensation.
- Government has incentive to do so because VC is able to improve project success.

Result 1: Highest quality projects funded by VC alone

Figure: Boundary conditions in (σ, p) space

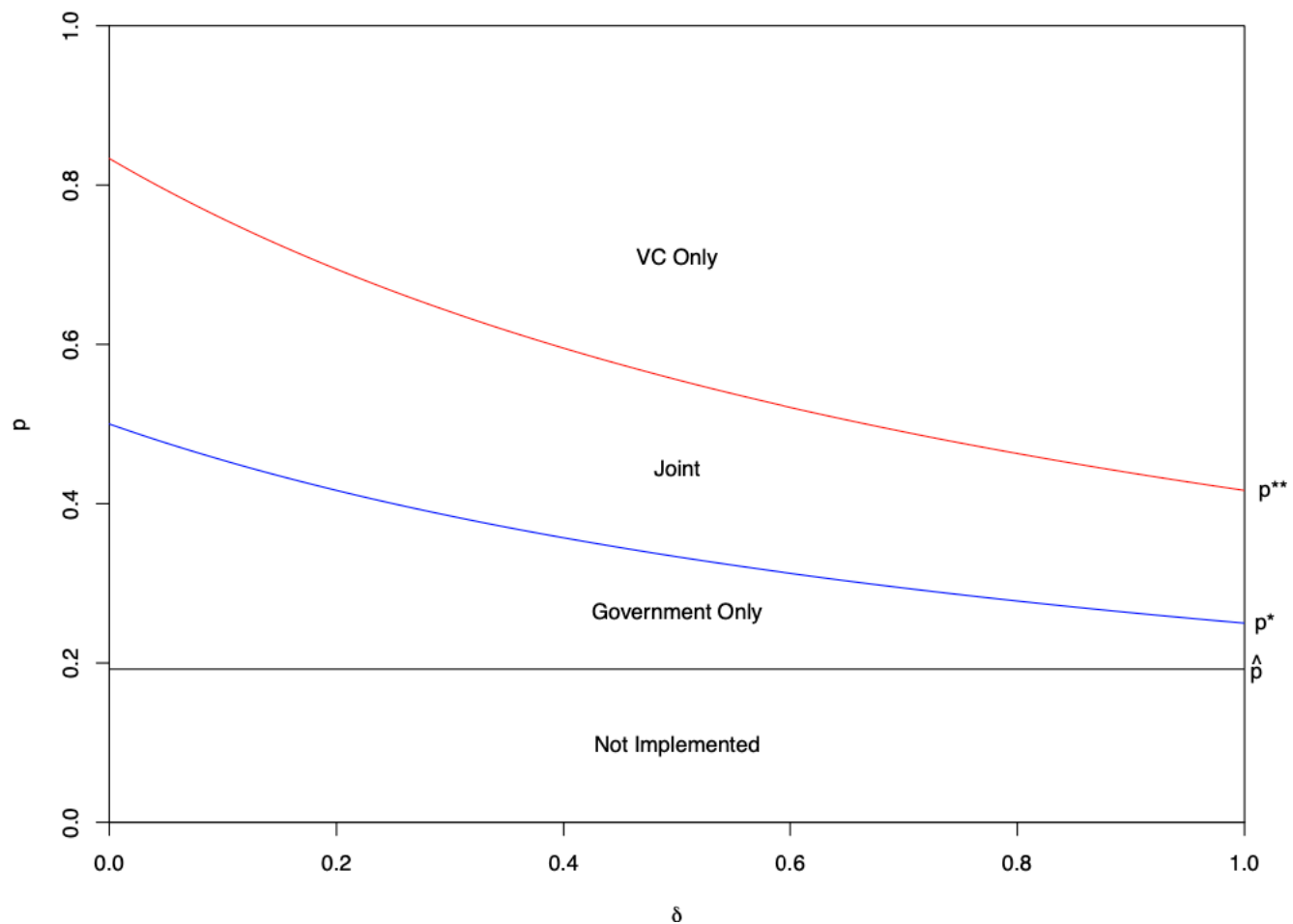


Notes: figure assumes parameter values of $\beta = 1.2$ (increase in success probability because of VC), $R = 1.2$ (private returns),

$\bar{b} = 0.4$ (internal funds of entrepreneur), $PB = 0$ (government private benefits).

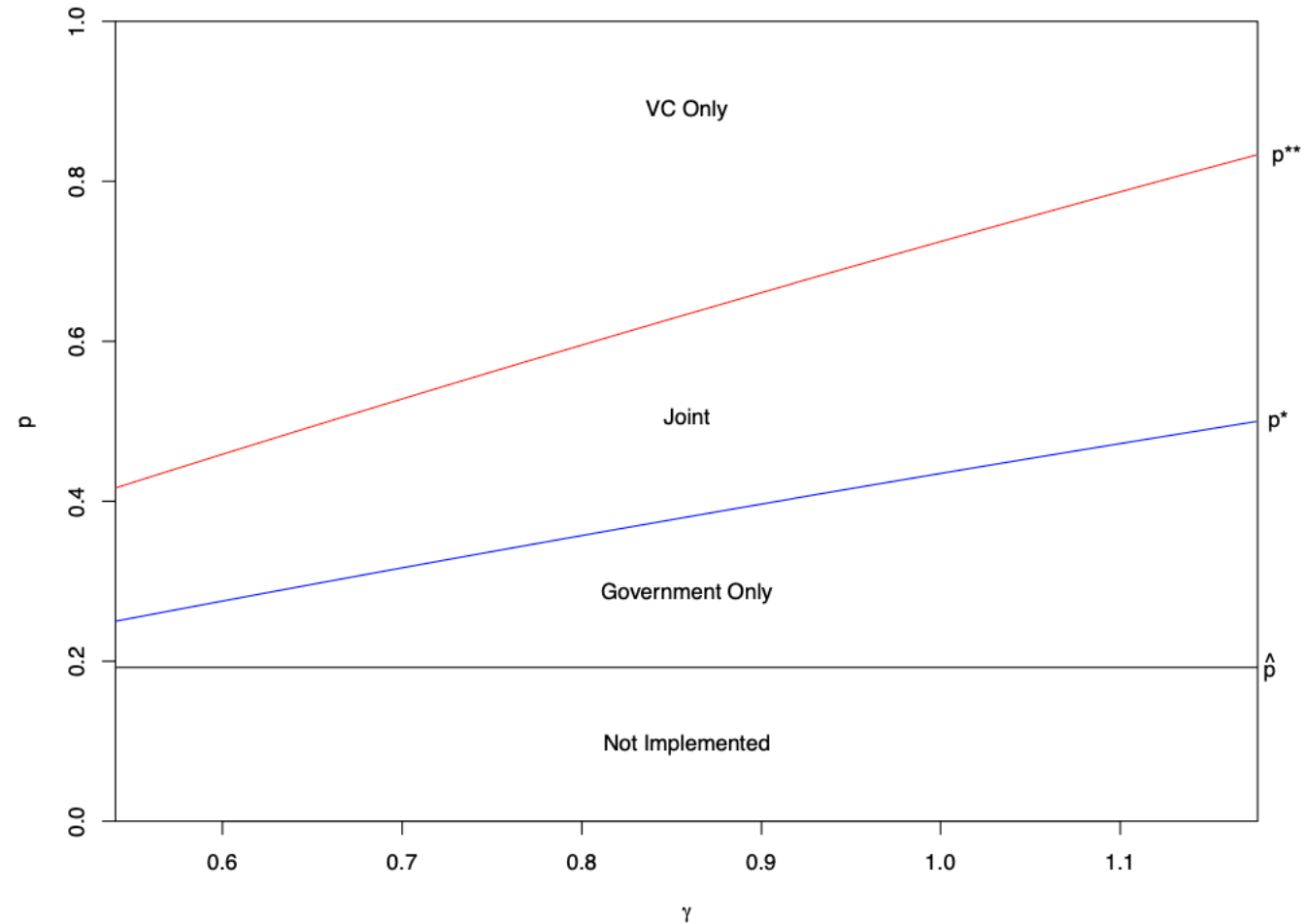
Result 2(i): Co-investment increases with VC effectiveness

Figure: Boundary conditions in (δ, p) space



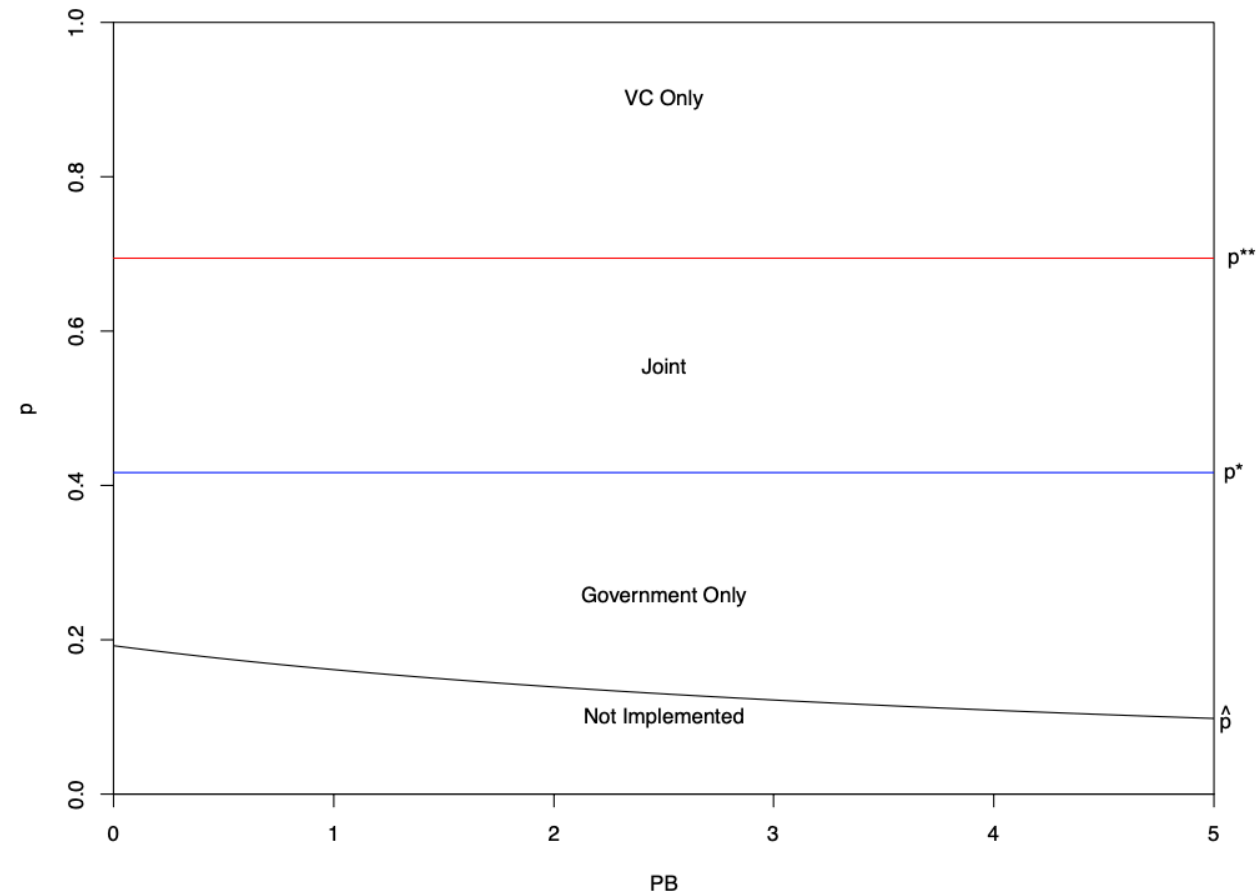
Result 2(ii): Co-investment decreases with VC search costs

Figure: Boundary conditions in (γ, p) space



Result 3: Government-only investment increases with private benefit extraction

Figure: Boundary conditions in (PB, p) space



Data collection on government funding programs

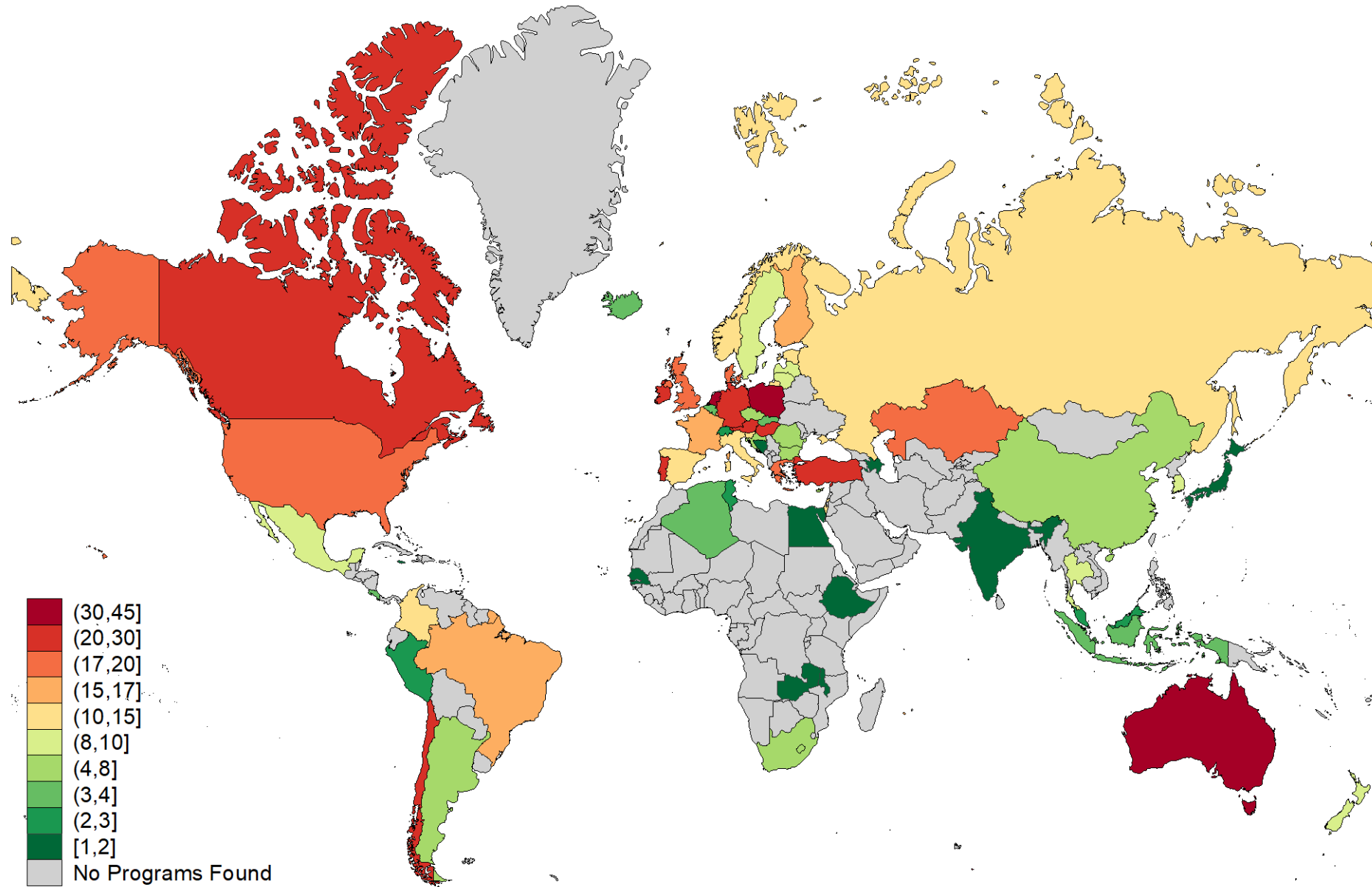
- Relied on 190 sources on public entrepreneurial finance programs that were published between 1998 and 2020:
 - Such sources included international bodies, national governments, and academics.
 - Many had features of programs records.
 - Then gathered information about program design, budgets, and evolution online.
 - Relied on the Internet Archive to collect information on programs whose websites no longer function.
- Also collected variety of data on country level.

Publisher of the Report	Count of sources	Percent
Organisation for Economic Cooperation and Development	139	73.2%
Academic papers	21	11.1%
European Union	5	2.6%
World Bank	3	1.6%
MTI	2	1.1%
United Nation	2	1.1%
African Development Bank Group and OECD	1	0.5%
CapGemini Consulting	1	0.5%
ERIA	1	0.5%
European Civil Society Platform	1	0.5%
European Investment Bank	1	0.5%
Finnish Ministry of Trade and Industry	1	0.5%
Foster Care Work Group	1	0.5%
Government of the United Kingdom	1	0.5%
Inter-American Development Bank	1	0.5%
International Monetary Fund	1	0.5%
Institut zur Zukunft der Arbeit	1	0.5%
Institute for Public Policy Research	1	0.5%
Manpower Group	1	0.5%
Migration Policy Institute	1	0.5%
Price Waterhouse Coopers	1	0.5%
Swedish Entrepreneurship Forum	1	0.5%
The Finance Project	1	0.5%
World Economic Forum	1	0.5%
Total	190	100.0%

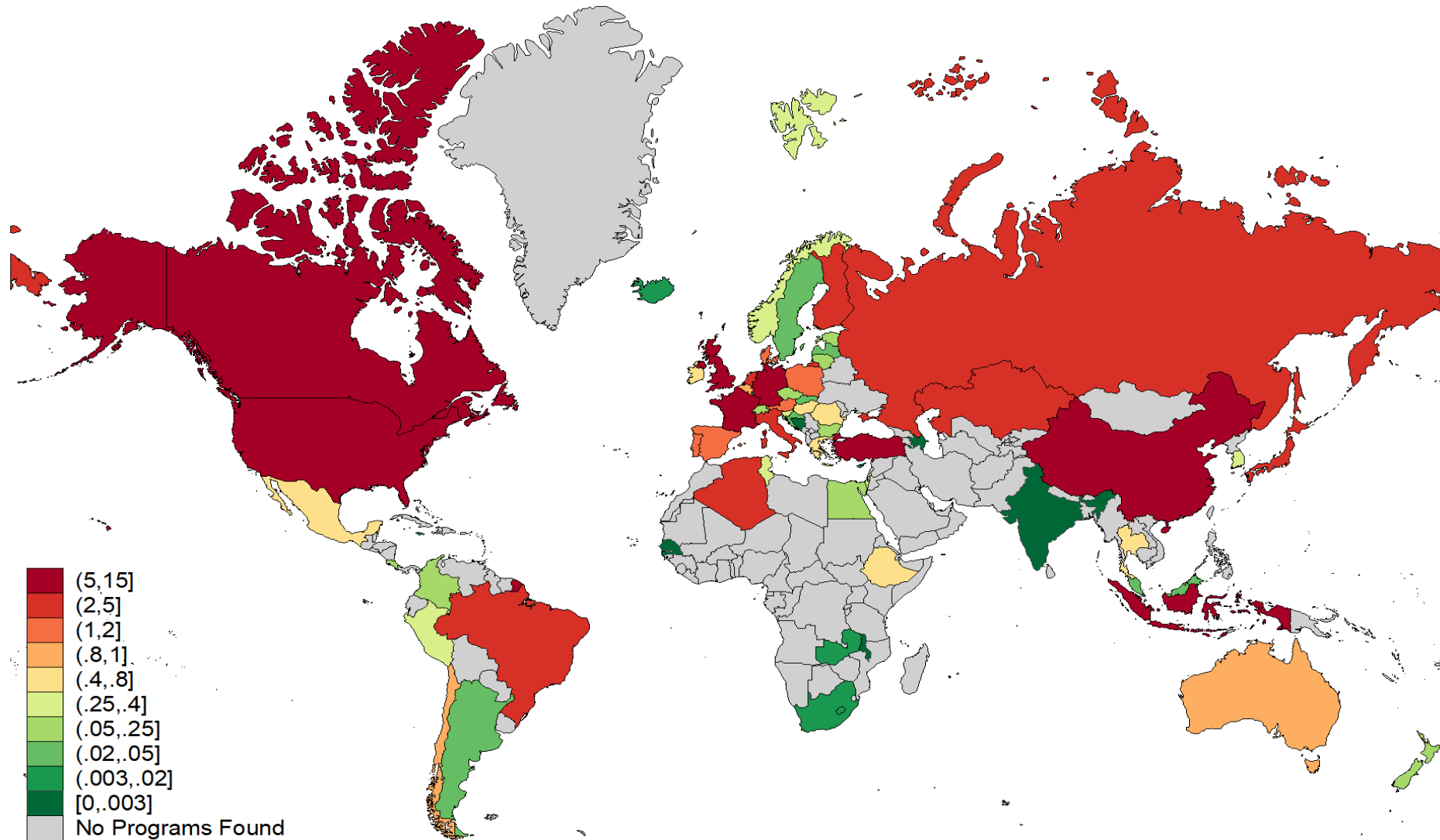
What is an included policy?

- Domestic focus: We dropped policies focused specifically on other markets.
- Financial orientation: Focused on programs that involved the financing of entrepreneurs, not just training or incubation.
- Nation-level policies:
 - Because we focused our analysis on the nation level, we dropped programs run by international bodies exclusively such as the International Finance Corporation.
 - We also dropped policies organized by states, provinces, and municipalities.
- Appropriate program level:
 - In some cases, there were “umbrella” policies that encompassed a number of clearly distinct programs with different types of financing provided and/or firms targeted. In these cases, we split the umbrella policies up into their clearly defined subprograms.
 - In some cases, policies were announced as separate programs, even though they had the same structure. We classified these as a single program and aggregated the budget information. In policies where there was a clear primary financing type but some additional capital provided (e.g., an equity financing program with a small loan component appended), we code the policy according to the primary financing type i.
- Sometimes programs changed design or scaled over time: approach depended on magnitude of changes.

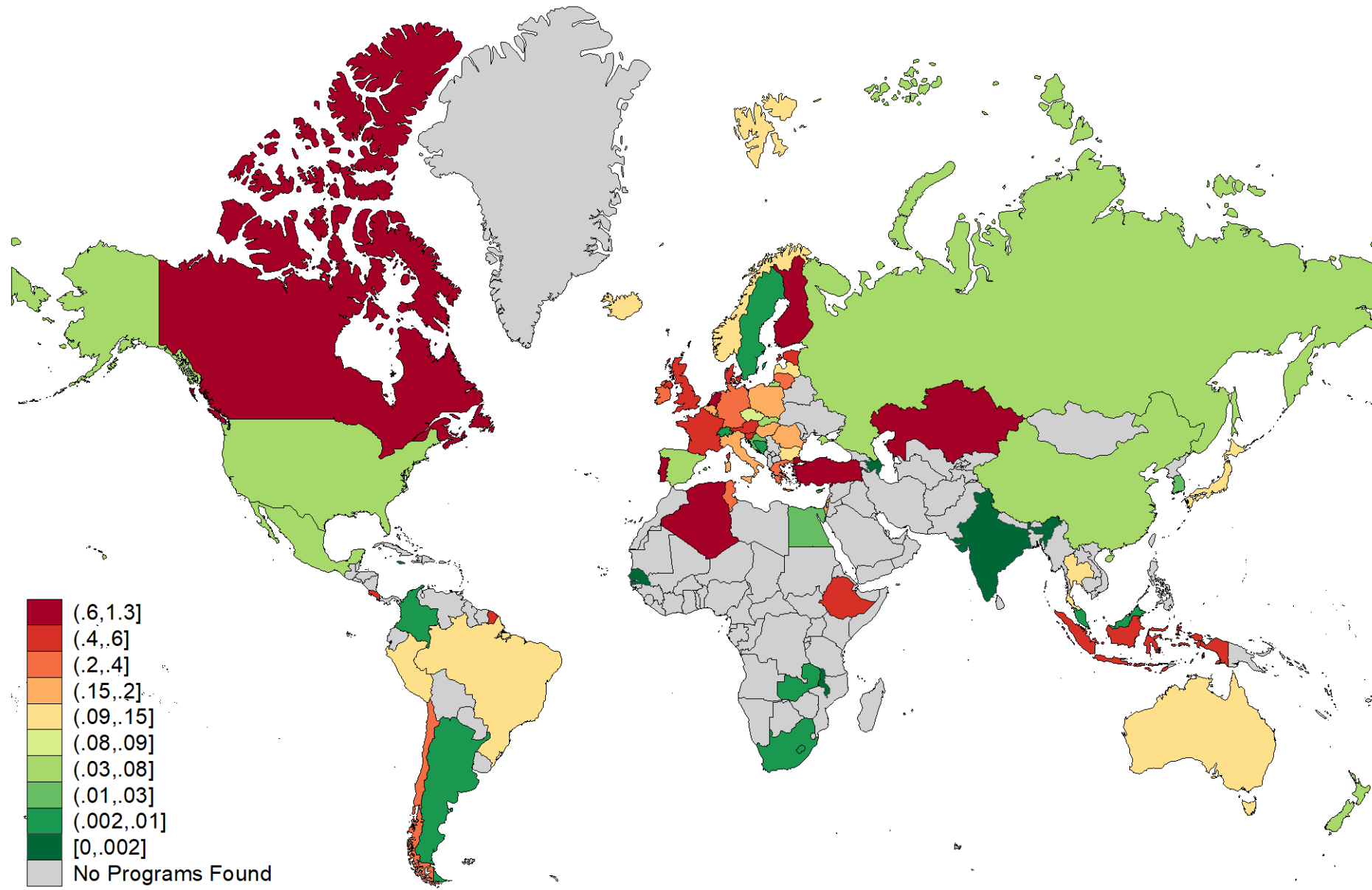
Count of distinct public entrepreneurial finance policies



Annual budgets, entrepreneurial finance programs (\$B)



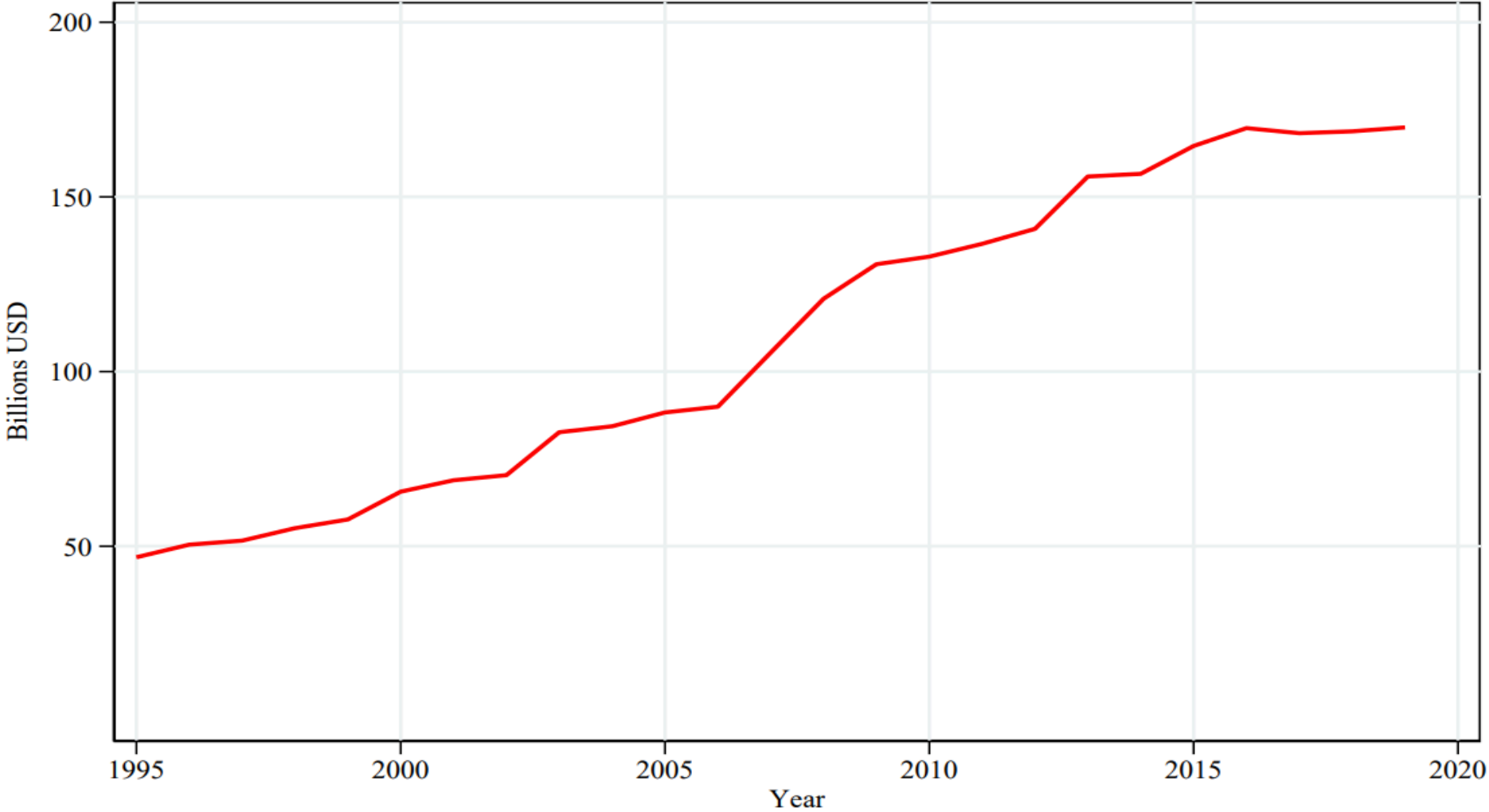
Average of annual budget/GDP (in %)



Distribution of the budget and number of entrepreneurial finance policies by nation

	Sum	N	Mean	P10	Median	P90
Total Policy Count	755	66	11.4	1	9	23
Total Policy-Years	7,368	66	111.6	17	83.5	234
Average of Annual Budget (USD Billions)	122.10	66	1.85	0.002	0.34	8.54
Average of Annual Budget/GDP (%)		66	0.227	0.001	0.106	0.662
Average length of policies (years)		66	11.2	5	10.08	18

Aggregate spending across all nations



Seek to test empirical predictions from model

Government collaboration with private venture investors should be more pronounced:

1. In better-run nations (less extraction of private benefits by government).
2. When VC has greater ability to add value:
 - For example, in earlier-stage projects with higher growth potential.
3. In nations with larger venture capital ecosystem (lower search costs).

The presence of public entrepreneurial finance programs should be associated with more innovation in that country.

Concerns about panel analysis

- Decision to begin a program is non-random, so unobserved confounding variables may drive the results:
 - Partially eliminate these concerns by including country fixed effects in our analysis.
 - Thus, controlling for all time invariant country-level characteristics.
- Time trends may correlate significantly across countries:
 - Also include year fixed effects.
- Governments often create funding programs that target specific industries:
 - In some empirical specifications, further include target industry fixed effects.
 - Also control in some cases for target industry-by-year fixed effects.
- These steps answer many but not all concerns.

Measuring private market involvement

For each individual program:

Construct a composite index that equals the sum of the following indicators:

1. Matching fund requirement
2. Private sector involvement in investment decision-making process
3. Finance financial intermediaries

Linking theory to empirics (1)

- As the effectiveness of private investors (δ) increases, co-investment funding becomes weakly more likely relative to government-only funding.
- Suggests private sector involvement will be greater in settings with early-stage focus:
 - Anticipate these settings, with greater information problems, will be ones where δ is particularly large.
- Examine at the program- level.

Private capital involvement and program stage

Dependent variable: composite index of private sector involvement

	(1)	(2)	(3)	(4)
Early-stage focus	0.080** (0.034)	0.086** (0.034)	0.075** (0.033)	0.084** (0.032)
ln (Population in prior year)	-0.026 (0.021)	-0.020 (0.020)	-0.021 (0.020)	-0.022 (0.021)
ln (GDP in prior year)	0.104*** (0.031)	0.129*** (0.038)	0.125*** (0.039)	0.130*** (0.040)
Constant	0.192 (0.146)	0.035 (0.254)	0.037 (0.261)	0.196 (0.266)
Adjusted R^2	0.036	0.039	0.041	0.031
Std. beta	7.978	8.579	7.494	8.377
Country FE	YES	YES	YES	YES
Program Initiation Year FE		YES	YES	
Industry FE			YES	
Industry x Program Initiation Year FE				YES
Observations	684	684	684	684

Robust standard errors in parentheses; clustered at the country level

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

Linking theory to empirics (2)

- As the cost of search (γ) for VC funding increases, co-investment funding becomes weakly less likely relative to government-only funding programs.
- Suggests private sector involvement will be greater in settings with more venture capital activity:
 - Anticipate these settings, with more venture firms, will be ones where γ is particularly low.
- Examine at the country-year-industry level:
 - Lagged private venture activity is the key independent variable.

Private capital involvement and VC investment

Dependent variable: Programs with private sector involvement

	(1)	(2)	(3)	(4)
ln (VC investments in prior year in industry-nation)	0.036 ^{***}	0.035 ^{***}	0.033 ^{***}	0.033 ^{***}
	(0.009)	(0.009)	(0.009)	(0.009)
ln (Population)	0.009	0.009	-0.074 ^{**}	-0.074 ^{**}
	(0.010)	(0.010)	(0.032)	(0.032)
ln (Per capita GDP)	0.022 ^{***}	0.023 ^{***}	-0.010 ^{**}	-0.010 ^{**}
	(0.008)	(0.008)	(0.005)	(0.005)
Constant	-0.040 ^{**}	-0.018	0.135 ^{***}	0.119 ^{***}
	(0.018)	(0.020)	(0.043)	(0.041)
Adjusted R^2	0.208	0.220	0.232	0.236
Std. beta	134.379	128.845	123.566	122.942
Country FE	YES	YES	YES	YES
Industry FE		YES	YES	
Year FE			YES	
Industry x Year FE				YES
Observations	40896	40896	40896	40896

Robust standard errors in parentheses; clustered at the country level

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

Linking theory to empirics (3)

- As governments obtain more private benefits (PB) from funding, government-only programs become more likely relative to co-investments.
- Suggests private sector involvement will be greater in settings with higher quality governments.
- Examine at the program level.

Private capital involvement in public programs

Dependent variable: composite index of private sector involvement

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Government effectiveness	0.128 ^{***} (0.044)	0.149 ^{***} (0.054)	0.145 ^{***} (0.054)	0.167 ^{***} (0.053)				
Rule of law score					0.135 ^{***} (0.037)	0.156 ^{***} (0.047)	0.152 ^{***} (0.047)	0.165 ^{***} (0.047)
ln (Population in prior year)	-0.015 (0.022)	-0.008 (0.020)	-0.010 (0.020)	-0.010 (0.021)	-0.010 (0.022)	-0.002 (0.021)	-0.004 (0.020)	-0.004 (0.021)
ln (GDP in prior year)	0.037 (0.044)	0.007 (0.059)	0.005 (0.060)	-0.013 (0.057)	0.012 (0.042)	-0.024 (0.059)	-0.025 (0.059)	-0.035 (0.057)
Constant	0.290 [*] (0.152)	0.538 [*] (0.270)	0.540 [*] (0.270)	0.505 (0.334)	0.360 ^{**} (0.150)	0.609 ^{**} (0.272)	0.609 ^{**} (0.272)	0.562 [*] (0.333)
Adjusted R ²	0.052	0.054	0.056	0.049	0.060	0.063	0.065	0.057
Std. beta	18.524	21.509	20.867	24.104	23.000	26.597	25.886	28.234
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Program Initiation Year FE		YES	YES			YES	YES	
Industry FE			YES				YES	
Industry x Program Initiation Year FE				YES				YES
Observations	637	637	637	637	637	637	637	637

Robust standard errors in parentheses; clustered at the country level

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

Linking theory to empirics (4)

- Model suggests that public financing (whether co-investment or only government) will expand companies funded:
 - Would expect more innovation with inception of these efforts:
 - Will focus on impact on innovation, using measures of U.S. patents.
 - Consistency, lack of impact of other policy shifts, ...
 - Any such analysis must be approached with caution, given estimation issues and the non-random decision to begin these efforts.

First concern

- The first of these issues is that we employed a staggered difference-in-difference analysis
 - Moreover, a single entrepreneurial finance policy typically initiate multiple subsequent ones.
 - Critiques such as Athey and Imbens (2018), point to potential biases.
- Employed four alternative approaches:
 - Method 1: We used first public entrepreneurial finance policy introductions only.
 - We included 30 country-year observations for each country (1990-2019, conditional on data availability)
 - Used all countries in the sample.
 - The 139 of the countries that were never treated were used as controls (reported here).
 - Method 2: We used first policy introductions, as well as subsequent initiations, so long as there were no policy introduction in the five years prior.
 - Method 3: We used first policy introductions, as well as subsequent initiations, so long as there was no introduction in the five years prior, with the addition of a new independent observation for each additional program.
 - Method 4: We used the stacked regressions approach implemented in Cengiz et al. (2019)
 - In this case we just used the five years prior to and after each policy initiation as observations for the treated and control nations.

Second concern

- Second, the decision to initiate these programs is non-random.
 - Familiar Manski (1993) reflection problem may hold here.
 - The same underlying considerations that led to a boost in innovation may also have triggered individual nations to start public entrepreneurial finance programs.
- Look at the effects dynamically.
 - Lack of pre-existing trends provided us with some comfort with respect to the causal interpretation of the results in this section.

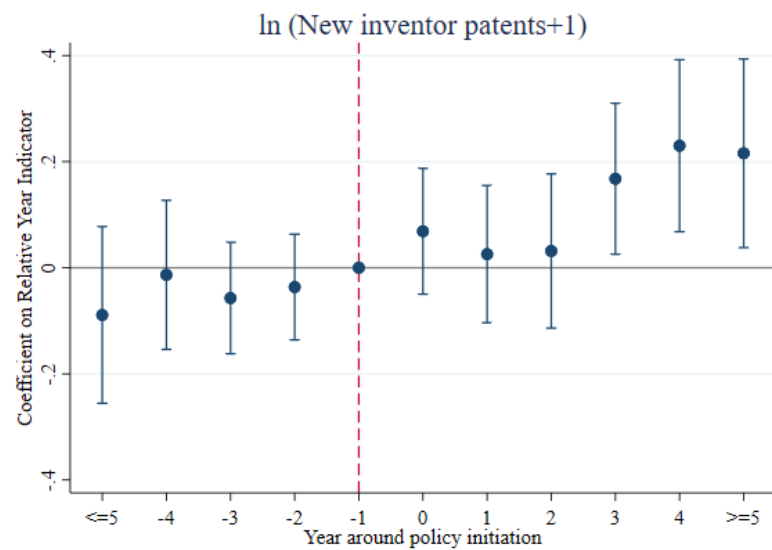
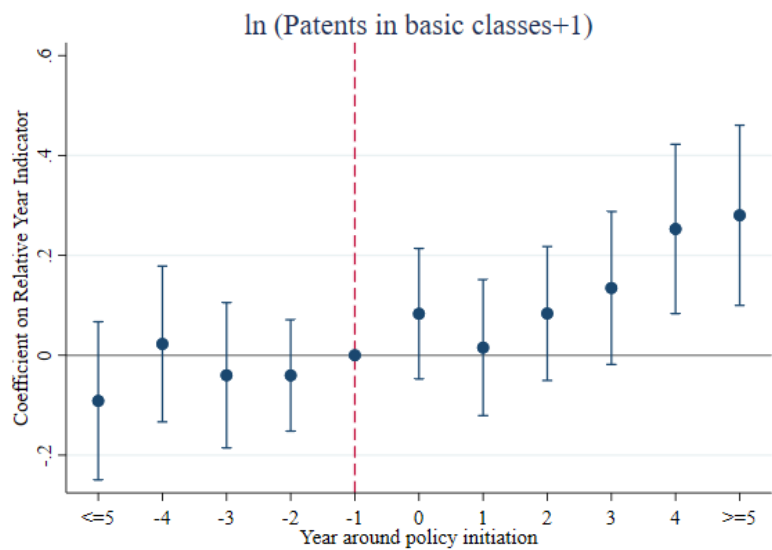
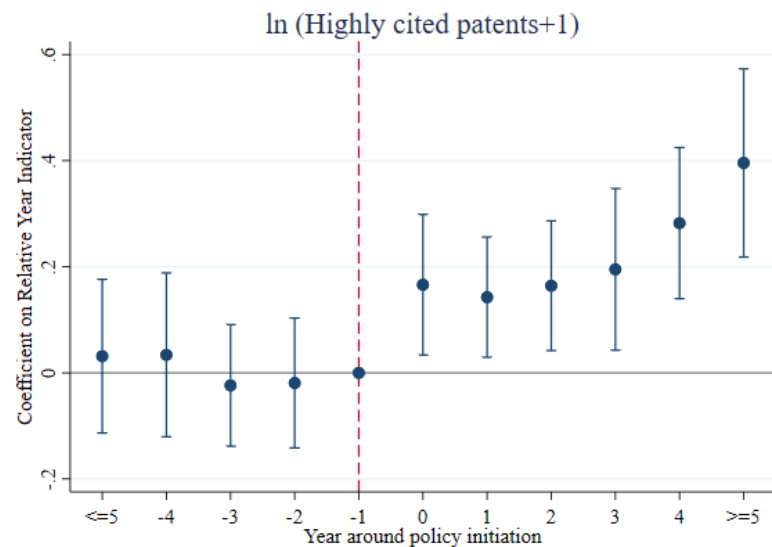
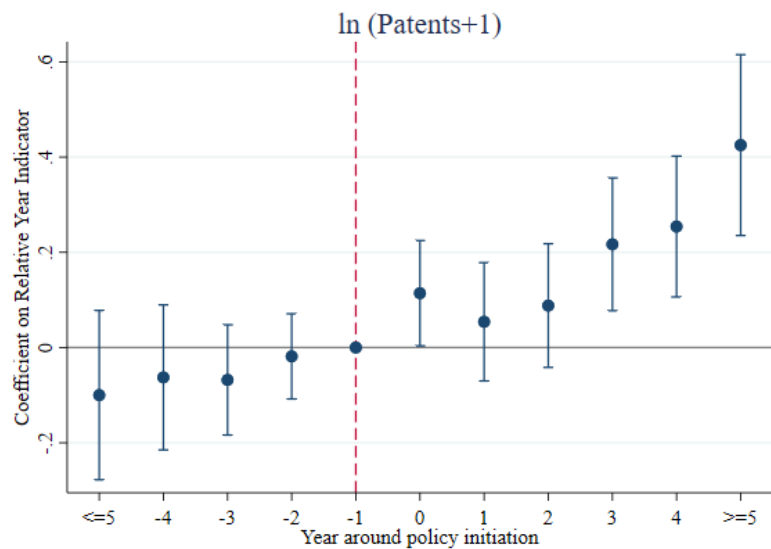
Empirical specification

- Our baseline analysis relied on the following specification:

$$\text{Innovation}_{c,t} = \alpha_c + \alpha_t + \beta \times \text{POST}_{c,t} + \gamma \times X_{c,t} + \varepsilon_{c,t} \quad (5)$$

- Where:

- $\text{Innovation}_{c,t}$ were the logarithms of (one plus) the four measures of the U.S. patent filings in a given country-year:
 - Patent count, most-cited patents, most basic patents, and patents by new inventors.
- $\text{POST}_{c,t}$ was a dummy variable denoting that the observation year was after that in which the country initiated its first program.
- The specification included country and year fixed effects, as well as controls for population, per capita GDP, and lagged venture capital activity.
- Standard errors were clustered at the country level.



New venture policies and innovation outcomes

	(1)	(2)	(3)	(4)
VARIABLES	Patents	Highly cited	Basic class	New inventor
Post Policy	0.344*** (0.0946)	0.276*** (0.0734)	0.244*** (0.0749)	0.212** (0.0823)
ln (Population)	0.186 (0.179)	0.0869 (0.0722)	0.166 (0.104)	0.292* (0.165)
ln (Per capita GDP)	0.0902* (0.0509)	0.0404 (0.0270)	0.0445 (0.0282)	0.0835* (0.0440)
ln (VC investments in prior year)	0.0609** (0.0253)	0.0528** (0.0229)	0.0550*** (0.0189)	0.0208 (0.0230)
Constant	1.137*** (0.301)	0.454*** (0.140)	0.639*** (0.166)	0.689** (0.270)
Observations	5,928	5,928	5,928	5,928
R-squared	0.958	0.941	0.948	0.948
Country FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Conclusions

- This paper examines government efforts to promote entrepreneurial finance - source of financing rivaling that form of venture funds.
- Present simple model seeking to explain why public entrepreneurial finance is positively associated with private markets.
- We examine 755 programs in 66 countries that are active between 1995 and 2019.
- Use of private capital markets in these programs' designs is commonplace:
 - Especially in early-stage focused programs and those run by better governments.
- Reduced search costs (more developed venture market) associated with more private sector involvement.
- Programs seem associated with growth in innovation.
- Together, the results suggests public sector relies on private financiers to boost effectiveness of initiatives.