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Survive, But Not Thrive? The Constraining Influence of Government Customers on Technology Start-Ups

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Survive, but not Thrive? The constraining Influence of Government Customers on Technology Start-Ups

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May 8, 2019

Government + Start-Ups

The US army will give startups who invent new weapons a cash prize

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Government Consumers + Start-Ups = ?

Start-ups often partner with governments through dedicated small-business innovation programs

- Governments subsidize innovation in to counter-act small business underinvestment (Anton & Yao, 1994; Gans & Stern, 2000)
  - Significant funding available (DoD Small Business funding ~$58B in 2016)
- Start-ups are "**resource lite**", making subsidies attractive (Kropp & Zolin, 2005)
- **Non-dilutive funding** a particularly attractive incentive for growth-oriented technology start-ups
  - Comparable to equity investment (Angel ~$285K, SBIR Phase I ~$225K)
  - 60% of SBIR companies are start-ups

Yet, we don't really know how government consumers are associated with start-up performance

- Entrepreneurship research on government funding partnerships focus on "**new technology ventures**" not the performance of "**new technology firms**" (Elston & Audretsch, 2011; Lerner, 1999; Toole & Czarnitzki, 2007; Wallsten, 2000)
- Empirical evidence focuses on **project performance**, not **firm performance** (i.e., survival, growth)
  - + Papers (Toole & Czarnitzki, 2009), Patents (Howell, 2017), Products (Link and Scott, 2010), Product Sales (Gans & Stern, 2000), Knowledge Spill-overs (Audretsch et al., 2002; Feldman, 2000), etc.
- Prior research does not disentangle **government-as-a-consumer** versus **government-as-an-investor** (Link & Scott, 2012; Hiatt et al., 2017; Howell, 2017)

SBIR
America's Seed Fund

Preview

Investigate the impact of government consumers on dual-use start-ups

- Government Consumers = “Mission Agencies” - e.g., DoD, NASA, DHS
- Dual-use industries = B2B/C and/or B2G (e.g., cyber security, aerospace)
- Technology start-ups require STEM SMEs and are < 5 yrs of age

Uncover the connection between government consumers and growth

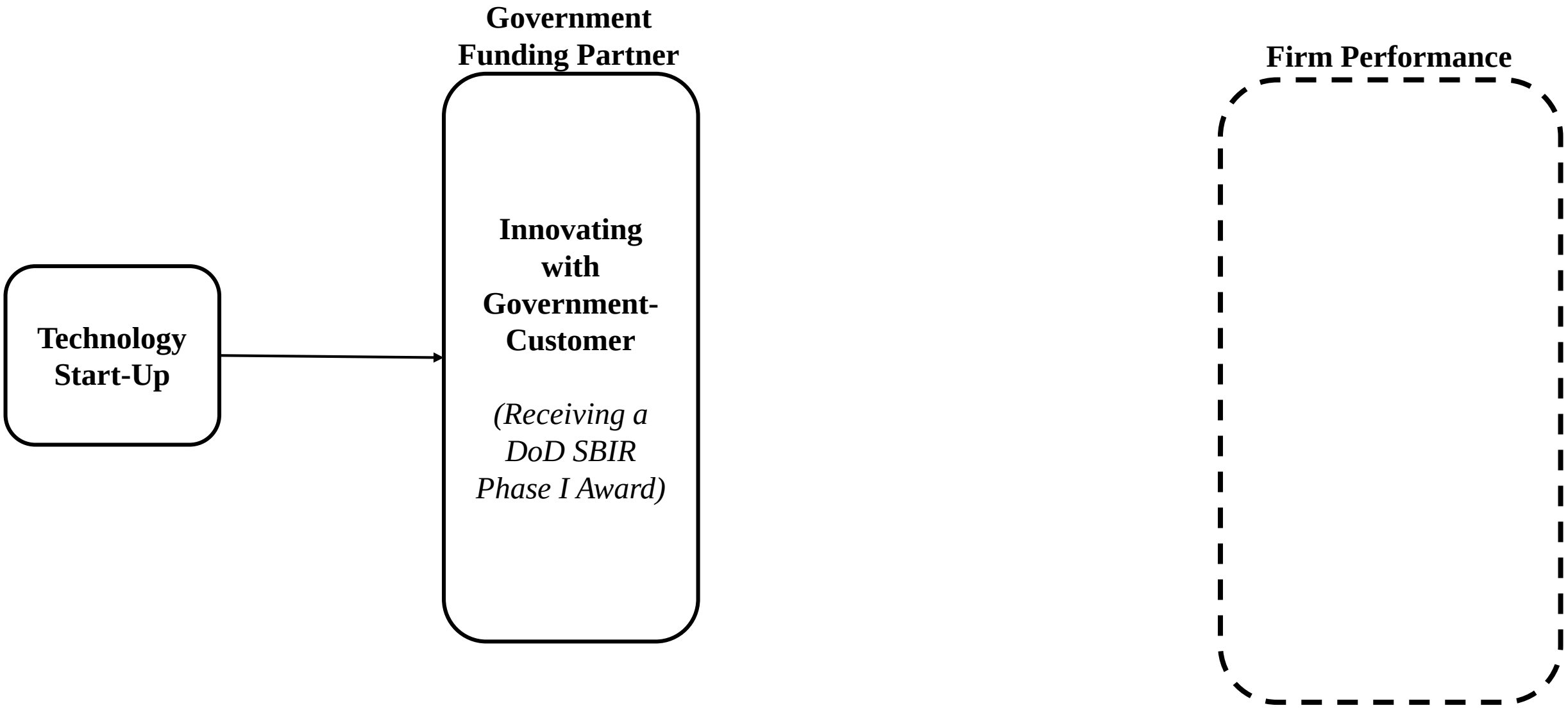
- Prior research has focused on innovation outcomes (e.g., patents, products)
- Largely ignored survival and growth outcomes

Find that government consumers are positively associated with technical innovation and survival, but slower growth

Research Question

How do ***government consumers*** influence ***start-up performance?***

Hypotheses Overview



Start-Up Performance via Opportunity Recognition

Opportunity Recognition (Kirzner, 1973)

- "Situations in which **new goods**, services, raw materials, markets and organizing methods **can be introduced** through the **formation of new means, ends, or means–ends relationships**" (Eckhardt and Shane, 2003)
- Opportunity recognition defined as "the process through which ideas for potentially **profitable new business opportunities** are **identified**" (Baron & Ensley, 2006; Kirzner 1979, Shane 2003)
- **Opportunity sources** include universities, investor networks, potential consumers, etc.

Those who are "good" at opportunity recognition perform better

- Combination of **perception** and **action** (Ardichvili et al., 2003; Bremner & Eisenhart, 2019; MacMullen & Shepherd, 2006)
  - Alert to new opportunities as they emerge (Ardichvilla et al., 2003)
  - Able to exploit opportunities (Wang & Decastro, 2017)
- **+ Innovation, Survival, Growth** (Gruber et al., 2008; Dencker & Gruber, 2015; Eshima & Anderson,2017)

Government Consumers as an Unique Opportunity Source

Government consumers provide technical resources

- Fund R&D (Auzolay et al, 2011; Branscomb, 1993; Sauermann & Stephan, 2012)
- Government consumers are often technical experts (Pahnke et al., 2015)
- Access to capital-intensive resources, such as national user facilities (Rathje & Katila, 2019)

H1: Start-ups who partner with government consumers are associated with a higher technological innovation rates than those who do not

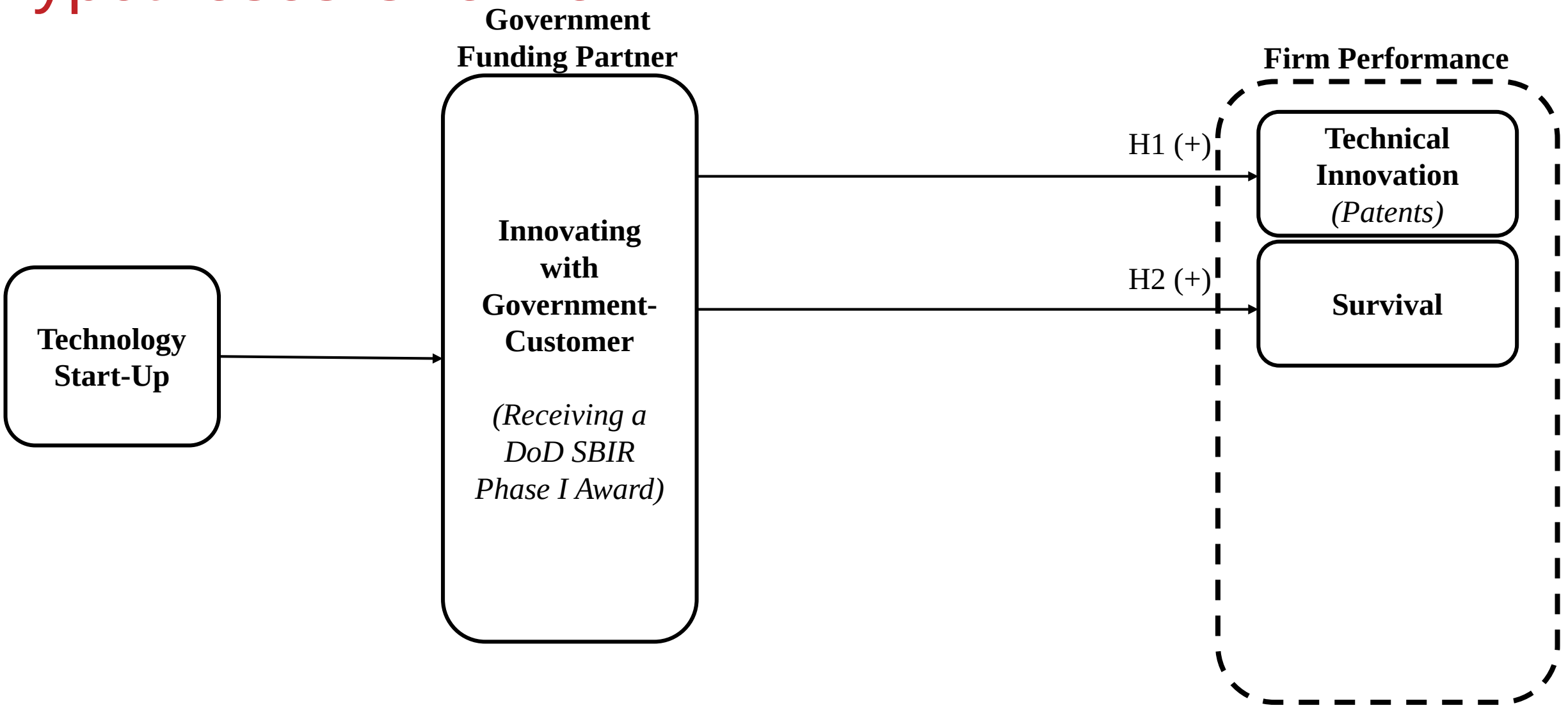
Government Consumers as an Unique Opportunity Source

Government consumers provide stability

- Legitimacy via certification & expanded political and social networks (Autio and Rannikko, 2016; Eesley et al., 2016; Hillman et al., 1990; Wang and Qian, 2011)
  - Certification of technical expertise is signaled by government partnerships (Armanios et al., 2017)
  - Government partners particularly useful in times of uncertainty (Hiatt et al., 2017)

H2: Start-ups who partner with government consumers are associated with higher survival rates than similar firms who do not

Hypotheses Overview



Iterative Opportunity Recognition

Iterative opportunity recognition is critical for growth

- Growth is contingent on recognizing multiple opportunities for exploitation (Cohen et al., 2018; Penrose, 1953; Gans & Stern, 2019)
- Research on "learn" prioritizes experimentation through iterative hypotheses testing, flexibility, and making low-commitment investments – i.e., **"pivots"** (Blank, 2013; Contigiani & Levinthal, 2019; Leatherbee & Katila, 2019; Reis, 2011)
    - Pivoting can be viewed as strategic action for opportunity recognition

Iterative opportunity recognition is difficult

- Pivoting **slows or stops once demand is found** (Contigiani & Levinthal, 2019)
    - Satisficing behavior could limit firms from finding optimum opportunities (Cohen et al., 2018; Stern & Gans, 2019)
- Structural constraints of present business models often limit flexibility to adapt to new business models (Vindova & Kotha, 2000; Eesley and Wu, 2017)

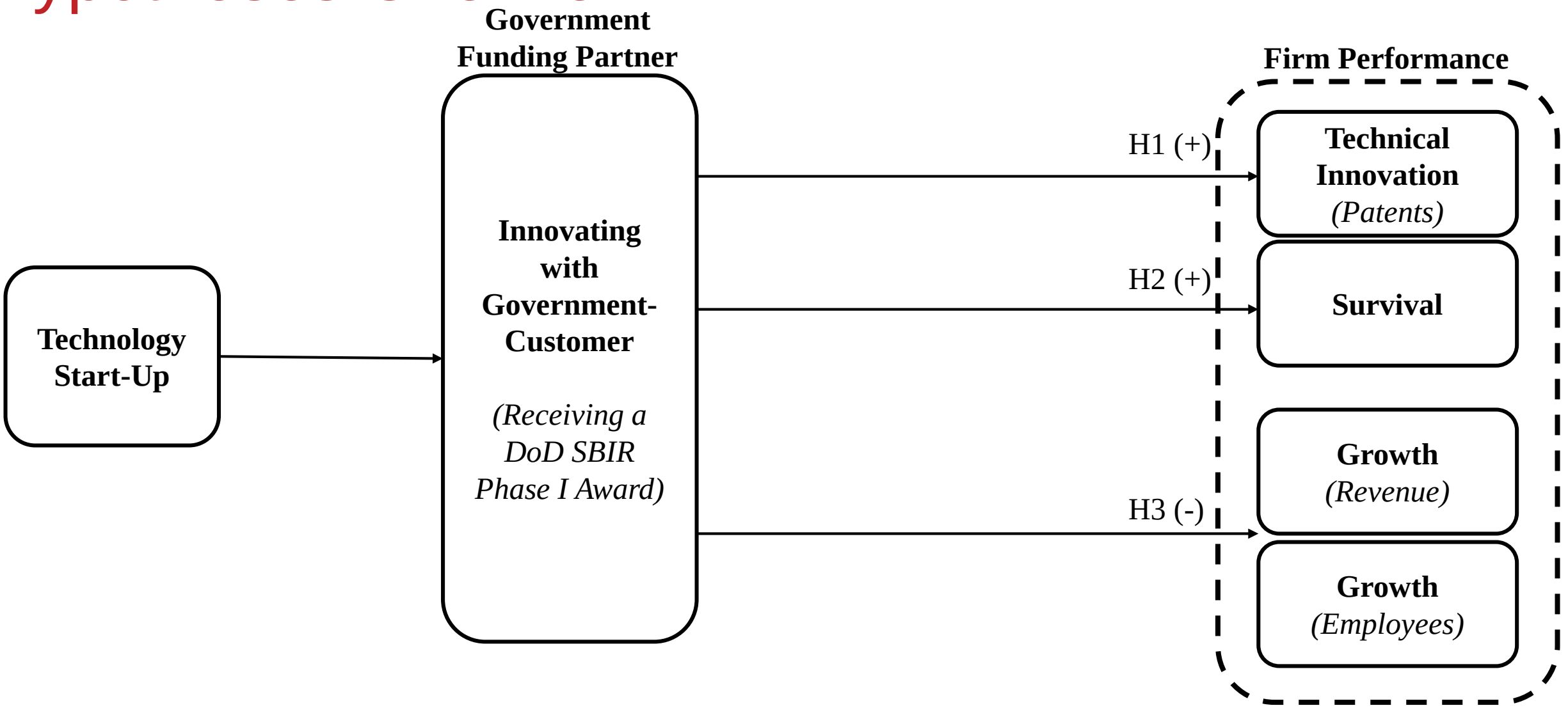
Government Consumers & Iterative Opportunity Recognition

Contracts focus work and restrict flexibility

- Encourage organizational structure to meet "B2G" business model (Lichtenberg, 1988; Flammer, 2018; 13 C.F.R. §§ 701-705.)
- Pivots require contract modifications (Branscomb, 1993; Ham and Mowery, 1998)
- Often lead to relational and cognitive lock-in with government partners (Mauer & Ebers, 2006)
- Opportunity closure: "limited ability to recognize future opportunities once an initial opportunity is exploited"

H3: Start-ups who partner with government consumers grow slower as compared to similar firms who do not

Hypotheses Overview



Opportunity Closure, Moderated

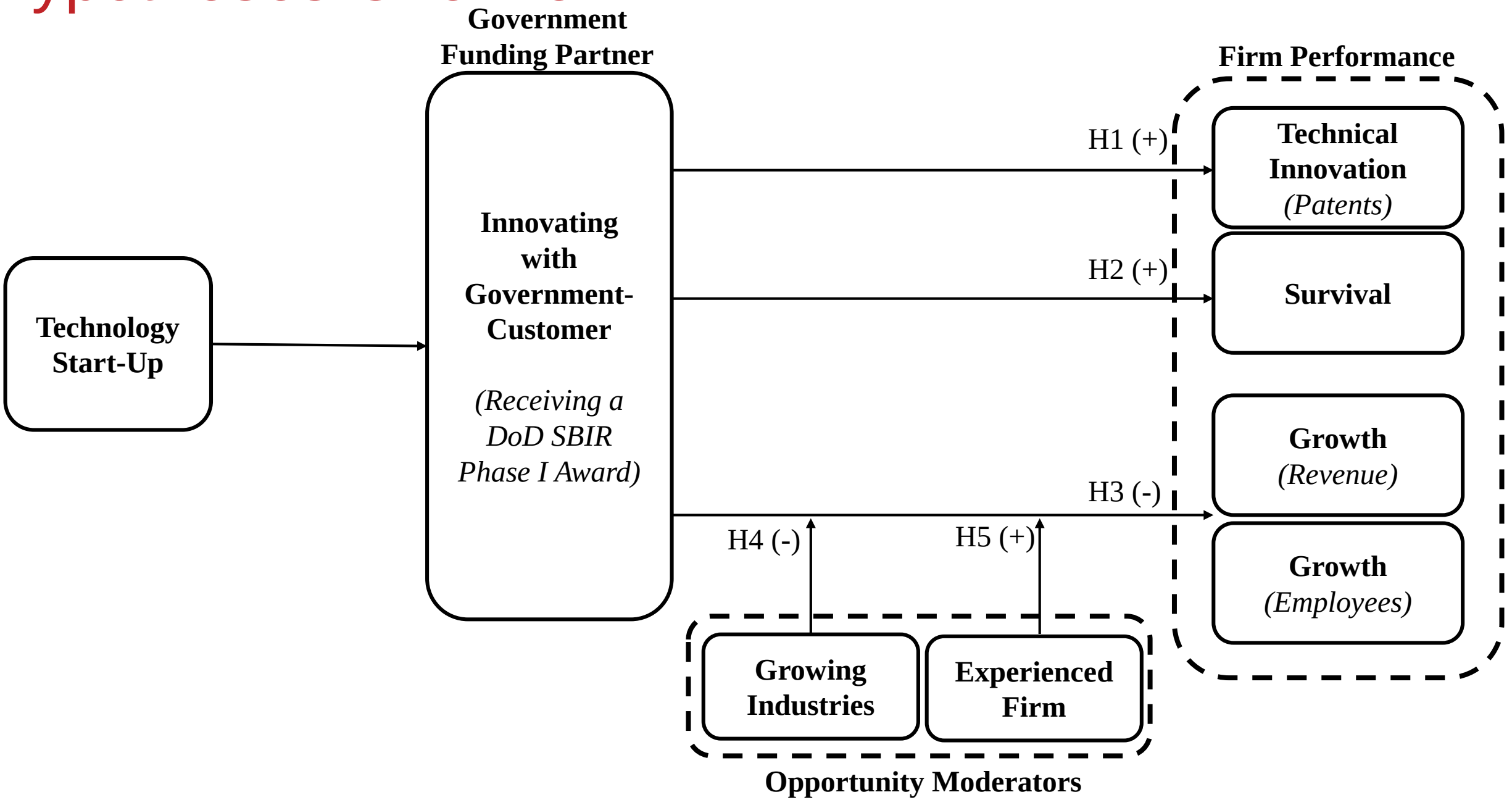
Industry Growth

- In growing industries (i.e., greater opportunities), iterative opportunity recognition is extremely important
    - Performant firms dynamically shift organizational forms, functions, and competitive advantages (Rindova & Kotha, 2001; Teece, 1986)
- **H4: The negative association between start-up growth and government consumers is strengthened in growing industries**

Firm Experience

- More likely to have already explored opportunities and selected a commercialization strategy (Rivkin & Siggelkow, 2003; Trigeorgis & Reuer, 2017)
- **H5: The negative association between start-up growth and government consumers is weakened by increasing firm experience**

Hypotheses Overview



Data

DoD SBIR Program

- Multi-phased innovation funding program dedicated to “product transition”
  - Phase I – up to $250K
  - Phase II – up to $3M
- SBIR makes up the predominance of government funding for early stage ventures (Audretsch, 2003; SBA, 2014)
  - 60% of DoD SBIR firms are “start-ups”
- DoD uses contracts (other agencies use grants)
- DoD prioritizes “mission needs” (i.e., consumer demands)

Data

Matched sets of dual-use ventures

- Full set of DoD SBIR-receiving, dual-use start-ups from 1997-2012 collected from SBIR.gov
  - 1,437 unique firms
- Match SBIR receiving firms to non-receiving SBIR counterparts
  - Matched on founding year, SIC, and location
  - 27,730 firms recovered (26,293 did not receive an award)
- Match firms to Dun and Bradstreet identifying information
  - Dun and Bradstreet reporting is required by all SBIR receiving companies
  - Useful in studying entrepreneurial growth (Eesley and Roberts, 2012)
- Correlated with the universe of companies in Thompson One & USPTO to indicate venture funding & patent data

Measures

Dependent Measures

- Patents, Firm Survival, Log Revenue, Log Employees (Bradley et al., 2011; Rao, 1994; Eesley and Roberts, 2012)

Independent Measures

- SBIR-awardee
- Industry Growth (Industry Entry Rate)
- Firm Experience (Age)

Controls

- Firm age, Industry (SIC), State, Patents, Venture Funding, Team Diversity, Temporal Effects (Beckman and Burton, 2008; Eisenhardt and Schoonhoven, 1990; Evans and Leighton, 1989; Zajac, 1988)

Methods

Cox Proportional Hazard

- Hazard function of dependent variable occurrence (Audretsch and Mahmood, 1995)
  - (+) Firms more likely to patent
  - (-) Firms more likely to survive

Differences-in-Differences (Short and Toffel, 2011)

- Controls for selection longitudinally
- Robust approach in evaluating policy treatments
- Estimate longitudinal performance

Results H1 & H2 (Innovation, Survival)

Table 2. Cox proportional hazard model

Variables	Patent		Survival	
	(1)	(2)	(3)	(4)
Independent Variables:				
SBIR-awardee		0.936****		-0.816****
		(0.828, 1.044)		(-1.250, -0.381)
Controls:				
Venture Raised	2.074****	2.057****	0.181	0.155
	(1.986, 2.162)	(1.968, 2.145)	(-0.119, 0.480)	(-0.146, 0.456)
Firm Age	0.015***	0.009*	-0.053****	-0.051****
	(0.005, 0.024)	(-0.001, 0.018)	(-0.074, -0.032)	(-0.071, -0.030)
Founding Team Size	0.0001	0.0004	-0.345***	-0.260**
	(-0.001, 0.001)	(-0.0004, 0.001)	(-0.596, -0.093)	(-0.514, -0.006)
Woman	0.252****	0.216***	-0.0001	-0.0005
	(0.104, 0.400)	(0.068, 0.363)	(-0.002, 0.002)	(-0.003, 0.002)
Minority	-0.132*	-0.191***	-0.114	-0.1
	(-0.267, 0.003)	(-0.326, -0.056)	(-0.459, 0.231)	(-0.445, 0.245)
Patents			-0.450***	-0.431***
			(-0.738, -0.162)	(-0.719, -0.143)
Dummies Included:				
SIC (4-digit)	Yes	Yes	Yes	Yes
State	Yes	Yes	Yes	Yes
N	27,730	27,730	27,730	27,730

Note: *p <0.1; **p<0.05; ***p<0.01; ****p<0.001

Results H3, H4, H5 (Revenue)

Table 4. *Revenue* : Diff-in-Diff

Revenue (Logged)			Growing Industries	Stagnant Industries	Younger Firm	Older Firm
	(1)	(2)	(3)	(4)	(5)	(6)
Independent Variables:						
SBIR-awardee		1.534****	2.613****	1.267****	2.622****	1.169****
		(1.401, 1.668)	(2.177, 3.050)	(1.134, 1.401)	(2.336, 2.908)	(1.022, 1.316)
After treatment		1.009****	1.261****	1.282****	1.558****	1.232****
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SBIR-awardee x After treatment		-0.725****	-1.532****	-0.569****	-1.736****	-0.440****
		(-0.870, -0.580)	(-2.057, -1.006)	(-0.718, -0.419)	(-2.033, -1.440)	(-0.608, -0.272)
Controls:						
Intercept	14.599****	13.639****	15.372****	14.159****	23.576****	15.438****
	(11.892, 17.306)	(10.947, 16.331)	(12.221, 18.523)	(12.489, 15.830)	(17.153, 30.000)	(13.615, 17.260)
Venture Raised	0.685****	0.668****	-0.093	0.847****	0.488****	0.827****
	(0.615, 0.756)	(0.598, 0.738)	(-0.358, 0.172)	(0.762, 0.932)	(0.389, 0.586)	(0.728, 0.925)
Firm Age	0.265****	0.232****	0.589****	0.169****	0.296****	0.137****
	(0.261, 0.270)	(0.228, 0.237)	(0.558, 0.621)	(0.162, 0.177)	(0.289, 0.303)	(0.129, 0.146)
Patents	0.037****	0.035****	0.016**	0.047****	0.025****	0.077****
	(0.029, 0.046)	(0.027, 0.044)	(0.001, 0.030)	(0.035, 0.059)	(0.016, 0.034)	(0.059, 0.095)
Founding Team Size	0.009****	0.009****	0.042****	0.008****	0.009****	0.009****
	(0.008, 0.009)	(0.009, 0.009)	(0.038, 0.046)	(0.008, 0.009)	(0.008, 0.010)	(0.008, 0.010)
Woman	0.594****	0.578****	0.590****	0.489****	0.590****	0.489****
	(0.530, 0.659)	(0.514, 0.642)	(0.498, 0.681)	(0.401, 0.577)	(0.498, 0.681)	(0.401, 0.577)
Minority	0.318****	0.290****	0.489****	0.226****	0.299****	0.259****
	(0.269, 0.367)	(0.242, 0.339)	(0.331, 0.646)	(0.167, 0.285)	(0.228, 0.370)	(0.194, 0.325)
Dummies Included:						
SIC (4-digit)	Yes	Yes	Yes	Yes	Yes	Yes
State	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
N	228,314	228,314	123,104	105,210	75,587	114,349
Adjusted R-squared	0.174	0.184	0.190	0.198	0.212	0.201

Note: *p<0.1; **p<0.05; ***p<0.01; ****p<0.001

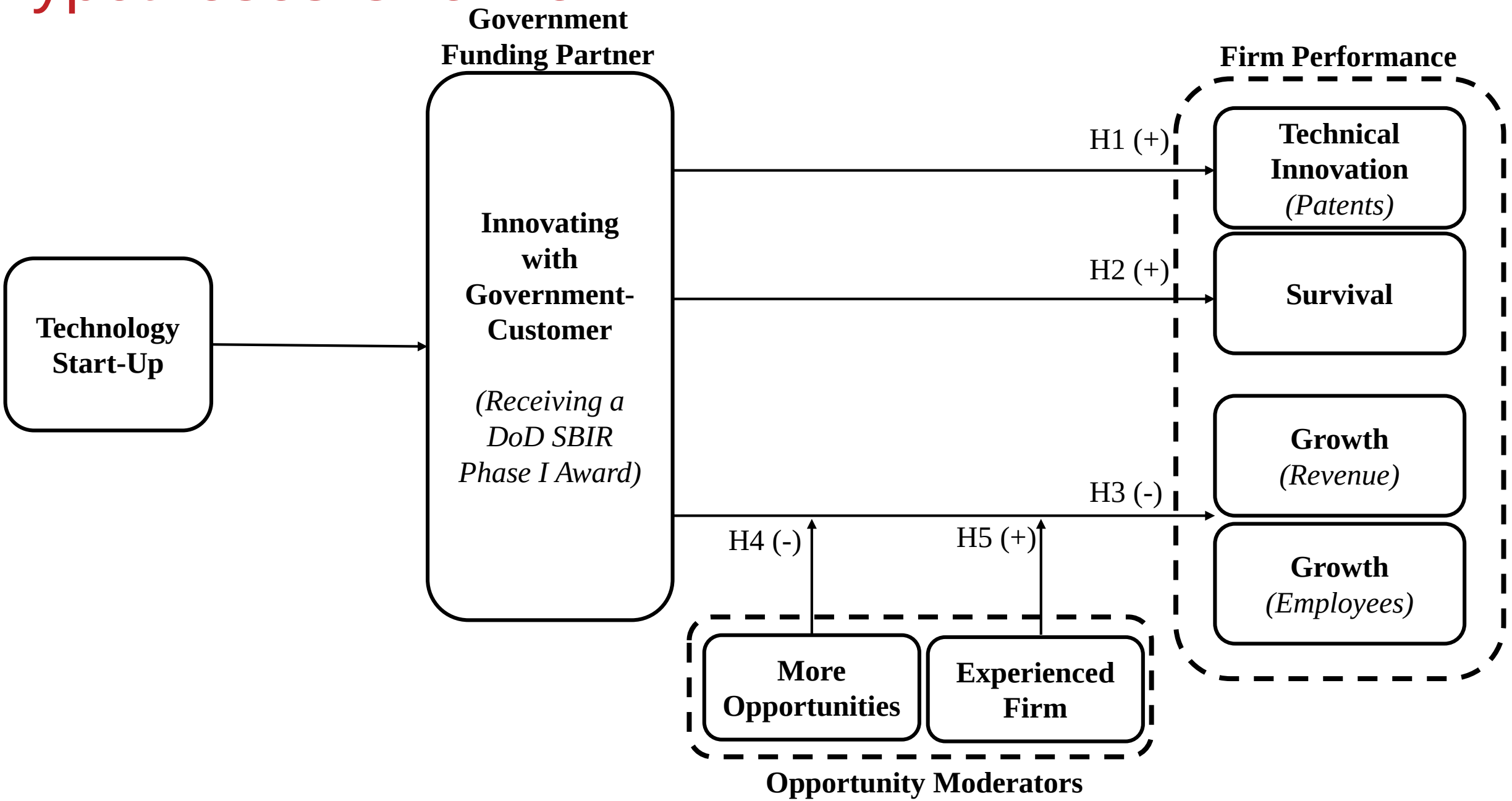
Results H3, H4, H5 (Employees)

Table 3. *Employees* : Diff-in-Diff

Employees (Logged)			Growing Industries	Stagnant Industries	Younger Firm	Older Firm
	(1)	(2)	(3)	(4)	(5)	(6)
Independent Variables:						
SBIR-awardee		0.253****	0.292****	0.225****	0.312****	0.220****
		(0.223, 0.283)	(0.230, 0.354)	(0.188, 0.261)	(0.253, 0.370)	(0.183, 0.256)
After treatment		0.128****	0.154****	0.148****	0.194****	0.156****
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SBIR-awardee x After treatment		0.107****	-0.052	0.168****	0.001	0.196****
		(0.074, 0.140)	(-0.127, 0.022)	(0.127, 0.209)	(-0.060, 0.062)	(0.154, 0.238)
Controls:						
Intercept	2.647****	2.377****	2.887****	3.678****	2.447****	2.926****
	(2.035, 3.258)	(1.770, 2.985)	(1.976, 3.799)	(3.175, 4.180)	(1.799, 3.096)	(2.508, 3.344)
Venture Raised	0.520****	0.515****	0.167****	0.608****	0.437****	0.588****
	(0.504, 0.536)	(0.499, 0.531)	(0.129, 0.204)	(0.585, 0.632)	(0.417, 0.458)	(0.563, 0.612)
Firm Age	0.061****	0.055****	0.062****	0.063****	0.059****	0.048****
	(0.060, 0.062)	(0.054, 0.056)	(0.058, 0.067)	(0.061, 0.065)	(0.058, 0.061)	(0.046, 0.050)
Patents	0.014****	0.013****	0.167****	0.608****	0.008****	0.034****
	(0.012, 0.016)	(0.011, 0.015)	(0.129, 0.204)	(0.585, 0.632)	(0.006, 0.010)	(0.030, 0.039)
Founding Team Size	0.006****	0.006****	0.018****	0.005****	0.005****	0.006****
	(0.006, 0.006)	(0.006, 0.006)	(0.018, 0.019)	(0.005, 0.006)	(0.005, 0.006)	(0.006, 0.007)
Woman	0.285****	0.278****	0.143****	0.338****	0.222****	0.320****
	(0.271, 0.300)	(0.263, 0.292)	(0.108, 0.178)	(0.317, 0.359)	(0.203, 0.241)	(0.298, 0.342)
Minority	-0.015***	-0.026****	-0.01	-0.044****	-0.003	-0.046****
	(-0.026, -0.004)	(-0.037, -0.015)	(-0.033, 0.012)	(-0.061, -0.028)	(-0.017, 0.012)	(-0.062, -0.030)
Dummies Included:						
SIC (4-digit)	Yes	Yes	Yes	Yes	Yes	Yes
State	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
N	228,314	228,314	75,587	114,349	123,104	105,210
Adjusted R-squared	0.269	0.278	0.342	0.27	0.248	0.301

Note: *p<0.1; **p<0.05; ***p<0.01; ****p<0.001

Hypotheses Overview



Summary & Implications for Policy

Summary

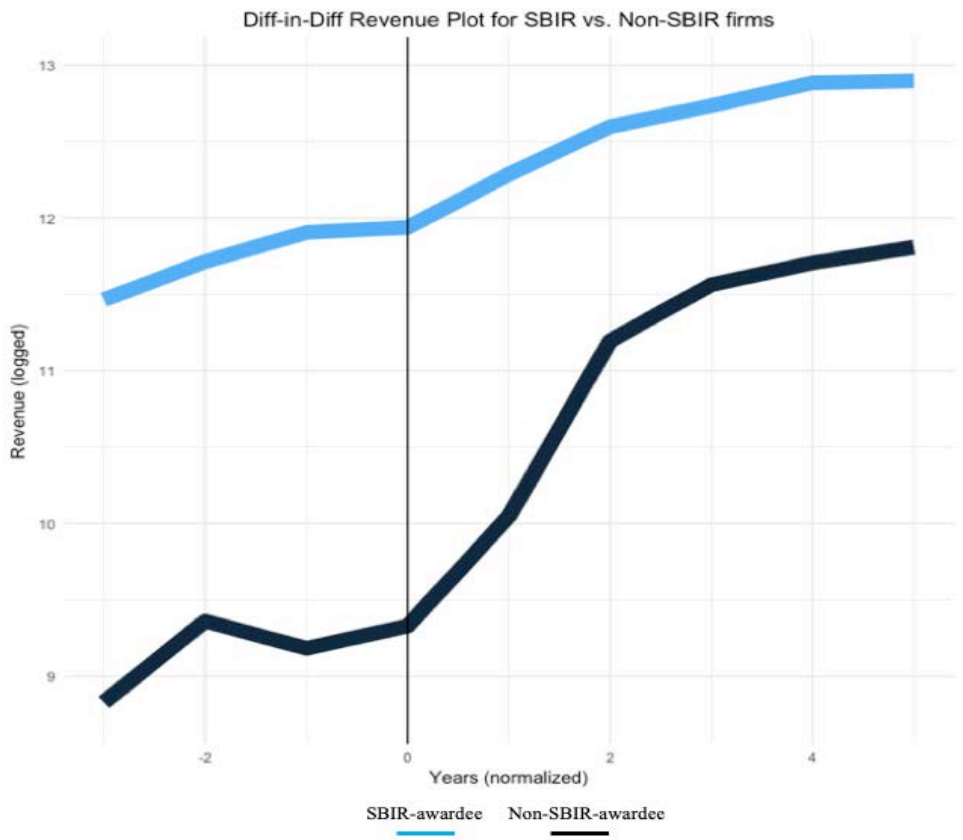
- Opportunity Recognition is critical for start-up performance
- Government as a consumer is an enticing resource for new firms
- Yet, the government can have long-term negative impacts on growth

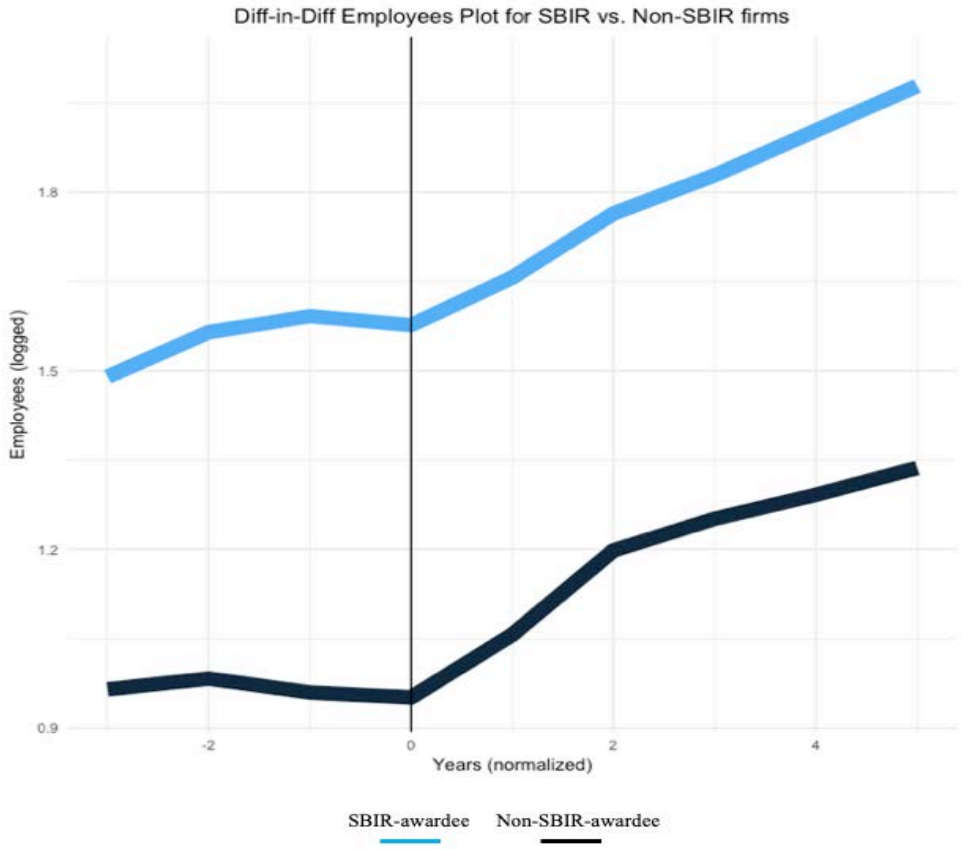
Policy Implications

- Innovation and Survival…great!
- Negative growth effects can result in negative selection
  - Cultural divide driven by economic incentives?
- Must consider start-ups as a unique category within “small-business”
  - What makes a small-business successful (i.e., innovation) might not make a start-up successful (i.e., growth)

Questions?

Results H3 (Growth)





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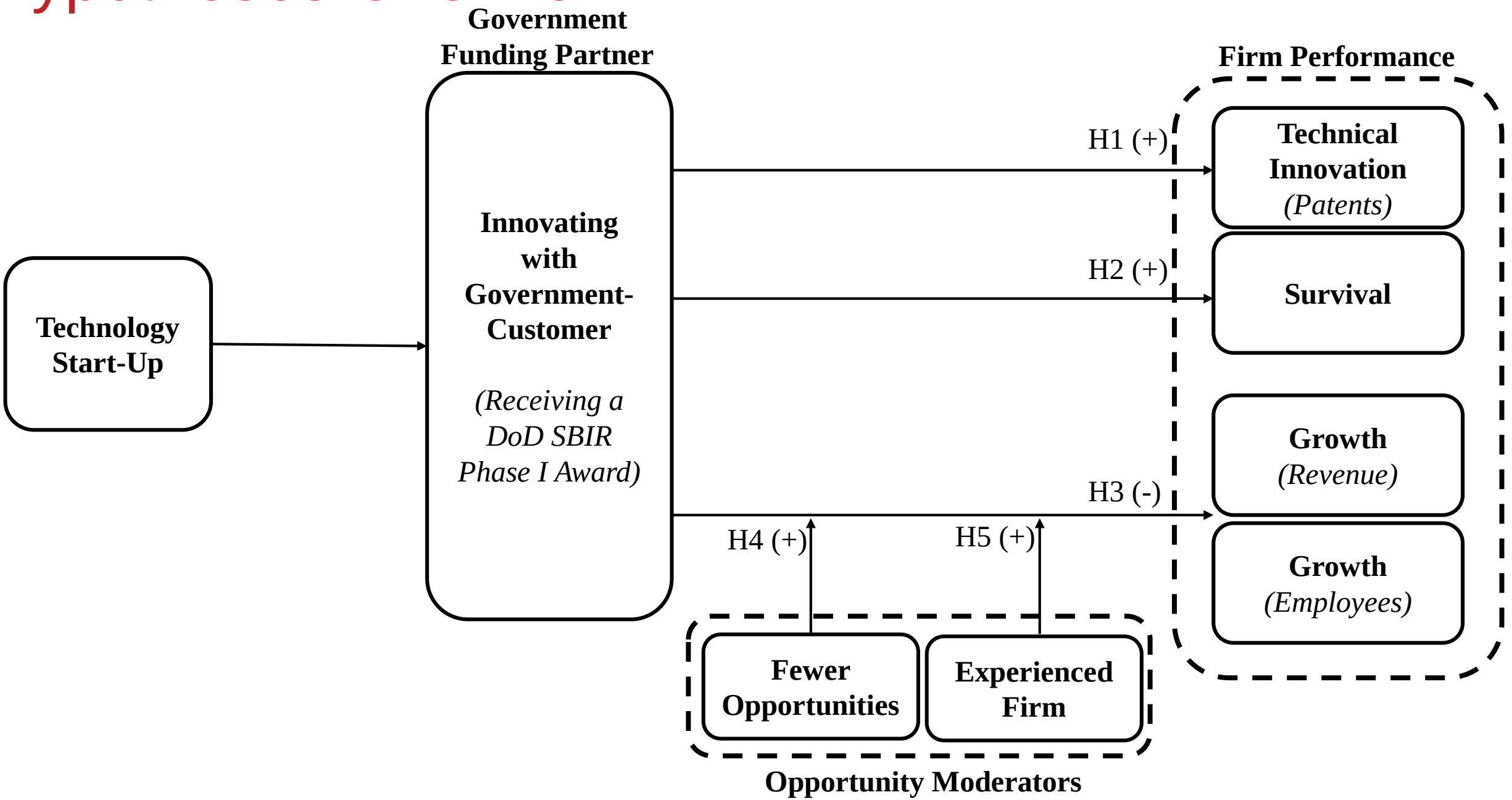

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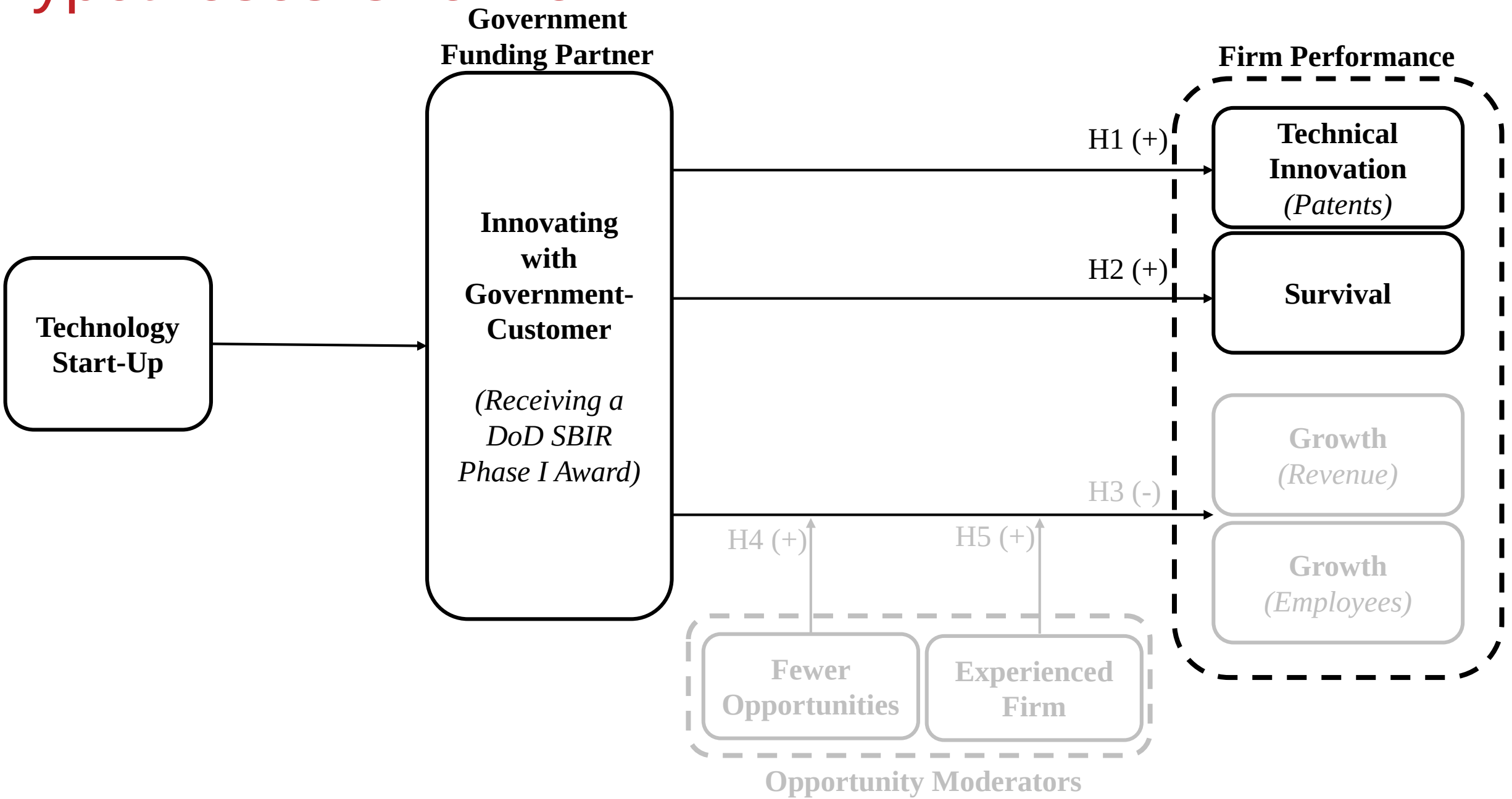

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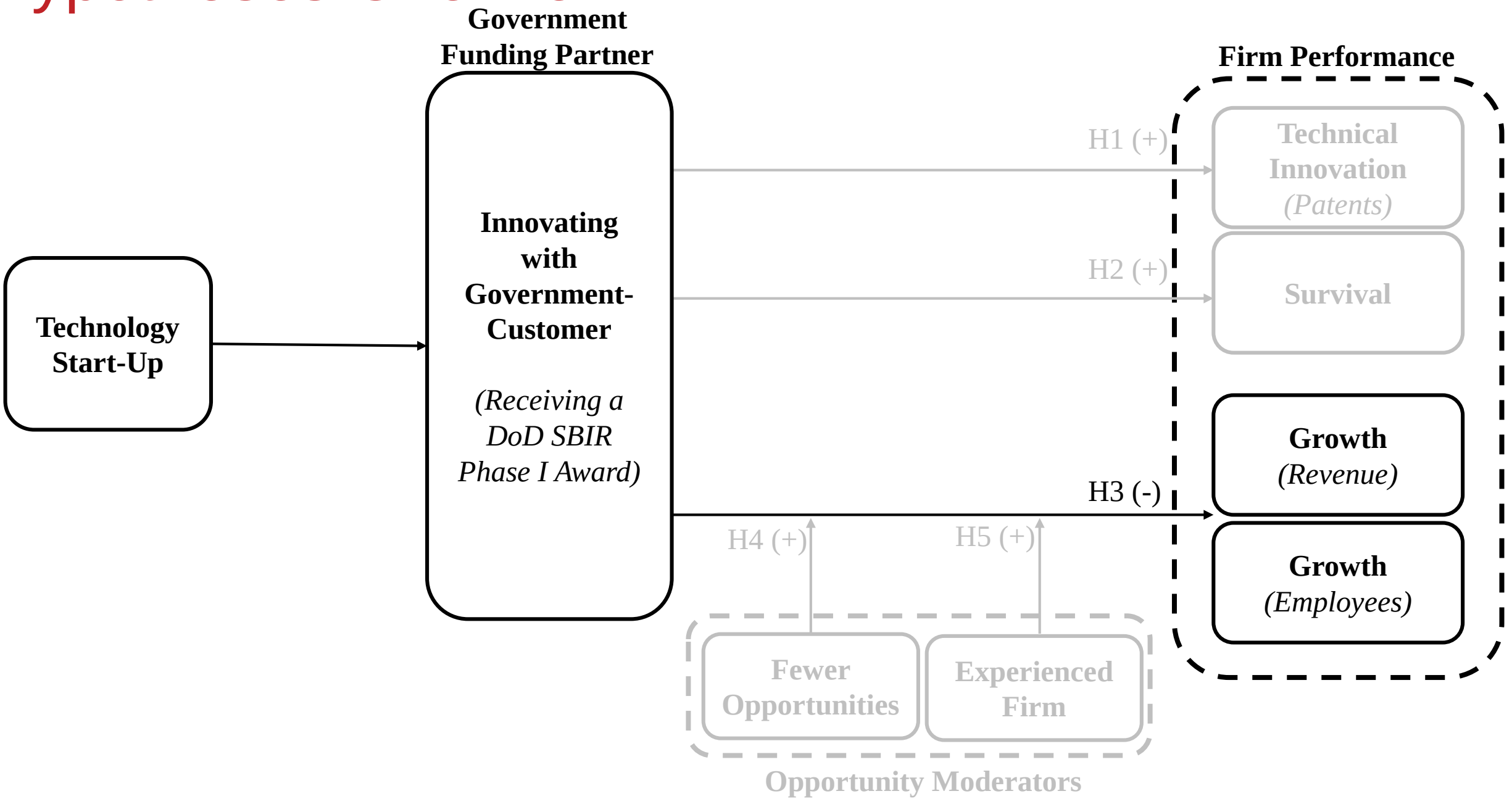

Government Customers + Small Business = Innovation

- Small-businesses are critically important to economic growth, yet tend to under-invest in innovation (Anton & Yao, 1994; Gans & Stern, 2000)
- A significant portion of government funding directed to small-businesses specifically for innovation
  - The U.S. Department of Defense (DoD) spending goal was 22% in 2016 ($58B total)
  - U.S. SBIR (Howell, 2017; Link & Scott, 2010), Chinese Innofund (Guo, Guo, & Jiang, 2016; Wang, Li, & Furman, 2017) , Swedish VINN NU (Söderblom, Samuelsson, Wiklund, & Sandberg, 2015), etc.
- Research has predicted positive "innovation" returns (Arichbald & Finifter, 2003)
  - + Papers (Toole & Czarnitzki, 2009), Patents (Howell, 2017), Products (Link and Scott, 2010), Product Sales (Gans & Stern, 2000), Knowledge Spill-overs (Audretsch et al., 2002; Feldman, 2000), etc.

Government as Customer-Driven Innovation

Government organizations can be consumers

- Mission-focused government funding agencies serve as consumer-driven organizations (Dasgupta, 1994; Link & Scott, 2012; Mowery, 2009)
  - Ex. While DoD and NSF both have R&D budgets, DoD has a $120B procurement budget
  - CVCs are perhaps the closest comparison (Smith and Shah, 2013)
- ***Government consumer organizations often prioritize procurement over basic research***
  - Ex: DoD uses “contracts” for innovation, while NSF uses “grants”
  - Theoretically provide access to lucrative follow-on contracts

Consumers as an Opportunity Source

The role of consumers

- Serve as a source of experimentation for novel ideas (Dahldaner et al., 2008; Franke & Shah, 2003)
- Provide contextualized knowledge of current market demands (Lüthje et al., 2005; Katila et al., 2017)
- Are particularly useful when "consumer-inventors" (Ogawa, 1998; Sanchez-Gonzalez et al., 2009; von Hippel, 1994)
    - Provide "cosmopolitan" expertise via consumer-inventor personal networks (Dahlander & Fredreiksen, 2012; Smith & Shah, 2013)

Performance Related Outcomes

- + Technical Innovation
    - Patenting (Adams et al., 2013; Dushintsky and Lenox, 2006), Patent Citations (Smith & Shah, 2013), Technical Prototypes (Dahlander & Fredreiksen, 2012)
- + Commercial Innovation
    - Product Introductions (von Hippel, 1976; Katila et al., 2017), Product Satisfaction (Urban & von Hippel, 1988; Franke & von Hippel, 2003), Service Introductions (Oliveria & von Hippel, 2009)

Opportunity Moderators: Opportunity Availability

Industry Growth & Opportunity Availability

- Growing industries are strongly correlated to opportunity availability (Dencker & Gruber, 2015)
- In growing industries (i.e., greater opportunities), iterative opportunity recognition is extremely important
    - Performant firms dynamically shift organizational forms, functions, and competitive advantages (Rindova & Kotha, 2001; Teece, 1986)

H4: The negative association between start-up growth and government consumers is strengthened in growing industries

Opportunity Moderators: Experienced Firms

Firm Experience

- More experienced start-ups will be better able to recognize opportunities (Baron, 2006; Baron & Ensley, 2006)

H5: The negative association between start-up growth and government consumers is weakened by increasing firm experience