Appendix N: Findings of peer-reviewed research

TABLE N-1
Summary of empirical research of effects of research and development (R&D) tax credits, angel investment tax credits, and commercialization programs

Paper	Type of program	Dependent variables	Units of analysis	Methods	Data sources	Findings
R&D tax credits						
Chang (2018)	Change in federal R&D tax credit laws 1981–1996	Business R&D expenditures	States	Panel data with instrumental variables	NSF Survey of Industrial Research and Development, Commerce Clearing House, Other 1981–2006	1% increase in R&D tax credit causes 2.8–3.8% in business R&D.
Rao (2016)	Changes in federal R&D tax credit during the 1980s	Business R&D expenditures	Firms	Panel data with instrumental variables	IRS corporate return data	$1 increase in tax credits results in $1.80 increase in R&D spending.
Finley, Lusch, and Cook (2015)	Effect of enactment of Alternative Simplified Credit (ASC) in 2007	Business R&D expenditures	Firms	Dynamic panel regressions	Compustat database 2003–2010	$1 increase in credit value increased R&D spending by $2.26.
Gupta, Hwang, and Schmidt (2011)	Effect of changes in federal R&D tax credit enacted in 1989	Business R&D expenditures	Firms	Generalized method of moment estimator for dynamic panel regressions	Compstat database 1981–1994	$1 increase in credit value increased R&D spending by $2.08
Wilson (2009)	Changes in effective federal and state R&D tax rates	Business R&D expenditures	States	Fixed effect panel data model	NSF Survey of Industrial Research and Development, tax credit features compiled from various sources 1981–2006	1% increase in state's research credit increases state R&D spending by 1.5%–2.1% in short-run and 2.5–3.7% in long-run.

Paper	Type of program	Dependent variables	Units of analysis	Methods	Data sources	Findings
Wu (2005)	State R&D tax credit availability	Industrial R&D expenditures per capita	13 U.S. states	Fixed effects panel data model	National Science foundation, Survey of Industrial R&D< Bureau of Economic Analysis, Gross State Product and employment, Other, 1979–1995 (every other year)	R&D tax credit is associated with more industrial R&D expenditures per capita (75–118 additional industrial R&D expenditures per capita).
Kao (2018)	R&D tax credit user qualified research expenditures	Patent citation metrics	Firms	Fixed effects panel data model with propensity score matched control group	Firm financial statements (10-Ks) from LexisNexis, Compustat, NBER Patent Network Dataverse, CRIE Patent database, Other; 1997-2007	R&D credit usage is associated with higher innovation quality as measured by patent citation metrics.
Fazio, Guzman and Stern (2020)	Measures of entrepreneurial quantity and quality	Measures of entrepreneurial quantity and quality	Counties in 25 states	Difference in difference	Startup Cartography Dataset, Upjohn Institute Panel Database on Incentives and Taxes, 1990–2010	State R&D tax credits are associated with 20% increase in quantity and quality-adjusted quantity of entrepreneurship over a 10-year period.
Bartik and Hollenbeck (2012)	Tax credit rate	Employment	Washington State Firms	Differenced panel data with instrumental variables	Firm survey responses and employment and earnings data from the Washington Employment Security Department, 2004–2009	R&D credit has positive but relatively small (0.5–0.6%) effect on employment, implying that cost per job of credit is approximately $40,000 per job.
Moretti and Wilson (2014)	Changes in effective federal and state R&D tax rates	Number of start scientists, biotech employment, non-traded sector employment, biotech wages, number of biotech establishments, biotech patents	U.S. states	Fixed effects panel data models, Triple differences	Wilson (2009) R&D tax credit data, IFI Claims Patent Services (based on USPTO), BLS Census of Employment and Wages, Census, U.S. Census Bureau County Business Patterns, 1990–2010	10% decline in user costs of capital induced by increase in R&D tax credit increase number of star scientists by 22%. Tax credits also associated with increase in biotech employment, construction employment, number of biotech establishments and patents. Wage and salary effects are small but statistically significant.

Paper	Type of program	Dependent variables	Units of analysis	Methods	Data sources	Findings
Wu (2008)	State R&D tax credit availability	High-tech establishments per 1,000 of population, high-tech share of all business establishments	U.S. states	Fixed effects panel data model	U.S. Census Bureau, County Business Patterns National Science Foundation, Other, 1994–2002	R&D tax credit is associated with 17 more high tech establishments per 1 million population and 0.07% of total business establishments. These equate to approximately 100 high technology establishments and 2,400 jobs per state.
Angel investment tax credits						
Denes et al. (2020)	State angel investment program availability, tax credit percentage, credit 'flexibility'; Firm angel investment tax credit receipt	Number of angel investments, angel-backed firms, and unique angel investors, various economic, entrepreneurial and innovation outcomes. Firm analysis: Venture Capital investment, IPO/Acquisition exit, employment.	50 states, firms in 12 states offering angel investment tax credits	State analysis: Staggered difference in difference, event study. Triple difference. Firm analysis: fixed effects panel data model of tax credit recipients and failed applicants.	State Analysis: Angel Investments from combining Crunchbase, VentureXpert, VentureSource, U.S. Securities and Exchange Commission Form D filings, National Establishment Time Series (employment), U.S. Census Quarterly Workforce Indicators (employment by firm ages and sizes), U.S. Census County Business Patterns 1985–2017. Firm analysis: microdata from state analysis plus public records on firm angel credit usage, 2005–2018.	State analysis: angel tax credits are associated with significant increase in number of angel investments, number of angel-backed firms, and number of unique angel investors 27.6%–32.3%. Increase in program flexibility leads to additional increase in angel investment quantity. Credit effects are weaker in states with higher supply of venture capital. Tax credits increase investment in low employment and growth firms and firms with fewer 'serial investors.' Tax credits not associated with increased state economic, entrepreneurial, and innovation outcomes such as employment in start-ups, job creation for young firms, establishment entry and exit, establishment counties, IPO/acquisition, entry of high-growth firms, and patents applications. State analysis: credits do not result in more follow-up venture capital investment or firm employment.

Paper	Type of program	Dependent variables	Units of analysis	Methods	Data sources	Findings
Howell and Mezzanotti (2019)	State angel investment program availability and "flexibility." Firm angel investment tax credit receipt	States: employment and number of firms by industry, age, and size, angel deals; number of angel investors, and amount; number of professional angel investors. Firms: VC raised within two years of tax credit; IPO/Acquisition exit; and employment	State analysis: U.S. states (minus California and Massachusetts), Firm analysis: firms in 12 states offering angel investment tax credits and nearby states without credits	State analysis: Staggered difference in difference. Firm analysis: fixed effects panel data model of tax credit recipients and failed applicants and nearest neighbor matches from non-tax credit states	State analysis: AngelList (angel investments), U.S. Census Quarterly Workforce Indicators (employment by firm ages and sizes), U.S. Census County Business Patterns, other, 2002–2016. Firm analysis: State public tax credit records, equity investment data (VentureXpert, Crunchbase, CB Insights), Dun and Bradstreet (employment), 2005–2018	Tax credits are associated with more angel deals and investors at the state-level but not small, young firm employment growth. At the firm level, tax credits do not result in more follow-up venture capital investment or firm employment.
Commercialization assistance programs						
Lanahan, Joshi and Johnson (2021)	SBIR Phase I recipient, B23	Employment	Firms	Staggered difference in differences with counterfactual group from coarsened exact matching (CEM); Fixed effects panel data model	SBA SBIR/STTR company and award listing, U.S. General Services Administration System for Award Management (SAM), National Establishment Time-Series, other. 2001–2015	SBIR award receipt is associated with 0.8 fewer employees three years after award slower employment growth. Receiving state SBIR match is associated with 0.5 fewer employees after receipt of first SBIR/STTR award.
Howell and Brown (2020)	SBIR Phase I grant receipt around award threshold	Employment, average earnings, revenues	Firms, employees	Difference in difference with regression discontinuity design	U.S. Department of Energy SBIR Phase I grant application data, US. Census Bureau Business Register, IRS W-2 data, Longitudinal Business Database; 2005–2013.	SBIR grant leads to 9% increase in employee earnings at firm level and 3–4% increase at employee level. Increased earnings are observed only for employees present at firm before award and effect increases with tenure. Grant also increases firm employment growth by 30% and revenue growth by 20%.

Paper	Type of program	Dependent variables	Units of analysis	Methods	Data sources	Findings
Zhao and Ziedonis (2020)	State R&D Program debt/convertible B23loan receipt	Venture capital, company survivor-ship, SBIR funding, patents productivity (i.e., patent filings, citation-weighted patents.)	Applicants to Michigan R&D commercializa-tion loan program	Regression discontinuity	Michigan Economic development corporation (application and funding data), Dow Jones VentureSource (Venture Capital), U.S. Small Business Administration (SBIR awards), Delphion (patents), Michigan Department of Licensing and Regulatory Affairs (other firm data). 2002–2008.	Award is associated with 20–30% increase in likelihood of firm survival and five additional venture capital investments. There is no statistically significant positive effect on SBIR funding or patent measures.
Lanahan and Feldman (2018)	SBIR Phase I State Match Program award receipt, size of state match	SBIR Phase II award receipt, employment, firm survival	SBIR Phase I awardees in Kentucky and North Carolina and surrounding control states (Arkansas, Missouri, South Carolina, and Virginia)	Difference in difference	SBA SBIR award data; Kentucky and North Carolina state match program project-level award data; National Establishment Time Series employment data, 2002–2010	State match funding improved likelihood of award recipients receiving Phase II award by 29.4%. Size of state match improves likelihood of Phase II award for projects in science and health and fewer previous SBIR Phase I awards. State match has no effect on firm employment but improves likelihood of firm survival by 15.2 percentage points.

Paper	Type of program	Dependent variables	Units of analysis	Methods	Data sources	Findings
Howell (2017)	SBIR Phase I grant receipt	Venture capital funding, firm revenue, patents	Firms	Regression discontinuity	U.S. Department of Energy Small Business Innovation Research (SBIR) Phase I grant application data, Patent data from Berkeley's Fund Institute; VC investment from ThomsonOne, CrunchBase and others; Revenue data from D&B and company websites; 1995-2013	Grant increased cite-weighted patents by 30%, increased chance of receiving venture capital investment by 10–19% as well as money raised and number of deals, doubles probability of positive revenue, and increase probably of firm survival by 12–14 percentage points and exit by IPO or acquisition by 4.5 percentage points.
Lanahan (2016)	SBIR Phase I State Match Program award receipt	Phase I application rates; SBIR Phase II award receipt	States	OLS, fixed effects, and Arellano and Bond estimator panel data models	SBA SBIR award and TechNet databases; Bureau of Economic Analysis (employment), other. 2000–2010	State match programs are associated with increased in Phase II success rates for firms in NSF SBIR program but not other (Department of Energy and NASA) programs. Results for application rates are generally not statistically significant.
Venture capital funds						
Barkley, DiFurio, and Leatherman (2004)	State venture capital program	Kansas	Firms	Comparison group and duration model	ES202	Program assisted firms added more jobs than comparison group. Firms had significantly higher survival rates.