

LAUREN LANAHAN: The Multilevel Innovation Policy Mix:
Three Essays on State SBIR Matching Programs
(Under direction of Maryann P. Feldman)

Abstract: This three-essay dissertation analyzes the impact of U.S. state government R&D investments on small business innovation. Essay one identifies and classifies the portfolio of state programs designed to enhance the federal SBIR program. It includes an empirical assessment of antecedent factors associated with states adopting and maintaining an SBIR Match program. Essay two examines the efficacy of the SBIR State Match program and finds positive benefits for National Science Foundation participants. Essay three exploits policy discontinuities at state borders and estimates both the differential and marginal effect of the SBIR State Match program on securing follow on federal funding.

Executive Summary

If scientific knowledge and innovation are crucial sources for economic growth and competitiveness, then we should want to identify and advocate those institutions and reward structures that are most efficient at bolstering this activity. The R&D enterprise, however, continues to expand, involving numerous actors and organizations (Stephan, 2012), complicating its analysis for scholars. As Jaffe and Jones and their collaborators (2014) highlight, the frontier for science and innovation systems is dynamic and multifaceted. Moreover, it is projected to continue to evolve in the coming decades. More research is needed not only to understand institutional norms, collaborations, and the nature of knowledge production, but also to inform policy that promotes optimal research.

In an effort to contribute to this broad discussion and to push research in a direction that is responsive to the changing scientific frontier, this dissertation examined the growing role of state government innovation policy through the lens of the U.S. federal Small Business Innovation Research (SBIR) program. The federal SBIR program stands as one of the most well known public programs supporting early-stage R&D activity for small firms (e.g. Lerner, 1996; Wallsten, 2000; Audretsch, 2003; Toole & Czarnitski, 2007; Wessner, 2008). Established in 1982, the Small Business Administration oversees an interagency consortium of 11 federal agencies that provide competitive extramural R&D funds for small businesses to demonstrate proof-of-concept (Phase I) and product development (Phase II). The SBIR program formally defines a third phase for commercialization; however, federal funds are not obligated at this phase as projects are expected to be competitive at this point for securing non-federal follow on funding. Alongside this activity, 45 U.S. states have introduced one or more SBIR-inspired programs designed to complement the federal program. These state programs can be broadly

classified as either outreach efforts to increase participation with the federal SBIR program or more aggressive match efforts to improve the competitiveness and advance the project downstream toward development and commercialization. There is considerable scholarship on the federal SBIR program, but there are no studies that consider the broader SBIR policy context that include state programs.

Examining state government innovation policy within the SBIR policy context offers an opportunity not only to understand the larger policy mix of public efforts directed to support early-stage innovative activity, but also to examine the impact of variations in the size of public R&D support on innovative activity within firms. The State Match program, in particular, allows for this analysis given that the states with the program share a common programmatic structure of offering a noncompetitive award to the pool of Phase I recipients.

The central aims of this dissertation are twofold. First, this project seeks to motivate the multilevel innovation policy mix as a framework for innovation policy analysis within a federalist system. In doing so, this research first brings greater attention to state innovation policies and then places state policy within a larger policy context. Second, drawing upon the portfolio of federal and state SBIR programs as an exemplar of a multilevel innovation policy mix, this project critically examines the set of complementary state policies on innovation among small, innovative firms. The implications from this research extend to a broad spectrum of policymakers – that include both state and federal levels – and also researchers, scientists and the greater public concerned with innovation policy and promoting economic development. The research for this project is presented in a three-essay format; each of the essay’s central aims and contributions are briefly reviewed in turn.

Multilevel Innovation Policy Mix: A Closer Look at State Policies that Augment the Federal SBIR Program (Essay 1)¹

Aims and Contributions

Serving as a foundational framework for this larger project, this essay draws attention to the larger multilevel system that is supportive of innovation and R&D. Too often we limit analysis of R&D to federal investments when in fact myriad organizations and institutions are stepping up to support early-stage innovative activity. Within a federalist system, state governments in particular are playing a greater role in this capacity. This essay offers a foundational overview of state R&D policy activity directed toward small businesses. The primary aims of this research are threefold: (i) to present a theoretical framework for understanding policy activity within a dynamic multilevel system; (ii) to identify the policy context of the portfolio of state programs designed to augment the federal SBIR program; and (iii) to empirically examine the antecedent factors that lead states to adopt one of the more aggressive programs – the State Match.

This essay pays particular attention to policy enhancement – where policy is initiated at the federal level and yields a positive response from state governments. The inherent nature of innovation demands substantial investment, placing the federal government in a critical position to afford and therefore initiate policy responses. State response to federal actions can broadly be viewed as an effort to garner a larger share of the federal funds and capture the resulting benefits. The shared imperative of bolstering innovative and economic activity, however, ties these multiple systems together and places state governments in an advantageous position to complement federal efforts.

¹ At the time of this submission, a version of the essay was under the third round of revision and tentatively accepted for publication at *Research Policy*. This peer-reviewed article is co-authored with Maryann P. Feldman.

Evidence points to a growing interest among states; however, our understanding of state innovation policy is limited given the notable methodological hurdles with this decentralized policy activity. The broad portfolio of SBIR policy activity – that includes State Outreach and State Match programs – illustrates the increasing role of state innovation policy. As of 2013, 45 states had one or more formal programs to augment the federal SBIR program. Not only does this serve as a central repository of U.S.-based SBIR policy activity, the empirical component of the essay offers compelling evidence that more attention should be focused on the multilevel innovation policy mix. Specifically, the results indicate that state policy implementation is associated with a confluence of multilevel factors driven not only by top-down federal actions, but also from bottom-up, internal state political and economic factors as well as from lateral pressures from peer states. By examining the motivating factors associated with state policy responses, the analysis demonstrates that state policies are shaped by the nature of the multilevel mix itself. In short, public policy is dynamic and contextual. For a more accurate understanding of innovation policy, it is important to consider how multiple levels of government interact.

Multilevel Funding for Small Business Innovation: A Critical Review of State SBIR Match Programs (Essay 2)²

Aims and Contributions

Building upon the foundational classification scheme in the first essay that clarifies the multilevel U.S. SBIR policy context, this essay examines the implications of the State Match. The primary aims for this essay are twofold: (i) to consider the policy implications for multilevel innovation policy analysis within a federalist system; and (ii) to offer a comprehensive

² At the time of this submission, a version of this essay was accepted for publication with the *Journal of Technology Transfer*.

examination of the State Match program by considering the dual advantages (Hsu & Ziedonis, 2013) of the program – both Phase II success rates and Phase I applications.

Program evaluation is important in its own right; and placed within a larger policy mix that extends to the federal and state government levels, the policy implications are even greater. From a state government perspective, this is an effort to invest in the local innovative economy to stimulate development and growth. From the federal perspective, the State Match can be viewed as a policy experiment that tests marginal adjustments to the size of the SBIR program. Importantly, regardless of the efficacy of the program, the policy implications of the State Match extend to both levels of government. If the program is found to be effective in increasing the competitiveness of Phase II applicants, the federal government may consider adjusting the size of the Phase I award. Rather than experimenting with the size of the Phase I award, the federal SBIR program can simply learn from state actions. Moreover, states without the program may consider adopting comparable programs to increase the likelihood of securing follow federal funding. Though of course, without adjustments in the size of the federal SBIR program, this would play out in a zero-sum format. In the event the benefits of the program are limited, the federal government may view the evidence as validation for the current size of the Phase I award. State governments with the program may opt to either increase the size of the award or invest resources elsewhere.

In terms of program evaluation, this essay offers a comprehensive assessment of a diffuse state government innovation program. Much of the scholarship has focused on case study analyses and descriptive overviews, which limits their generalizability and validity (e.g. Combes & Todd, 1996; Berglund & Coburn, 1995). However, the standard structure of the State Match program – notably the noncompetitive match to the pool of successful Phase I recipients – offers

an opportunity to examine a state policy on a larger national scale. The results indicate that the benefits of the State Match vary; the program differentiates recipients of the State Match competing for the NSF SBIR Phase II funding. The results were not robust for Phase I application activity. While the State Match can be viewed as a marginal increase in the size of the Phase I award – given its noncompetitive nature – I expected prospective applicants on the margin to compete for the Phase I funding. Most of the State Match programs are relatively new, however, with initial adoptions dating after the 2001 federal SBIR reauthorization. What the null results suggest is that prospective applicants may be unaware of the state support. Increased awareness of the match may alter behavior.

While there is evidence here in this analysis and in other studies to suggest that the financial demands vary across industrial sectors, the SBIR program and State Match programs are broadly set up as blanket policies and do not reflect these differences. These results suggest that architects of the program may want to adjust the size of the match to reflect the heterogeneity in financial demands across the various sectors. The federal SBIR program has made initial efforts in this vein by increasing the maximum size of the DHHS SBIR awards to \$300,000 for Phase I and up to \$3 million for Phase II; however, more could be done to tailor the program to early-stage innovative needs.

Approximating Exogenous Variation in R&D: SBIR Projects and State Matching Funds

(Essay 3)³

Aims and Contributions

³ At the time of this submission, a version of this essay was under peer-review at the *Review of Economics and Statistics*. This article is co-authored with Maryann P. Feldman.

Building upon the broad state-level evaluation of the State Match presented in essay two, this essay takes a narrower approach by employing a project-level evaluation of the program for a contiguous region. In doing so, this essay includes the population of Phase I awards for two states with the State Match – Kentucky and North Carolina – and four contiguous states without the State Match – Arkansas, Missouri, South Carolina and Virginia. Importantly, the two treated states were selected given that they adopted the program in 2006 and 2005, respectively, and offer varying sizes of the match. This allows for a differential and marginal examination of the policy. Placed within the context of the federal SBIR program, between state comparisons are feasible given that the population of Phase I projects achieved a minimum level of competency through the federal SBIR review. Moreover, this approach offers a strong design not only to treat the noncompetitive State Match as an exogenous increase to the R&D investment, but also to examine innovation policy directed toward projects rather than firms.

The results from this analysis build upon the findings from essay two. Notably, the effect of the State Match varies both by industrial focus and firm research capacity. More specifically, in contrast to projects without the State Match, the results indicate that additional funding improved the competitiveness of Phase I recipients competing for the Phase II awards among projects with a directed focus in the basic sciences – NSF and DHHS funded – and with less prior success with the SBIR program. Results from a comparison of means test indicate that these firms in particular are smaller and younger than the average SBIR recipients. Results from the marginal analysis also found positive effects of the program; for this set of models, the results indicate that more money is worth more when invested in projects with less experience with the program. Program success was defined as securing the Phase II award; however,

employment change was also considered. The results for these models were not robust; this is likely due to measurement error with this metric.

Additional efforts were made to understand the underlying mechanisms of the State Match program. Assuming that Phase I recipients move on to compete for the Phase II award given the dearth of funds at this early-stage of activity, the state funds may advance a project by enabling improvements in its technical or scientific aspects, or they may simply enable improvements in the Principal Investigator's grant writing skills. Both of these would improve the competitiveness of a Phase II proposal, but the former more directly meets the objectives of the program – advancing early-stage innovation. The results from a comparison of means test indicate that projects with a State Match that move on to secure the Phase II take longer than those without the State Match by roughly three months. This offers preliminary evidence for the former scenario to suggest that the funds are used to increase the incubation period of the Phase I project before moving on to compete for the larger Phase II funding.

Taken together, marginal increases in early-stage innovative activity yield positive benefits – in terms of securing additional follow on federal funding – for projects affiliated with the NSF and DHHS program with less prior success with the SBIR program. Viewing prior SBIR activity as a proxy for firm R&D research capacity, this suggests that firms with less success are able to more effectively leverage the additional funding. As suggested by the results from the prior study, rather than offering a blanket policy of a standard State Match, policymakers may want to tailor the award. This has implications for both state and federal policymakers and firms invested in innovative research. Elaborating on the former, state policymakers may view these results as evidence that marginal investments can leverage significant follow on funding when invested in specific types of innovative endeavors. Federal

policymakers, on the other hand, may consider adjusting the structure of the Phase I award for certain programs. Importantly, the value of the R&D investment varies and this has direct implications on the firms conducting this innovative activity. The results from essay two found that the effect varies across industrial focus, whereas this study offered additional evidence to show that the effect varies by the firm's research capacity as well.

Future Research

This dissertation project brings greater focus to the multilevel innovation policy mix. The SBIR policy context, in particular, presents an opportunity to examine the interactions across multiple levels of innovation policy in a federalist system that share a common imperative of promoting innovation and bolstering economic activity. In doing so, this research directs greater attention to state government innovation policy, which is too often overshadowed by federal activity.

The scientific frontier is changing and becoming increasingly complex and collaborative. As a researcher, it is important to be responsive to the changing context. Non-traditional sectors – including state governments and also non-profit organizations – deserve greater scholastic attention. This is needed in addition to clarifying and articulating the amalgamation of federal innovation policies. An inherent belief that scientific knowledge and innovation promote societal benefits and prosperity underlies much of the motivation to invest and examine R&D. Accurately and precisely measuring these connections, however, presents notable empirical challenges including breaking down the R&D process of inputs, outputs, outcomes, and impacts over the short-, medium-, and longer terms. Collectively, this complex process comprises the infamous *black box* that is hard to illuminate.

This dissertation project directs greater attention to state innovation policy and sets up a research design to assess the efficacy of marginal investments in early-stage R&D at the level of the project, rather than firm. More work, however, remains. Including data on SBIR project-level application activity would extend and complement this analysis. This would offer more complete information regarding the behavioral responses to the federal and state SBIR programs. In addition, we assume that all Phase I recipients move on to compete for Phase II funds; however, alternative outcomes should be explored. This includes securing additional non-federal funding and trading activity including firm acquisitions.

Building upon the notion of the innovation policy mix, R&D support increasingly stems from a broader range of sources that include state & local, university and nonprofit R&D investments. To extend this line of research, greater attention is needed to examine the relationships between this broader portfolio of sources. In addition, this research project advances our understanding of R&D by focusing on investments in projects. While this offers a closer examination of the mechanisms that advance innovation, another line of future research could explore innovation policy directed toward individuals. Building off the SBIR program, there is great potential in looking at the activity of SBIR Principal Investigators. This would contribute to the large literature that traces the activity of STAR scientists – more senior, established scholars – in terms of their patterns of invention and innovation (e.g. Lane & Bertuzzi, 2011; Zucker & Darby, 1997).

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