Economic implications of raising the threshold funding limits on US Small Business Innovation Research awards

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Abstract:

The purpose of this paper is twofold. First, we investigate empirically the economic implications of increasing the threshold funding limits on Small Business Innovation Research (SBIR) awards. Specifically, we estimate the impact of an increase in an SBIR Phase II research award amount on the likelihood that the funded project will reach technical completion, that is, it will not be discontinued early or fail. Although an increase in the threshold amount of Phase II awards was mandated by the Act of 1992, and although a recent SBIR policy directive allows such, the economic implications of an increase have yet to be considered in any systematic manner. Second, we offer a call for a further evaluation of the SBIR program, and more broadly a prospective evaluation of public-private partnership science and technology programs, along the lines of an investigation of the determinants of milestone successes and failures.

Keywords: Small Business Innovation Research (SBIR) | R and D | innovation | science and technology

Article:

The Small Business Innovation Development Act of 1982 (Public Law 97-219) created the Small Business Innovation Research (SBIR) program.[1] Its purposes are to:

- stimulate technological innovation;
- use small business to meet federal R&D needs;
- foster and encourage participation by minority and disadvantaged persons in technological innovation; and

[1] The Act of 1982 amended the Small Business Act of 1953 (Public Law 85-536) which established the Small Business Administration. SBIR is a set-aside program.

- increase private-sector commercialization innovation derived from federal R&D.[2]

The Act of 1982 called for each federal agency with an extramural R&D budget in excess of US$100 million in 1982, or in any year thereafter, to set aside not less than 0.2% of its extramural budget in 1983, to increase to 1.25% in 1986, and to remain at that percentage in subsequent years.[3] These monies were to be allocated to small businesses with less than 500 employees as Phase I and Phase II awards. A Phase I award, according to the Act of 1982, was for determining the scientific and technical merit and feasibility of ideas pursuant to the SBIR program solicitation. A Phase II award extends Phase I research with the expectation of commercialization and follow-on non-SBIR funds. Phase I awards were capped at US$50,000 and Phase II awards were capped at US$500,000.[4] In 1986, the 1982 Act was extended through 1992 by Public Law 99-443.

The Small Business Research and Development Enhancement Act of 1992 (Public Law 102-564) reauthorized the SBIR program for eight years. The Act of 1992 raised the amount of the set-aside over time to 2.5%, broadened the purposes of the SBIR program by explicitly stating that the SBIR program should enhance the participation of small businesses that are 51% owned and controlled by women, and increased Phase I awards to US$100,000 and Phase II awards to US$750,000. It also went on to state that there should be an 'adjustment of such amounts once every 5 years to reflect economic adjustments and economic considerations'.

The Small Business Reauthorization Act of 2000 (Public Law 106-554), extended the SBIR program until September 30, 2008. It retained the 2.5% set-aside and did not increase the amounts of Phase I or Phase II awards. The Act of 2000 also called for the National Research Council (NRC) within the National Academy of Sciences to 'conduct a comprehensive study of how the SBIR program has stimulated technological innovation and used small businesses to meet federal research and development needs ...'. However, the US Congress did not reauthorize the SBIR program by the September 2008 deadline; rather it temporarily extended the program until March 20, 2009 through Public Law 110–235. The Senate version of the reauthorization bill (S. 3029) included, among other things, an increase in Phase I funding to US$150,000 and an increase in Phase II funding to US$1,000,000 with provisions for these funding guidelines to be exceeded by 50%.[5]

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[2] The Act of 1982 was based on the following premises: technological innovation creates jobs, increases productivity, competition, and economic growth; small business is the principal source of significant innovation in the US, although the vast majority of federally-funded R&D is conducted by large businesses, universities, and governmental laboratories; and small businesses are among the most cost-effective performers of R&D and are particularly capable of developing R&D results into new products.

[3] In 1983 the amount allocated under the SBIR program totaled US$45 million.

[4] These amounts are not stated in the Act of 1982. They originally came from a policy directive to the Small Business Act, to which the Act of 1982 was an amendment. They are explicitly referred to in Senate Report 110-447 (US Senate, 2008).

[5] These funding amounts had been recommended by the NRC in its 2008 final report to Congress (Wessner, 2008: 9):

> The real value of SBIR awards … has eroded due to inflation. Given that Congress did not indicate that the real value of awards should be allowed to decline, this erosion in the value of awards needs to be addressed. In order to restore the program to the approximate initial levels, adjusted for inflation, the Congress should consider making a one-time adjustment that would give the agencies latitude to increase the standard size of Phase I awards to $150,000, and to increase the standard size of Phase II awards to approximately $1,000,000.

However, on March 19, 2009 the House and Senate reauthorized the SBIR program until July 31 of that year though Public Law 110-10. It was again reauthorized through September 30 by Senate continuing resolution S. 1513, and on September 23 House bill H.R. 3614 extended the program until October 31, 2009. On that date, Senate bill S. 1929 again extended the program until April 30, 2010. Currently Senate bill S. 3839 again extended the program until January 31, 2011. At issue continues to be whether the existing Phase I and Phase II process should remain, whether the dollar amount for Phase I and Phase II awards should be increased, and whether venture capitalists should be involved as partners with firms involved in the SBIR process.[6] While this debate lingers in Congress, the Small Business Administration amended the SBIR policy directive on March 30, 2010 to allow the threshold amount for Phase I awards to increase to US$150,000 and to US$1,000,000 for Phase II awards.[7]

The remainder of this paper is as follows. In the next section we summarize the NRC database for the Department of Defense (DoD) awards that we relied upon, and we present our exploratory empirical findings about the impact of increasing the threshold award amount of an SBIR Phase II award on the likelihood that the funded project will reach technical completion. Then we cautiously interpret our findings from both an economic and policy perspective and offer concluding remarks.

NRC database and empirical findings

The Small Business Reauthorization Act of 2000 mandated that, among other things, the NRC conduct 'an evaluation of the economic benefits achieved by the SBIR program' and make recommendations to Congress for 'improvements to the SBIR program', as noted above. In 2005, the NRC conducted an extensive and balanced survey based on a population of 5,650 projects completed from Phase II awards by the DoD over the years 1992–2001; 3,055 firms in which these research projects were conducted were surveyed.[8,9] Included among the surveyed projects were 29 non-randomly chosen success stories.[10] Of the 3,026 randomly surveyed projects, there were 891 firms that responded about identified projects.[11]

The NRC report goes on to state that the:

> … Small Business Administration should continue to provide the maximum flexibility possible with regard to award size and the agencies should continue to exercise their judgment in applying the program standard.

[6] See Congressional Research Service (2009) for a detailed overview of the reauthorization efforts.

[7] These amounts are, as they have been in the past, benchmarks. As the data below show, some awards have exceeded these guidelines for a number of years by multiple amounts.

[8] Four other agencies were included in the survey: the National Institutes of Health, National Aeronautics and Space Administration, the Department of Energy, and the National Science Foundation. DoD is the largest agency in terms of awards and projects surveyed, and thus it is the agency considered in this paper. In 2005, the year of the survey, DoD accounted for 52% of the money allocated to Phase II awards.

[9] Implicit in the NRC data set is a four-year lag between funding and completion of a project. Thus, projects funded in 2001 are assumed to be completed by 2005, the year of the survey.

[10] The NRC surveyed a number of non-randomly selected projects because they were projects that had realized significant commercialization and the NRC wanted to be able to describe such interesting and important success stories.

[11] Descriptive statistics from the survey are summarized, but not analyzed by Wessner (2009).

Two of the focal variables in this paper are Phase II project failure and the award amount of the Phase II project. A research project is defined herein as having not reached technical completion or having failed (*failure* = 1, and 0 if not failed) if it is reported in the NRC database to have been discontinued before being completed;[12] and the award amount (*awardamt*) equals the US dollar amount of the Phase II award.

Table 1 presents descriptive statistics on these two variables. Of particular note is that 24% of Phase II research projects were discontinued before completion. The Phase II projects that failed in the period 1992–2001 accounted for US$135.5 million of the total funding to the 891 projects in the NRC database of US$646.3 million.[13] And, DoD awards have frequently exceeded the US$750,000 threshold that previously existed.[14]

Table 1. Descriptive statistics on variables from random sample of projects

Variable	*n*	Mean	Standard deviation	Minimum	Maximum
failure	891	0.2402	0.427	0	1
awardamt	891	725.41	350.93	69.67	_,190.97
failure = 1	214	633.97	199.04	69.67	1,600.00
failure = 0	677	754.63	382.22	99.30	6,190.97
commercialize	677	0.3560	0.479	0	1

Note: *awardamt* is measured in US$1,000; *commercialize* is relevant for 76% of projects that were not discontinued

Table 2. Percentage of funded projects that fail, by award amount decile

Award amount (in US$)	Number of projects	Failures (%)
< 453,698	89	40.45
453,698–545,094	89	25.84
545,094–600,000	78	32.05
600,000–710,486	100	32.00
710,486–735,234	89	23.60
735,234–747,617	88	21.59
747,617–749,930	90	24.44
749,930–750,000	41	19.51
750,000–950,032	137	15.33
> 950,032	90	7.78
	891	

As shown in Table 1, not completed or failed projects are, on average, smaller in terms of award amounts. More specifically, Table 2 shows the mean percentage of projects that failed, by award

[12] The survey question is: 'What is the current [in 2005] status of the project funded by the referenced SBIR award?' The response that defined failure is: 'Efforts at this company have been discontinued. No sales or additional funding resulted from this project'. Of course, termination of a project prior to technical completion may make economic sense. However, this survey question defines failure for the purposes of this paper.

[13] Over the period 1992–2001, DoD funded 5,822 Phase II projects at a total cost of US$4.13 billion. Because the NRC sample of 891 projects is random, failed DoD Phase II projects over this time period accounted for nearly US$1 billion (US$992 million based on a 24.02% average failure rate).

[14] It is beyond the scope of this paper to pursue whether there actually was an institutional need for a directive or for a Congressional mandate to raise the threshold amount. As one reviewer of this paper noted, it may be that there is a bias of funders to award amounts above the US$750,000 threshold to those projects with a higher expectation of non-failure. We acknowledge this possibility (see Table 2), but we have no way to control for it in our empirical exercise.

amount decile. The pattern of these means suggests that the likelihood that a Phase II project is discontinued decreases as the award amount decile increases.

More formally, we estimated a bivariate probit model using the random sample of 891 projects, and we found a negative and statistically significant correlation between the amount of the Phase II award and the probability of failure, as anticipated from Table 2.15,[15,16] Based on our results, we calculated the probability of failure at a funding level of US$750,000 to be 22.26% and the probability of failure at a funding level of US$1,000,000 to be 14.38%. Thus, at these values, the SBIR policy directive, and presumably any similar forthcoming reauthorization bill, will have economic implications one of which is to reduce the probability that a funded Phase II research project will be discontinued or will fail by about eight percentage points. Stated alternatively, one economic implication of increasing the threshold funding limits on SBIR Phase II awards is to increase the likelihood that a funded project will be completed.

Discussion of the findings

We examine project completion versus project failure as an early-on performance measure because other metrics (e.g. commercialization), given the stated purposes of the SBIR program, assume that the funded research is, at a minimum, completed. Thus, not failing to complete a research project implies that the project has passed an initial necessary condition for possible future success as defined by the program's stated purposes.[17]

Our empirical findings suggest that, other things remaining constant, the probability that a funded Phase II project will be completed, and thus will meet its technical goals, will increase by eight percentage points when funding is increased from the US$750,000 threshold level to US$1,000,000.[18] Regarding the economic outcome associated with these additional completed projects, the descriptive statistics in Table 1 show that only about 36% of completed Phase II projects ever produce technologies that are commercialized *commercialize* = 1, and 0 otherwise), and commercialization is a stated purpose of the SBIR program.[19] In addition, the probability of a given project being commercialized is statistically unrelated to its Phase II award amount.[20]

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[15] The results from the probit model, with standard errors in parentheses, are:

failure	=0.1366	–0.0012 *awardamt*
	(0.162)	(0.0002)
		Sigma = 815.54
		Wald Chi^2(1) = 28.13
		Log likelihood = –474.12
		n = 891

We calculated the predicted probit index for both an award amount of US$750,000 and US$1,000,000 and then determined the corresponding predicted probability from the normal distribution.

[16] Link and Scott (2009, 2010) have shown that there is no selection bias among DoD awards.

[17] In addition, to the best of our knowledge, the economics of research failure *per se* has yet to be empirically investigated.

[18] As one reviewer of this paper noted, any policy discussion about SBIR threshold funding limits is not independent of the debate about the SBIR percentage set-aside. We do not disagree on this point, but our empirical exercise by design only focuses on the former issue. Certainly the latter debate will continue as parties express their vested interests.

[19] The survey question is: 'Did a commercial product result from the Phase II project?' [Yes or no]

[20] The results from the probit model, with standard errors in parentheses, are:

Thus, the overall economic impact associated with the SBIR policy directive, and presumably with the aspect of any forthcoming reauthorization bill that contained the same amount of threshold funding increase, will likely be small. On average, 36% of the additional 8% of projects that do not fail may reach commercialization.

That said, the empirical exercise presented in this paper could be interpreted with an eye toward broader policy perspectives.[21] As background, the United States has a long history of public accountability, traceable at least to President Woodrow Wilson's fiscal reforms and more specifically to the Budget and Accounting Act of 1921. The Government Performance and Results Act (GPRA) of 1993 initiated program performance reform and evaluation. Following in the spirit of GPRA, Peter Orszag, Director of the Office of Management and Budget sent a memorandum on October 7, 2009 to the heads of executive departments and agencies on the subject of program evaluation:

> Rigorous independent program evaluations can be a key resource in determining whether government programs are achieving their intended outcomes … . Evaluations can help policymakers and agency managers strengthen the design and operation of programs. Ultimately, evaluations can help [government policy] determine how to spend taxpayer dollars effectively and efficiently …

And, the latest initiative, announced on June 1, 2010—the Science and Technology for America's Reinvestment: Measuring the Effect of Research on Innovation, Competitiveness and Science, or STAR Metrics—is one more element within the expanding spectrum of public accountability.

Our findings could be interpreted as support for a call for the US Congress to include with any authorized increase in the threshold amount of Phase II SBIR awards a systematic evaluation of the implications of that action. In other words, perhaps a prospective evaluation should be conducted rather than a retrospective evaluation after the legislation is enacted. A prospective evaluation to identify covariates of both project failure and project commercialization should perhaps be considered by Congress for inclusion in any forthcoming SBIR reauthorization bill, and, much like in the 2000 reauthorization, perhaps Congress should charge the NRC to undertake this study.[22]

commercialize	= 0.4280 (0.108)	–0.0001 *awardamt* (0.0001) Sigma = 12877.37 Wald $Chi^2(1) = 0.377$ Log likelihood = –440.58 *n* = 677

[21] In an effort to avoid the law of decreasing credibility (Manski, 2010), we have attempted herein to let the NRC data speak for themselves. That said, any dichotomous survey question is narrow by intent (i.e. to elicit an answer), and thus it misses many subtleties such as, in our case, the degree of project failure or the breadth of project commercialization. Thus, we offer the following discussion more as a vehicle to stimulate thought rather than as a policy mandate.

[22] The need for a systematic analysis of the economics of failure has been argued by Link and Link (2009) within the context of SBIR and other entrepreneurial public programs. It would not be surprising that, based on the extant academic literature, a prospective evaluation would also find that university involvement in an SBIR project would

The NRC final report to Congress notes that any comparison of empirical findings from one agency to another about SBIR should be made carefully (Wessner 2008, p. 109):

> Comparisons between SBIR programs at different agencies … must be regarded with considerable caution. [W]idely differing agency missions have shaped the agency SBIR programs, focusing them on different objectives and on different mechanisms and approaches.

But, there are common elements to public support of research, especially in small firms, regardless of the agency funding the research. The scale of research capital needed for a project to succeed, in a broader sense than simply not failing, varies across technologies and across the technical capital of the researching firm. Thus, while there are institutional and mission differences across SBIR programs, there are also research commonalities. Perhaps then our findings could be interpreted more broadly as a suggestion to Congress to create an evaluation structure that is boldly charged with the responsibility of conducting economic evaluations of the private performance of public support of science and technology.[23]

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References

Congressional Research Service 2009. The Small Business Innovation Research (SBIR) Program: Reauthorization Efforts, Report for Congress. Congressional Research Service: Washington, DC.

Hall, Bronwyn H, Albert N Link, and John T Scott 2003. Universities as research partners. *Review of Economics and Statistics*, **85**(2), 485–491.

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not only reduce the likelihood of failure, but also, for completed projects, would increase the likelihood of commercialization (Hall *et al*., 2003; Link and Ruhm, 2009).

[23] As Link and Scott (forthcoming) have argued, the appropriate evaluation question to ask about the economic performance of public funding of privately-performed research is one that facilitates an economic understanding of whether the public sector should be underwriting a private-sector firm's research, namely: What is the social rate of return from the program, including spillovers, compared to the private rate of return? Or: What proportion of the total profit stream generated by the private firm's R&D and innovation does the private firm expect to capture; and hence, what proportion is not appropriated but is instead captured by other firms that imitate the innovation or use knowledge generated by the R&D to produce competing products for the social good?

Link, Albert N and Christopher J Ruhm 2009. Bringing science to market: commercializing from NIH SBIR awards. *Economics of Innovation and New Technology*, **18**(4), 381–402.

Link, Albert N and Jamie R Link 2009. *Government as Entrepreneur*. New York: Oxford University Press.

Link, Albert N and John T Scott 2009. Private investor participation and commercialization rates for government-sponsored research and development: would a prediction market improve the performance of the SBIR program? *Economica*, **76**(302), 264–281.

Link, Albert N and John T Scott 2010. Government as entrepreneur: evaluating the commercialization success of SBIR projects. *Research Policy*, **39**(5), 589–601.

Link, Albert N and John T Scott (forthcoming). *Public Goods, Public Gains: Calculating the Social Benefits of Public R&D*. New York: Oxford University Press.

Manski, Charles F 2010. Policy analysis with incredible certitude, NBER working paper 16207. Cambridge, MA: National Bureau of Economic Research.

US Senate 2008. SBIR/STTR Reauthorization Act of 2008 Report 110-447. Washington, DC: US Senate.

Wessner, Charles W 2008. *An Assessment of the SBIR Program*. Washington, DC: National Academy Press.

Wessner, Charles W 2009. *An Assessment of the SBIR Program at the Department of Defense*. Washington, DC: National Academy Press.