The Impact of Seed-Grant Funding on Extramural Research Awards

by

James M Costa*

ABSTRACT. The Grant-in-Aid Program is a State sponsored seed grant program whereby the State of Minnesota provides the University of Minnesota approximately $2 million annually to fund new faculty research. Recently, the Graduate School engaged in an internal review of the Grant-in-Aid program. The purpose of the review was to determine how effective their seed grant program was in enabling University faculty to obtain additional grant funding from agencies outside the University. The following study discusses this review in some detail. An econometric analysis of survey data indicates that the seed-grant program is highly effective in enabling faculty to gain additional research funding. Further it was found that the ability of a faculty member to obtain additional extramural funding is dependent upon the discipline in which the research is being conducted.

key words: research productivity, seed grant, grant funding

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* James M Costa is a Graduate Student and Research Assistant in the Department of Applied Economics at the University of Minnesota.

Primary Contact: James M Costa

Department of Applied Economics
University of Minnesota
337g Classroom Office Building
1994 Buford Avenue
St. Paul, MN 55108-6040

Phone: (612) 625-9715
Fax: (612) 625-6245
e-mail: cost0030@tc.umn.edu

The Grant-in-Aid Program

The Grant-in-Aid of Research, Artistry, and Scholarship Program (GIA Program) is a State sponsored seed grant program whereby the State of Minnesota provides the University of Minnesota approximately $2 million annually to fund faculty research. Under the guidelines of the program, seed grants which are awarded on a competitive basis, are primarily intended to support research programs of "new/junior faculty" who would otherwise not have a sufficiently well established program to attract extramural funding, funding from outside of the University system. The program has been in operation at the University for nearly 20 years.

Justification of the Study

Given the ever-increasing pressure on the University from the State to improve efficiencies in their operations most University entities have been required to justify their worth in the State's eyes in order to continue receiving State supported funding. Numerous studies have explored the relationship between academic research and spill-overs to industry (Jaffe, Acs et al, and Tornquist and Kallsen). However, the literature pertaining to returns to academic research within the university system is generally limited to broad research productivity studies of faculty. Here the literature is extensive. (Print & Hattie, Zamarripa, Ramsden, and Pratt) However, most of these studies make no particular emphasis on seed grant funding as a potential driver of academic research productivity. Consequently, the Graduate School, which administers the GIA program, felt it necessary to perform an objective evaluation of the GIA program. Specifically, the graduate school

sought to answer the question: Was the GIA program actually having a positive impact on the research productivity of new faculty?

Objectives

1) To assess the impact of seed grant awards on the ability of faculty to obtain outside funding.

2) To examine how an investigator's research discipline/department affects his/her ability to obtain outside funding, given prior receipt of a seed grant award.[1]

Hypotheses

1) Seed grant money is a critical lever in enabling researchers to generate subsequent outside funding for all fields of research.

2) Researchers in the fields of Arts and Humanities will be relatively less successful in generating outside funding than those in the Sciences.[2]

Initially a survey was designed to measure the research productivity of prior grant recipients. Given that faculty members from all disciplines across the University are eligible to apply for a GIA, it was felt necessary to broadly define productivity so as not to impose a bias against researchers in any given field. Hence, productivity was defined as both monetary and non-monetary outcomes *directly* resulting from receipt of a seed grant award. In particular, a monetary outcome was defined as any extramural award resulting from and occurring since the time of the GIA award. Similarly, a non-monetary outcome

[1] It is widely accepted that faculty from the fields of Arts and Humanities have relatively fewer extramural funding opportunities than do faculty from most other fields of research. Consequently, the Arts and Humanities disciplines were singled out to assess the relationship between seed grant funding and research productivity in those particular non-science fields.

[2] Here sciences is broadly defined as all fields other than Arts and Humanities. This broad grouping of other disciplines was selected to isolate the Arts and Humanities fields, thus facilitating the test of hypothesis 2.

was defined as any publication, chapter written in a book, patent, musical composition, professional presentation at a national or international meeting, or artistic sculpture resulting from and occurring since time of the GIA award.

Data

The first data source is a database maintained by the Graduate School and pertains only to GIA recipients. These data describe characteristics such as the amount of the GIA award, the year in which it was received, the department in which the grant recipient worked, as well as the name and gender of the grant recipient. From this data set, a sample of three years of grant recipients was extracted. In an attempt to capture the effects of differences in productivity over time, years selected were spaced apart to measure awards granted 10 years, 6 years, and 3 years from the present (the survey was administered in 1996). Care was taken to ensure that each year represented a nearly identical group of faculty members, with respect to gender, department, and award size. The hypothesis regarding spacing of the years was that the typical researcher may find productivity resulting from a GIA to reach its peak approximately 6 years following the receipt of the GIA.

A second data source was a database from the University's Office of Research and Technology Transfer Administration (ORTTA). This office serves as the accounting body for all faculty-grant recipients. Any grant won by a University faculty member from an agency source outside of the University is channeled through this organization. The grant money is then paid out to the faculty according to specific guidelines set by the State, the

University, and the funding agency. From the ORRTA database, data were extracted pertaining to all extramural funding that a GIA recipient had been awarded since the time of receiving their initial GIA.

Mechanics of the Survey

By combining data from both the GIA database and the ORTTA database, a personalized summary of the individual's grant history was incorporated into each survey. Specifically, this summary identified the faculty member's initial GIA award, as well as a list of all their extramural awards since the time of the initial GIA. The individual was asked to indicate via a "check" which of the outside grants were related in whole or in part to receipt of the indicated GIA. These checks provided a means of differentiating between related and unrelated monetary outcomes. To measure non-monetary productivity, the survey provided a comprehensive list of various forms of non-monetary research outcomes, e.g., publications, chapters written in books, musical compositions, etc. The survey recipient was asked to quantitatively indicate the total number of outcomes for each different category.

Success Rate

The data set of all GIA recipients for the years of 1994, 1991, and 1987 totaled 606 individuals. Of these 606, 109 recipients were dropped from the sample due to attrition. The remaining 497 candidates were surveyed, of which 358 responded, a 72% response rate.

Profile of the Non-Respondents

While many attempts were made to reach a 100% survey response, 139 GIA recipients remained as non-respondents. In order to assess whether or not this group exhibited any common characteristics that would set them apart from the respondents group, a descriptive analysis of their demographic features was performed. These features included gender, year of grant award, size of grant award, total extramural award dollars, and the department or discipline in which the non-respondent worked. The same features or characteristics were assessed for the group of respondents. The two groups were then compared. Careful evaluation suggested that the non-respondents represented no unique group but rather were normally distributed across the sample of all 497 GIA recipients.

Econometric Analysis

The measured response effects resulting from receipt of a GIA included both continuous and discrete dependent variables. Consequently different estimation techniques were required for each case. For the continuous dependent variable both an ordinary least squares and a binomial logit model were estimated (Models 1a and 1b). In the case of the discrete dependent variable a Poisson count model was estimated (Model 2). The variables are defined as follows: (Table 1 presents a statistical descriptive summary of the variables.)

Variable Definitions

y_1	Related Monetary Outcomes: A continuous variable representing all extramural research awards directly related to the University GIA.
y_2	Non-Monetary Outcomes: A discrete variable that representing an index of all non-monetary outcomes directly resulting from the University GIA.
x_1	GIA Award Amount: A continuous variable representing the amount of the GIA award.
x_2	Gender: A dummy variable taking the value of 0 if the researcher is male, and 1 if female.[3]
x_3	Unrelated Monetary Outcomes: A continuous variable representing all extramural research awards *not* related to the University GIA.
D_1	1985-1986 Sample Year: A dummy variable taking the value of 1 if the faculty member received the GIA in 1985-1986, or 0 if otherwise.
D_2	1989-1990 Sample Year: A dummy variable taking the value of 1 if the faculty member received the GIA in 1989-1990, or 0 if otherwise.
D_3	1992-1993 Sample Year: A dummy variable taking the value of 1 if the faculty member received the GIA in 1992-1993, or 0 if otherwise.
D_4	Sciences Research Field: A dummy variable taking a value 1 if the grant recipient was from a department of sciences and 0 otherwise.
D_5	Arts and Humanities Research Field: A dummy variable taking a value 1 if the grant recipient was from a department of arts & humanities and 0 otherwise.
$y_1 BNRY$	Related Monetary Outcomes Binary: A binary variable representing 0 if y_1 = \$0.00, and 1 if y_1 >\$0.00.

[3] While no specific interest was taken in the role of gender per-se, gender has received considerable attention in the research productivity literature (Vasil), particularly regarding the role of women in sciences. (Preston) Consequently this variable was included in the analysis to explore any possible gender specific outcomes.

Table 1. Descriptive Statistics of Variables

	Mean	*Median*	*Mode*	*Std. Dev.*	*Minimum*	*Maximum*
Y_1	$150,798	$22,900	$0	$303,668	$0	$2,868,900
Y_2	10.589	6	2	14.560	0	100
X_1	$8,279	$7,775	$10,000	$5,489	$204	$49,000
X_2	0.226	0	0	0.419	0	1
X_3	$186,687	$0	$0	$490,646	$0	$5,760,800
D_1	0.313	0	0	0.464	0	1
D_2	0.335	0	0	0.473	0	1
D_3	0.352	0	0	0.478	0	1
D_4	0.737	1	1	0.441	0	1
D_5	0.263	0	0	0.441	0	1

(N = 358)

Model 1a

To estimate the magnitude of the relationship between receipt of a GIA, x_1, and the ability of a researcher to generate extramural funds, y_1, an ordinary least squares regression was performed for the following model:

$$y_1 = \beta_0 + \beta_1 D_2 + \beta_2 D_3 + \beta_3 x_1 D_4 + \beta_4 x_1 D_5 + \beta_5 y_2 + \beta_6 x_2 + \beta_7 x_3 + \varepsilon \quad (1)$$

where y_1 is the monetary outcome; $(x_1,..,x_3$ and $D_1,..,D_5)$ are regressors as described above, and ε_i is a stochastic error term.

From this first specification (1), note that x_1 has been interacted with D_4, and D_5, to indicate individual productivity differences between fields of research. Results from this first estimation are presented in Table 2.

Table 2. Least Squares Estimates of Model 1a

	Coefficient	T-ratio	P-value
Constant	5191.106	0.156	.8761
D_2	-79270.884	-2.186	.0295
D_3	-85022.972	-2.277	.0234
$x_1 D_4$	16.609	6.079	.0000
$x_1 D_5$	3.706	0.672	.5018
y_2	4944.201	5.161	.0000
x_2	1607.887	0.048	.9614
x_3	0.165	5.627	.0000
$R^2 = 0.28$	F-stat [7,350] = 19.44 P = 0.000		

The significance of the estimated coefficient for $x_1 D_4$ implies that grant recipients from the science disciplines are able to generate a substantial level of extramural funding as a result of a GIA, a factor of over $16 for every $1 GIA received. (Recall the average GIA award = $7,785.) The high p-value for $x_1 D_5$ indicates that the GIA is not a significant factor in obtaining extramural awards for researchers in the Arts and Humanities disciplines. We also note that gender, x_2, is not significant. By including, y_2 and x_3 in this model, the inherent research ability of the grant recipient is taken into account. Both y_2 and x_3 are significant.

Model 1b

To estimate the likelihood of winning an extramural grant based on the same set explanatory variables used in Model 1a., a binomial logit regression was run on the following model. The results of the binomial logit regression are presented in Table 3.

$$Prob(y_1BNRY = 1) = \frac{e^{\beta X}}{1+e^{\beta X}} \qquad (2)$$

where : $y_1BNRY = 0$ if $y_1 = \$0$

1 if $y_1 > \$0$

$\beta X = \beta_0 + \beta_1 D_2 + \beta_2 D_3 + \beta_3 x_1 thD_4 + \beta_4 x_1 thD_5 + \beta_5 y_2 + \beta_6 x_2 + \beta_7 x_3$

$x_1 th = x_1$ rescaled to thousands

Table 3. Binomial Logit Estimates of Model 1b

	Coefficient	T-ratio	P-value	Marg. Effect*
Constant	-0.0447	-0.152	0.8792	-0.0109
D_2	-0.0877	-0.283	0.7769	-0.0214
D_3	-0.6578	-2.009	0.0445	-0.1604
$x_1 thD_4$	0.1008	3.489	0.0005	0.0246
$x_1 thD_5$	-0.1650	-2.759	0.0058	-0.0402
y_2	0.0088	1.001	0.3167	0.00216
x_2	-0.1336	-0.473	0.6359	-0.0326
x_3	0.5974 E-06	1.487	0.1369	0.1456 E-06
χ^2 = 76.67 7 df , sig. = .0000				

* marginal effects were calculated by taking the partial derivative of the probabilities with respect to the vector of characteristics. They are computed at the means of the explanatory variables.

Here again we note the impact of the GIA program on the likelihood of receiving an extramural award by observing the significance of the interaction variables. The logit model shows that both $x_1 thD_4$, and $x_1 thD_5$ variables are significant. However, one can note from the marginal effects coefficients the positive contribution of a GIA to the Science fields versus a negative contribution to the Arts and Humanities. This result provides further support to the hypothesis that researchers in the Arts and Humanities disciplines are likely to be productive in ways not well measured by monetary outcomes alone. To explore this hypothesis in greater detail, the following model will estimate the relationship among the GIA program, x_1, and non-monetary productivity, y_2.

Model 2

Given that the variable used to measure non-monetary outcomes, y_2, is a discrete count representation of the total number of non-monetary outcomes a given researcher may have, an estimation technique that allowed for such characterization of the dependent variable was needed. The Poisson count model is appropriate for such an estimation. The results of the count model estimation are as presented in Table 4. The model specified was:

$$y_2 = \beta_0 + \beta_1 D_2 + \beta_2 D_3 + \beta_3 x_1 D_4 + \beta_4 x_1 D_5 + \beta_5 x_2 + \beta_6 x_3 + \varepsilon \quad (3)$$

Table 4. Poisson Count Estimates of Model 2

	Coefficient	T-ratio	P-value	Marg. Effect*
Constant	2.4279	69.92	0.0000	25.710
D_2	-0.3338	-8.048	0.0000	-3.524
D_3	-0.4975	-11.450	0.0000	-5.268
$x_1 thD_4$	0.0168	5.444	0.0000	.1779
$x_1 thD_5$	0.0235	3.689	0.0002	.2491
x_2	0.1381	3.597	0.0003	1.4626
x_3	0.878E-07	3.189	0.0014	.929E-06

χ^2 = 172.27
6 df , sig. = .0000

* marginal effects were calculated by taking the partial derivative of the expected values with respect to the vector of characteristics. They are computed at the means of the explanatory variables.

The count model estimation reveals that all variables are significant. It is interesting to note the positive contribution of the GIA to both fields of research. Careful inspection of the marginal coefficient estimates for $x_1 thD_4$, and $x_1 thD_5$ show that for researchers in the Arts and Humanities disciplines, the GIA has an approximately 40% greater contribution toward generating non-monetary outcomes than it does for those in the Science disciplines. This result lends support to the hypothesis that the GIA program is indeed effective in enhancing the productivity of researchers in fields of research that have traditionally less opportunity for extramural funding. Unlike the earlier two models, in the count model the gender variable is significant. It indicates that female researchers are more productive than males in terms of generating non-monetary research outcomes.

Further, the sample year variables suggest that one's ability to be productive, as measured by non-monetary outcomes, is improved as the duration of time increases since receiving a GIA. Being that GIA recipients are predominantly new/junior faculty whose research programs are typically not fully established, this is a very intuitive result.

Conclusion

This study was carried out to assess the impact of seed grant money on one's ability to generate outside funding. The regression estimates indicate that the average faculty researcher from the Sciences disciplines will generate over $16 for every $1 GIA received. Further analysis demonstrated that the GIA also enhances the research productivity in non-monetary measures, particularly for in the Arts and Humanities fields.[4]

The results of this study have shown that indeed a causal relationship exists between receipt of a seed grant award and one's ability to generate extramural funding. Additionally, as one would expect, a researcher's ability to generate such funding is also dependent upon their field of research. Thus the hypotheses regarding the existence of both causal relationships are accepted. In regards to formulating policy for the funding of higher education, these findings suggest that the University Administration should look

[4] A quick financial calculation reveals that for all 358 survey respondents, the University invested a total of $2.96M in GIA awards. In return, those awardees generated $53.9M in extramural funding directly resulting form their GIA awards, a very substantial return on investment.

favorably upon the performance of the GIA Program and recommend its continued support to Minnesota State Legislature.

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