THE IMPACT OF NATIONAL SCIENCE FOUNDATION RESEARCH SUPPORT ON THE RESEARCH PRODUCTIVITY OF MINORITY AND NONMINORITY ECONOMISTS: EVIDENCE FROM 1995 SESTAT DATA

*Gregory N. Price**

Abstract

This paper explores the link between National Science Foundation (NSF) research funding and the research productivity of minority and nonminority Ph.D economists. Utilizing 1995 SESTAT Public data, parameter estimates from a Zero-Altered Poisson model of research productivity reveal that not having NSF research support and minority status are determinants of the probability that an economist leaves a regime in which no research productivity is observed. The results suggest that for minority economists who have never had NSF research funding, the receipt of such funding would increase their research productivity as measured by publications in refereed journals.

Key Words: *Minority Economists, Research Productivity , National Science Foundation*

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Current Version: *October 24, 2000*

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I. Introduction

Economics faculty research productivity is an important social good. The basic and applied research efforts of economics faculty add to the stock of knowledge, and either directly or indirectly engender progress. This is not only the case for economics faculty at designated research universities. Bodenhorn (1997) shows that increasingly, the economics faculty of non-research universities are expected to do research, and account for a nontrivial proportion of the stock of economics research.

The research productivity of economics faculty is also important for tenure. If an economics faculty member is not a productive researcher, the likelihood of tenure is compromised at those colleges and universities where the promotion and reward system places a premium on faculty research—especially publications in refereed journals. To the extent that tenure track professors have an incentive to do safe and uncontroversial research so as to maximize their tenure probabilities, it is conceivable that tenured status encourages more innovative research efforts, or it at least extends the period over which the faculty member can contribute to the stock of knowledge.

One of the more sobering facts about the economics faculty of colleges and universities in the U.S is the continuing underrepresentation of minorities among the tenured ranks. The share of minorities among the ranks of tenured economics faculty is similar to their overall representation on the faculty.[1] Utilizing data from the American Economic Association's 1997 Universal Academic Questionnaire, Collins (2000) reports summary statistics which

[1]Turner, Myers, and Creswell (1999) report that across all the academic disciplines, as of 1999 racial minorities—defined as individuals who are either black, Hispanic, or Native American—accounted for 10 percent of the professoriate. With respect to the U.S. population, the population share of minorities was 22.1 percent. With respect to the discipline of economics that status of minorities is particularly sobering. Collins (2000) reports that in 1995, black, Hispanics, and Native Americans accounted for 3 percent of the economics doctorates employed by four year colleges and medical institutions.

reveal that among all colleges and universities, blacks and Hispanics account for 1.6 percent and 1.2 percent respectively of tenured faculty in economics.[2] For the academic institutions with doctoral programs in economics, black and Hispanics account for .08 percent and 1.7 percent respectively of tenured faculty in economics.[3]

There are at least two reasons why the underrepresentation of minorities among the tenured economics faculty of colleges and universities should raise concerns. First, tenured minority economics faculty can serve as role models that encourage other minorities to pursue doctorates in economics, which would increase the future supply of minority economists.[4] If racial and ethnic diversity among the ranks of the nation's Ph.D economists is a worthy social goal, an increase in the percentage of minority economics faculty that are tenured would be beneficial. Second, and notwithstanding the role model effect, there is evidence suggesting that the research productivity of minority economics faculty is positively correlated with the number of an institution's baccalaureate graduates that go on to earn doctorates in economics (Agesa, Granger, and Price; 1998, 2000). This suggests that the research productivity of minority economists is important not only to the extent that it maximizes the probability of tenure which would enhance minority representation among the tenured ranks, but that minority faculty research productivity also impacts the future supply of minority Ph.D economists.

Given the implied link between economics faculty research productivity, tenure, and the impact it has on the future supply of economists, an understanding of what influences the research productivity of minority economists could cast insight upon what policy interventions are possible, if any, that would increase both the tenure probabilities and future

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[2]See Table 7 in Collins (2000).

[3]See Table 7 in Collins (2000).

[4]The recent theoretical analysis of affirmative action in academic hiring by Chung (2000) demonstrates that an increase in the proportion of minorities on the faculty have the effect of enhancing confidence among minority students that they too can succeed as college professors.

supply of minority economists. Stephan (1996, p. 1217) has argued that "another factor that affects research productivity and varies by cohort is access to the resources that affect research". Thus, one factor that could matter for the individual research productivity of Ph.D economists, that has yet to be explored, is the effect of having National Science Foundation (NSF) funding.

This paper explores the link between NSF funding for research in economics, and the extent to which it matters for the research productivity of economists in general, and minority economists in particular. If the correlates of minority and nonminority faculty research productivity are distinguishable (Creamer, 1998), these differences could translate into research productivity differentials. NSF research support is of course not the only determinant of faculty research productivity, as factors such as age, compensation, student quality, and quality of doctoral training all seem to matter (Agesa, Granger and Price, 2000). Notwithstanding the importance of all the plausible determinants of individual economist research productivity, the central focus of this paper is to determine the importance of NSF funding.

NSF research support for economists is likely to be important along several dimensions. NSF funding can be viewed as conferring upon the recipient a prestige that attracts other resources to subsidize research. Many published articles in the top economics journals acknowledge NSF funding. An author who successfully publishes research that was subsidized with NSF funding could presumably leverage this experience so as to command other resources, both within his institution, and without, to subsidize future research efforts that result in refereed publications.[5]

Economics research subsidized by the NSF could also have a learning effect that enhances the ability of NSF grantees to do research addressing the important questions in the discipline which result in papers that are ultimately published in refereed economics

[5]Wachtel, (2000 p. 22) has recently argued that "The imprimatur of an NSF grant carries significant leverage by aiding in acceptance of articles by the major journals, receiving further grants from private foundations and other government funding agencies, and career advancement".

journals.[6] Successful NSF grant applications satisfy the standards of reviewers who are in many instances scientists that establish and enforce the norms that govern publications in refereed journals. Thus, NSF grant applicants may benefit from learning the norm governing what standards apply for published articles, that they otherwise would not—which increases the chance of articles being published upon submission.

The remainder of this paper is organized as follows. Section II dicusses the conceptual framework, data, and the empirical specification of the research productivity equation. Given that the dependent variable—publications in refereed journals, is a discrete measure, research productivity equations are cast within a Poisson regression framework. The results are provided in Section III. Section IV concludes.

II. Conceptual Framework, Data and Empirical Specification

This paper views the decision of an individual economist to engage in research in a manner similar to Levin and Stephan (1991). It is assumed that the individual economist has a utility function with research output as an argument. Utility is maximized by producing research output with a research production function, over a career which begins with the receipt of the Ph.D in economics, and ends at retirement.

For the individual Ph.D economist, the production function for research output can, be viewed as having the general form $\mathrm{R}_i = \mathrm{f}(\theta)$, where R_i is the research output of the i*th* Ph.D economist, and θ is a vector of plausible factors/inputs of research production. This is a very general functional relationship, and the econometric specification of it below

[6]Ellison (2000) provides a theoretical account of the social norms that evolve among journal referees for the type of papers that are ultimately published in economics journals. Authors, if they are to be successful publishers, must comply with the social norm governing publishable papers. It is in this context that NSF review process is valuable, as it is a way for potential authors to learn the the norm that publishable papers must be in compliance with, which could increase the probability of getting published.

presupposes that research output is separable from the utility function of Ph.D economists. In general, for given elements of θ, this specification is flexible enough to capture, where relevant, both the investment and consumption motives for research activity by individual economists [Levin and Stephan (1991)].

To estimate the parameters of econometric specifications of the research production function, data from the NSF's 1995 Scientists and Engineers Statistical Data System (SESTAT) are utilized. SESTAT is an integrated dataset containing data from three sources: the National Survey of College Graduates (NSCG), the National Survey of Recent College Graduates (NSRCG), and the Survey of Doctorate Recipients (SDR). As the interest of this paper is the research productivity of economists with doctorates, the SESTAT data utilized are those reported by individuals with an economics doctorate in the 1995 SDR.[7]

The research productivity of individual economists is measured from the response provided by 1995 SDR respondents regarding the extent to which they have authored or coauthored articles in refereed journals. It is a self-reported measure of publication activity.[8] For the 1995 Public SDR, the responses are coded for 12 categories, and each class, with the exception of respondents reporting zero publications or having more than 50, which has a width of 1, have a width of 5.

The categorical self-reported publication data were integerized to capture the natural discreteness of article counts, by assuming that for each class of width 5, the number of self-reported articles for a respondent has a uniform discrete distribution. In particular, for each respondent, the number of actual self-reported refereed publications is integerized

[7]The SDR has been sponsored by the NSF and other federal agencies since the early 1970s. The survey consists of a sample of individuals who earned Science and Engineering doctorates at U.S Colleges and Universities. The survey is biennial, and every two years a new sample of doctorate earners is added from another NSF sponsored survey: the Survey of Earned Doctorates.

[8]In particular, question A32.2 of the 1995 SDR asks the respondent: Since April 1990, how many articles that you have authored or co-authored have been accepted for publication in a refereed professional journal?

by drawing R_i from a discrete uniform distribution implied by the category for which the respondent self-reported. For each category, the response is integerized by assuming that the R_i is generated by:

$$f(R_i) = \frac{1}{K} \qquad for \qquad R_i = R_1. \ldots . R_K$$

where for a given category of K values, R_1 is the lowest valued integer, and R_K is the highest valued integer.

Given the integerization of the self-reported number of publications for the survey respondents, it is assumed that R_i is Poisson random variable with density:

$$Prob(R_i = n) = f(R_i) = \frac{e^{-\lambda_i}\lambda_i^n}{n!}$$

where R_i is the number of self-reported publications of individual economist i, $n = 0$, 1, 2, . . . N, $e = 2.71828$, and $\lambda_i =$ the expected value and variance of R_i. Viewing individual research output as a Poisson random variable seems reasonable given that research output is a count of published articles, and a Poisson distribution is a discrete probability distribution where zero is a natural outcome of the distribution.[9]

To estimate the parameters of the research production function, a Poisson regression model is utilized, which results from specifying λ_i as a function of a vector of exogenous variables:

$$ln\lambda_i = \beta'\theta$$

where β is a coefficient vector, and θ is a vector of exogenous variables that determine the

[9]Having zero as a natural outcome of the distribution generating publications is ideal as it obviates the need to employ double logarithmic regression specifications as in Bodenhorn (1997), or treating the data as being truncated at zero as in Levin and Stephan (1991). For a more detailed justification of using a Poisson probability distribution for research publications, see Agesa, Granger, and Price (2000).

expected value of refereed publications for the ith economist.[10] The log-likelihood function L(β) has a gradient and Hessian given by:

$$\frac{\partial L(\beta)}{\partial \beta} = \sum [\theta'(R_i - e^{\beta'\theta})] = 0$$

$$\frac{\partial^2 L(\beta)}{\partial \beta \partial \beta'} = \sum [-(R_i' R_i) e^{\beta'\theta})] < 0$$

Equating the gradient to zero solves for β, and the negativity of the Hessian ensures a global maximum of the log-likelihood estimator of the coefficients in β .

The research productivity equation to be estimated is of a general form similar to that of Levin and Stephan (1991):

$$\begin{aligned} \lambda_i = E(R_i) = exp(\beta_0 \quad &+ \quad \beta_1 AGE + \beta_2 SALARY + \beta_2 RSEVN \\ &+ \quad \beta_3 RSEFF + \beta_4 VINT + \sum_{i=5}^{K} \beta_i X_i) \end{aligned} \tag{1}$$

where E is the expected value operator, as λ_i is the expected value of the number of self-reported publications R_i. The first four explanatory variables are similar in spirit to those considered by Levin and Stephan (1991). AGE measures, in years, up to April 15, 1995, how old the respondent is. SALARY measures annual compensation. RSEVN and RSEFF are proxies for the individual's research environment and effort respectively. VINT is a measure of doctorate vintage.

The regression strategy of this paper is to consider the explanatory power of these variables for the research productivity of economists in a cross-section, and to augment it

[10]Michener and Tighe (1992) note that the Poisson density has a history as a specification offered to explain count data. For example, L. von Bortkiewicz (1898) applied it to explain mule-kick deaths. The specific regression formulation where λ is expressed as a function of exogenous variables has been considered by Hausman, Hall, and Griliches (1984), Chappell, Kimenyi, and Mayer (1990), and more recently by Agesa, Granger, and Price (2000).

with other plausible determinants of research productivity, captured in the $\sum_{i=4}^{K} \beta_i X_i$ term. These additional variables will include dummies for racial minority status and NSF funding, along with their interaction, which will permit an assessment of the extent to which NSF funding per se, and its interaction with minority status, impact upon the research productivity of economists.

III. Results

Tables 1 and 2 report, respectively, the definitions, and summary statistics (mean and standard deviation) of variables utilized for estimating various specifications of the research productivity equation in equation (1) above. The sample consists of 923 observations from SESTAT data. A total of 1065 observations on Ph.d economists were in the data, but 142 were not suitable as a result of no response and/or miscodings on the publication and income/earnings measures. Minority economists constitute approximately 12 percent of the sample.

The summary statistics reported in Table 2 reveal, for the economists in the sample, some striking racial disparities. First, on average and relative to nonminority economists, minority economists report fewer publications. To the extent that tenure is driven primarily by publications, this may partially explain why the percent of nomminority economists that are tenured exceeds that of minority economists in the sample by approximately 18 percent. Finally given the focus of this paper, the percent of nonminority economists who report having had NSF research support exceeds that of minority economists by a factor of two and a half. In general, NSF support for economists in the overall sample is low, however the disparity between nonminority and minority economists seems striking.

To the extent that NSF research support is an important input into the research production function of economists, racial disparities in NSF support could potentially contribute to racial disparities in tenure across the population of economists on the faculty of colleges

and universities. This is particulary likely to be true if the primary determinant of tenure is refereed publications. To examine the sensitivity of tenure to research productivity, Table 3 reports simple probit estimates of rudimentary specifications of the determinants of tenure.

Columns (1), (2), and (3) report estimates of the tenure specification over the entire sample, the subsample of nonminority economists, and the subsample of minority economists respectively. For all three specifications the coefficient on R_i is positive and significant. This suggests, not surprisingly, that the probability of tenure is increasing in research productivity as measured by the number of authored or coauthored refereed publications. Moreover, the coefficients on the minority dummy variable by itself, and its interaction with R_i are insignificant. This suggests that being a minority economist per se and/or being a minority economist that is productive in research, does not affect, favorably or adversely, the probability of being tenured.[11]

That tenure probabilities increase with respect to research productivity has straightforward implications for the covariates of individual economist research productivity. For those covariates that are crucial inputs into the research production process, tenure probabilities will also be increasing with respect to these covariates. The central concern of this paper is to what extent is NSF research support a covariate of minority and nonminority economist research productivity. If NSF is a covariate of research productivity ,it will also have an effect on tenure probabilities. The research productivity equation specified in one is amenable to examining this by including suitable variables in the $\sum X_i\beta_i$ term.

Table 4 reports simple Poisson regression parameter estimates for the research productivy equation. Six specifications are reported based on two different measures of compensation (salary and total earned income), and estimated separately for the entire sample of economists, the subsample of nonminority economists, and the subsample of minority

[11]The insignificance of minority status as a determinant of tenure probabilities in the sample is in contrast to the findings of Ards, Brintnall and Woodard (1997), who find that in the case of political scientists with doctorates, being a minority lowers the probability of tenure.

economists. To facilitate convergence of the Poisson log-likelihood function, four of the variables (AGE, SALARY, TEARN, VINT) were logarithmically transformed. For each specification two diagnostic measures are also reported. The coefficient α is the result of an auxiliary regression that tests for mean-variance equality, or overdispersion—a restriction required if the conditional mean of R_i is to be equal to $\lambda_i = exp(\beta'\theta)$.[12] As a goodness of fit measure, the ratio of the number of zeros predicted by the estimated Poisson model ($\sum[\hat{\lambda}_i = 0]$) to the number of actual zeros ($\sum[R_i = 0]$), is computed and reported.

For the entire sample of economists, the parameter estimates reported in columns (1) and (2) of Table 4 are similar with respect to the measure of income. The expected value of research productivity increases with respect to effort, income, and when the environment in which the economist is employed is such that basic and applied research are dominant work activities. In contrast, the expected value of research productivity decreases with respect to age, and degree vintage. Being a minority economist, all things being equal also lowers the expected value of research productivity, as indicated by the negative and significant sign on the MINOR dummy variable.

Given the central concern of this paper, what is instructive about the results in columns (1) and (2) is the positive and significant sign on the dummy variable for having NSF support. Having NSF research support apparently increases the expected value of research productivity. In addition, the positive and significant sign on the interaction of having NSF support and being a minority economist, suggests that NSF research support for minority economists ameliorates and offsets the adverse impact that being a minority has on the

[12]More generally, if R_i is a Poisson random variable, Cameron and Trivedi (1990) show that a test for mean-variance equality is based on the hypothesis test: H_o: $var(R_i) = \lambda_i$ versus the alternative H_a: $var(R_i) = \lambda_i + \alpha g(\lambda_i)$, where $g(\lambda_i)$ is a function specified to equal 1, λ_i, or λ_i^2. A test for mean-variance equality is a *t*-test for significance of α in the auxiliary regression: $\sum w_i g(\lambda_i)[\ (R_i - \lambda_i)^2 - R_i - \alpha g(\lambda_i)\ ] = 0$, where $\sum w_i g(\lambda_i)$ is a weight based on a consistent estimate of the coefficent vector of the exogenous variables. If the coeffficient on α is insignificant, the null hypothesis of mean-variance equality cannot be rejected.

expected value of research productivity.

The results reported in columns (3) - (6) of Table 4 are the Poisson regression parameter estimates for the subsample of nonminority and minority economists. For the relevant subset of explanatory variables, the results are similar to the parameter estimates over the entire sample. For both nonminority and minority economists, having NSF support increases the expected value of research productivity. For minority economists, the magnitude on the dummy for having NSF support exceeds that of nonminority economists. This suggests that NSF research support to minority economists results in a larger pay-off in terms of research productivity, relative to nonminority economists.

The fit of the simple Poisson model varies across the sample. For the entire sample the model successfully predicts no more than 2 percent, approximately, of the actual zero-valued publication observations. In the subsample of nonminority economists, no more than 30 percent, approximately, of the zero-valued publication observations are successfully predicted. For the subsample of minority economists, the fit is much better. For the specification in column (5), the simple Poisson model successfully predicts 56 percent, approximately, of the actual zero-valued publication observations.

Notwithstanding the variability of the goodness of fit across the specifications in columns (1) - (6), the positive and significant coefficient on α for each specification leads to the rejection of the mean-variance equality restriction required of the simple Poisson regression specification of research productivity. The data are characterized by overdispersion, suggesting the inadequacy of the simple Poisson specification. In this context, the poor fit of the model across the specifications in Table 4 may be a result of the inadequacy of the Poisson specification to explain the data.

An alternative to the simple Poisson specification that results in overdispersion, or mean-variance inequality, arises where there are an excess or preponderance of zero observations, and the process generating the zero observations on publications is different from the process generating the nonzero observations. There are indeed a preponderance of zeros for

the sample. For the entire sample of economists, approximately 82 percent of the observations on self-reported publication are zero. For the subsample of nonminority and minority economists, the percent of zero valued publications observations are approximately 81 and 89 percent respectively.

One way to extend the simple Poisson specification so as to accommodate a preponderance of zeros is to imagine the zero observations arising from two regimes as in Lambert (1992). Suppose that R_i takes on the value of zero in regime one with probability q_i, but in regime two, R_i takes on the value λ_i with probability (1 - q_i). Since a zero can occur in both regimes:

$$Prob[R_i = n = 0] = q_i + (1 - q_i)e^{\lambda_i}$$

$$Prob[R_i = n > 0] = (1 - q_i)\frac{e^{\lambda_i}\lambda_i^n}{n!}$$

If we further assume that the regime split is determined by $q_(i) = z_i = F(\sum \gamma_i X_i)$, where $F(\cdot)$ is a normal cumulative density function, the X_i are variables that determine if R_i is in regime 1 or regime 2, and the γ_i are coefficients. This extension of the simple Poisson model is known as the Zero-Altered Poisson (ZAP) model.[13]

Given the preponderance of zero-valued publication observations, and the rejection of mean-variance equality restriction for all the specifications in Table 4, a ZAP model is implemented by postulating:

$$z_i = F[\gamma_1 VINT + \gamma_2 NSFSUP]$$

[13]Calling this extension of the simple Poisson model a "Zero-Altered Poisson" model is due to Greene (2000) who notes this extension has been alternatively described as the Poisson "With Zeros" [Mullahy (1986)], and the Zero-Inflated Poisson [Lambert, (1992)] It is easy to demonstrate that for the for this model: E(R_i) = (1 - q_i) and Var(R_i) = λ_i(1 - q_i)(1 + $\lambda_i q_i$). Clearly, the Zero-Altered Poisson model is characterized by overdispersion, as the mean and variance are no longer identical.

This implies that the regime split between publications being zero and being generated by a Poisson process is a function of the year in which an individual economist earned the doctorate, and whether or not the economist has had NSF research support. The γ coefficients indicate the effect that each variable has on the probability of belonging to the zero publications regime.

The inclusion of VINT in z_i seems a plausible assumption as Levin and Stephan (1991) find evidence that the research productivity of scientists declines with the vintage of their doctoral degree. This is based upon the idea that knowledge acquired during the doctoral graduates of later vintage, is more current than the doctoral graduates of early graduates. As the knowledge base of economists of earlier vintage is more depreciated relative to those of early vintage, it seems reasonable that the probability of having zero publications varys inversely with vintage.

Two considerations motivate the inclusion of NSFSUP in z_i. First, being awarded an NSF grant may confer upon the grantee an ability and prestige to leverage other research subsidizing resources that enhances the ability to publish in refereed journals. In this context, not having NSF support could increase the probability of not having any publications, which would partially explain whether or not an observation belongs to the regime of zero-valued publications. Finally, it is quite possible that receiving NSF support is a function of the the grant applicants track record as measured by refereed publications. The inclusion of NSFSUP in z_i partially resolves the possible selection and endogeneity bias associated with NSF research support by making it a determinant of whether or not a Ph.D economist belongs to a regime in which the actual nonzero count of publications is determined by having NSF research support.

Table 5 reports the ZAP model parameter estimates for the same specifications that were reported in Table 4. The parameter estimates are based upon the regime switching function $z_i = \mathrm{F}(\cdot)$ specified as a Probit equation. As the ZAP model is not nested within the simple Poisson, Table 5 also reports v, the test statistic developed by Vuong (1986), and

suggested by Greene (2000) as suitable for testing the ZAP model against the non-nested alternative of the simple Poisson model. If the absolute value of v is greater than or equal to 2, the ZAP model adequately explains the data relative to the simple Poisson model.[14]

For all the specifications reported in Table 5, the Vuong test statistic exceeds that absolute value of 2, suggesting the adequacy of the ZAP model for the data. In terms of goodness of fit, each specification successfully predicts approximately all of the zero-valued publication observations—a substantial improvement over the fit of the simple Poisson results reported in Table 4 . For the subsample of minority economists, the constant term and the variable NSFSUP were omitted due to singularity of the covariance matrix when they were included. Thus, for the minority economist subsample, the reported parameter estimates are only suggestive, and not directly comparable to the results in columns (1) - (4) of Table 5, or to the results reported in columns (5) - (6) of Table 4.

The results reported for the ZAP specifications in columns (1) - (4) are of Table 5 are in striking contrast to the simple Poisson results reported in Table 4. Having NSF research support, and being a minority with NSF research support are no longer have a significant and positive effect on research productivity for Ph.D economists with publications. Instead, NSF

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[14]The Vuong test statistic reported in Table 5 is the version suggested by Greene (2000) and is computed as follows: let $f_1(y_i \mid \mathbf{x}_i)$ be the predicted probability that the random variable Y equals y_i under the assumption that the distribution is a ZAP, let $f_2(y_i \mid \mathbf{x}_i)$ be the predicted probability that the random variable Y equals y_i under the assumption that the distribution is a Negative Binomial, and let $m_i = \log[f_1(y_i \mid \mathbf{x}_i)/f_2(y_i \mid \mathbf{x}_i)]$, the Vuong test statistic is:

$$v = [n^{1/2}(1/n\sum m_i)/(1/n\sum(m_i - \bar{m})^2)^{1/2}]$$

The non-nested alternative is specified as a Negative Binomial model. This is based upon the idea that since the Negative Binomial model is essentially a Poisson model with gamma heterogeneity (Gerber, 1992), that allows for overdispersion, the Vuong test statistic permits a determination as to whether even after allowing for overdispersion, are there still excess zero observations that are adequately explained by the ZAP model.

research support determines whether or not a Ph.D economist belongs to the regime of zero-valued publication observations. The coefficient γ_2 is positive and significant, suggesting that the probability of not having any publications increases with respect to not having NSF support. The positive and significant sign on γ_1 implies that the probability of belonging to the regime of zero-valued publications increases with respect to the vintage of the economics doctorate.

For the subsample of minority economists, as the specifications reported in columns (5) - (6) in Table 5 are different, the γ coefficients are suggestive. As is the case for the the entire sample, and the subsample of nonminority economists, γ_1 is positive and significant. The coefficient on γ_2, while insignificant, is negative, suggesting again that not having NSF support has a tendency to assign economists to a regime of zero-valued publication observations even in a small sample of minority economists.

In general, the results reported in Table 5 suggest that NSF research support matters for the research productivity of economists, in a particular way. Having had NSF research support apparently matters for whether or not the number of publications is not zero. Beyond zero publications, NSF support does not seem to matter, suggesting that the receipt of NSF research support. increases the probability that a Ph.D economist crosses the zero publication threshold.

In the entire sample, only one minority economist reported having NSF support. Given that minority economist research productivity is positively correlated with tenure probabilities and the number of minorities that earn doctorates in economics, an interesting science policy question is: would increased NSF research support to minority economists matter for their research productivity? This is a useful inquiry to the extent that diversity among the ranks of Ph.D economists is a desirable science policy objective. If indeed increased NSF support could enhance the research productivity of minority economists, the payoffs would be more minority economists coming through the pipeline (Agesa, Granger, and Price, 1998), and given the results from the tenure equations reported in Table 3. more

tenured minority economists on faculties of colleges and univesities.

The results reported in Table 5 do not permit a clear assessment of whether increased NSF research support to minority economists would enhance their research productivity. The significance of the minority status variable while negative, only suggests that for economists above the threshold of zero publications, being a minority is associated with lower research productivity. The results reported in Table 5 show that not having NSF research support increases the probability of having zero research productivity. If minority status also increases the probability of being in the zero research productivity regime, and minority economists are less likely to receive NSF support, increased NSF research support to minority economists could enable them to cross the zero research productivity threshold.

Table 6 reports the results of the ZAP model over the entire sample of economists with the regime switching equation augmented to include the dummy variable for minority status.[15]The Vuong test statistic suggests the adequacy of the ZAP model, and the model explains approximately all the zero-valued publication observations. In addition to the doctoral vintage and NSF research support dummy, the dummy for minority status is positive and significant in the regime switching equation. Thus, being a minority Ph.D economist increases the probability of being in the no research productivity regime. Moreover, the dummies for minority status, and its interaction with the dummy for NSF support are rendered insignificant by including the dummy for minority status in the regime switching equation.

As both minority status and having no NSF support increase the probability of having no research productivity, the results reported in Table 6 have a straightforward implication for the likely effects of increased NSF research support to minority economists. Given that

[15]In particular, the augmentation of the regime switching equation results in:

$$z_i = F[\gamma_1 VINT + \gamma_2 NSFSUP + \gamma_3 MINOR]$$

having no NSF research support and being a minority economist increases the probability of having zero research productivity, the results in Table 6 suggest that increased NSF research support to minority economists who have never had such support would push them across the zero productivity threshold.

IV. Conclusions

The central concern of this paper was to determine the importance of NSF research support for the research productivity of minority and nonminority economists. Parameter estimates from a Zero-Altered Poisson Model reveal that NSF research support does matter for the research productivity of economists in a particular way. NSF research support seems to matter for enabling economists to cross the threshold of zero research productivity. Once across that threshold, the results suggest that NSF research support does not matter for the number of articles published by economists.

Being a minority economist and not ever having NSF research support were among the factors that increased the probability of having zero research productivity. This finding suggests that the receipt of NSF research support by minority economists who have never had NSF funding, and have yet to publish, would enable them in crossing the zero research productivity threshold. As minority economist research productivity is correlated with minority faculty tenure and the number of minorities who earn doctorates in economics, a further implication is that an NSF policy of funding the research efforts of minority economists who have never had such support would indirectly mitigate the underrepresentation of minority Ph.D economists among the rank of tenured economics faculty, and the pipeline.

In general, the results reported here suggest that NSF research support enhances the research productivity of any economist, minority or nonminority, who has never had such support—being a minority economist only reduces the likelihood of receiving such support. The fact that minority status reduces the likelihood of receiving NSF support raises trou-

bling concerns about possible bias in the manner in which the NSF awards research support. Wachtel (2000) for example, has recently provided evidence that since 1974, NSF research support has been disproportionately awarded to economics faculty at fifteen top tier research universities. This suggests that the NSF award process is not unbiased in that the distribution of awards is skewed. The results here suggest another possible bias—against minority economists. If indeed there is a bias against minority economists in the funding process, this bias undermines the NSF's officially stated committment to enabling the careers, and mitigating the underrepresentation of minority Ph.D economists.[16]

There are some possible limitations of the results reported here. Given the other important determinants of research productivity that are not included in the model estimated here, the parameter estimates could suffer from omitted variable bias. The cross-sectional nature of the data also prevent the determination of life cycle effects on research productivity as in Levin and Stephan (1991). In all the specifications reported however, the variable for age was always negative and insignificant. Notwithstanding these limitations, the results offer suggestive insight into the role that research resources such as NSF funding have upon the research productivity of minority and nonminority economists. If racial diversity among the ranks of economic scientists who make substantial contributions to the stock of knowledge is a socially desirable goal, the results reported here are suggestive as to how such a goal can be realized.

[16]The bias against minority economist, if it exists, need not be based on their group membership. Wachtel (2000) findings suggest that success in obtaining NSF research support is correlated with past success. This introduces a bias based on past success. To the extent that minority economists have little past success, as the data and results reported here suggest, minority economists may not be biased against because they minorities, but because they have no track record of success getting NSF research support.

Table 1
Definition of Variables

Variable	*Definition (Survey.Question)*
R_i:	Total number of authored or co-authored articles published in refereed journals between April 1990 and April 1995.(SDR.A32)
AGE:	1995 minus year of birth. (SDR.D18)
SALARY:	Annual salary (excludes wages, bonuses, overtime, commissions, consulting fees, net income from a business, and income from summertime teaching, research, and post doctoral appointments) of respondent as of the week of April 15, 1995. (SDR.A37)
TEARN:	Total earned income (includes, wages, bonuses, overtime commissions, consulting fees, net income from a business, and income from summertime teaching, research, and post doctoral appointments), of respondent for 1994. (SDR.A51)
RSEVN:	A dichotomous variable that equals one if the respondent reports that basic and applied research are his primary and secondary work activity. (SDR.derived)
RSEFF:	Total number of authored or co-authored papers prepared for presentation at regional, national or international conferences. (SDR.A31)
VINT:	Year in which the respondent earned doctorate in economics. Measured as one of 14 five year intervals beginning with the year 1930, and ending with 1999. (SDR.derived)
MINOR:	A dichotomous variable that equals one if the respondent is a member of a racial minority group (Black, Hispanic, Native American, Alaskan Native, or Other). (SESTAT.00)
NSFSUP:	A dichotomous variable that equals one if during the week of April 15, 1995, the respondent had any work supported by a grant from the National Science Foundation. (SDR.A41)
TENURE:	A dichotomous variable that equals one if the respondent is tenured. (SDR.A17)

Notes:
SDR.derived means that the response was derived from other questions reported in the SDR.
SESTAT.00 means that the response was derived from information reported in SESTAT.

Table 2
Mean and Standard Deviation Of Variables*

Variable	All Economists	Non-Minority Economists	Minority Economists
R_i	1.93	2.04	1.15
	(5.16)	(5.32)	(3.56)
AGE	49.32	49.37	48.92
	(10.13)	(10.11)	(10.33)
SALARY	67414	67645	65654
	(31080)	(31168)	(30483)
TEARN	71592	71685	70879
	(34268)	(34193)	(34990)
RSEVN	.665	.673	.607
	(.472)	(.469)	(.491)
RSEFF	6.63	6.65	6.40
	(7.34)	(7.39)	(6.93)
VINT	1977.4	1977.1	1979.7
	(9.96)	(10.04)	(9.08)
MINOR	.116	-	-
	(.320)	-	-
NSFSUP	.022	.023	.009
	(.146)	(.151)	(.097)
TENURE	.434	.442	.374
	(.496)	(.497)	(.486)
N	923	816	107

Notes:

* Standard deviations are in parentheses.

N = number of observations.

Table 3
The Impact of Research Productivity
On Tenure: Probit Estimates*

Regressand: Tenure

Regressors	All Economists	Non-Minority Economists	Minority Economists
	(1)	*(2)*	*(3)*
$Constant$	.404	.406	.338
	$(.018)^a$	$(.018)^a$	$(.048)^a$
$MINOR$	-.057	-	-
	(.050)	-	-
R_i	.018	.018	.031
	$(.003)^a$	$(.003)^a$	$(.013)^b$
$MINOR \times R_i$	.486	-	-
	(.489)	-	-
N	923	816	107

Notes:
* Standard errors are in parentheses.
N = number of observations.
[a] Significant at the .01 level.
[b] Significant at the .05 level.

Table 4
Poisson Regression Parameter Estimates
Of Research Productivity Equation

Regressand: R_i = Total number of authored or co-authored publications.

	All Economists		**Nonminority Economists**		**Minority Economists**	
Specification:	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Regressors:						
Constant	434.68 (53.07)[a]	280.02 (54.45)[a]	1026.8 (99.66)[a]	901.40 (100.82)[a]	143.72 (353.0)	418.88 (322.94)
*ln*AGE	-1.32 (.171)[a]	-1.12 (.172)[a]	-3.48 (.314)[a]	-3.36 (.315)[a]	- 1.07 (1.15)	- 2.29 (1.06)[b]
*ln*SALARY	.174 (.029)[a]	- -	.267 (.051)[a]	- -	2.94 (.336)[a]	- -
*ln*TEARN	- -	.445 (.035)[a]	- -	.606 (.059)[a]	- -	2.07 (.309)[a]
RSEVN	.417 (.039)[a]	.406 (.039)[a]	1.16 (.083)[a]	1.15 (.083)[a]	2.10 (.386)[a]	1.73 (.378)[a]
RSEFF	.027 (.001)[a]	.026 (.001)[a]	.035 (.001)[a]	.034 (.001)[a]	.083 (.006)[a]	.076 (.006)[a]
*ln*VINT	-56.72 (6.91)[a]	-36.84 (7.09)[a]	-135.00 (12.85)[a]	- 118.03 (13.12)[a]	- 23.07 (45.73)	- 57.38 (41.98)
MINOR	- .202 (.055)[a]	- .236 (.057)[a]	- -	- -	- -	- -
NSFSUP	.133 (.074)[c]	.124 (.092)[a]	.499 (.106)[a]	.482 (.106)[a]	1.54 (.369)[a]	1.33 (.373)[a]
MINOR × NSFSUP	.675 (.350)[a]	.537 (.321)[c]	- -	- -	- -	- -
α	5.14 (.810)[a]	4.86 (.643)[a]	4.98 (.845)[a]	4.71 (.682)[a]	1.49 (.311)[a]	1.85 (.447)[a]
$\sum(\hat{\lambda_i} = 0)/\sum(R_i = 0)$	.019	.023	.292	.306	.384	.565
N	923	923	816	816	107	107

Notes:
Standard errors in parentheses.
N = Number of observations.
[a] Significant at the .01 level
[b] Significant at the .05 level

Table 5
Zero-Altered Poisson Regression Parameter Estimates
Of Research Productivity Equation

Regressand: R_i = Total number of authored or co-authored publications.

	All Economists		**Nonminority Economists**		**Minority Economists**	
Specification:	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Regressors:						
Constant	434.70 (88.42)[a]	280.05 (80.67)[a]	1026.6 (82.96)[a]	901.17 (80.43)[a]	- -	- -
lnAGE	- 1.16 (.245)[a]	- .925 (.232)[a]	- 2.83 (.235)[a]	- 2.58 (.233)[a]	- .62 (1.28)	- 1.15 (1.27)
lnSALARY	.101 (.043)[b]	- -	.037 (.039)	- -	1.44 (.643)[b]	- -
lnTEARN	- -	.290 (.047)[a]	- -	.189 (.043)[a]	- -	.675 (.419)
RSEVN	.234 (.116)[b]	.219 (.128)[c]	.278 (.091)[a]	.278 (.097)[a]	2.10 (2.13)	.067 (3.78)
RSEFF	.011 (.0007)[a]	.012 (.0008)[a]	.013 (.0007)[a]	.012 (.0004)[a]	.014 (.013)	.006 (.015)
lnVINT	- 56.57 (11.51)[a]	- 36.59 (10.51)[a]	- 133.63 (10.80)[a]	- 117.45 (10.48)[a]	- 1.59 (1.57)	- .132 (.976)
MINOR	- .124 (.072)[c]	- .128 (.071)[c]	- -	- -	- -	- -
NSFSUP	.018 (.101)	.028 (.112)	.007 (.118)	.008 (.128)	- -	- -
MINOR × NSFSUP	.172 (1.56)	.003 (2.25)	- -	- -	- -	- -
γ_1	.0008 (.00004)[a]	.0007 (.00004)[a]	.0008 (.00005)[a]	.0008 (.00005)[a]	.0009 (.0002)[a]	.001 (.0002)[a]
γ_2	- .781 (.453)[c]	- .869 (.450)[b]	- 1.44 (.473)[a]	- 1.42 (.469)[a]	- 1.61 (1.73)	- 3.37 (5.01)
v	47.91	47.22	39.19	39.69	11.78	16.74
$\sum(\hat{\lambda}_i = 0)/\sum(R_i = 0)$	1.001	1.001	1.001	1.001	1.001	1.001
N	923	923	816	816	107	107

Notes:
Standard errors in parentheses.
N = Number of observations.
[a] Significant at the .01 level
[b] Significant at the .05 level
[c] Significant at the .10 level

Table 6
Zero-Altered Poisson Regression Parameter Estimates
Of Research Productivity Equation

Regressand: R_i = Total number of authored or co-authored publications.

	All Economists	
Specification:	*(1)*	*(2)*
Regressors:		
Constant	464.69 (90.75)^a	280.05 (80.79)^a
lnAGE	- 1.18 (.251)^a	- .917 (.233)^a
lnSALARY	.121 (.043)^a	- -
lnTEARN	- -	.282 (.047)^a
RSEVN	.221 (.119)^c	.217 (.128)^c
RSEFF	.013 (.004)^a	.012 (.004)^a
lnVINT	- 56.59 (11.81)^a	- 36.58 (10.52)^a
MINOR	- .090 (.070)	- .117 (.088)
NSFSUP	.054 (.101)	.029 (.116)
MINOR × NSFSUP	- .054 (1.14)	- .013 (2.8)
γ_1	.0008 (.00004)^a	.0007 (.00005)^a
γ_2	- 1.65 (.473)^a	- .872 (.453)^c
γ_3	.611 (.334)^c	.635 (.333)^c
v	47.89	47.34
$\sum(\hat{\lambda_i} = 0)/\sum(R_i = 0)$	1.004	1.008
N	923	923

Notes:
Standard errors in parentheses.
N = Number of observations.
^{a} Significant at the .01 level
^{c} Significant at the .10 level

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