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AN INVESTIGATION OF THE LAG BETWEEN THE START OF RESEARCH AND THE DEVELOPMENT OF NEW TECHNOLOGY

By

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1. INTRODUCTION

This paper is concerned with the lag which occurs between the start of NASA-sponsored research and the development of new technology. It is obvious that some lag exists. Technology does not spontaneously result the moment research commences. The crucial question here is, is there a common[1] gestation period for all NASA technology?

Social scientists studying the output of privately financed research and development have assumed the existance of such a common gestation period or lag. For example F. M. Scherer's recent work "The Propensity to Patent"[2] tries to correlate R & D expenditures with patent output in various industries. Scherer compares R & D expenditures made in 1974 to the patents issued between June 1976 and March 1977. This implies a lag of 18 to 39 months between research expenditures and the patenting of new technology. If we subtract the average nine months it takes to obtain a patent,[3] we obtain a 9 to 30 month period between research and patent application.

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[1] The word "common" was chosen deliberately. An alternative is "average", but an average can always be calculated from observations of lag times. "Common" implies the variance in lag times for different technologies is small.

[2] Presented at the 1980 Allied Science Association Meeting at Denver Colorado, September 5, 1980.

[3] This was reported by C. A. Agnew et. al., "A Study of Some of the Effects of Public R&D on the Private Sector," Princeton, N.J.: Mathtech Inc., October 30, 1979.

This work attempts to measure the lag by correlating measures of R & D effort with measures of technological output. Such output measures are only as good as the data on which they are bas[illegible] data problems are discussed in some detail below.

The following model will be the focus of our thinking on the relationship between research and the development of new technology.

$$T(k) = f(R(k-m), R(k-m+1), \ldots, R(k-1), R(k)) \qquad (1)$$

where $T(k)$ is the technology developed in year k

$R(i)$ is the research effort made in year i

m is the number of years after which research effort does not affect technological output

Equation 1 suggests that the technology developed in time period k, T(k), is a function of the research effort, R(.), made in time period K and in previous time periods k-1, k-2, ... , k-L. The function f(.) generally can take on any form. For this exercise however, only linear models will be considered. The relationship as written also suggests that the functional relationship remains constant through time.

This is what the linear model proposes:

$$T(k) = a + c_m R(k-m) + \ldots + c_o R(k) \qquad (2)$$

A nonlinear model is more complex than this. However, it allows additional units of research effort to have different marginal effects. Economies of scale therefore can be modeled such that additional research efforts result in more than proportional increases in technological output. Scherer tests for nonlinearities in his work[4] and finds that statistically significant nonlinearities existed in some industries and not in others. The significant nonlinearities were both positive and negative indicating both economies and diseconomies of scale.

Scherer's finding of statisically significant departures from the linear model benefited from an extremely large sample size. There are not enough data points available for this study to attempt to draw equally strong conclusions. For example, in a quadratic model, ignoring interaction effects (i.e. cross-product terms), the number of coefficients which must be estimated is one less than twice the number to be estimated for the linear equation. A linear three year lag model requires four coefficients while the quadratic three year lag model requires seven.

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[4] Scherer, op. cit.

2. MEASURING RESEARCH EFFORT AND TECHNOLOGY DEVELOPMENT

Social scientists have always found it difficult to study research and technology. Many of their problems have related to data; those wishing to make statistical inferences about research and technology are forced to utilize indirect indicators of these quantities. Results and interpretations of studies using such indicators are questioned by academics and decision makers alike.

Social scientists commonly use two different indicators of research effort:[5] R&D dollars spent and employment of scientists and engineers; they also comonly use two different indicators of technological output: invention disclosures reported and patent applications made. Each of these measures has drawbacks when used to study industrial research and development, as discussed in the following subsections.

2.1 R&D DOLLARS

Generally the amount of money spent on R&D is not consistently measured because accounting practices vary from organization to organization and through time. In the case of NASA, this is not an important consideration, unless comparisons are made between NASA and other R&D entities. However, other problems exist.

From the viewpoint of federal budgeting, NASA is an R&D agency, and almost every dollar it spends is considered R&D spending. Unfortunately,

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[5] For example, Solo's and Scherer's work already mentioned.

much of this money is not spent on research or the development of new technology. For example, the money NASA spends acquiring launch vehicles is considered R&D spending. This is the case even though the technology for making a Centaur or Delta rocket has already been developed, and paid for. The same is true for the procurement of other technologically advanced equipment (e.g. computers, tracking devices).

It is possible to look at NASA budgets and roughly separate the money spent on "true" R&D from the rest. However, exercises of this type result in expenditure estimates that tend to be proportional to the total NASA budget.[6] Hence, the resulting expenditure streams should result in statistical predictions that do not differ by more than a proportionality constant.

The work reported here therefore uses total NASA expenditure figures, rather than picking out research expenditures from the rest. Figure I gives the history of NASA outlays in constant dollars by calendar year. The figures were derived from fiscal year data by averaging, and converted to constant dollars using the GNP price deflator. (The data used for the figure are given in Appendix A. Its derivation is described in Appendix C.)

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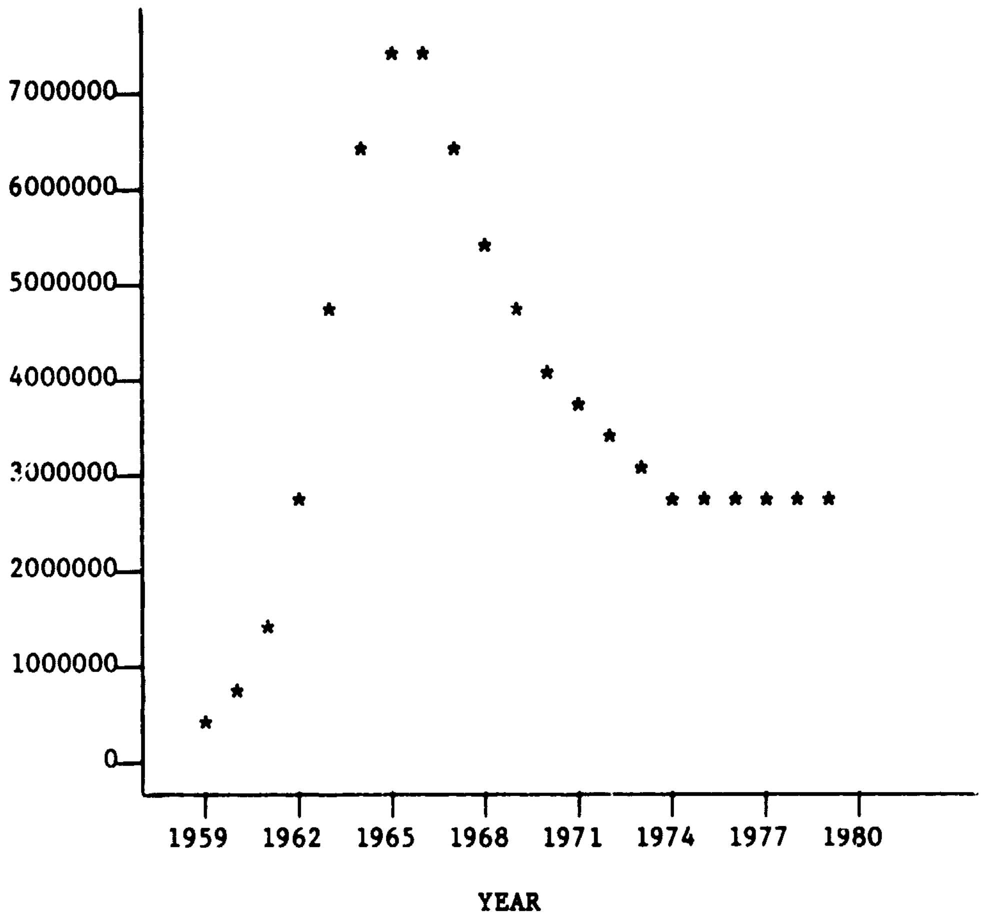
[6] Unpublished work by Henry Hertzfeld at NASA demonstrates this fact, but it is not surprising that this should be the case. The budgetary process is such that it is easier to get congressional approval for budgets that are proportional to previous budgets than to risk major changes.

Figure I

NASA R&D OUTLAYS
By Calendar Year in 1972 Dollars



2.2 NASA EMPLOYMENT

As measures of R&D effort employment statistics face criticism because employees differ in ability, desire and level of interest in their work. Moreover, individuals counted as scientists and engineers may actually be management personnel, no longer engaged in research. Records exist on the number of civil service employees working for NASA through the years, showing what type of worker they were. However, since NASA contracts with private firms for most of its research, these numbers do not give a complete picture. Some records are kept on the number of people employed by contractors. Unfortunately, these are kept for only a small percentage of contracts. NASA estimates the employment generated by other contracts from budget expenditures using a multiplier and price deflator. The resulting employment figures are definitely not independent of expenditure records.

Even though employment records do not exist for the entire NASA program, the in-house employment records are valuable because the number of NASA employees classified as scientists and engineers provide an indirect measure of NASA's internal research and development effort. However, this figure still has the drawbacks that some scientists and engineers perform management tasks or oversee contract research, and do not perform research themselves. Still, the internal figures are probably a better indicator of NASA's internal research effort than the totals, and are used here for that purpose.

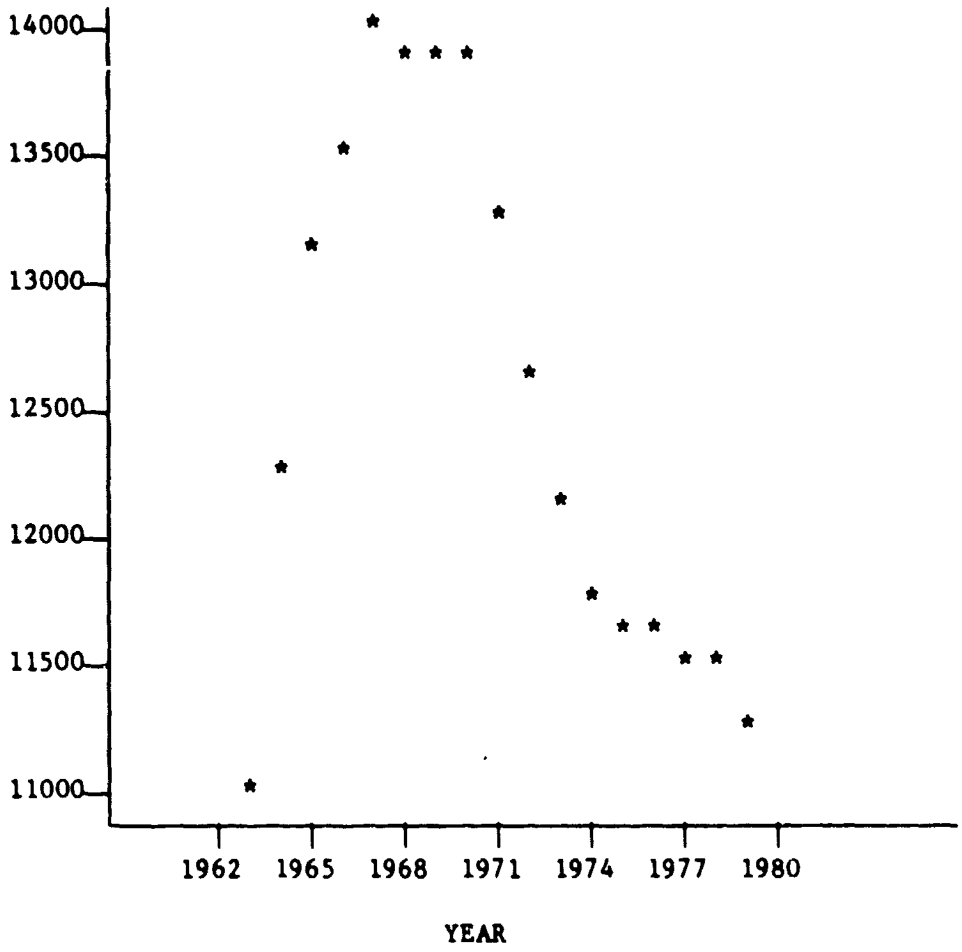
The employment history is given in Figure II. (The data are given in Appendix A. Its source is described in Appendix C.)

2.3 INVENTION DISCLOSURES

NASA employees and contractors are required to disclose potentially significant inventions to NASA. A general problem with invention disclosure reporting, however, is that individual technologists are subject to the varying rules of their particular organization. In addition, there is the inherent desire of private organizations to keep inventions secret.

Figure II

NASA EMPLOYMENT OF SCIENTISTS AND ENGINEERS



Both NASA employees and contractors are required to report newly developed technology to NASA authorities. The reports are made to the NASA field center responsible for the work and coordinated by a technology utilization (TU) officer. The TU officer assigns a case number to the invention and starts a screening process which leads to decisions on whether or not a patent application should be made and whether or not the new invention should be announced in the NASA's Tech Brief Journal. All inventions which enter the screening process are counted as invention disclosures.

Invention disclosures thus have a problem, shared with patent data, when used as indicators of new technology: the disclosures are for inventions of differing quality. It might be more accurate to use only inventions which successfully pass through the screening process; for such inventions, either a patent application is made or an anouncement is made in the *Tech Brief Journal*. Unfortunately data on such inventions are not readily available.

Difficulty in identifying which inventions are to be reported also leads to problems with the disclosure series used here. Companies working for NASA are required by their contracts to report any new technology developed. Contractors and contract managers have guidelines for reporting of new technology. The guidelines were printed in handbooks and published in 1966 and 1969.[7] The rules for reporting have not changed since then but the NASA effort put into enforcing the rules has not necessarily been constant. If the effort has remained constant then the invention disclosures are equivalent measures for each year since the reporting rules were published. On the other hand, if, as seems likely, NASA's enforcement effort has been flagging, then the more recent invention disclosures tend to understate the technology developed.

Even NASA employees do not operate under a clear a set of invention disclosure rules. Inventions are reported by employees and their supervisors to Technology Utilization (TU) Officers at each field center. The reporting takes place because employees are aware of the TU program and

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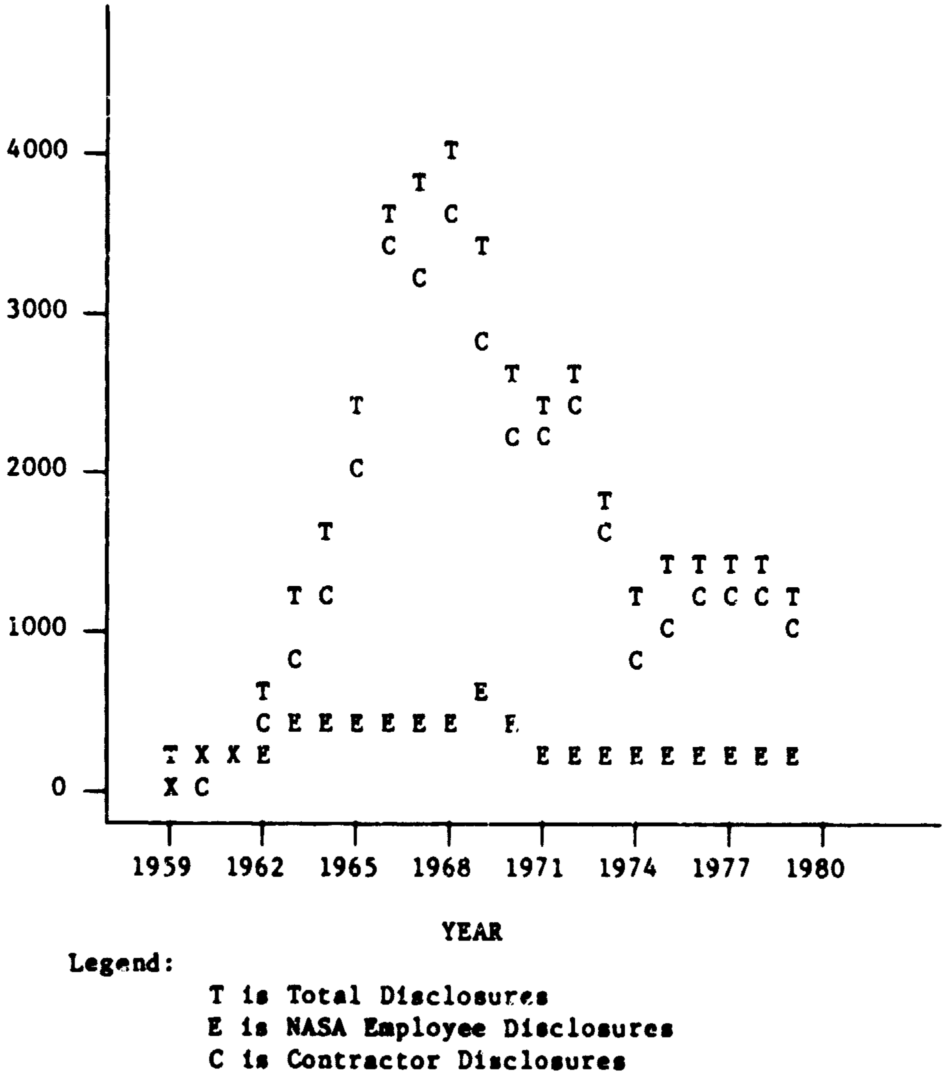
[7] These are NASA Handbook (NHB) 2170.1 and NHB 2170.3.

because of an Incentive Awards Program. The Incentive Awards Program at NASA rewards inventors based on the value of their invention (as determined by an awards committee). The relationship between this program and invention reproting is not clearly defined. It is very difficult to say how employee invention reporting has varied over time at NASA.

The invention reporting records are given in Figure III. (The associated data are given in Appendix A. Its source is described in Appendix C.)

Figure III

NASA INVENTION DISCLOSURES



2.4 PATENT APPLICATIONS

The general problems with using patent applications as an indicator of the results of R&D include: patent policies vary from organization to organization; patents do not promote the commercialization of technology that is not patentable; and it does not always pay to patent those new technologies which are patentable.[8]

At NASA, patent applications are filed for ten to twenty percent of the inventions reported. Title to patented inventions can be obtained by NASA, the contractor or the NASA employee inventor. NASA obtains title to all patented inventions not wanted by their inventors. Final disposition of title to other inventions depends on the applicability of NASA's Patent Waiver Regulations (for contractors) and Executive Order 10096 issued by President Nixon (for employees).[9] Only a few employee patents are not owned by NASA while approximately half of the contractor patents remain with the contractor.

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[8] These problems have been discussed in detail by many of the scholars who have used these data before. Almost all discussions reference Jacob Schmookler's work. His discussions are contained in his book *Invention and Economic Growth*, Cambridge: Harvard University Press, 1966; and the first part *The Rate and Direction of Inventive Activity*, The Universities-National Bureau Committee for Economic Research and the Committee on Economic Growth of the Social Science Research Council, Princeton: Princeton University Press, 1962, pp. 19-92. Recent work by Donald A. Dunn also discusses the problems of patents as indicators of the advancements in some technologies: "Information Resources and the New Information Technologies: Implications for Public Policy", National Science Foundation report to the President and Members of Congress, *The Five Year Outlook on Science and Technology*, Vol II pp. 493-507, May 1980.

[9] It is not clear what happened to employee inventions before the Nixon order, but since so few employees have tried to keep their inventions, the numbers are not significant.

Other problems associated with patents as indicators of R&D output relate to the government's decision making process for patents. Private companies tend to acquire patents for commercial reasons; the government does not base its decision entirely on the commercial potential of an invention.[10] "Defensive" reasons are often mentioned to justify obtaining patents on NASA inventions without commercial potential; this includes NASA obtaining patents to prevent companies or foreign governments from acquiring exclusive rights to technology it needs for various missions. Another reason mentioned is to reward employees for work done; an employee who makes a useful but not commercially valuable invention is rewarded by having the agency obtain a patent.

Since many patenting decisions are not made solely on the basis of commercial factors, patents may not be a stable indicator of the output of newly developed technology. In fact if we look at NASA's patent history, we find that the number of patent applications made by NASA has remained relatively constant. The number has not been nearly as volatile as invention disclosures. As invention disclosures declined in the 70's, the percentage of disclosures for which patent applications were made, increased. This suggests that patents in the later years overstate the technology developed by NASA compared to the earlier patents.

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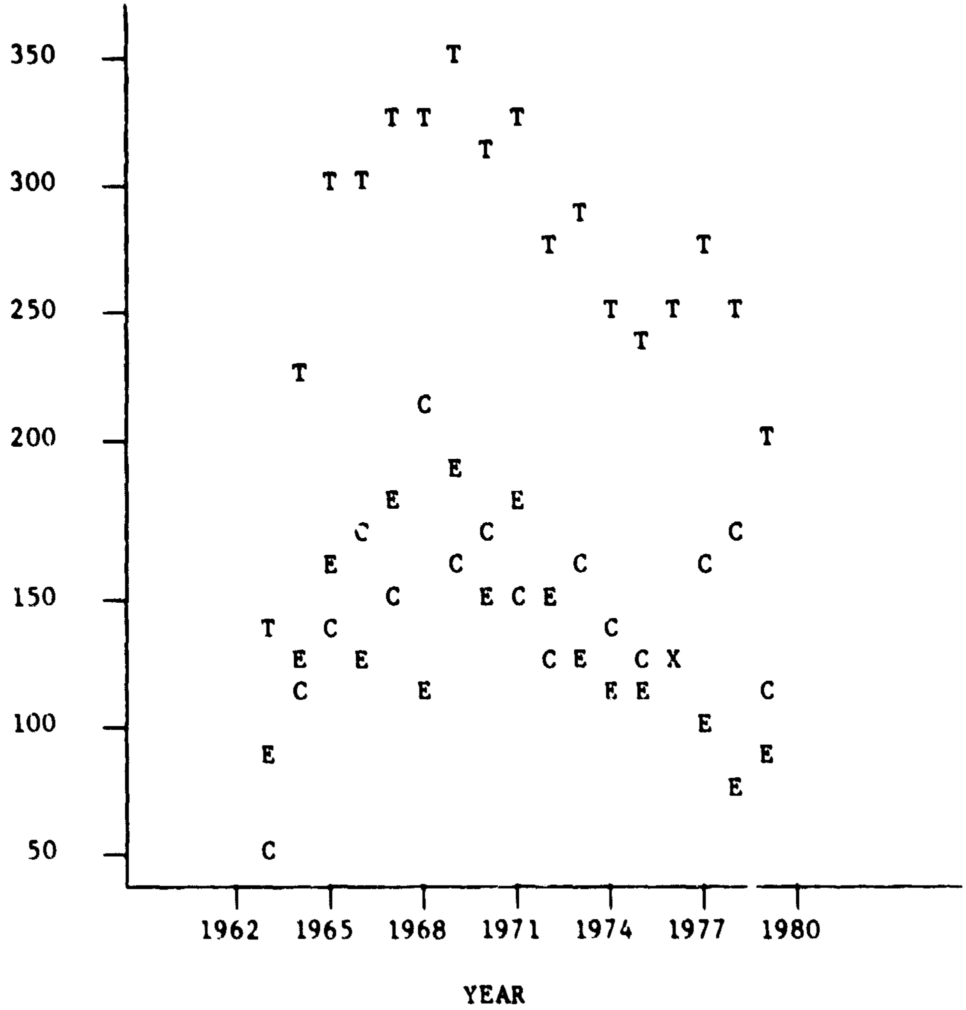
[10] This difference has been recognized for a long time. See for example Mary A. Holman, "The Utilization of Government Owned Inventions", Patent Trademark and Copyright Journal of Education and Research (IDEA), 7(2):109-7, 1963; Donald S. Watson and Mary A. Holman, "Patents From Government Financed Research and Development", Patent Trademark and Copyright Journal of Education and Research, 8(2):pp. 199 ff, 1964; and Robert A. Solo, "Patent Policy for Government Sponsored Research and Development", Patent Trademark and Copyright Journal of Education and Research, 10:143-206, 1966.

NASA's patent application history is given in Figure IV. (The data on which Figure IV is based can be found in Appendix A. Its source is described in Appendix C.)

Figure IV
NASA PATENT APPLICATIONS



Legend:
T is Total Disclosures
E is NASA Employee Disclosures
C is Contractor Disclosures

3. THE STATISTICAL TESTS

3.1 METHOD

The statistical method for determining whether a common lag exists is based on Mizon,[11] who suggests sequential testing of related hypotheses. First equation 2 is restated.

$$T(k) = c(o)\ R(k) + c(1)\ R(k-1) + \ldots + c(m)\ R(k-m) + a \qquad (2')$$

The number "m" would be a number of years after which research effort has no effect on the technology developed in year k. The sequential test hypothesizes *a priori* a value for m which is certain to be valid, and tries to find a smaller lag which is consistant with the observed data. Given the formulation of Equation 3, we test the hypotheses

$$\begin{aligned} &H(m): c(m) = 0 \\ &H(m-1): c(m) = c(m-\ell) = 0 \\ &H(m-2): c(m) = c(m-1) = c(m-2) = 0 \\ &\qquad\qquad \vdots \end{aligned}$$

Each hypothesis is tested by forming an F-ratio. When the probability level of the test reaches a critical level (i.e. when F becomes large enough to reject $H(m-\ell)$ say), the procedure stops and the hypothesis accepted is that the lag is ℓ. The test proceeds backwards (from longer to shorter lags).

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[11] Grayham E. Mizon, "Inferential Proceedures in Nonlinear Models: An Application of a UK Industrial Cross Section Study of Factor Substitution and Returns to Scale", *Econometrica*, 45(5):1221-1242, 1977.

In this work, the tests are performed with an m of 5. A higher value of m would have left very few degrees of freedom. As it is, with 21 observations on research effort and technological output, data lagged five years allows only 16 cases to be used in the statistical calculations.

Although the tests described above are not necessarily independent, the critical value is chosen as if this were the case. If the overall critical value of the test is to be A the individual F tests have a critical value of A' where

$$A = 1 - (1 - A')**M$$

or approximately, $A' = A/M$. The goal was to obtain overall results at a 5% level. Hence in the case of $M = 5$, each individual test used a 1% critical value.

3.2 RESULTS.

Six sets of hypotheses were tested. The results are given in Appendix B. The Appendices tables show the F statistic for the test that the last $m-\ell$ variables are zero. (m is the maximum lag and ℓ is the hypothesized lag.) Also contained in these tables are the coefficients of the resulting models, computed two ways: with and without an intercept. (In many cases the intercept was not significantly different from zero.) The tables below summarize the results of the Appendices. It shows the lag (ℓ) obtained from each specification of dependent and independent variables.

Table of Significant Lags for m = 5

Independent Variable	Dependent Variables	Lag
Total Invention Disclosures	Total Outlays	1
Total Patent Applications	Total Outlays	1
Contractor Invention Disclosures	Total Outlays	1
Contractor Patent Applications	Total Outlays	*
Employee Invention Disclosures	Employment	0
Employee Patent Applications	Employment	*

* No relationship was significant.

4. CONCLUSIONS

The lags found by this procedure vary from one to zero years. This is shorter than Scherer's asumption of 9 to 30 months.[12] A possible explanation for this difference is that research on government R&D projects commences before the indicators of research effort show a change. For example, when the government contracts with a company to do research, the company may have done some work prior to the execution of the contract. Further expenditures will be recorded by NASA only after they are billed for work executed by the contractor. Also important is that a large payment may even come at the end as with many incentive award contracts.

Thus, the time between when the money is spent and an invention is disclosed or patent application is made may be shorter than the time between when the contractor does the work and prepares a disclosure or patent application. These factors suggest the the shorter lags discovered here are not unreasonable.

The lags between employment and technological output appear to be shorter than the lags between total outlays and technological output. A possible explanation for this result is that employment figures are even slower to indicate changes in research effort than spending changes. This is not too surprising since government agencies are slow to reduce their size as the work they do is cut back.

A potentially surprising conclusion is that the observed lag as it relates to patent applications is shorter than the lag as it relates to

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[12] Scherer, op. cit.

invention disclosures. One would think that on the basis of government reporting regulations and patent law, the patent application lag should be greater than or equal to the invention disclosure lag. Government regulations specify clearly that invention disclosures are to be made promptly upon reduction to practice of the invention. The decision to patent generally involves an assessment of commercial risk against known patenting costs, and a patent application involves months of preparation. Thus, it would be surprising to find a patent application being filed even simultaneously with a disclosure for the same invention, were the world to obey government regulations perfectly.

Furthermore, even if a disclosure to a government agency were to constitute a public disclosure (which it may or may not), the firm is still granted a one year grace period to obtain U.S. patent rights. Thus, if a firm is only interested in U.S. patent protection, patent law removes the incentive to patent first and disclose later.

The explanation for this unexpected result lies perhaps in the history of judicial reaction to patent infringement cases, and in the resultant forms of protection adopted by firms. Supreme Court and lower court hostility to patent protection, in addition to the cost and lengthy process of filing and protecting a patent, has led many firms to adopt "trade secret" protection. "Trade secret" protection has been upheld under state law, and has been adopted particularly among industries featuring rapidly evolving technology. In these industries a particular invention could become obsolete even prior to the issuance of the patent, so that the incentive to patent is entirely removed.

Since NASA hires contractors to perform research and development work on advanced technology, it is likely that NASA contractors will find trade secret protection advantageous. Even if their technology does not risk obsolescence in the immediate future, the firm might evaluate the costs and risks of patenting and protecting the patent as being in excess of the gains derived from obtaining that patent. Trade secret protection would in either case be preferred, and it would be to the firm's benefit to delay disclosure as long as possible.

The lag between contract funding and either invention disclosure or patent application is thus seen to be a function of individual perceptions on the appropriate method of protecting particular intellectual property, and of corporate policy. This insight may best explain the unusual results concerning disclosure and patent lags. For those inventions that are perceived best protected by patents, an application is filed early. For those on which a patent is not seen advantageous, no disclosure action is taken until the latest possible time. Note that this last result can also occur because of a human reluctance to engage in auxiliary paperwork, leading to procrastination in reporting activities such as invention disclosures.

A final conclusion relates to indicators of technological output. The sequential hypothesis testing showed that invention disclosures correlated better to the measures of research effort used than did patent applications. This suggests that invention disclosures are a better indicator of technological output than patent applications. This is not surprising since the decision to make a patent application is more complex than the decision to make an invention disclosure. NASA's attitude regarding patent applications has not been as consistant as its attitude regarding invention disclosures. Moreover, most congressional interest and policy direction has related to patenting rather than the disclosure of information.

APPENDIX A

DATA FROM FIGURES IN THE TEXT

YEAR	R&D OUTLAYS	EMPLOY OF S & E	INVENTION DISCLOSURES		PATENT APPLICATIONS			
					NASA OWNED		EMPL OWND	CNTR OWND
			NASA	CNTR	EMPL	CNTR		
1959	403024		92	17				
1960	831132		123	71				
1961	1439784		131	162				
1962	2701702		212	449				
1963	4701678	10965	435	759	71	32	15	23
1964	6362569	12249	412	1203	114	83	9	25
1965	7429852	13115	382	2094	149	91	9	45
1966	7404628	13556	367	3310	112	112	10	60
1967	6423671	13956	487	3268	164	91	11	57
1968	5439636	13851	434	3551	106	163	10	48
1969	4621709	13839	535	2827	184	118	4	43
1970	3911732	13837	415	2145	142	113	4	57
1971	3547862	13227	265	2145	165	85	12	66
1972	3387050	12616	265	2304	144	72	9	55
1973	3116698	12085	279	1608	118	111	8	46
1974	2809087	11770	251	878	108	84	9	48
1975	2724077	11665	260	1091	105	72	8	49
1976	2815187	11629	260	1152	110	93	12	31
1977	2791196	11544	260	1200	101	112	4	54
1978	2654686	11465	252	1123	75	140	2	38
1979	2659570	11284	221	1052	89	73	2	42

Appendix B
Hypothesis Testing with m = 5

Total Invention Disclosures by Total Outlays
(With Intercept)

Hypothesis Years Tested	F-Statistic	Degrees of Freedom		Prob < F
5	2.5137	1	9	0.1473
4,5	1.6412	2	9	0.2468
3,4,5	1.5332	3	9	0.2718
2,3,4,5	2.9484	4	9	0.0820
1,2,3,4,5	22.5616	5	9	0.0001

Parameter	Estimate	Standard Error
Intercept	203.262	169.170
0	- 3.495 E -4	9.505 E -5
1	8.177 E -4	8.842 E -5

(No Intercept)

Parameter	Estimate	Standard Error
0	- 3.051 E -4	8.865 E -5
1	8.161 E -4	8.949 E -5

Patent Applications by Total Outlays
(With Intercept)

Hypothesis Years Tested	F-Statistic	Degrees of Freedom		Prob < F
5	0.0735	1	9	0.7924
5,4	2.2586	2	9	0.1604
3,4,5	3.0752	3	9	0.0833
2,3,4,5	4.0751	4	9	0.0372
1,2,3,4,5	10.3186	5	9	0.0016

Parameter	Estimate	Standard Error
Intercept	209.330	18.892
0	- 3.855 E -5	8.41 E -6
1	5.319 E -5	8.42 E -6

(No Intercept)

Parameter	Estimate	Standard Error
0	- 1.751 E -5	2.473 E -5
1	7.493 E -5	2.472 E -5

Contractor Disclosures by Total Outlays
(With Intercept)

Hypothesis Years Tested	F-Statistic	Degrees of Freedom		Prob < F
5	4.1834	1	9	0.0711
4,5	2.2531	2	9	0.1609
3,4,5	1.6947	3	9	0.2371
2,3,4,5	2.4541	4	9	0.1212
1,2,3,4,5	18.0903	5	9	0.0002

Parameter	Estimate	Standard Error
Intercept	77.732	160.991
0	- 3.690 E -5	9.046 E -5
1	7.884 E -4	8.414 E -5

(No Intercept)

Parameter	Estimate	Standard Error
0	- 3.520 E -4	8.155 E -5
1	7.875 E -4	8.232 E -5

Contractor Patent Applications by Total Outlays (With Intercept)

Hypothesis Years Tested	F-Statistic	Degrees of Freedom		Prob < F
5	0.0826	1	9	0.7803
4,5	0.0671	2	9	0.9356
3,4,5	0.0504	3	9	0.9841
2,3,4,5	0.0381	4	9	0.9967
1,2,3,4,5	1.4238	5	9	0.3035
0,1,2,3,4,5	1.25	6	9	0.3676

Coefficients For A 1 Year Lag With Intercept

Parameter	Estimate	Standard Error
Intercept	119.034	15.539
0	- 2.840 E -5	6.914 E -6
1	3.399 E -5	6.924 E -6

Employee Invention Disclosures by Employment
(With Intercept)

Hypothesis Years Tested	F-Statistic	Degrees of Freedom		Prob < F
5	2.0602	1	9	0.2107
4,5	1.4389	2	9	0.3209
3,4,5	1.9889	3	9	0.2342
2,3,4,5	2.5550	4	9	0.1657
1,2,3,4,5	5.9982	5	9	0.0357
0,1,2,3,4,5	19.8761	6	9	0.0024

Parameter	Estimate	Standard Error
Intercept	- 419.378	231.598
0	6.070 E -2	1.845 E -2

(No Intercept)

Parameter	Estimate	Standard Error
0	0.0274	1.599 E -3

Employee Patent Applications by Employment
(With Intercept)

Hypothesis Years Tested	F-Statistic	Degrees of Freedom		Prob < F
5	0.0523	1	9	0.8281
4,5	3.5463	2	9	0.1099
3,4,5	2.1060	3	9	0.1833
2,3,4,5	2.4460	4	9	0.1766
1,2,3,4,5	2.8015	5	9	0.1413
0,1,2,3,4,5	6.0781	6	9	0.0332

Parameter	Estimate	Standard Error
Intercept	- 168.758	64.200
0	2.381 E -2	5.112 E -3

(No Intercept)

Parameter	Estimate	Standard Error
0	0.01041	4.855 E -4

Coefficients For A 1 Year Lag
With Intercept

Parameter	Estimate	Standard Error
Intercept	- 168.090	75.228
0	1.697 E -2	1.200 E -2
1	6.828 E -3	1.164 E -2

Appendix C

Data Sources

The expenditure data originated from the yearly fiscal data reported in the NASA Pocket Statistics of 1980. For the years before the transition quarter, the value for calendar year X was computed as the average of fiscal year X and X + 1. After the transition quarter, calendar year X was computed as three-fourths of fiscal year X and one-fourth of fiscal year X + 1. For the transition year, the amount was one-half of the fiscal year plus the transition amount plus one-fourth of the next year's amount. The resulting calendar year numbers were then discounted using the GNP price deflator.

The employment data were obtained from NASA's personnel office. They are the number of employees classified as scientists and engineers employed at the end of each fiscal year.

The invention disclosure and patent application information came from the yearly summary of NAsA patent activities put out by the General Counsel for Patent Matters. The summary for 1980 was in an undated memo of general distribution circulated in mid-1981.