The (Indirect) Costs of Conducting Research

IHELG Monograph
04-04

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20TH ANNIVERSARY

1982-2002
The (Indirect) Costs of Conducting Research

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Abstract

The nation’s postsecondary institutions are experiencing increasing costs due to the indirect costs associated with supporting extramural research (Senate Committee, 1997). Because facilities and administrative (F&A) rates are lower at colleges and universities than at other research institutions, these educational institutions pay a portion of F&A costs that would otherwise be reimbursable from the federal government (Office of Science and Technology Policy, 2000).

This paper used the National Center for Education Statistics’ (NCES) Integrated Postsecondary Education Data System (IPEDS) database to identify whether there is a relationship between research budgeting and instructional expenditures. It was hypothesized that institutions that witnessed large increases in research expenditures over a 10-year period would have significantly lower instruction expenditure increases as compared to other institutions. It was further hypothesized that the change in variables associated with research would have a negative relationship with the change in instructional costs per student.

Two statistical methods were used to determine the impact of research expenditures on instructional expenditures per student. These included a two-factor model that considered the changes in research expenditures over a ten-year period and Carnegie institutional types; a second method was a multiple regression analysis equation that considered a number of research-related variables to help predict the change in instructional expenditures per student.

Both methods failed to show an impact of research funding and expenses on other institutional expenses. The research performed in this study took a macro-economic view
of data and aggregated this for many different institutions. Despite the similarities among institutions of similar Carnegie type, the research was unable to control for great differences among these institutions internally and administratively. Further research that seeks a relationship between institutional planning and research costs should take a micro-economic view of institutions and should consider other variables more closely aligned and sensitive to changes in the research function.
Introduction

Between 1976 and 1996, the average annual tuition at public institutions increased 390%, from $642 to $3,151 (National Commission on the Cost of Higher Education, 1998). This increase in tuition is due to the increase in expenditures at higher education institutions. According to the National Center for Education Statistics’ Integrated Postsecondary Education Data System (IPEDS) database, education and general (E&G) instruction expenses increased 70% from 1991 to 2001 at public Doctoral/Research extensive institutions (NCES, 2002). The increase in E&G expenditures has occurred among all expenditure areas, including E&G research expenditures, which have increased on average 71.5% for the same institutions during the same time period (NCES, 2002).

The federal outlook and requirement for research and development (R&D) has increased considerably, and educational institutions have increased their research functions to accommodate this increased need. According to the Office of Management and Budget (OMB), the President’s budget for FY2004 is estimated to be $112.1 billion for R&D, which is a 27.5% increase over that spent in FY2002 (OMB, 2003). Educational institutions have been major recipients of this increased funding; the National Science Foundation (NSF) reported that the federal obligation to universities and colleges for research increased 78% from 1991 to 2001 (NSF, 2001).

Extramural research funding from the federal government has been identified as a likely source of alleviating budget problems. It is the contention of this report that this approach overlooks the costs of supporting this research.
Inadequate and Expensive Facilities

Although educational institutions have received greater funding, they often have inadequate facilities to conduct research. NSF reported that more than half of all research-oriented institutions have inadequate research space in every science and engineering field except mathematics (NSF, 2000). The report also indicated that to meet current research commitments, "research-performing institutions reported that they needed an additional 28.5 million net assignable square feet of science and engineering research space, or 20 percent more than they currently have" (NSF, 2000, p. 29). New research construction has occurred, but at great cost to institutions. Institutional funds comprised 60% of the funding through private donations, internal funds, tax exempt bonds and other funding; state and local government provided 31% of the funding and the federal government provided 9% of the funding (NSF, 2000).

Construction and renovation of research space often assumes that costs will be offset by reimbursement from research activity funded by grants and contracts. The RAND Science and Technology Policy Institute concluded in a study that, although the federal government has reimbursed universities between $3.6 and $4.2 billion per year, they fail to reimburse an additional $0.7 to $1.5 billion in costs allocated to federal projects (Science and Technology Policy Institute, 2000). This calculation was for federal government research, which generally has higher reimbursement rates than research funded by state governments, local governments, or private organizations.

Facilities and Administrative Rate Explained

Organizations that fund grants and contracts generally reimburse a percentage of the overhead, or indirect costs, that generally can be associated with a grant or contract.
These costs more properly are called facilities and administrative (F&A) costs. Facilities costs refer to those costs associated with providing and maintaining a research facility, and may include heating and cooling, janitorial maintenance, and building depreciation. Administrative costs refer to those costs associated with managing the research functions at an institution, such as the provision of a sponsored projects office or the provision of the library. OMB defines F&A costs as those costs incurred for common or joint research objectives, and therefore cannot be identified readily and specifically with a particular sponsored project, an instructional activity, or any other institutional activity (OMB, 1998). Therefore, typically they are charged as a percentage of the total direct costs associated with conducting research.

The method for charging F&A costs to the funding organization is determined during the awarding process. Typically, for federal awards, a percentage of the direct costs of research is added to the award to the institution using an F&A rate. The F&A rate is negotiated with either the U.S. Department of Health and Human Services or the Office of Naval Research. It is determined using a simple formula (see Figure 2), which is the institutional facilities and administrative costs of conducting research divided by the modified total direct costs of conducting research. The negotiation considers very thoroughly those costs placed in the assumed as F&A costs, and those considered for the direct costs. The modified total direct costs (MTDC) are those direct research costs that omit costs that should not incur an overhead rate such as the costs of large equipment. When negotiated, the amount and type of F&A costs and the MTDC are closely scrutinized by a government reviewer. Often as a result of negotiations educational institutions are not always able to recover all the F&A costs associated with research.
(OSTP, 2000).

Figure 2.

\[
\text{(Facilities Costs + Administrative Costs)} = \frac{\text{Facilities and Administrative Cost Rate}}{\text{Modified Total Direct Costs}}
\]

Potential Effects of Unreimbursed F&A Costs

As F&A costs are not fully recoverable, institutions may take on a greater burden when increasing the research function. OSTP indicated that if resources are not provided fully to sponsor research by federal agencies effectively, then universities must cover the remaining costs from other sources (1998). University administrators have cited state and federal regulatory burdens as well as the unreimbursed costs of conducting scientific research as contributors to the rapid growth in the cost of attending college (Senate Committee, 1997).

A study conducted by Andersen LLP illustrates the point that F&A costs often are not covered by the F&A revenue from the research funding organizations (Andersen, 2000). A small medical university with a robust research function asked the firm to conduct a study to determine the perceived increase in the F&A costs and the potential F&A rate due to the completion of a building to be used specifically for research activity. The F&A costs were forecasted to increase from $15.8 million in FY 1999 to nearly $20.1 million in FY 2002 (See Table 1).

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>Indirect Cost Pools</th>
<th>FY99</th>
<th>FY00</th>
<th>FY01</th>
<th>FY02</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Indirect Costs</td>
<td>$15,817,314</td>
<td>$16,809,077</td>
<td>$19,034,163</td>
<td>$20,992,927</td>
<td></td>
</tr>
<tr>
<td>Modified Total Direct Costs</td>
<td>$34,402,338</td>
<td>$36,810,502</td>
<td>$39,387,237</td>
<td>$42,144,343</td>
<td></td>
</tr>
<tr>
<td>Facilities &amp; Administrative Cost Rate (Andersen, 2001)</td>
<td>45.98%</td>
<td>45.66%</td>
<td>48.33%</td>
<td>49.81%</td>
<td></td>
</tr>
</tbody>
</table>
The F&A rate would need to increase from 45.98% in FY 1999 to 49.81% in FY02 to continue to support the anticipated F&A cost increases in research. In this situation the university was dependent on two actions, as they already had started the construction on the research building: (a) they planned on a renegotiated F&A rate and (b) they needed to attract $7.7 million in additional research in four years. A renegotiation is unlikely to result in the federal negotiators awarding an additional 4 percentage points. The institution did not have a clear plan on how to meet the additional $7.7 million in research that would be needed to meet the break-even point; it was assumed that the university would attract new researchers who would bring research with them to the new research building (Andersen, 2000). This illustrates the risks that educational institutions are taking in the effort to attract more research funding.

Effort Reporting

A final issue that impacts research institutions is unreported faculty and technical personnel effort on research projects. Hours worked on research that goes unreported to a granting agency is assumed by the educational institution. There are probably three reasons why a researcher may not report or may under-report their time on a grant: (1) they have met or exceeded the labor budget line within the grant, (2) the researcher works more than a 40 hour work week and reports the percentage of time wrong, or (3) the researcher does not understand the responsibilities for time reporting and is reserving the labor budget for other individuals associated with the grant or contract. The federal government granting agencies assume that unreported labor costs on a grant are cost-sharing on the part of the institution.
Given this perspective on cost sharing, the research institution has the risk of absorbing costs in two ways. Directly they absorb the cost of the human resource time not reported on the research. Indirectly, a federal auditor may loosely determine the amount of cost-sharing, and may place this in the MTDC (the denominator of the F&A rate calculation), which may have the deleterious effect of lowering the institutional F&A rate.

The National Science and Technology Council (NSTC) identified this as an issue and has created the following action item to address unreported effort and voluntary cost-sharing. “The NSTC will assess the impact of accounting practices on voluntary cost sharing by universities, particularly as it relates to the donation of faculty time to research projects” (NSTC, 2001, p. 7).

**Purpose of Study**

Research is a very expensive and complex operation, and one that represents a large component of an institution’s annual expenditures. This study attempted to show that there is a negative relationship between education and general (E&G) research expenditures and instructional expenditures. Of particular interest are those organizations that have experienced large increases in their research function over a period of ten years. Another variable of interest are Carnegie Classified Doctoral/Research Extensive (DRE), Doctoral/Research Intensive (DRI), Masters I (MI), and Masters II (MII) institutions (Carnegie, 2001).

**Method**

To support the purpose of the study, two statistical methods were employed. First, the researcher used a two-factor model to explore the differences among Carnegie
institution type and the percent of research expense increases. Second, multiple
regression variables were identified to predict the behavior of the dependent variable, the
change in instructional expenditures per student.

Data Collection

Institutions included in the sample were all public Carnegie DRE, DRI, MI, and
MII institutions that submitted financial data to the NCES IPEDS database for 1991 and
2001 (NCES, 2003). Due to different accounting procedures, differences in mission, and
internal governance differences among public and private institutions, private institutions
were not included in the sample. Public and private educational institutions report
finances differently, which includes a different mechanism for reporting annual
expenditures to the federal government. Private institutions use the Federal Accounting
Standards Board guidelines, while public institutions use the Governmental Accounting
Standards Board guidelines.

Specific data elements that were downloaded from the IPEDS database include
the following:

Institution Name

Unit Identification Number

Education & General Instructional Costs – 1991 and 2001

Education & General Research Costs – 1991 and 2001

Total Student Enrollment, 2001

Male and Female Student Enrollment, 1991

Revenue from State Grants and Contracts, 1991 and 2001
Revenue from Local Grants and Contracts, 1991 and 2001

Variables

Independent Variables. To compare research data among several types of institutions of varying sizes, and function, the financial data were normalized by looking at the percent of change over the ten-year period. For example, the study investigated the change in research costs from 1991 and 2001. This percent change allowed for comparability among institutions such as The University of Maryland, a large research-oriented university, with The University of Maryland Eastern Shore, a smaller master’s institution.

Carnegie institutions that were included in the sample were DRE, DRI, MI, and MII institutions. DRE and DRI institutions were grouped together in a general Doctoral/Research category because institutions in these groups offer a wide range of baccalaureate programs, and they are committed to graduate education through the doctorate (Carnegie, 2001). MI and MII institutions were grouped in a general Master’s group because institutions in both of these groups offer a wide range of baccalaureate programs, and they are committed to graduate education through the master’s degree (Carnegie, 2001).

Dependent Variable. The key dependent variable was Education & General instructional costs (instruction). To normalize this variable, instructional expenditures for 1991 and 2001 were divided by fall institutional student enrollment. The 1991 and 2001
numbers were compared and the percent change was computed. The main dependent variable throughout the study is the change in instructional costs per student.

*Omitted Institutions.* Institutions that were omitted from the study include those that did not report complete data. Of the original 868 public institutions for which data were downloaded, 427 (51.6%) institutions had data complete enough for inclusion in the study. An example of an institution omitted from the study was a college that reported research and instructional costs for 1991, but not for 2001.

*Two-Factor Analysis of Variance*

A two-factor two-level design was employed to determine the effects of institution types and the change in research costs on the change in instructional costs per student. The two independent variables were institution type and the percent change in research costs. Each factor had two levels. The two levels for the institutions were represented by DR institutions and Research institutions. The two levels for the research expenditures level were a low research cost increase (those institutions that increased less than 50% over ten years), and a high research cost increase (those institutions that increased research costs 75% to 300% over ten years). The dependent variable was the percent change in instructional costs per student. The model is depicted in Figure 3:
Figure 3. Two Factor Model

<table>
<thead>
<tr>
<th>Carnegie Institution Type</th>
<th>Research Cost Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctoral Research Extensive and Intensive</td>
<td>Low $\Delta&lt;50%$</td>
</tr>
<tr>
<td>Masters I and II</td>
<td>MLOW</td>
</tr>
</tbody>
</table>

Multiple Regression

Standard multiple regression was conducted to determine which independent variables ($\%$ change in research costs [chegres]; $\%$ change in revenue from federal grants and contracts [chrfedgc]; $\%$ change in revenue from state grants and contracts [chrstatgc]; $\%$ change in revenue from local grants and contracts [chrlocgc]; $\%$ change in revenue from private grants and contracts [chrpricg]) were predictors of the percent change in instructional costs per student.

Results

Two-Factor Analysis of Variance

Of the 431 institutions identified for the study, 265 had a change in research costs that fit into one of the two research cost categories (Low or High). See Figure 4 for the group numbers by factor and level.
Figure 4. Number of Institutions in Each Level of Each Factor

<table>
<thead>
<tr>
<th>Carnegie Institution Type</th>
<th>Research Cost Categories</th>
<th>Low $\Delta&lt;50%$</th>
<th>High $75%&lt;\Delta&gt;300%$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctoral Research Extensive and Intensive</td>
<td>n = 31</td>
<td>n = 83</td>
<td></td>
</tr>
<tr>
<td>Masters I and II</td>
<td>n = 72</td>
<td>n = 79</td>
<td></td>
</tr>
</tbody>
</table>

The SPSS for Windows software package (Release 11.0.1, 15 Nov. 2001) was used to determine the difference in scores reported among the two independent variables including an interaction. The research employed Univariate analysis of variance (ANOVA) and comparison of means to determine the interaction effect and to measure the main effects of the different factor levels.

The null hypothesis for the comparison of means was that the means would remain equal across both factors of each independent variable. An additional null hypothesis was that there would be no interaction effect.

Homogeneity of variance was tested within the ANOVA. A line plot was then created of the means of the independent variable. The crossing lines in Graph 1 demonstrate the possible presence of factor interaction among institution type and change in research costs.
Figure 5 shows the results of the ANOVA and Figure 6 shows the mean and standard deviation of the dependent variable by factor and level. Main effect results revealed that the percent change in instructional costs was not significantly different among institutions with high and low research cost increases, $F(1, 261) = 2.576, p=.110$, partial $n^2=.01$. Carnegie institution type was not a significant factor in the percent change in instructional costs, $F(1, 261) = 0.048, p=.827$, partial $n^2<.00$. Although the line plot showed an interaction in Graph 1, there was not a statistical interaction between the two factors, $F(1, 261) = 0.002, p=.589$, partial $n^2=.001$. For all three tests of differences the analysis failed to reject the null hypotheses.

Figure 5. Two-way ANOVA Summary Table

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>Df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
<th>ES</th>
</tr>
</thead>
</table>

Between factors

<table>
<thead>
<tr>
<th></th>
<th>% Change in Research Costs</th>
<th>Institution Type</th>
<th>% Change in Research Costs X Institution Type</th>
<th>Within factors</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.140</td>
<td>1</td>
<td>0.140</td>
<td>2.576</td>
<td>0.110</td>
</tr>
<tr>
<td>Institution Type</td>
<td>0.003</td>
<td>1</td>
<td>0.003</td>
<td>0.048</td>
<td>0.827</td>
</tr>
<tr>
<td>% Change in Research Costs</td>
<td>0.002</td>
<td>1</td>
<td>0.002</td>
<td>0.293</td>
<td>0.589</td>
</tr>
<tr>
<td>X Institution Type</td>
<td></td>
<td></td>
<td></td>
<td>0.001</td>
<td></td>
</tr>
</tbody>
</table>

Within factors: 14.140 261 0.005
Total: 34.560 265

Figure 6. Means and Standard Deviations by Factor and Level

<table>
<thead>
<tr>
<th>Carnegie Institution Type</th>
<th>Research Cost Categories</th>
<th>Low Δ&lt;50%</th>
<th>μ</th>
<th>σ</th>
<th>High 75%&lt;Δ&gt;300%</th>
<th>μ</th>
<th>σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctoral Research Extensive and Intensive</td>
<td></td>
<td>0.2401</td>
<td>0.2468</td>
<td>0.3066</td>
<td>0.2024</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Masters I and II</td>
<td></td>
<td>0.2501</td>
<td>0.2458</td>
<td>0.2831</td>
<td>0.2451</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Multiple Regression

Before standard multiple regression was conducted, an analysis of the independent variables was conducted to check for a normal distribution and homoscedasticity among the variables. Descriptive statistics are included by variable in Figure 7.
The five independent variables were all extremely skewed and had very high positive kurtosis statistics, indicating that they were leptokurtic. (Extreme skewness and kurtosis statistics are shaded in Figure 7). This indicates a probable violation of the normality assumption. Further analysis included the preparation of histogram charts to demonstrate the distribution of scores graphically. Graphs 2 – 7 demonstrate the distribution of percentages from the educational institutions.

Graphs 2 – 7. Distribution of Variables
It can be observed in the five independent variables that there is an extreme skew to the right, indicating distributions that are not normal. A further test of normality included the Kolmogorov-Smirnov test; test statistics are included in Figure 8.

Figure 8. Kolmogorov-Smirnov Test for Normality

<table>
<thead>
<tr>
<th>Kolmogorov - Smirnov</th>
<th>Z - Statistic</th>
<th>df</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>% change in instructional costs per student</td>
<td>0.834</td>
<td>424</td>
<td>0.49</td>
</tr>
<tr>
<td>% change in research costs</td>
<td>7.747</td>
<td>379</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>% change in revenue from federal grants and contracts</td>
<td>3.799</td>
<td>423</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>% change in revenue from state grants and contracts</td>
<td>9.039</td>
<td>404</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>% change in revenue from local grants and contracts</td>
<td>6.206</td>
<td>220</td>
<td>&lt;.01</td>
</tr>
</tbody>
</table>
Conversion of the variables was considered but rejected since the majority of the data would be required to be discarded or changed. Regression analysis is a parametric test that requires normally distributed variables. It was not conducted since results would violate the assumption of variable normality.

Conclusions

Both statistical analyses attempted (two-factor analysis of variance, multiple regression) neither confirmed nor denied the claim that the change in research costs and revenue has a negative correlation with the change in instructional costs. The data used for both analyses had significant issues that affected the study’s ability to demonstrate results. The conclusions drawn from this study are relevant to the data collection, factor identification, and data manipulation within the study. Since the two-factor analysis of variance failed to reject the three null hypotheses, and the regression analysis could not be computed due to normality concerns, no conclusions can be made regarding the effect of research activity on instructional costs.

Macro vs. Micro

The researcher took the assumption that educational institutions can be reviewed using a macro-economic model. This may be true, but the variables used are not specific enough to the operation of research at the institution to indicate significance. The variables used are also not easily compared among different institutions.

This analysis omitted private institutions due to their differences in accounting, public funding, and the general differences in mission in comparison to public
institutions. The failure to demonstrate results from this study may indicate that vast
differences exist among the institutions included in the analysis. There certainly is a
difference in the level of grant and contract funding; of the institutions included in the
sample, federal grant and contract revenue for 2001 ranged from $463,000 to $529
million.

The change in grant and contract revenue generated over ten years does not
provide a specific indication of how university leaders administer funding. It indicates
that more funding was received, but it does not indicate what happened at the institution
as a result of the increased funding. This research made the assumption that general
trends would be observed over a period of time that may indicate the need for closer
analysis. Despite the fact that this assumption was not supported, there still are
indications in the federal literature base that closer analysis is warranted.

Use of Percentages

The use of percentages to adjust institutional data for comparability is a valid
technique provided the changes over the period of ten years were normal for the
variables. This technique did work for the dependent variable, change in instruction costs
per student, but resulted in abnormal distributions for the change in research costs and
change in the grant and contract revenue variables.

Normalization of Research Costs and Revenue. The abnormal distributions
associated with the research variables may have been normalized if they were divided by
a number associated with research such as the number of research grants and contracts
awarded in the year, the number of principal investigators, or the net assignable square
feet of research space. As noted above, this served to give a normal distribution to the
dependent variable, instruction costs per student. These variables were not included in this study because they were not readily available through the IPEDS database.

*Dramatic Increases among Masters Institutions.* The Masters I and Masters II institutions were involved actively in increasing research funding and experienced major increases in research expenses over the period. The mean percent change in revenue expenditures for Masters institutions was 593.45%, with a standard deviation of 24.59%. Despite this effect causing a skewed distribution, this demonstrates the increased pressure that institutions have placed on research expansion.

**Suggestions for Further Research**

Further research is required to show the impact of the research function on institutional finances. This study effectively demonstrates data problems to avoid in future research. It has, however, caused further consideration of financial variables and the appropriate context to consider those variables. Future research conducted in this topical area should consider variables that indicate more about an institution’s research function, other dependent variables, and should be more focused on a specific institution or an institution and very similar peers.

*Identification with F&A Cost and Rate Variables*

Future research that considers the impact of the research function on institutional decision-making should consider variables associated with F&A costs. As identified in the Introduction section of this paper, F&A costs are under high scrutiny from federal funding organizations, as well as from institutions. A future study may consider the impact of F&A Cost reimbursement on institutional finances. A formula that may be
used in future research includes the following formula for unreimbursed F&A Costs (see Table 2).

<table>
<thead>
<tr>
<th>Table 2 – Unreimbursed F&amp;A Cost Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unreimbursed F&amp;A Costs = (F&amp;A Rate X MTDC) - Total F&amp;A Costs Rcvd</strong></td>
</tr>
</tbody>
</table>

**Key:**
- Unreimbursed F&A Costs - costs that were not reimbursed due to a variety of internal research administration issues
- F&A Rate - The negotiated facilities and administrative cost percentage rate that is approved by DHHS or the Office of Naval Research
- MTDC - the Modified Total Direct Costs, those research related costs that incur F&A costs
- Total F&A Costs Rcvd - The Total F&A Costs billed and/or received from sponsors

**Use of Other Dependent Variables**

The change in instructional costs per student is not the only variable that could be used to indicate an effect of the research function on institutional finances. The change in annual tuition per student may indicate the impact on students. A researcher also may consider other education and general (E&G) variables normally associated with students and instruction, such as E&G Academic Support, E&G Student Services, or E&G Scholarships and Fellowships.

**Review Education Institution and Peers**

A more closely tailored study may include one that pertains to just one institution, or one that considers one institution and peers that have similar missions, financial support, and accounting structures. Rather than compare the differences of Doctoral/Research institutions with Masters institutions, a more interesting and
significant study may be comparisons of Land-Grant Universities and Colleges in the Midwest with Land-Grant Universities and Colleges in the Western United States.
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