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Basic Research and Productivity Increase in Manufacturing: Additional Evidence

By Albert N. Link*

In a recent paper in this Review, Edwin Mansfield illustrated empirically (using a sample of ten petroleum and six chemical firms) that firm rates of productivity change are related to the amount of company-financed basic research performed, \textit{ceteris paribus}. In this note additional evidence is presented which is supportive of Mansfield's findings. This analysis is based on a sample of fifty-one major manufacturing firms active in \textit{R&D}; it is unique in that the impacts of company-financed and government-financed basic research expenditures are considered determinants of productivity growth.

The following model was estimated:

\begin{equation}
\rho_i = \beta_0 + \beta_1 C_{Bi} + \beta_2 C_{Di} + \beta_3 G_{Bi} + \beta_4 G_{Di} + \beta_5 U_i + \epsilon
\end{equation}

where \(\rho_i\) is the average annual rate of change in total factor productivity between 1973 and 1978 in the \(i\)th firm; \(C_{Bi}\) and \(C_{Di}\) are the ratio of company-financed basic research expenditures to net sales in the \(i\)th firm and the ratio of company-financed applied research plus development expenditures to net sales in the \(i\)th firm; \(G_{Bi}\) and \(G_{Di}\) are the ratio of government-financed basic research expenditures to net sales in the \(i\)th firm and the ratio of government-financed applied research plus development expenditures to net sales in the \(i\)th firm; \(U_i\) is the percent of unionization in the 3-digit industry in which the firm performs its main operations; and \(\epsilon\) is an error term.\textsuperscript{1}

The least squares results are\textsuperscript{2}

\begin{equation}
\rho_i = -1.37 + 2.31 C_{Bi} + 0.19 C_{Di} + 1.17 G_{Bi} - 0.002 G_{Di} - 0.025 U_i;
\end{equation}

\(t\)-statistics are reported in parentheses.

These findings confirm Mansfield's proposition that company-financed basic research is a significant determinant of firm productivity growth. In addition, these results suggest that government-financed basic research is also a significant determinant. Previous researchers (for example, see Nestor Terlecky) using a similar model and industry data found that government-financed \textit{R&D} (as a total) has no statistical impact on industry productivity growth and concluded with data from Compustat (see my 1981 book). Data pertaining to the percent of each firm's total \textit{R&D} expenditures that are company- and government-financed, disaggregated into basic, applied, and development, were obtained by survey and correspond to 1976. These percentages were imputed to the firm \textit{R&D} estimates reported by Compustat for 1976. Unionization data relate to the percentage of workers in each 3-digit industry who are covered by collective bargaining (see Richard Freeman and James Medoff).

\textsuperscript{2}An applied research to sales ratio and a development to sales ratio for company- and government-financed expenditures were entered separately in a similar regression. The estimated coefficients on the applied research term and the development term were not significantly different from each other, regardless of source of financing. Those results are not reported. An alternative model was also estimated, where \(\rho_i\) was regressed on \((C_{Bi} + C_{Di}), (G_{Bi} + G_{Di}),\) and \(U_i\). The results imply that, between 1973 and 1978, the marginal rate of return from total company-financed \textit{R&D} was about 38 percent and from total government-financed \textit{R&D}, about 11 percent.

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\textsuperscript{2}The fifty-one firms represent seven manufacturing industries: aircraft and missiles (3 firms), chemicals (12 firms), electrical equipment (4 firms), machinery (12 firms), petroleum (10 firms), scientific instruments (2 firms), and transportation equipment (8 firms). The rate of change in total factor productivity was estimated from data of Compustat (see my 1981 book). Data pertaining to the percent of each firm's total \textit{R&D} expenditures that are company- and government-financed, disaggregated into basic, applied, and development, were obtained by survey and correspond to 1976. These percentages were imputed to the firm \textit{R&D} estimates reported by Compustat for 1976. Unionization data relate to the percentage of workers in each 3-digit industry who are covered by collective bargaining (see Richard Freeman and James Medoff).
that government contracted R&D is not part of the relevant R&D investment of an industry. The results reported here suggest that the basic portion of government-sponsored R&D is an important part of the R&D investments of a firm.

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Exceptions are Italy and Spain, which hardly experienced any increase in labor productivity over this period.

Figure 1. Labor Productivity and Total Hourly Labor Compensation Growth, 1995-2016.

Germany. This article analyses the determinants of research and development (R&D) and the role of innovation on labor productivity in Catalan rms. Our empirical analysis found a considerable heterogeneity in rm performances between the manufacturing and service industries and between low- and high-tech industries.

Small and young rms in the high-tech KIS sector are very prone to carrying out R&D and they invest more in innovation projects. R&D expenditures, output innovation, investment in physical capital, market share and export have positive effects on labor productivity in both the manufacturing and service sectors. Firm size, on the other hand, has a positive effect on productivity in manufacturing industries but not in services.