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R&D depreciation, stocks, user costs and productivity growth for US R&D intensive industries

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Abstract

This paper estimates R&D depreciation rates for U.S. R&D intensive industries. R&D annually depreciates at; 18% for chemical products, 26% for nonelectrical machinery, 29% for electrical products, and 21% for transportation equipment. These depreciation rates lead to new estimates of the marginal (gross of depreciation) returns to R&D capital; 0.25 for chemical products, 0.31 for nonelectrical machinery, 0.34 for electrical products, and 0.27 for transportation equipment. R&D investment significantly contributed to productivity growth; virtually 100% in chemical products, 55% in nonelectrical machinery, 38 percent in electrical products, and 84% in transportation equipment.

JEL classification: D24; O47

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1. Introduction

The growth of research and development (R&D) capital critically depends on its 'economically useful' life. For example, an acceleration in R&D depreciation causes relatively

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more resources to be devoted to knowledge creating activities in order to sustain a constant knowledge outcome. This resource re-allocation raises the opportunity cost of R&D, and thereby, with all other things constant, reduces the rate of knowledge creation. Thus, estimates of R&D depreciation rates are a critical component for the measurement of R&D capital. The first objective of this paper is to estimate R&D depreciation rates for the major U. S. R&D intensive industries; namely chemical products (SIC 28), nonelectrical machinery (SIC 35), electrical products (SIC 36), and transportation equipment (SIC 37). These four industries account for 78% of manufacturing R&D expenditures, 60% of business sector R&D, and 53% of manufacturing output.

The second objective is to compute the R&D capital stocks for these industries, based upon the estimated depreciation rates. As a practical matter, estimates of R&D depreciation rates are potentially useful to the current debate regarding the capitalization of R&D expenditures in the national income and product accounts (NIPA). Presently, NIPA treats R&D expenditures as an intermediate input for business, while for nonprofit institutions and government R&D is treated as current consumption. As a result the contribution of R&D to national savings is underestimated. Thus, capitalizing R&D provides for a more accurate set of national accounts, but requires estimates of R&D depreciation rates (see for instance the discussion in Fraumeni and Okubo, 2004; Carson et al., 1994).

R&D is a durable or capital input, since its productive capability lasts for more than one period. Consequently, accounting for the productive contribution of R&D involves an evaluation of its benefits over several periods. Jorgenson and Griliches (1967), Diewert (1980), Hulten and Wykoff (1981), Harper et al. (1989), and Hulten (1990) recognize that an appropriate evaluation implies a distinction between the price of using or renting an asset over time, and the price of owning or purchasing it on a particular date. The two prices are related in the following manner; the price of ownership equals the discounted expected stream of future rental payments or user costs that the asset is expected to yield over time. With respect to the measurement of R&D capital, this price distinction creates complications for ‘own use’ situations, as the implicit asset ‘transfer’ between owner and user results in user costs that are not observed in market data. This unobservablity problem is particularly acute for R&D, since typically it is not market-transacted. This issue leads to the third objective of the paper, which is to calculate R&D user costs for the R&D intensive industries, and further with the new user costs, provide new estimates of R&D price elasticities.

R&D accumulation is an important determinant of productivity growth (see the survey by Griliches, 1995). Investment in R&D reduces production cost, as inputs are more effectively transformed into outputs, and it alters output characteristics, thereby providing new products to the marketplace. These features enhance productive efficiency, and consequently improve productivity performance. Using the new estimates of R&D stocks and user costs, the last objective of this paper is to determine the contribution of R&D to total factor productivity (TFP) growth for each of the R&D intensive industries.

This paper considers R&D depreciation within the context of intertemporal cost minimization, where depreciation rates are estimated simultaneously with other parameters characterizing the overall structure of production. Depreciation rates reflect technical efficiency and indicate the productiveness of ‘old’ capital required to generate the same level of services as ‘new’ capital (Jorgenson, 1989; Hulten and Wykoff, 1996). However, the