Firm IQ, Patent Counts and Some R&D Puzzles

Anne Marie Knott
Washington University in St. Louis
One Brookings Drive, Box 1133
St. Louis, MO 63130-4899
knott@wustl.edu
(314)935-4679

Abstract

Since the publication of "The Rate and Direction of Inventive Activity" in 1962, the dominant measure of R&D effectiveness has been patent counts. There are three concerns with patent counts. Perhaps most important is that less than 30% of firms conducting R&D have any patents. Second, there is substantial variance in patents' economic value, e.g., the patent for copying DNA versus patents that are never commercialized. Third, patents are a poor predictor of firm market value. Thus patents are neither a universal, uniform, nor reliable measure of R&D effectiveness. We introduce a measure of R&D effectiveness (IQ) that is all three. Moreover it is estimated from financial data, so can be adopted by academics as well as practitioners at low cost.

Our hope is that existence of the measure will generate improvement in R&D effectiveness just as TQM improved product quality and hospital report cards reduced hospital morbidity. Two things are necessary for these improvements to occur: 1) characterizing the market value of IQ so practitioners have an incentive to improve, and 2) characterizing the antecedents of IQ, so practitioners know how to improve.

Background on the measure

The measure we propose is firm-specific output elasticity of R&D. We call the measure firm IQ because, like individual IQ, it is a relatively durable measure of problem solving ability. In the case of individuals, high IQ translates as the number of problems solved correctly per unit time; in the case of firms, high IQ translates as more commercial “problems” solved per R&D dollar, or solving any given problem for fewer R&D dollars.

The measure was originally devised to solve the “absorptive capacity puzzle” (Knott 2008). The theory of absorptive capacity (Cohen and Levinthal 1989, 1990) is one of path dependence: the ability to assimilate new knowledge from spillovers is increasing in the firm’s prior R&D spending. This appeared to have empirical support from in that innovative output was increasing in the interaction between R&D and spillovers (Jaffe 1986). The puzzle was: “what does a firm doing 50% of an industry’s R&D have to learn from a handful of firms each doing 5% or less of industry R&D. Isn’t much of the laggards’ spending used merely to replicate what the leader already knows?”

Empirical use of the IQ measure allowed us to demonstrate the significant interaction term was capturing an omitted variable—heterogeneity in the output elasticity of R&D (IQ). When we include IQ in the estimation, the interaction term becomes insignificant. Thus it is not that increased spending increases firms returns to R&D, it is that firms differ in their returns and optimal spending increases with those returns.

Methodology-market value of R&D

Current work explores whether the measure is able to resolve another puzzle in the R&D literature: the market value of R&D. Theories of innovation typically assume firm R&D behavior is endogenously determined by industry conditions. If all firms in an industry share these conditions, and behave optimally then in equilibrium all firms should have identical R&D investment. Accordingly cross sectional increases in R&D within an industry reflect suboptimal behavior and should therefore decrease market value. However the empirical record consistently demonstrates the opposite. Firms with higher R&D investment have higher market value.

We propose that the inconsistency between theory and empirics stems from an assumption of homogenous firms. If instead firms have heterogeneous R&D elasticities (IQ), then a) the optimal levels of investment will differ across firms (firms with higher IQ invest more), and b) the market value per dollar of investment will differ across firms (firms with higher IQ have higher value per R&D dollar). Thus as with the absorptive puzzle, causality is reversed: It is not that R&D increases market value, it is that higher IQ has higher market value of R&D and therefore stimulates greater investment.

This IQ hypothesis yields five propositions regarding firm behavior and market value: 1) Firms differ in their IQ, 2) Optimal R&D (and firm spending) increases with IQ, 3) The market value of R&D disappears when we control for firm aptitude (IQ) via fixed effects (FE), 4) The market value of RD^{IQ}, persists in FE, and 5) R&D decreases market value when we instrument for the optimum R&D using IQ. We test these propositions for publicly traded firms in the 25 most R&D intensive industries using Compustat. (We also test first difference versions of these models which examine firm and market response to changes in IQ).

Methodology-antecedents of IQ

While the IQ measure is valuable in resolving some existing empirical puzzles, its real value is its ability to measure the effectiveness of firm and public innovation policies. Toward that end, the main component of our study is empirical work to characterize the antecedents of IQ. The work has two phases, an initial qualitative phase, and a subsequent quantitative phase. In the qualitative phase we plan to conduct in-depth interviews with paired firms in five to ten industries. Each pair consists of a high IQ firm and a low IQ firm in a given industry. From these interviews we hope to identify a set of factors that distinguish high and low IQ firms across the industries. In the quantitative phase, we plan to survey a broader set of firms engaged in R&D to determine the significance of each factor in explaining IQ.

Current state of the research

We had estimated IQs for all US publicly traded firms engaged in R&D as a byproduct of the absorptive capacity work. We have refined the IQ estimates in the market value study by adding advertising to the production function. We have conducted preliminary tests of the market value propositions. All propositions are supported in GLS, FE and FD specifications. We are currently engaged in robustness checks and writing.

With regard to the antecedents study, we have identified high and low IQ pairs for ten industries. We are working with the industrial research institute (IRI) and Olin Business School's development office to secure participation of these firms in interviews.