A Critical Issue for the Post-Crisis World: Innovation and Innovation Policy

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MAPI Studies Innovation

- **Our paper was motivated by growing concern among federal policy makers about the lack of yardsticks to measure the effectiveness of technology policy.**
- **In our paper, we designed a simple model of innovation in the U.S. manufacturing sector and developed innovation indicators.**
- **Our Results highlight the narrowness of the literature, which incorrectly equates R&D with innovation. We also demonstrated the potency of innovation policy. Even small, realistic changes in such key variables as expenditures on basic scientific research can have significant innovation benefits.**
- **We studied both product and process innovation. The latter is often ignored in popular and academic circles. But it has tangible competitive benefits.**

What Do Economists Know About Innovation?

- **While economists have learned a great deal since the path breaking work on technological change that was conducted during the late 1950s, innovation remains something of a mystery. While we are convinced of its critical role in material living standards, there is still much to learn about the innovative process itself and how to measure and encourage innovation.**
- **Empirical and conceptual work suggests that Research and Development spending (R&D) is an incomplete measure of innovation. R&D is one of many inputs in the innovation process.**
- **Much R&D investment does not result in marketable new products or product improvements.**
- **An Hypothesized link between academic frontier science and industrial innovation has gained much attention as of late. It has been found to exist, but not pervasively-mostly in the biotech area.**

Experimental Design of the MAPI Paper

- **We empirically modeled manufacturing innovation in a more comprehensive manner than most research to date.**
- **We defined innovation as increases in long-run economic output that result from the creation of new products and product improvements as well as new processes and process improvements.**
- **We statistically linked an empirical representation of product innovation (utility patents) and process innovation (multi-factor productivity in manufacturing) with a range of innovation inputs that were gleaned from recent literature. These inputs include basic frontier science conducted in universities, the R&D workforce, capital investment, workforce quality, and information technology investment.**
- **We used the fitted values from our models to construct process and product innovation indicators.**
- **We used our equations to simulate the impact of changes in innovation inputs on product and process innovation growth.**

What Did We Find?

- **We found that the growth rate of the science and engineering workforce lagged two years, basic university R&D lagged six years, and manufacturing R&D as a percent of manufacturing sales comprise a statistically solid model of product innovation.**
- **We tried removing the R&D variable from the product model with inconclusive results. This suggests that further study is still needed to advance our understanding of the role of R&D.**
- **The results illustrate the return to university frontier science. The equation roughly suggests that a 10 percent increase in nominal dollar expenditures on basic university R&D generates a 3.6 percent increase in a 4-year moving average of utility patents.**

What Did We Find?

- **Basic university R&D and the growth of the science workforce also matter to process innovation (the latter with the same 2-year lag as in the product model).**
- **But total economy-wide capital spending, current and lagged 3 years, is of great importance to process innovation, as well. This corroborates the results from other research, which shows that lags of several years strengthen the relationship between capital spending and business productivity.**
- **The process equation also illustrates the return to key investments. A 10 percent increase in total equipment and software investment is, at least over the short term, associated with a 2.4 percentage point increase in multi-factor productivity (MFP) in manufacturing, with a further increase of nearly 1.3 percentage points after 3 years. A 10 percent increase in university R&D would increase MFP by 1.9 percent five years hence.**

A Little Investment Goes a Long Way

- **The simulations of our equations revealed that small differences in innovation inputs (such as science and engineering workforce, university R&D expenditures, and capital investment) matter quite a bit. We looked over a 10-year horizon and inputted 3 scenarios. These scenarios were "trend" (assuming the same as the previous 10-year average) and then modest deviations from trend in the form of "optimistic" and "pessimistic" scenarios.**
- **If Policy Makers Were to Create An Increase of two-tenths of a percentage point in manufacturing R&D intensity, a slightly more than two percentage point increase in the growth of Expenditures on Frontier Science, and a 1.6 percentage point increase in the growth of the R&D workforce, they would find that product innovation growth improves markedly.**
- **With regard to process innovation, the same qualitative observations hold-although absolute growth rates are smaller. In the optimistic scenario, the process innovation growth rate more than doubles, while in the pessimistic scenario there are small annual declines.**

Conclusions and Implications of the MAPI Paper

- **We believe that our empirical work provides a benchmark of the innovative performance of the U.S. manufacturing sector. This will help policy makers and corporate strategists to better understand the determinants of innovation and to track innovation growth.**
- **The drivers of innovation extend well beyond business R&D spending. Capital investment, basic university research, and science employment all matter.**
- **Our research provides clear evidence of the importance of university R&D to both product and process innovation. We conclude that efforts to boost funding of university R&D as well as to build and encourage university-industry linkages will pay off in tangible innovation benefits.**
- **Governments must look beyond the short term in developing innovation policy. As our equations show, increases in innovation inputs do not immediately increase the growth of innovation output.**