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Can Mergers and Acquisitions Internalize Positive Externalities in Funding Innovation?

- **Technological innovation is a key driver of economic growth**
- **However, innovations usually involve huge upfront costs, and the benefits associated with these innovations are spread across various sectors of society so that the value of these benefits are not easily appropriable by the innovating firm**
- **The positive externalities of fundamental innovations cause individual firms to underinvest in them compared to the socially optimal levels, given the large costs and the limited appropriability of the benefits associated with the innovation**

Technological innovation is a key driver of economic growth. However, innovations usually involve huge upfront costs, and the benefits associated with these innovations are spread across various sectors of society so that the value of these benefits is not easily appropriable by the innovating firm. The positive externalities of fundamental innovations cause individual firms to underinvest in innovations. For example, an electric car battery manufacturer may work on a more efficient way of storing energy. If the technology is successfully developed, it can be used not only in electric cars, but also in other industries' products, such as home appliances or cell phones. While the electric car battery manufacturer can reap the profits from selling electric car batteries, it is hard for the firm to appropriate the profits of the battery arising from its use in other industries. Therefore, the electric car battery manufacturer will underinvest in the research and development (R&D) of the more efficient battery technology.

In this paper, we empirically test whether mergers and acquisitions (M&As) can internalize the positive externalities by merging firms from both the user industries and the producer industries of an innovation. After the merger or acquisition, the combined firm is able to capture the benefits associated with the innovation in both user industries and producer industries. Therefore, the combined firm should have greater incentives to fund the innovation and file more patents.

The notion that innovative activities are difficult to finance in a freely competitive marketplace has been around for a long time, and this is a typical positive externality problem in economics. Economists have realized that the market can sometimes (at least partly) internalize the positive externality. For example, beekeepers can collect honey from their hives, but the bees will also pollinate surrounding fields and thus aid farmers. If the beehives and fields are owned separately, the number of beehives may be lower than the socially optimal level. However, if the farmer also owns beehives, he or she will increase the number of beehives. Similarly, by funding firms from both the user industries and the producer industries of an innovation, the combined firm has incentives to increase the innovation because it will capture a higher proportion of the benefits of the innovation than it would otherwise.

Empirically, we test this hypothesis by using two datasets: M&As from the Thomson Reuters Securities Data Company (SDC) Platinum, which contains data on how firms merge with each other, and a novel US patent and citation dataset, which contains data on firms that file the patents and citations received by the patents. We start by defining the upstream (innovation producing) and downstream (innovation-using) firms for each industry using the patent citation dataset. If patents filed by firms from one industry are most cited by another industry in the previous 10 years, we define the former industry as the upstream industry and latter industry as the downstream industry. Firms in the upstream industry are the innovation producers, while firms in the downstream industry are the innovation users. We then show that after a merger between firms in upstream and downstream industries (i.e., both producers and users of an innovation), the combined firm becomes more innovative compared to the case where the two firms remain separate. We use various measures of innovation that are used in the literature.

Bena and Li (2014) ask a similar question and find that if two firms share the same innovation knowledge base, the combined firm after the merger is more productive compared to

the case where the two firms remain separate. One drawback of their result comes from the firm level data. For instance, Google Inc. announced an acquisition against Motorola Mobility in 2011. In the year before the announcement, Google filed around 1,000 patents in multiply technological classes, and Motorola Mobility had 6,800 pending patents, yet not all these technological classes of the acquirer share the same knowledge with the innovation of the target. The synergy of innovation related mergers and the increase of innovation output should mainly come from the targeted technological classes.

To better pin down the effect of mergers on patents, we further construct a firm tech-class level dataset. Instead of providing associated SIC codes in patent documents, the United States Patent and Trademark Office (USPTO) assigns patents to three-digit technological classes that are based on technology categorization instead of final product categorization. Because targets in about 90% of the M&A deals are private firms, their patent and technological class data are unavailable. Therefore, in this setting, we know the technological classes of the acquirers and the industries the targets belong to. Similar to the industry-to-industry relationship, we define an industry-to-technological-class relationship using the patent citation dataset. If patents filed by firms from one industry are most cited by (most likely to cite) patents from one technological class in the previous 10 years, we define that the industry and the class have a producer-user (user producer) relationship. We can then compare the affected technological classes to other unaffected classes to better pin down the effect of mergers between innovation producers and users. Moreover, a technological class can be related to the target firm in one merger and unrelated in another merger at the same time, so we can then capture the effect of related M&A within the same technological class. We show that targeted firm tech-classes become more innovative after mergers compared to other firm tech-classes.

If M&As between innovation users and producers do internalize positive externalities and incentivize innovation, firms should fund more innovation in targeted technological classes and less in other classes, compared to before mergers. We find that this is indeed the case: we observe an increase of innovation output in the targeted classes and a decline in other classes. Moreover, we find that financially unconstrained firms tend to reallocate resources to targeted classes from other unaffected classes.

Finally, we test the impact of innovation related M&As on tech-class level innovation. If a technological class is more likely to be involved in related mergers, the innovation should be

enhanced in that technological class. Our results support this hypothesis. The first identification challenge comes from the concern that the increase may be mechanical. It may be the case that innovation increases after mergers not because of the synergy or internalizing positive externality, but simply due to the fact that target firm files patents anyway. For example, Sevilier and Tian (2012) show that firms undertake M&As for the purpose of acquiring innovation. To address this concern, first, we use unrelated mergers as the control group in the firm-level regressions so that the mechanical increase cancels out with each other. This may not eliminate the concern of mechanical increase because one can argue that target firms in related mergers tend to be more innovative. We address this concern in the firm-class level regressions. Targets and acquirers in related mergers do not necessarily file patents in the same technological class. In fact, among the M&A deals with public target firms, the technological classes of acquirers and targets do not overlap in most of the deals. Moreover, even when acquirers and targets have overlapping technological classes, they are not necessarily defined as targeted classes, and are included in the control group. Therefore, the increase of patents in targeted technological classes are not caused by mechanical reasons.

The second concern is that the increase of innovation and M&A activity can be endogenous. For example, a firm with large amount of free cash may invest more in innovation and M&A activities at the same time. We address this concern by including M&A deal fixed effects and technological class fixed effects in the regressions. To further establish a causal effect between M&A activity and innovation, we follow the method developed by Savor and Lu (2009) and compare the change of innovation around successful mergers to that of mergers withdrawn for reasons that are exogenous to innovation. For example, we exclude mergers that are withdrawn due to the disagreement on the future development strategy between the acquirer and the target because this reason may be related to future innovation strategy. By ruling out the systematic relation between a firm's innovation and the probability of a failed merger, this strategy can help identify the causal effect of a firm's M&A on its innovation output. A firm that decides to invest more in innovation can choose to acquire another firm with relevant knowledge to achieve this goal. However, in the case where the merger is withdrawn, the innovation output in that firm does not increase. Our result is consistent with existing literature and shows that the innovation output increases more after successful user-producer mergers compared to failed user-producer mergers.

Another identification challenge comes from shocks at the industry level. For instance, suppose an industry is growing fast and its product market is becoming more and more competitive. Firms will merge to exploit synergies to differentiate its products from its competitors. By the same token, the innovation of the industry may also reach the peak given the inverted-U shape relationship between competition and innovation (Aghion, et al 2005). This industry with more patents are more likely to become the top producer or user of innovation of other industries. Therefore, industry level shocks may be driving both innovation related M&As and innovation outputs. Fortunately, the concern of such shocks can be mitigated by using firm tech-class level data because the tech-class level relationship is less correlated with acquirers' industry condition. In addition, we control for any shocks to technological classes by including a full set of class-year fixed effects. The fixed effects are identified because a technological class can be involved in a related merger and an unrelated merger at the same time.

Our paper contributes to the M&A literature and the innovation literature in at least two ways. We are the first to develop a measure of innovation-user and innovation-producer industries and a user-producer relationship between industries and technological classes, which can be used in future research. And we show that M&As between an innovation-user and an innovation producer can internalize the positive externalities associated with funding innovation, and the increase of innovation is driven by the targeted technological classes.