Project Selection and Investment Carryovers in the Drug Development Process

Effective project selection seeks the benefit of past knowledge and success while driving competitive differentiation. On the one hand, firms benefit from undertaking R&D activities in domains where they can draw on prior knowledge and which are technologically similar to their rivals. The existence of R&D spillovers affects firm-level productivity, whereby R&D output is positively related to the R&D investment of “technological neighbors.” On the other hand, competition may discourage follow-up investments as pioneering firms “fish out the pool” and capture the most profitable opportunities. As firms constantly strive to ensure returns and growth in increasingly competitive markets, it is imperative to understand whether the “right” projects are selected and the “wrong” ones are terminated and what drives project success. The question arises: how do firms appropriate scarce resources in the face of competitive pressures?

We leverage a novel data set which allows us to track the drug development pipelines of the top 15 pharmaceutical companies over the last two decades. We use this data set to follow individual development projects at the clinical indication-level as they move into, through, and out of the pipeline, and as they move between firms through deals and M&As. As such, this affords us the ability to follow projects as firms and their competitors decide to either invest in or terminate them. The first part of the analysis thus revolves around uncovering the internal (prior experience in a technological domain) and external (competitive pressures and rivals' technological signals) drivers of resource allocation decision.

The results provide empirical evidence for several factors which affect the decision to invest in or forgo a drug development project. First, we analyze how prior experience in a technological domain (i.e., clinical indication) affects the likelihood of selecting a future project in the same domain. The outcomes of past projects affect the cost, value, and probability of success
of the next project iteration. Thus, firms partly make their selection decisions by leveraging internal experience to update their beliefs regarding the likelihood and value of successfully bringing an extra drug to market for the same indication. Even though having a drug on the market may negatively affect the value of a second drug in the same market, we find that firms are more likely to invest in projects in technological domains where prior investments and projects have succeeded. In other words, firms are likely to allocate resources to product lines where the underlying technology has succeeded in the past. On the other hand, we find evidence that where a firm has failed in the past, it is less likely to invest in the same domain in the future.

Second, we empirically demonstrate that firms also decide where to allocate resources based on the decisions of their rivals. As rivals invest in early-stage and late-stage projects, the firm takes these investments as signals which reveal information about the technological viability of individual solutions in the domain. Rival investments in early-stage projects at the discovery and pre-clinical phases are uninformative technological signals; yet, they are a strong indication of a rival's intention to enter the market. Thus, rather than compete in a highly uncertain technological domain, firms are likely to diversify efforts towards different markets. However, late-stage investments by rivals to send drug candidates to clinical trials are strong technological signals regarding the perceived viability of the drug candidates and the technological domain. These technological signals dominate the competitive signal, inducing firms to target and invest in projects in the same domain as their competitors. Moreover, this effect is markedly nuanced: firms may not enter a domain if their rivals have too great a technological head-start. If rivals are too far ahead in the development process, the likelihood of entering the same domain decreases.

Yet, the analysis of what determines effective project selection necessitates the examination of those factors which drive project success. In an extension to the first part of the study, we seek
to uncover which project- and firm-level characteristics anticipate the success of a drug. However, if the selection decision and the ultimate success of a project are both driven by some unobservable factor, the empirical estimation of the determinants of success may be biased. We acknowledge the endogenous nature of the decision to select which projects to invest in by estimating bivariate probit models with selection.

The analysis first shows that returns to investments for a specific clinical indication persist to future projects by continuing to deliver value. In other words, we find strong evidence of investment carryovers. As firms send compounds to clinical trials, they uncover the technical characteristics of the technological domain. Thus, conditional on being selected into clinical trials, future projects in previously successful domains have a significantly higher probability of success: one extra prior success increases a follow-up project’s likelihood of success by 14%. We provide further anecdotal evidence that such carryovers do not necessarily represent only incremental improvements, but they may also lead to significant innovations.

This study enhances our understanding of how firms make investments under uncertainty and allocate resources to projects. We show how firms balance technological signals and competitive forces in deciding which projects to pursue. Our findings also provide actionable guidance for senior managers: the results suggest that once a particular solution in a domain has been found, it pays to focus on the domain and build “on top” of prior successes. Thus, strategies that focus on consistently building the scientific understanding over longer R&D programmes might pay off in the long run. Moreover, we find that it is mainly project- and operational-level characteristics (such as the quality or technology of the drug) which are the strongest predictors of success and failure. The levers which decision-makers and project managers may pull to influence success therefore seem to be within arm's reach.