Endogenous Appropriability

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Innovation’s private value is typically less than its social value, so to encourage innovation, researchers in economics and strategy have focused on how innovators can appropriate value across different economic, institutional, and strategic environments (Teece 1986; Gans and Stern 2003). For start-ups without pre-existing assets such as manufacturing capabilities or brand reputation, researchers have identified appropriability through formal intellectual property protection (which we will refer to as a “control” approach) and first-mover competitive advantage (which we will refer to as an “execution” approach) as distinct paths.

Most research has taken a start-up’s appropriability regime as exogenous, i.e., environmentally determined (e.g., control-orientation in biotechnology, and execution-orientation in Internet software). This paper develops a simple model highlighting the interplay between control and execution as alternative routes to appropriability. Whereas a control strategy allows an innovator to forestall imitation once established, control itself takes time, and so can delay market entry. In contrast, an execution strategy is premised on taking advantage of the benefits arising from rapid market entry such as customer learning, reputational advantages, or coordination on a standard. Does the start-up shield itself from competition through investing in entry barriers or does it invest in dynamic capabilities allowing it to “get ahead, stay ahead”?

We derive two main results. First, the choices of control and execution are strategic substitutes. Notably, when the ability to learn from early customer feedback in the marketplace is sufficiently high, an entrepreneur might choose not to invest in intellectual property protection even if such protection is costless and effective. Second, the choice between control and execution interacts with other key strategic choices such as whether to pursue a narrow or broad customer segment, or whether to commercialize a “minimal viable product” versus a more robust version. Innovation appropriability depends not only on the instruments available to an innovator, but on how those instruments interact with each other as part of the firm’s (endogenous) entrepreneurial strategy (see Ching, Gans, and Stern 2016; Gans, Stern, and Wu 2016).

I. The Model

We consider an entrepreneur, who has already developed an idea with a maximal (social) value in any given period, equal to one. To introduce an innovation, the innovator incurs a one-time sunk development cost $C$, and each firm operating in the market incurs a per-period fixed operating cost of $c$ ($c < 1$); the potential net present value of the market is, therefore, $\frac{1 - c}{1 - \delta} - C$, where $\delta$ is the discount rate.

Innovators can lose their ability to capture value in two ways: imitation and competitive follow-on innovation. Imitation occurs in period $t + 1$ (with certainty, and resulting in subsequent profits of zero) if the idea is introduced into the market in $t$ without any intellectual property protection and the start-up does not undertake activities during $t$ to obtain a period $t + 1$ advantage over potential rivals. Alternatively, the potential for follow-on innovation arises each period with probability $\lambda$, and this can be introduced by the start-up or a competitor (depending on the
appropriability regime) at an incremental sunk cost of C (for simplicity, we assume the value of the market remains the same (i.e., one) over time).

If the innovator releases the product to the market without intellectual property protection or capabilities for future advantage, they enjoy a single-period of monopoly followed by complete loss of appropriability (we refer to this possibility as opportunistic entry).

Entrepreneurs can mitigate this through control and/or execution. Under control, the start-up defers product launch until they can control their innovation has been established through mechanisms such as formal intellectual property protection, contract-based control mechanisms, or product design approaches such as through the establishment of proprietary architectures. The key assumption is that control takes time to establish. We focus on the case where the only cost of control is an opportunity cost (i.e., there are zero financial costs). The control strategy is assumed to yield two distinct benefits: precluding imitative competition (with probability one) and, for any new follow-on innovation opportunity, allows the start-up to have priority over that subsequent innovation with probability α (e.g., as a measure of intellectual property breadth).

Under execution, there is immediate product introduction at a per-period incremental cost e (< 1 − c), yielding two distinct benefits. First, the start-up establishes a marginal cost advantage over potential rivals in the subsequent period (though these capabilities decay after one period and so require reinvestment each period). Second, the start-up can sense and take advantage of follow-on innovation opportunities which match these capabilities with probability β (a measure of the impact of product market learning on their ability to “get ahead, stay ahead”). As such, under both control and execution, an entrepreneur has the possibility to secure rents from follow-on innovations.

II. Control versus Execution

There are four appropriability strategies: opportunistic entry, control, execution, or both. Taking advantage of the fact that the optimal strategy will be independent of whether that was the initial innovation opportunity or a subsequent follow-on innovation opportunity (and so the strategy is state-independent), we can compare each strategy’s stationary net present value.

Opportunistic Entry.—The entrepreneur commercializes the product immediately at a cost C and has the market to themselves for one period. However, imitative entry in the next period and beyond results in a total loss of appropriability. Under opportunistic entry, the entrepreneur earns

\[ v_{OE} = 1 - c - C \]

Control.—The entrepreneur establishes control after a one-period delay but loses control each period (including during the time before they initially come to market) with probability \( λ(1 − α) \). The net present value is

\[ v_{CON} = \delta \frac{(1 - λ(1 - α))(1 - c) − λαC}{1 - (1 - λ(1 - α))δ}. \]

Execution.—The entrepreneur enters immediately but incurs an incremental per-period cost to develop capabilities that foreclose imitative entry and gain an advantage on access to follow-on innovation:

\[ v_{EXE} = \frac{1 - c - e - λβδC}{1 - (1 - λ(1 - β))δ}. \]

Control and Execution.—This involves the entrepreneur pursuing both strategies, which allows them to exploit both directions in sustaining leadership, but also they must incur both costs. Their product introduction is delayed for one period yet they must incur the execution cost e in all periods:

\[ v_{BOTH} = \frac{-e + (1 - λ(1 - α)(1 - β)δ(1 - c) − λ(α + β - αβ)δC}{1 - (1 - λ(1 - α)(1 - β))δ}. \]

Comparing these yields our first result.

PROPOSITION 1: Control and execution are substitute strategies.

This means that the marginal return to either approach is reduced if the other is being undertaken (i.e., \( v_{BOTH} - v_{EXE} \leq v_{CON} - v_{OE} \)). This condition holds because while both strategies
have distinct costs, both strategies yield a similar benefit—the deterrence of short-term entry and the potential to forestall follow-on innovation competition. While the costs of each strategy are independent, the marginal benefit of each is reduced when the other strategy is also implemented. For start-ups, where both human and financial resources are highly constrained, there will be a meaningful trade-off between an investment in the types of activities that would allow the firm to forestall imitation or gain a legal right to block follow-on innovation versus those activities that would focus the young firm on learning about customers or developing the capabilities required to “get ahead, stay ahead.” As we emphasize in Ching, Gans, and Stern (2016), a particularly interesting case to consider is when, because of uncertainty about how each strategy will be realized in the market, the start-up is unable to rank these alternatives in terms of their ability to forestall follow-on innovative entry by competitors (i.e., \( \alpha = \beta \)). In this scenario, execution will be preferred to control if \( 1 - \delta (1 - \lambda (1 - \beta)) > \frac{e}{1 - \alpha} \). Execution is chosen when the rate of generation of product innovations is high, or the ability to leverage current incumbency into future leadership is low. As well, for a sufficiently low discount factor (i.e., when the start-up is impatient to earn revenue), execution will again be preferred. Importantly, we find that a start-up innovator may choose to forego intellectual property as part of their optimal strategy even when formal intellectual property protection is costless and yields strict appropriability once established. Finally, when the new (patentable) product rate (\( \lambda \)) is rapid, execution is more likely, lowering observed patent rates.

III. Entrepreneurial Strategy Complementarities

We now consider how the appropriability choice interacts with other elements of entrepreneurial strategy.

A. Customer

For a given innovation, a start-up often faces a choice of whether to focus initially on a niche customer base or attempt to appeal to the mass market. Targeting a smaller customer segment comes at the expense of demand but offers the potential for a lower cost of learning about customers (allowing the firm to maintain a dynamic advantage over imitative rivals).

How does this customer choice relate to the choice between control and execution? Consider a start-up who is considering a market segment size choice, \( \sigma < 1 \), where the net returns each period are \( \sigma - c(\sigma) \) where \( c \) is an increasing and convex function of \( \sigma \). The variable \( \sigma \) both determines the size of the (served) market each period, and impacts the per-period cost of market operation (since serving a larger market is more expensive at an increasing rate). As well, suppose that the choice of \( \sigma \) impacts the cost of implementing an execution-oriented approach: \( e \) is also an increasing function of \( \sigma \); in other words, with a broader market segment, the start-up faces a higher cost of effort to maintain dynamic capabilities that forestall imitative entry and allow for a higher chance of taking advantage of follow-on innovation opportunities (\( \beta \)). Contrast this with the cost structure associated with a control-oriented strategy. Control costs—such as obtaining formal intellectual property protection or proprietary product design—are largely independent of the size of the market being served. At the same time, the ability to use control over a design and customer base in the current generation as a means for deterring follow-on innovation competition in subsequent generations is likely enhanced (at least on the margin) when the start-up serves more customers initially. In other words, \( \alpha \) is also a function of \( \sigma \) (\( \alpha'(\sigma) \geq 0 \)); the larger the market you acquire, the easier it is to defend market leadership against follow-on innovation. The resulting optimization problem for the start-up establishes complementarity between market size and the choice of appropriability regime.

**PROPOSITION 2:** Suppose that \( e'(\sigma) > 0 \) and \( \alpha'(\sigma) \geq 0 \). Let \( \sigma^*(s) \) be the optimal customer share of the entrepreneur under \( s \in \{EXE, CON\} \), respectively. Then \( \sigma^*(EXE) < \sigma^*(CON) \).

**PROOF:**

In a period where control is chosen the optimal share is determined by

\[
\max_{\sigma} \{-C + \left(1 - \lambda (1 - \alpha(\sigma))\right)\delta (\sigma - c(\sigma) + v_{CON}) - \lambda \alpha(\sigma) \delta C\}.
\]
This gives a first order condition:
\[
\lambda \alpha'(\sigma) \delta (\sigma - c(\sigma) + v_{CON} - C) \\
+ (1 - \lambda (1 - \alpha(\sigma))) \delta (1 - c'(\sigma)) = 0.
\]
The first term is positive, implying that
\[
1 \leq c'(\sigma^*(CON)).
\]
For a period where execution is chosen, the optimal share is determined by
\[
\max_{\sigma} \{-C + \sigma - c(\sigma) - e(\sigma) \\
+ (1 - \lambda (1 - \beta)) \delta v_{EXE} - \lambda \beta \delta C\}.
\]
This gives a first order condition: \[1 - c'(\sigma) = e'(\sigma) \] implying that \[1 > c'(\sigma^*(EXE))\].
Recalling that \(e\) is convex completes the proof. ■

Intuitively, the efficacy of control (versus execution) is enhanced if the start-up secures a larger customer base. Though obviously simplified, this result suggests that we will observe an execution strategy associated with a smaller initial customer base upon launch than a control strategy; recalling that in the latter case, product launch comes later.

B. Technology

A second domain for strategic choice on the part of a start-up innovator is whether to bring an early-stage version of their product to market to receive customer feedback before undertaking subsequent R&D investment (a “minimum viable product” in the terminology of the “lean start-up” movement) or whether to ensure that the first product is robust with a high level of functionality and reliability. To see how this choice of whether to release a “beta” version of a product interacts with the control/execution choice, consider an alternative to our baseline model where the entrepreneur can forego paying the fixed product development cost \(C\), and instead immediately come to market with an “MVP” that involves a lower value for each consumer, \(u_{MVP} < 1\), and a higher per-period cost of serving the market, \(c_{MVP} > c\). To ensure that an investment in execution remains a viable strategy, assume that \((u_{MVP} - c_{MVP}) > e\). Finally, assume that the start-up cannot rank the long-term profitability of alternative commercialization paths (i.e., \(\alpha = \beta\)). The start-up innovator, therefore, faces the simultaneous choice between control and execution and a choice between an MVP or traditional product development approach.

**PROPOSITION 3:** For \(\alpha = \beta\), an MVP is a complement (substitute) to execution (control).

**PROOF:**
Note that the return to execution versus control (under MVP) is:
\[
\frac{(u_{MVP} - c_{MVP}) - e}{1 - (1 - \lambda (1 - \beta)) \delta} - \delta \frac{1 - \lambda (1 - \alpha)(u_{MVP} - c_{MVP})}{1 - (1 - \lambda (1 - \alpha)) \delta}.
\]
While without MVP the relative return to execution is:
\[
\delta \frac{(1 - \lambda (1 - \beta))(1 - c - e) - \lambda \beta C}{1 - (1 - \lambda (1 - \beta)) \delta} - \delta \frac{(1 - \lambda (1 - \alpha))(1 - c) - \lambda \alpha C}{1 - (1 - \lambda (1 - \alpha)) \delta}.
\]
An MVP will be a complement with execution if the relative return to execution rises when an MVP is chosen, i.e., if
\[
u_{MVP} - c_{MVP} - e \\
- \delta (1 - \lambda (1 - \beta))(1 - c - e) + \lambda \beta C \\
> (1 - \lambda (1 - \alpha)) \delta (u_{MVP} - c_{MVP} - (1 - c)) \\
+ \lambda \alpha C
\]
\[
\Rightarrow (u_{MVP} - c_{MVP}) > e,
\]
which is true by assumption. The substitution result is the symmetric dual of this result. ■

Put simply, both execution and an MVP product development strategy prioritize early marketplace introduction at the expense of the establishment of long-term competitive advantage. Control involves more patience because of implementation delays, and this is complementary to a product development approach that focuses on “getting the product right.”
C. Identity

We finally consider how appropriability strategy depends on the “identity” of the start-up founders themselves. The opportunity cost of time borne by the start-up to engage in execution, the costs of navigating complex business activities associated with control, or even the innovator’s discount rate are likely to depend not simply on technology and market characteristics, but on the identity of the start-up innovators. For example, these parameters are likely different for younger innovators (e.g., students who have a low cost of time but who are unfamiliar with complex business processes) than more seasoned innovators such as a serial entrepreneur or faculty member. As such, execution will have higher returns for younger, less experienced founders while control will have relatively high returns for more senior experienced innovators.

In Ching, Gans, and Stern (2016), we explore this by focusing on a sample of paper-start-up pairs (i.e., innovations from publications jointly authored by faculty and students resulting in a new firm). We find that faculty-led start-ups are more heavily oriented toward formal intellectual property rights, while student-led firms are more timely in their speed from publication to firm founding, first funding, and first product introduction.

V. Conclusion

Our objective has been simply to raise the prospect that the realized appropriability regime governing an innovation depends not only on the instruments available to an innovator to protect private returns, but how those instruments interact with each other as part of the firm’s entrepreneurial strategy. This approach stands in contrast to most research that has taken the appropriability regime to be an exogenous feature of the environment. Control and execution are not simply two mechanisms for appropriability, but can be strategic substitutes, and so start-up innovators will choose between them as they consider how to commercialize their innovations. In some cases, appropriability may require investments in both control and execution so they may be correlated (Ching, Gans, and Stern 2016 find evidence for substitutability). When start-ups face a clear choice, this interacts in natural and potentially testable ways with other elements of the firm’s entrepreneurial strategy (Gans, Stern, and Wu 2016). How these arise in practice and the nature of entrepreneurial choice are promising avenues for further research.

REFERENCES


