Endogenous Appropriability

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Innovation appropriability is generally taken as a characteristic of the environment afforded, say, by the strength of formal intellectual property protection. Here we demonstrate that how appropriability is achieved is a choice made by the entrepreneur. They can choose *control* – protection from future competition via formal intellectual property (such as patents, copyrights or trade secrets) or other pre-emptive entry barriers – or *execution* – a more rapid approach to market in pursuit of capabilities that can be leveraged for future competitive advantage. An execution approach can be profitable even when the conditions for control are favorable. We show how the appropriability choice interacts with other choices such as customer type or technology.

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Since Nelson (1959) and Arrow (1962), economists have understood that the private value of an innovation may be significantly lower than its social value, and that this gap may result in significant underinvestment in innovation. This insight has prompted significant study by economists and researchers in related fields such as strategy focusing on how innovators can appropriate the value of their innovations, and how this varies across different economic, institutional and strategic environments (Teece, 1986; Cohen, Nelson, and Walsh, 2000).

Attention has been focused on the appropriability of innovations arising in new firms (i.e., entrepreneurial start-ups) that are unable to leverage existing capital or product market assets such as manufacturing capabilities or brand reputation (Aghion and Howitt, 1992; Gans and Stern, 2003). This literature has identified at least two appropriability approaches for start-up innovators: reliance on formal intellectual property protection such as patents and copyrights (which we will refer to as a "control" approach) and first-mover competitive advantage (which we will refer to as an "execution" approach). Most theoretical and empirical research in economics and strategy have taken the appropriability regime governing a given start-up innovation to be exogenous, resulting from the economic and strategic environment in which the start-up operates. For example, start-up innovators in the biotechnology industry such as Genentech are presumed to appropriate returns through their ability to leverage the interplay between strong formal intellectual property rights and regulatory entry barriers (Pisano, 1997), while Internet software entrepreneurs such as Netflix or Amazon are presumed to appropriate through rapid time-to-market and their ability to learn from customers to "get ahead, stay ahead" (Teece, Pisano and Shuen, 1997; Sutton, 2012).

This paper develops a simple model highlighting the interplay between control and execution as alternative routes to appropriability. A core element of this model is that, whereas a control strategy allows an innovator to forestall imitation once control is established, control itself takes time to establish, 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 learning from customers, early reputational advantages or coordination on a standard. In effect, the sharpest distinction is between choices that are predicated on the startup being shielded from future competition by entry barriers (as might be afforded by formal intellectual property protection, control of key assets or some network effects) versus that competition being met by superior quality or cost capabilities that are built and developed early. In other words, investing in control is akin to investing to compete for the market whereas investing in execution is competing in the market. In one case, appropriation is through pure future rents while, in the other, it is through quasi-rents. However, it is important to note that the distinction can be subtler in practice. For instance, a firm might move quickly to generate network effects but the end result may be an effective entry barrier that makes switching to future competitors harder (e.g., the case of Facebook). In this situation, the end goal may be control but some initial investments may be indistinguishable from a pure focus on execution.

We derive two main results. First, we find that, as an endogenous choice of the start-up, control and execution are strategic substitutes. Rather than simply reflecting exogenous and independent environmental conditions governing the fraction of value captured by the innovator, the choice of an appropriability strategy by the start-up shapes the appropriability regime that ultimately governs the innovation. For example, 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 for their innovation, even if intellectual property protection is costless. Second, the choice between control and execution is interdependent with other key strategic choices for start-up entrepreneurs, such as their choice to pursue a narrow or broad customer segment, or their choice of whether to commercialize a "minimal viable product" version of their innovation or only commercialize products with high levels of technical functionality and reliability.

I. The Model

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

There are two potential ways that the innovator can lose their ability to capture value from the idea: imitation and competitive follow-on innovation. Imitation occurs in period t+1 (with certainty, and resulting in subsequent profits of 0) 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.

A separate risk facing the innovator is the potential for follow-on innovation commercialized by a rival. A potential follow-on innovation arises each period with probability λ that can be introduced into the market at an incremental sunk cost of C. For simplicity, we assume that, though the follow-on innovation when commercialized supercedes the earlier product generation (i.e., the original start-up will end up earning 0 in subsequent periods if the follow-on innovation is introduced by a competitor), the value of the market remains the same across periods (i.e., at a unit mass of 1 with WTP of 1).[1]

If the entrepreneur simply releases the product to the market without intellectual property protection and without developing capabilities yielding a marginal cost advantage into the next period, the innovator will enjoy a single-period of monopoly followed by the complete loss of appropriability (we will refer to this possibility as *opportunistic entry*). As such, the entrepreneur will evaluate alternative mechanisms for enhancing their appropriability through their ability to forestall imitation and competitive follow-on innovation.

We consider two strategies: control and execution. Under control, the start-up delays product launch until their ability to control their innovation has been established, such as through formal intellectual property protection such as patents or copyrights, contract-based control mechanisms such as non-disclosure agreements or non-compete agreements with employees, or product design approaches such as through the establishment of proprietary architectures.[2] The key assumption is that, even when control is effective, control takes time to establish (or, equivalently, results in a delay in the ability to bring the product to market quickly).[3,4] Control yields two distinct benefits: it precludes 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 (which we can interpret then as a measure of the breadth of control over the innovation; as in O'Donoghue, Scotchmer and Thisse, 1998).

Alternatively, under execution, the entrepreneur introduces the product to the market immediately, and incurs a per-period incremental cost e ($< 1 - c$), yielding two distinct benefits through the development of product market experience capabilities. First, these capabilities allow

[1] This is similar to the standard set-up employed in the quality ladder models (O'Donoghue, Scotchmer and Thisse, 1998).

[2] While we focus here on the direct benefits from control as the start-up brings the product to market, formal intellectual property rights will also be complementary with cooperation (as opposed to competition) with established product market players, as formal intellectual property rights allows start-ups and established firms to overcome the disclosure problem inherent to negotiating an agreement (Gans and Stern, 2000; Gans, Hsu, and Stern, 2002).

[3] In Ching, Gans and Stern (2016), we find that, among a group of academic entrepreneurs with start-ups with a basis in an earlier academic paper, those start-ups receiving intellectual property protection were significantly delayed in their time to firm founding, first external funding, and first product launch.

[4] This may also manifest itself in a targeted approach to build network effects such as when Facebook initially restricted access to particular educational institutions.

the start-up to establish 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, execution allows the start-up to sense and take advantage of follow-on innovation opportunities that match these capabilities (Gans, 2016). Thus, we assume that with probability β, (a measure of the impact of product market learning on their ability to "get ahead, stay ahead"), the entrepreneur can exploit a follow-on innovation faster than any rivals and capture the market for that product generation. Therefore, under both control and execution, if successful, an entrepreneur can secure rents from follow-on innovations.

II. Control Versus Execution

We now turn to analysis of the appropriability strategy that will be undertaken by the start-up. There are four options for investment in the face of a new innovation: opportunistic entry, control, execution, or control+execution. To do so, we start by describing the stationary net present value from each strategy, taking advantage of the fact that, given the model set-up, the optimal strategy chosen in response to a given innovation opportunity will be independent of whether that was the initial innovation opportunity or a subsequent follow-on innovation opportunity (and so the strategy is time-independent).

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 all periods thereafter) results in a total loss of subsequent appropriability. Under opportunistic entry, the entrepreneur earns:

(1) $v_{OE} - C = 1 - c - C \Rightarrow v_{OE} = 1 - c$

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 $\lambda(1\text{-}\alpha)$. The net present value, v_{CON}, is therefore:

(2) $v_{CON} - C = \big(1 - \lambda(1-\alpha)\big)\delta(1 - c + v_{CON}) - \lambda\alpha\delta C - C$

$\Rightarrow v_{CON} = \delta\frac{(1-\lambda(1-\alpha))(1-c)-\lambda\alpha C}{1-(1-\lambda(1-\alpha))\delta}$

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. The net present value of this strategy is therefore:

(3) $v_{EXE} - C = -C + 1 - c - e + \big(1 - \lambda(1-\beta)\big)\delta v_{EXE} - \lambda\beta\delta C$

$$\Rightarrow v_{EXE} = \frac{1-c-e-\lambda\beta\delta C}{1-\big(1-\lambda(1-\beta)\big)\delta}$$

Control + 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 (continual effort and delay). Thus, the expected payoff is:

(4) $v_{BOTH} - C = -C - e - \big(1 - \lambda(1-\alpha)(1-\beta)\big)\delta(1 - c + v_{BOTH}) - \lambda(\alpha + \beta - \alpha\beta)\delta C$

$$\Rightarrow v_{BOTH} = \frac{-e+\big(1-\lambda(1-\alpha)(1-\beta)\big)\delta(1-c)-\lambda(\alpha+\beta-\alpha\beta)\delta C}{1-\big(1-\lambda(1-\alpha)(1-\beta)\big)\delta}$$

Our first result is that execution and control are substitute strategies from the perspective of the entrepreneur. This means that the marginal return to either one is reduced if the other is being undertaken. This is summarised in the following proposition.

Proposition 1. *Control and execution are substitute strategies.*

Note that, formally, the two strategies are substitutes if $v_{BOTH} - v_{EXE} \leq v_{CON} - v_{OE}$. The proposition is proven by putting in the values into the inequality and showing it holds. Intuitively, both strategies have distinct costs – execution has an on-going cost while control has the cost of delay – but they have benefits that are comparable – each allows competition to be forestalled in the short-term and potentially in the long-term as well. Thus, the short-term benefits of each are perfectly substitutable while the long-term benefits are substitutable imperfectly. Given this, if both strategies are undertaken together, the costs of each are not mitigated but the marginal benefits of each are diluted. Hence, they are substitutes.

This implies that a resource-constrained firm – who faces difficulty in bearing the costs of either strategy – will likely find it optimal to focus on one strategy or the other. The choice between them will depend on their relative long-term benefits versus their relative costs. Note that when both benefits are equal (i.e., $\alpha = \beta$), then execution will be preferred to control if: $1 - \delta\big(1 - \lambda(1-\beta)\big) > \frac{e}{1-c}$. By our earlier assumption, the RHS is less than 1 while the LHS approaches 1 as the discount factor becomes small. Otherwise the RHS is increasing in λ. Intuitively, execution is preferable when either the rate of generation of product innovations is high or the ability (with either strategy) to leverage current incumbency into leadership in the next generation is low. All of this suggests that the more short-term focussed an entrepreneur is either in access to financial resources, returns to the current idea are front-loaded in time or because of the inter-generational product competitiveness in the market, the more likely execution is to be the optimal strategy.

In summary, we have demonstrated here that focusing on execution is a viable, alternative strategy to investing in control. What is more, while it is possible to pursue both strategies, they are substitutes meaning that resource-constrained entrepreneurs will likely find it optimal to focus on one or the other. In the next section, we consider what this means for other strategic choices that may be within an entrepreneur's choice set.

III. Entrepreneurial Strategy Complementarities

We now turn to consider how the choice of whether to focus on execution impacts on other strategic choices an entrepreneur might make.

A. Customer

Entrepreneurial ventures often have a choice as to the market or market segment they pursue (Gans, Stern and Wu, 2016). One important dimension of this choice is whether to pursue a niche or a mass market. The difference between the two is that the mass market is likely to face broader competition from incumbents compared to the niche while the niche market may have a lower scale than the mass market. How does the choice of customer relate to a venture's broader choice over whether to pursue execution or control?

To consider this suppose that a niche market targets a smaller share of customers ($\sigma < 1$) but also lowers the costs of being active in the market. Thus, suppose that the net return each period is $\sigma - c(\sigma)$ where c is now an increasing and convex function of σ. The idea is that serving more consumers requires a greater level of fixed costs in each period.

At the same time, suppose that customer share (σ) impacts on the total effort required to maintain a competitive advantage for those customers. Thus, let e (the required effort to maintain a competitive advantage in each period) be a function of σ with $e'(\sigma) > 0$; that is, the broader your target market, the higher the effort required to have a competitive advantage based on capabilities.

What about the impact of this choice on the value realised from control? When one considers control via intellectual property protection, the issue is the overall strength of that protection which is something that considers the nature of technology rather than the customer group being targeted.

It may be that a narrowly specified patent is associated with a niche market and is easier to obtain and defend but it could equally be the case that a narrowly specified patent is all that is required to be defensible when a large number of customers are served. Hence, we assume there is no readily apparent impact of this choice on control via intellectual property protection.

What about control via the acquisition of key resources in the industry, most specifically, a locked-in share of consumers in a market? If control is to be achieved via this route, then there is a minimum share of customers that would have to be targeted. This suggests that α is a function is σ with $\alpha'(\sigma) \geq 0$; that is, the larger the share of customers you acquire, the easier it is to defend your market leadership as the next generation technology arises.

Given this, we can demonstrate the following proposition.

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: To see this, note that in a period where control is chosen the optimal share is determined by:

$$max_{\sigma}\{-C + (1-\lambda(1-\alpha(\sigma))\delta(\sigma - c(\sigma) + v_{CON}) - \lambda\alpha(\sigma)\delta C\}$$

This gives a first order condition:

$$\lambda\alpha'(\sigma)\delta(\sigma - c(\sigma) + v_{CON} - C) + (1-\lambda(1-\alpha(\sigma))\delta\big(1 - c'(\sigma)\big) = 0$$

Note that, as the first term is positive, this implies that $1 \leq c'(\sigma^*(CON))$ (holding with equality if $\alpha'(\sigma) = 0$).

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: $1 - c'(\sigma) = e'(\sigma)$ which implies that $1 > c'(\sigma^*(EXE))$. Recalling that c is convex completes the proof. □

Intuitively, the efficacy of control is enhanced if the venture secures a larger customer base whereas the reverse is true for execution. Thus, we expect to see 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.

It is important to note that this result is deliberately simplified. It may well be that the set of customers targeted has broader impacts than just on e and α as assumed here. However, these two effects are likely to be more general and hence, be a driver of the choice and worth highlighting.

B. Technology

Obviously most entrepreneurial ventures are based on certain technical insights and so there is only a limited scope to 'choose your technology.' However, there is often a choice – especially for product-oriented ventures – to prioritise how products are delivered to consumers and the quality of the product consumers are sold.

For instance, as emphasised by Ries (2010), a resource-constrained venture can learn more about the market for their product by launching what is termed a 'minimum viable product' or MVP. In general, this product is one that involves high costs of serving consumers while learning takes place. The advantage is that the product can be brought to market quickly. Alternatively, a venture can invest in 'getting the product right.' In this case, the likely trajectory of consumer value is likely to be higher. The cost of this is that, in contrast to providing an MVP, it takes time for superior value to reach consumers.

To formalize this, suppose that our baseline model currently captures the 'getting the product right' aspect – that is, a right product is one with a value to consumers of 1 and fixed costs of provision of *c*. However, suppose that to provide this product you have to wait one period after you expend development costs, *C*. By contrast, you can launch an MVP immediately but at a higher cost $c_{MVP} > c$ and lower value, $u_{MVP} < 1$, where we assume that $(u_{MVP} - c_{MVP}) > e$. The advantage of doing this is that it saves on development costs as you are able to test the product in the market and learn from it. To capture this, we assume that *C* need not be incurred in this case.

Given this, we can prove the following:

Proposition 3. *Suppose that $\alpha = \beta$. Choosing an MVP is a complement to execution and a substitute to control.*

PROOF: Note that the return to execution versus control (under MVP) is:

$$\frac{(u_{MVP} - c_{MVP}) - e}{1 - \big(1 - \lambda(1-\beta)\big)\delta} - \delta\frac{\big(1 - \lambda(1-\alpha)\big)(u_{MVP} - c_{MVP})}{1 - \big(1 - \lambda(1-\alpha)\big)\delta}$$

While under 'right' the relative return to execution is:

$$\delta\frac{\big(1 - \lambda(1-\beta)\big)(1 - c - e) - \lambda\beta C}{1 - \big(1 - \lambda(1-\beta)\big)\delta} - \delta\frac{\big(1 - \lambda(1-\alpha)\big)(1 - c) - \lambda\alpha C}{1 - \big(1 - \lambda(1-\alpha)\big)\delta}$$

An MVP will be a complement with execution if the relative return to execution rises when an MVP is chosen. This happens if:

$$u_{MVP} - c_{MVP} - e - \delta\big(1 - \lambda(1-\beta)\big)(1 - c - e) + \lambda\beta C$$
$$> \big(1 - \lambda(1-\alpha)\big)\delta\big(u_{MVP} - c_{MVP} - (1 - c)\big) + \lambda\alpha C$$
$$\Rightarrow (u_{MVP} - c_{MVP}) > e$$

which is assumed to be true. The substitution result is the symmetric dual of this result. □

Put simply, execution relies on earlier returns which is enhanced when those returns are front-loaded in time (as they are with an MVP). By contrast, control already embeds greater patience which is compatible with other strategies that rely on patience such as 'getting the product right.'

IV. Conclusion

This paper examines how competition can be a choice for entrepreneurial firms. While this had been explored with respect to whether entrepreneurs compete with established firms or not (Gans and Stern, 2000), here we introduce a new dimension in terms of how they compete or, more specifically, the timing of competition. Traditional approaches to appropriability have focused on competition for the market whereby entrepreneurs invest upfront to control the market in the future. However, drawing upon a tradition in strategic management that focusses on dynamic capabilities, we have shown how entrepreneurs can still appropriate value by competing the market using capabilities afforded by early market entry and experience to generate quality, cost or timing advantages over future rivals. This insight can help understand the constellation of choices entrepreneurial firms make as well as how they deal with uncertainty (Gans, Stern and Wu, 2016). For instance, Ching, Gans and Stern (2016) demonstrate that because the costs of control or upfront whereas those for execution are on-going, the latter can be desirable when there is uncertainty about the future value of an innovation.

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