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Can Physics Help Us Understand Why Ventures Fail?

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"Entrepreneurial entropy" is the natural result of pursuing innovation and opportunities. It can be deadly for struggling ventures that bet the house.

Like uncombed hair and unweeded gardens, entrepreneurial ventures tend to get messier and harder to control over time. That's because pursuing innovation and new market opportunities requires betting resources, which can't be recovered if the innovation doesn't materialize or the market doesn't respond.

We call this phenomenon "entrepreneurial entropy," based on the second law of thermodynamics. That law says that any process producing "work" converts energy into outcomes – but the process can't be reversed. Once we use that energy we can't recover it. In a recent study (https://journals.sagepub.com/doi/abs/10.1177/10422587231151957) published in *Entrepreneurship Theory & Practice*, we set out to better understand entrepreneurial entropy and how it can affect startup firms. Overall, we found that entrepreneurial ventures can succeed if they develop systems that manage entropy: structures, processes, and properties that enable them to take prudent risks, minimize waste, and combat disorder.

How Entropy Takes Over

When a firm commits its own energy – its resources – into developing an innovative, forward-looking product or service, that energy is used up and disorder increases if the initiative is unsuccessful. Too many wrong bets increase entrepreneurial entropy even more, until the firm exhausts its resources and ultimately fails. Unfortunately this happens to about 90% (https://www.inc.com/sam-blum/startup-failures-have-doubled-there-are-ways-to-ensure-yours-wont-suffer-the-same-fate.html) of all startups.

And established firms are not immune either. Betting on moonshots to escape competitive mediocrity or disadvantage can lead to great success. But major changes from the traditions and expertise of the business, made too quickly, mean that the business will not have the expertise it needs to handle that shift, risking huge losses.

Yet the very nature of entrepreneurship requires innovation and risk-taking. Firms that don't do this will stagnate. But the necessary risk-taking, innovative and proactive behaviors strain organizational resources and result in disorder and turmoil – what we call entrepreneurial entropy – and it can be difficult to know when to turn off the spigot on a lost cause. When the firm is already underperforming greatly against its peers, entrepreneurs and managers reacting by making large abrupt changes in their levels of entrepreneurship and innovation are at more risk, because underperforming firms don't have the advantages of current success. In other words, failing ventures that decide to "bet the house" on one bold idea have the most to lose.

Because they are pioneering, ventures consume large amounts of resources in their innovative, risky, and proactive behaviors and exhaust finite resources while producing outputs whose returns and odds of success are uncertain, distant, and prone to setbacks and sunk costs. In other words, acts of entrepreneurship and innovation are capable of substantial gains and losses. We can think of this an "exploration liability effect." The challenge for entrepreneurs and managers is to rein in this effect so that entropy stays manageable.

Studying this Phenomenon

To get a handle on how entropy affects ventures, we studied 804 US large technology firms across nine high-technology industries over 18 years, from 2000 through 2018. These firms spent an average of $850 million on

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research and development. To determine their degree of entrepreneurial orientation (EO), we looked at their actual behavior demonstrated in their financial accounts. Financial indicators tell us exactly what a firm did with its resources, capturing its behaviors and outcomes each year. We measured their innovativeness with R&D intensity; we measured their proactiveness with the percentage of annual earnings reinvested in the company; and measured their risk-taking based on unsystematic risk and volatility in their stock price. We then calculated the extent to which these firms made small or large changes in their EO from one year to the next. We also calculated a hazard ratio to figure out the risk of a firm failing due to its actions.

What We Found

What we found surprised us.

First, being more entrepreneurially oriented (exhibiting higher risk-taking, innovativeness, and proactiveness) increases the risk of firm failure by 24.9% with every one-point increase in EO. Given the multiplicative nature of the hazard ratio, if we were to compare two firms whose levels of EO were 10 points apart, the risk of failure of the less entrepreneurial firm would be 90.8% of the more entrepreneurial one (or 9.2% lower).

Second, the higher the firm's entrepreneurship and innovation, the more rapidly it reduces the resources available to its efforts, and disorder increases as its resources become fewer and fewer. It is this resource exhaustion that increases the risk of firm failure over time, unless entrepreneurs and managers come to grips with replenishing the firm's resources.

Third, large abrupt changes in the entrepreneurial orientation of the firm increase the risk of firm failure by an additional 4.7%. But this is even more so when the firm is already underperforming against its industry peers. What this means is that switching to a high level of entrepreneurship and innovation to get out of a hole is just going to make that hole worse: there are other better strategic options available like turnaround.

Takeaways

Our research in no way says that entrepreneurs should stop taking risks and be less innovative. Innovation is the lifeblood of all firms. What our findings do suggest is that entrepreneurs must continue to take risks, but in a controlled and thoughtful way that slows down the rate of entropy. Entropy comes from two core sources: exhausting the resources of the firm on tenuous and unproductive entrepreneurial initiatives, and jumping to an aggressively high level of entrepreneurship and innovation without putting the structures, processes, and routines in place to handle that change.

At high levels, the firm risks suffering the exploration liability costs of entrepreneurship without securing its benefits. Scrutinizing entrepreneurial plans to filter out tenuous and unproductive initiatives is essential to getting entropy under control. This prevents squandering resources on bad ideas. The problem is not that entrepreneurs make bad decisions deliberately. It's often because high levels of entrepreneurial orientation driving the firm's strategy and decisions become intoxicating, fixating attention on opportunities and novelty instead of strategy and competitive advantage.

If you need to redirect your efforts to pursue an opportunity – and are risking going from modest entropy to much higher entropy – think carefully about the motive and whether other viable strategic options are better placed to deal with the situation. This can include divestment, reinvestment, and turnaround strategies rather than a leap into the unknown. Remember that underperforming for several years means you do not have the benefits of success and most likely your structures, routines and capabilities aren't up to the task.

It might be tempting to think that an easy solution to this problem is to simply pull resources from other activities. This is not so easy! Resources dedicated to existing product-service activities show increasing levels of asset specificity – they become more and more tied to those activities and cannot be liquidated or reapplied to other efforts or to new initiatives. Trying to do this will likely only worsen the malaise. Audit and manage your resource stocks carefully and strategically to reduce vulnerability to rapid resource exhaustion when some of your entrepreneurial efforts (inevitably) fail

Perhaps the most important takeaway from our study is that managing entrepreneurship is not its antithesis! The key issue here is not avoiding EO but successfully managing it over time to reduce the cost of failure and limit exposure to its downside while preserving access to growth opportunities made possible by an EO.

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Senior Editor Mat Hughes explains the concept of entrepreneurial entropy here.

Link to video

Professor Mat Hughes (https://soundcloud.com/user-49751720) · Entrepreneurial entropy: What can entrepreneurs, innovators, and managers learn from physics (https://soundcloud.com/user-49751720/entrepreneurial-entropy-what-can-entrepreneurs-innovators-and-managers-learn-from-physics)

Explore the Research

Entrepreneurial Entropy: A Resource Exhaustion Theory of Firm Failure From Entrepreneurial Orientation (https://journals.sagepub.com/doi/abs/10.1177/10422587231151957) . Entrepreneurship Theory and Practice, January 2024.

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