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A THEORY OF VISIONARY DISRUPTION

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ABSTRACT

Exploitation of disruptive technologies often requires resource deployment that creates conflict if there are divergent beliefs regarding the efficacy of a new technology. This arises when a visionary agent has more optimistic beliefs about a technological opportunity. Exploration in the form of experiments can be persuasive when beliefs differ by mitigating disagreement and its costs. This paper examines experimental choice when experiments need to persuade as well as inform. It is shown that, due to resource constraints, persuasion factors more highly for entrepreneurial than incumbent firms. However, incumbent firms, despite being able to redeploy resources using authority, are constrained in adoption as exploration cannot mitigate the costs of disagreement

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1 Introduction

While disruption conveys a myriad of interpretations and meaning, a common thread is that it results in change. Whether it be an entrepreneur using a technology to redeploy an industry's resources or an incumbent firm discarding some resources and embracing others, the effects of disruption can be widespread. This raises the question of the role of affected agents in the disruptive process itself. To some of them, disruption is a pure cost even if it is not successful. To others, disruption is an opportunity if successful but otherwise a cost. Thus, we should neither want nor expect all to embrace disruption. For many, the lament of historian Jill Lepore (2014), "[d]isruptive innovation is competitive strategy for an age seized by terror" resonates.

Like much of the innovation literature, whether a disruptive technology is exploited or not is often seen as the decision of a single-minded actor. When it is popularised, this person is a 'visionary' but in academic articles they are mere agent in possession of a plan. The challenge facing them is how to consider an exploitation decision that necessarily is undertaken under conditions of considerable uncertainty.

This challenge has led to a study of how those agents gather information to determine exploitation decisions – a process that is called exploration. Christensen (1997) famously described issues with the exploration process that caused incumbent firms to incorrectly assess potentially disruptive technologies by focusing on their impact on their main customers when the technology actually was, initially, likely to be beneficial for marginal ones.[1] Ries (2011) called for startup entrepreneurs to engage in a low-cost or lean process of experimentation in determining whether to exploit a technological opportunity. This led to approaches such as the minimum viable product, an experimental foray into a market with an intentionally weak product with the hope of getting quick, clear feedback on whether to continue. Both of these approaches posit experiments that 'raise the bar' for exploitation so that when it is exceeded the signal to proceed is clear. By contrast, some experiments involve 'putting your best foot forward.' This is exemplified by Segway developing a product, complete with factory, that worked out of the box before tested in the market. A similar strategy of experimentation is often pursued by Apple. The idea is, that if these products fail in the market, it is a clear signal further exploitation will not be profitable.

Most of the literature on exploration to inform exploitation has not examined the type of experiments as just described but the value of them (see Kerr et al. (2014), Gans et al. (2019), Agrawal et al. (2021) as recent examples). An exception is Gans (2021) that

[1] Similar observations were made by Henderson and Clark (1990) in terms of feedback on technical efficacy sought internally within an incumbent firm. See Gans (2016) for a review.

explicitly considers experimental type chosen by incumbents and entrants in competition with one another. That paper shows that the choice of experimental type is a meaningful one precisely because it creates an asymmetry in the quality of signals received regarding the potential efficacy of a technology opportunity that, in turn, can inform exploitation choices. For a firm pre-disposed to exploit a disruptive technology (often an entrant), an informative experiment (absent cost considerations) favours 'putting your best foot forward' while a firm pre-disposed not to exploit a disruptive technology (often an incumbent), an informative experiment involved 'raising the bar' as Christensen (1997) observed.

This paper builds on Gans (2021) to consider environments where doing so has implications for resources and, thus, will elicit or require responses or 'buy in' from existing resource providers. Those resource providers are often the repositories for the costs of disruption even if the technological opportunity should work out. The historical accounts of Microsoft and IBM by Bresnahan et al. (2011) have demonstrated that, even when those resource providers are not nominally in control of exploitation decisions, pressure and resistance by them played a role in those decisions. Here, the focus is on how this shapes the type of exploration undertaken. It is demonstrated that, in addition to the *informativeness* of experiments that influence the primary decision-maker, experiments can also be chosen with a distinct, and sometimes conflicting, motive to persuade resource providers of the efficacy of subsequent exploitation decisions.[2]

The second contribution of the paper is to focus on 'visionaries.' A visionary is a leader who has an optimistic prior that a technological opportunity is worth exploiting; formally, they would be pre-disposed to exploit the opportunity without gathering further information.[3] This follows the framework and definition of van den Steen (2005) although the setting and research questions considered here are quite distinct. In the absence of other agents, Gans (2021) shows that such leaders would choose 'putting your best foot forward' experiments that provide a clear signal that the vision is not likely to be successful. However, here, other agents may not share the optimism of the visionary and, thus, there is a motive to use experiments to *persuade* them of the vision's potential success.

This produces several findings. First, visionary entrepreneurs, who are resource constrained, find it optimal to use 'raising the bar' experiments (such as those advocated by Ries (2011)) in order to persuade resource owners to contribute resources to exploitation of the new technology with a lower level of required equity in a venture. That is, for them, persuasion motives outweigh informativeness ones in exploration. Second, visionary incum-

[2]Manso (2011) examines how a principal sets incentives for an agent to engage in exploration over exploitation but does not consider a persuasive role for experiments.

[3]There is a well established literature that shows that over-optimistic managers are more likely to pursue innovations; see, for example, Galasso and Simcoe (2011).

bent leaders, who are not resource constrained and, thus, can rely exclusively on *authority* to redeploy resources to exploiting the new technology, undertake 'best foot forward' experiments. This is shown using a model of internal organisational disagreement developed by Hart and Holmstrom (2010) extended to an environment of uncertainty.[4] It is shown that while the potential for such disagreement may make an otherwise visionary incumbent leader less pre-disposed to exploitation, it is the impact on pre-disposition rather than persuasion per se that drives their exploration choice. Third, comparing the two, it is likely that visionary incumbent firms will be more likely to be observed exploring and exploiting new disruptive technologies than visionary entrepreneurs but, in the process, they are more likely to incur disruption costs associated with a failed vision. In effect, the need to persuade, that entrepreneurs face, operates as a check on the authority that incumbent leader's have (see van den Steen (2010b) for related insights).

The paper proceeds as follows. In Section 2, the baseline environment is set-up and the results of Gans (2021) reviewed. Section 3 then considers the entrepreneur's exploitation and exploration choices while section 4 does the same for an incumbent based on the framework developed by Hart and Holmstrom (2010). In each case, the implications of a shared vision are explored as well as extensions when resources are scarce. Section 5 then compares the two and a final section concludes.

2 Model Setup

There are two types of resources available and utilised in an industry/market, A and B. Each resource has what will be termed an 'alternative' employment wherein they can generate value of v_A and v_B respectively. Incumbent firms combine one unit of A and one unit of B in production to yield value $\gamma(v_A + v_B)$ where $\gamma > 1$. This is their 'primary' use. Incumbent firms have their own resources to achieve this combination (e.g., managerial capabilities or technological know-how) and those resources are relatively scarce.[5] In a given incumbent firm (I) that is the focus of analysis here, A and B resources are managed in separate divisions by managers (labelled a and b) who aim to maximise γv_A and γv_B respectively.[6] I focuses on maximising gross profits, $\gamma(v_A + v_B)$ as resource acquisition costs are sunk.

We examine what happens when a new technological opportunity with distinct resource requirements arrives. The new opportunity has the feature that it requires only B type

[4] Another approach to internal disagreement, not used here but likely with similar effects is that of van den Steen (2010a).

[5] For concreteness, suppose that there are N units of each resource and M incumbent firms where $M < N$.

[6] The different alignments of divisional managers and the entire firm (I) will play a role in what follows. These can arise from focused incentive contracts designed to maximise divisional profits.

resources that can be redeployed to exploit it. Redeploying resources as a result of exploiting the new technological opportunity is assumed to be costly. Each time a resource is deployed to a new use involves a cost of c. If A and B resources are jointly employed in production, then exploiting the new opportunity involves costs of $2c$ as B-resources are deployed for the new opportunity while A-resources are deployed independently. In this respect, c parameterizes the direct costs of disruption.

The new technological opportunity has, prior to exploitation, an uncertain value captured by a random value $\widetilde{V} \in \{0, V\}$. It is assumed that:

$$\underbrace{V + v_A - 2c}_{\text{Max Value After}} \geq \underbrace{\gamma(v_A + v_B)}_{\text{Max Value Before}}$$

That is, the technological opportunity can potentially generate sufficient value that makes it worthwhile for I to redeploy B resources to the new opportunity and A resources back to their alternative employment. Exploitation of the opportunity reveals $\widetilde{V}$.

Note that it is assumed that resource redeployment or switching costs are incurred only once. Therefore, if the new technological opportunity does not work out, moving the resources back is costless meaning that a failed exploitation results in total redeployment costs of $2c$ for combined A and B users.[7]

Alongside I, the technological opportunity can be exploited by an entrepreneur (E) who does not presently operate in the industry. For E, they need only attract B resources that are employed in their alternative use. However, as will be discussed further, they are financially constrained which impacts on how those resources are attracted. We will use the label, R, for the owners of independently employed B resources.[8]

2.1 Agent beliefs

The final critical set of primitives in the model are the beliefs of various agents. In addition to I, E and R, there are two divisional managers of that firm (a and b). Each agent, $i \in \{E, R, I, a, b\}$ have heterogeneous priors over whether $\widetilde{V} = V$ denoted by p_i.

To limit attention to cases of interest, some assumptions are made regarding the structure of beliefs. Beliefs, p_i, can take on two values P and p where $p < P$. It is assumed that exploitation is privately optimal for agents E and I for whom beliefs are P but not if they

[7]Adding a switching cost every time resources are deployed can be done with no change on the model outcomes here and, thus, these are set to zero for notational simplicity.

[8]Below we will also comment on what happens if all B resources are currently employed in combination of A resources.

	👍	👎
$\widetilde{V} = V$	λ_V	$1 - \lambda_V$
$\widetilde{V} = 0$	$1 - \lambda_0$	λ_0

Table 1: **Experiment Conditional Probabilities**

are p. For E, this implies:

$$PV + (1 - P)v_B - c > v_B > pV + (1 - p)v_B - c \implies P(V - v_B) > c > p(V - v_B)$$

while for I, this implies:

$$P(V + v_A) + (1 - P)\gamma(v_A + v_B) - 2c > \gamma(v_A + v_B) > p(V + v_A) + (1 - p)\gamma(v_A + v_B) - 2c$$

$$\implies P\big(V + v_A - \gamma(v_A + v_B)\big) > 2c > p\big(V + v_A - \gamma(v_A + v_B)\big)$$

Thus, if beliefs are the reference belief, p, then the technological opportunity is not worth pursuing in the absence of further information. By contrast, if beliefs are what will be referred to as 'visionary,' i.e., P, then, even without further information, the opportunity is worth exploiting. It will be assumed throughout that independent B resource owners, R, only hold the reference belief. Thus, they are predisposed not to exploit the technological opportunity.

2.2 Experimental set

To gather information prior to exploitation, there exist experiments that I or E can use to gather a signal regarding $\widetilde{V}$. A typical experiment, $T(\lambda_V, \lambda_0)$, that can be conducted at an arbitrary cost generates a signal '👍' if $\widetilde{V} = V$ which is accurate with probability, λ_V and a signal '👎' if $\widetilde{V} = 0$ which is accurate with probability, λ_0 (see Table 1); that is, $\Pr[\widetilde{V} = V | 👍] = \lambda_V$ and $\Pr[\widetilde{V} = 0 | 👎] = \lambda_0$. It is assumed that it is possible that $\lambda_V \neq \lambda_0$ so that there are differences between false positives and false negatives associated with $T(\lambda_V, \lambda_0)$.

Experiments are drawn from a set distinguished by different combinations of (λ_V, λ_0). Each parameter can take on any value in $[0, 1]$ so long as $\lambda_V + \lambda_0 \leq \Lambda \in [1, 2)$.

2.3 Some preliminaries

To build intuition, it is useful to briefly re-state the results from Gans (2021) regarding how exploitation choices are made when decision-makers do not have to take into account their interactions with others; that is, experiments are conducted purely for informing whether to exploit or not (rather than to persuade others). Specifically, note that the experimental choices are (a) likely to be extreme within the set of feasible experiments (that is, $T(\Lambda-1,1)$ or $T(1,\Lambda-1)$) and (b) preferences for each extreme will be guided by a decision-maker's pre-disposition towards exploitation in the absence of information.

To explain this, note, first, that these extreme experiments involve:

- ('Raise the bar') An experiment, $T(\Lambda-1,1)$, that yields '👍' implies that $\Pr[\widetilde{V} = V|$👍$] = 1$. That is, this experiment provides a clear signal that a technology is worth exploiting.

- ('Best foot forward') An experiment, $T(1,\Lambda-1)$, that yields '👎' implies that $\Pr[\widetilde{V} = V|$👍$] = 0$. That is, this experiment provides a clear signal that a technology is not worth exploiting.

It is optimal for an agent to follow any clear signal when making their choices. However, as $\Lambda > 1$, these experiments are sufficiently informative that, in either case, if the signal is '👍,' it is optimal to exploit while if it is '👎' it is optimal not to exploit.

Second, we can write down the expected payoffs to E and I from these extreme experiments:

- Given beliefs, p_E, E's expected payoff from following the signal is: (i) for $T(\Lambda-1,1)$, is $p_E(\Lambda-1)(V-c)+(1-p_E+p_E(2-\Lambda))v_B$ and (ii) for $T(1,\Lambda-1)$, is $p_E(V-c)+(1-p_E)(2-\Lambda)(v_B-c)+(1-p_E)(\Lambda-1)v_B$.

- Given beliefs, p_I, I's expected payoff from following the signal is: (i) for $T(\Lambda-1,1)$, is $(\Lambda-1)p_I(V+v_A-2c)+(1-p_I+p_I(2-\Lambda))\gamma(v_A+v_B)$ and (ii) for $T(1,\Lambda-1)$, is $p_I(V+v_A-2c)+(1-p_I)(2-\Lambda)(\gamma(v_A+v_B)-2c)+(1-p_I)(\Lambda-1)\gamma(v_A+v_B)$.

From this it is straightforward to see that if a firm is pre-disposed to not exploiting the technology (for E if $p_E(V-v_B) < c$ and, for I, if $p_I(V+v_A-\gamma(v_A+v_B)) < 2c$) then they will choose $T(\Lambda-1,1)$ over $T(1,\Lambda-1)$. Intuitively, if a firm is pre-disposed against exploiting, an experiment is valuable if it persuades them to exploit instead. As $T(\Lambda-1,1)$ provides a clear signal that exploitation will succeed, firms prefer that experiment. The reverse preference holds when firms are pre-disposed to exploit the technology. Thus, in the absence of other factors, visionary firms (where $p_i = P$) will choose $T(1, \Lambda - 1)$ that gives a clear signal if the technology is likely to fail.

Note that the *exploitation thresholds* for E and I to be pre-disposed to exploit the technology are:

$$p_E > \bar{p}_E \equiv \frac{c}{V - v_B} \qquad\qquad p_I > \bar{p}_I \equiv \frac{2c}{V + (1-\gamma)v_A - \gamma v_B} \tag{1}$$

As $V - v_B > (1-\gamma)(v_A + v_B)$ (with $\gamma < 1$ and $V > v_B$ by our earlier assumptions on P), $\bar{p}_E < \bar{p}_I$.[9] Thus, there exists a range of common priors held by E and I where E is pre-disposed to exploit and I is not. This is due to the fact that I loses value from its A division by exploitation, that is, a replacement effect and that division suffers distinct disruptive costs (c). As Gans (2021) discusses this is a likely feature of disruptive/architectural technological opportunities.

This means that there is a sense in which entrepreneurial firms are more likely to choose experiments that are slanted towards positive news (i.e., $T(1, \Lambda - 1)$) than incumbent firms. The question in the present paper, however, is whether these experimental preferences continue to hold when each type of firm must interact with other agents with different beliefs/interests.

3 Visionary Entrepreneurs

The focus of this paper is the dual role that experiments play of informing the main decision whether to exploit the new technology or not and, if necessary, to alter the dealings between the key decision-makers and other agents through persuasion. To begin, the case of a visionary entrepreneur where $p_E = P$ is examined. That entrepreneur will require B resources and since those with the lowest opportunity cost are in the independent B-sector controlled by resource owners, R, it is there that the entrepreneur will target to procure those resources.

3.1 The Entrepreneur's Exploitation Choice

How will the entrepreneur procure B-resources? Recalling that $p_R = p$, as $P(V - v_B) > c > p(V - v_B)$, this could potentially be achieved with E committing to pay R at least $v_B + c$. However, it is assumed here that the entrepreneur does not have the financial assets to make a fixed price commitment that guarantees R's return. Instead, E can offer R a share, $\alpha \in (0, 1)$ of the venture's ex post value. In this case, the lowest α that needs to be

[9]Note that using this notation, we have assumed that $P > \bar{p}_I$ and $p < \bar{p}_E$.

offered is given by $\alpha(pV+(1-p)v_B)-c \geq v_B \implies \alpha \geq \frac{v_B+c}{pV+(1-p)v_B}$. Note, however, that this $\alpha > 1$ given our earlier assumptions on p. Thus, additional information will be required to persuade R to employ resources in exploiting the new technological opportunity.

3.2 The Entrepreneur's Exploration Choice

The entrepreneur believes the venture is ex ante viable whereas the resource owner does not share that belief. The difference in beliefs constrains the opportunity to attract resources as E must cede more equity to R than is possible. This creates a motivation for exploration that yields a signal of $\widetilde{V}$ so as to persuade R that the venture is viable.

Following an experiment, $T(\lambda_V, \lambda_0)$, R's posterior probabilities are:

$$\Pr[\widetilde{V}=V|\text{👍}] = \frac{\lambda_V p}{\lambda_V p + (1-\lambda_0)(1-p)} > p$$

$$\Pr[\widetilde{V}=V|\text{👎}] = \frac{(1-\lambda_V)p}{(1-\lambda_V)p + \lambda_0(1-p)} < p$$

where the final inequalities arise as $\lambda_V + \lambda_0 > 1$. Given this, a resource-owner is said to be *persuadable by T* if

$$\frac{\lambda_V p}{\lambda_V p + (1-\lambda_0)(1-p)}(V - v_B) \geq c \implies \frac{\lambda_V}{1-\lambda_0} \geq \frac{(1-p)c}{p(V-v_B)}$$

As $p(V-v_B) < c$, this places a constraint on how high λ_V and λ_0 need to be in order for this experiment to be persuasive.

What experiment, $T(\lambda_V, \lambda_0)$, will E choose? While being persuadable is required to make the experiment worthwhile, an experiment performs two other functions. First, the more an experiment weights λ_0 over λ_V, the lower is the minimum equity required for R after a positive signal. Specifically, that minimum equity is:

$$\underline{\alpha} \equiv \frac{v_B+c}{\Pr[\widetilde{V}=V|\text{👍}]V + (1-\Pr[\widetilde{V}=V|\text{👍}])v_B} = \frac{(\lambda-(1-p)(\Lambda-1))(v_B+c)}{p\lambda V + (1-p)(1-\Lambda+\lambda)v_B}$$

Second, as noted earlier, as the entrepreneur is predisposed to exploit the technology, they will have an interest in maximising the probability that a positive signal is received. This will lead them to favour experiments with a higher λ_V over λ_0.

The following proposition demonstrates that this trade-off between minimising equity and maximising positivity is resolved in favour of the former.

Proposition 1 *Suppose that $p_R = p$. E maximises expected profits subject to R's persuad-*

ability constraint by choosing an experiment $T(\Lambda - 1, 1)$.

All proofs of propositions are in the Appendix. To see why this holds, note that R's expected profits are v_B as $\underline{\alpha} = \frac{v_B + c}{V}$ and E's expected profits are $(\Lambda - 1)P(V - v_B - c)$. Compared to a hypothetical situation where E controlled or could pre-emptively procure B-resources for a fixed fee, the need to persuade R reduces E's expected profits by $\Lambda - 1$.

Thus, the type of experiment chosen when a visionary entrepreneur needs to persuade R is distinct than when they do not. Recall that if they were choosing an experiment to inform whether to exploit or not, a visionary entrepreneur would choose $T(1, \Lambda - 1)$ as this provided a clear signal they should not exploit. Note that it is entirely possible that, with this experiment, R would be persuadable if $\frac{1}{2-\Lambda} \geq \frac{(1-p)c}{p(V - v_B)}$. However, what Proposition 1 shows is that even if R is persuadable with $T(1, \Lambda - 1)$, E chooses an experiment, $T(\Lambda - 1, 1)$, where ‘👍’ is a clear signal that the prospects for the opportunity are favourable while, for ‘👎,’ it is unclear whether the technology will succeed or fail. While this does not offer information to change E's decision, it does reduce the amount of equity required following the experiment which turns out to have an larger impact on E's expected payoff. Therefore, even though R does not necessarily control E's exploit decision, the experimental choice will be guided by the benefits to persuading R rather than purely informing E.

3.3 Shared vision

It is useful to examine how these results change if R held E's visionary beliefs, so that $p_R = P$. In this case, even in the absence of further information, there exists an $\alpha < 1$ such that enough equity can be given to R (namely, $\underline{\alpha} = \frac{v_B + c}{PV + (1-P)v_B} < 1$) to allocate resources to E's control.

What experiment will E choose when there is a shared vision? In this case, alignment means that $T(1, \Lambda - 1)$ is preferred to $T(\Lambda - 1, 1)$ by E taking into account the equity given to R as $P > \frac{c}{V - v_B}$. Thus, if they do not have to persuade R of their vision, the experimental choice of E switches to one that involves slanted news in favour of ‘👍’ with a clear signal if the opportunity should not be exploited.

3.4 Scarce resources

Thusfar, to procure B resources, E has only had to attract those resources from an independent use. What if, however, all B resources were presently employed in combined production with A resources? In this case, a B resource owner (who also owns A resources) will need to be compensated for the full impact of redeploying B resources; namely, $\gamma(v_A + v_B) + 2c$.

To determine this full impact, we need to consider what happens if the new technological opportunity does not work out. In this case, we assume that the B resources revert back to R who then restores the original firm using the combined resources. The deployment will be feasible if there exists an α such that:

$$\alpha pV + pv_A + (1-p)\gamma(v_A + v_B) - 2c \geq \gamma(v_A + v_B)$$

This yields a minimum equity of $\underline{\alpha} = \frac{p(\gamma(v_A+v_B)-v_A)+2c}{pV}$. As before, by our assumptions on p, this is not feasible in the absence of further information.

In this case, it is easy to see that E will still optimally choose an experiment $T(\Lambda - 1, 1)$ as this will, if it yields a '👍' signal, convince R to redeploy the B and A resources of their firm. Thus, rather than the change in exploitation threshold (i.e., critical level of P such that E is predisposed to exploit) what is driving the choice of experiment is the incentive to minimise the required equity share given to R.

4 Visionary Incumbents

While an entrepreneur faces constraints in having to persuade independent resource owners to contribute resources to exploit the opportunity, an established firm has no such constraints. They already have B-resources. However, those need to be deployed to the new opportunity which may well have repercussions throughout the organisation. To consider this, the model of Hart and Holmstrom (2010), or specifically, its application to the disruptive technology adoption space by Gans (2022)) is used as a means of capturing how internal disagreement can shape a firm's decisions.

The incumbent firm is comprised of two divisions, $i \in \{A, B\}$ each of which has a single manager, (a, b) who manages (A, B)-type resources respectively. These managers care only about the performance of their own division.[10] This may be because of explicit rewards or from career concerns that all vary with division performance.

What happens when an incumbent firm is lead by a visionary with $p_I = P$? As with the entrepreneurial firm, the exploitation choice is considered before examining any exploration prior to it.

[10] In Hart and Holmstrom (2010), managers also care about a private benefit that arises from their decisions. Here, following Gans (2022), we abstract from those effects as they do not play an important role here.

4.1 The Incumbent's Exploitation Choice

Recall that the new technological opportunity, if adopted, costs each division c and potentially creates disagreement within the organisation. If the new opportunity does not succeed, the organisation returns to the status quo but the exploitation costs $2c$ are foregone. However, also recall that, if the new technological opportunity generates no value, switching back involves no additional costs.

The impacts of this exploitation choice differ for each division. For a, exploiting the new opportunity causes divisional performance to change from γv_A to $p_a v_A + (1 - p_a)\gamma v_A - c$; an increment of $p_a(1-\gamma)v_A - c < 0$. Thus, a would always oppose an exploitation decision and no amount of additional information would alter their position.

For b, the new opportunity, if exploited, may lead to an expected improvement in divisional performance of $p_b V + (1 - p_b)\gamma v_B - c$ compared with γv_B if there is no exploitation. Depending on p_b, the increment, $p_b(V - \gamma v_B) - c$, may be positive or negative. If this increment is negative, then b joins a in opposing exploitation while, if it is positive, b and a disagree on the exploitation decision. The interesting case is where such disagreement occurs and, thus, it is assumed that $p_b(V - \gamma v_B) > c$. Notice that if $p_b = P$, this holds by the earlier assumptions on P.

A visionary incumbent manager does not have to separately procure B resources to exploit the opportunity. But, unlike their entrepreneurial counterpart, I will internalise the broader impacts of exploiting the new technological opportunity on their existing business (as exemplified by the impacts on the A division). Following Hart and Holmstrom (2010), I will face additional (dead-weight) costs as a result of internal disagreements. Here their specific theory is adopted to model such costs.

The Hart and Holmstrom (2010) disagreement costs come directly from the fact that divisional managers may feel aggrieved if their preferred action is not taken by the overall manager and the level of costs imposed are proportional to the difference in divisional profits as a result of the action taken. The costs that are assumed by Hart and Holmstrom (2010) are a share, $\theta \in [0, 1]$, of the degree of aggrievement.[11] This represents 'shading' whereby the firm as a whole has reduced performance, say, because of demotivation, misbehaviour or the erosion of relational contracting.[12] By contrast, a divisional manager that agrees with the choice will be compliant and no additional costs (or benefits) will arise.

[11] In Gans (2022), a and b have different θ's. Here we use symmetry as a simplication. This does not change the qualitative results that follow although Gans (2022) notes that this case means that internal disagreement issues do not change the overall technology adoption decision for the firm.

[12] Hart and Moore (2008) provide a more comprehensive discussion but the mechanism is one by which an aggrieved person can transfer that aggrievement back to the firm while at the same time making themselves feel better in the process. Related ideas are discussed by van den Steen (2009).

In this case, note that, if the firm pursues the new technological opportunity, the degree of shading from a is $\theta\big((\gamma-1)v_A+c\big)$ if the opportunity succeeds, θc if the opportunity is exploited but does not succeed, while if I does not exploit the opportunity, the degree of shading from b is $\theta\big(p_b(V-\gamma v_B)-c\big)$. Importantly, note that, while expected aggrievement if I does not exploit the opportunity depends on b's prior, if I exploits the opportunity, expected aggrievement, i.e., $\theta(P(1-\gamma)v_A-c)$, depends only on I's prior. This is a subtle effect. While aggrievement arises as a result of the decision and whether a expects to lose from it given their own prior, p_a, the realised aggrievement costs depend on how much a is aggrieved ex post. Thus, expected aggrievement costs anticipated by I depend on I's prior, here, P. As will be shown shortly, this dichotomy impacts on exploration incentives for I.

Because the new technology introduces a new decision with conflict, there is no escaping shading. Note that I will be more likely to exploit the technology if $p_b=P$ rather than p. Indeed, if $p_b=p$, b would be aggrieved as well as $p(V-\gamma v_B)<c$. Thus, it is assumed in what follows that $p_b=P$ and they share I's vision and, importantly, would be aggrieved if the opportunity were not exploited. This assumption will, however, be revisited below.

Under this assumption, either a or b will potentially be aggrieved and I, whether visionary or not, cannot avoid that. Given this, I will pursue the technological opportunity if:

$$\underbrace{P(V+v_A)+(1-P)\gamma(v_A+v_B)-2c}_{\text{Firm Expected Profits from Exploitation}}-\underbrace{\theta(P(\gamma-1)v_A+c)}_{a\text{'s Expected Aggrievement}}$$

$$\geq \underbrace{\gamma(v_A+v_B)}_{\text{Firm Profits from Non-Exploitation}}-\underbrace{\theta\big(P(V-\gamma v_B)-c\big)}_{b\text{'s Expected Aggrievement}}$$

$$\implies P\big(V+(1-\theta(\gamma-1))v_A-\gamma(v_A+v_B)\big)+\theta\big(P(V-\gamma v_B)-c\big)\geq(2+\theta)c$$

This potential aggrievement from a puts a constraint on the adoption of the new technology when it would otherwise be optimal.

What does this imply for I's exploitation threshold (i.e., the critical level of P such that I is pre-disposed to exploit)? Assuming that $p_b=P$, this threshold is given by:

$$P\big(V+v_A-\gamma(v_A+v_B)\big)\geq 2c+\theta\big(P(\gamma-1)v_A+c\big)-\theta\big(P(V-\gamma v_B)-c\big)$$

$$\implies (1+\theta)\big(P(V+v_a-\gamma(v_A+v_B)\big)>(1+\theta)2c$$

This holds by the definition of P. Note that the exploitation decision is actually independent of θ. This is the main result of Gans (2022). It arises because while technology adoption aggrieves a, not exploiting aggrieves b. If the degree to which aggrievement translates into firm costs (θ) is the same for both divisions, these forces balance out and aggrievement does not distort the exploitation choice. Differences would alter this with, say, $\theta_A > \theta_B$ causing exploitation to be reduced by internal disagreement. In this case, a visionary incumbent may be stifled by internal issues and become pre-disposed not to exploit despite their optimistic assessment of the technological opportunity. Because, as will be analysed in detail below, only b's potentially different beliefs could impact on the exploitation decision, we abstract away from these other distortions in this paper.

4.2 The Incumbent's Exploration Choice

Consider now how the type of an experiment used in exploration impacts on the exploitation outcome. Suppose that, like E, I has an experiment, $T(\lambda_V, \lambda_0)$, that can be conducted at an arbitrary cost. The experiment will impact on the posterior probabilities of I, a and b.

Importantly, the experiment will not be chosen to persuade a (the potential party resistant to change) but instead b (the party potentially in favour of change). To see this, note that the experiment will not impact on a's expected aggrievement from I's perspective. This means that if I will choose to exploit the opportunity even if the signal is '👎,' then the experiment itself will have no value as it does not change I's decision (which is aligned with b's preferences).

The experiment does impact on b's potential aggrievement if I chooses not to exploit the technology as a result of it. This makes analysis of the outcomes from experiments complicated because the experiment itself can change whether b is aggrieved or not which, in turn, impacts on the thresholds for I's decision – that is, b being aggrieved provides an additional motive for I to exploit the technology.

The following proposition characterises the full set of experimental choices for I.

Proposition 2 *Suppose that $p_B = P$. I maximises expected profits by choosing $T(1, \Lambda - 1)$ if and only if*

$$P \geq \min\left\{\frac{(2+\theta)c}{V-\gamma v_B+(1+\theta)(\gamma-1)v_A}, \frac{c}{(2-\Lambda)(V-\gamma v_B)+c(\Lambda-1)}\right\}$$

Otherwise I chooses $T(\Lambda - 1, 1)$.

The threshold in Proposition 2 is the point where if P exceeds this threshold either I is pre-disposed to exploit (despite aggrievement from a) or b may be aggrieved if I chooses not to exploit the opportunity. If P is below this threshold, both I and b agree, ex ante, that exploitation is unlikely to be desirable and so choose an experiment to inform them otherwise. The proposition shows that when I is pre-disposed not to exploit but b expects to be aggrieved if I does not exploit, I chooses an experiment to persuade b that exploitation is not desirable with an experiment that would give a clear signal of that. Thus, the proposition shows that when there potentially is disagreement, I adopts an experiment based on persuasion rather than informativeness criteria.

4.3 Lack of shared vision

Thusfar, we have assumed that b shares I's vision in that $p_b = P$. But what if, like, say R, $p_b = p$ as well and the vision is not shared? In particular, suppose that $p(V - \gamma v_B) < c$ but that $c < V - \gamma v_B$ (i.e., b is only aggrieved if the technology is exploited but is not successful. Thus, unlike a, b's potential aggrievement is conditional. With this, in the absence of exploration, if I exploits the opportunity, b will be aggrieved at a level of θc if it is not successful but $\theta \max\{c - (V - \gamma v_B), 0\}$ if it is successful. For simplicity, we will assume that $c \leq V - \gamma v_B$. That is, b benefits only if the technology is successful but disagrees with the exploitation decisions and so is aggrieved if it is not successful.

Given this, I's exploitation threshold becomes:

$$P\Big(V + (1 - \theta(\gamma - 1))v_A - \gamma(v_A + v_B)\Big) \geq +(1 - P)\theta c + (2 + \theta)c$$

Thus, compared with the earlier assumption that meant b was aggrieved only with a decision not to exploit, the exploitation threshold of I is higher as b's aggrievement now pushes against exploitation rather than for it.

What does this mean for I's experimental choice? An experiment can potentially persuade b that exploitation is favourable to them. This happens if:

$$\frac{\lambda_V p}{\lambda_V p + (1 - \lambda_0)(1 - p)}(V - \gamma v_B) \geq c$$

Note that this is achieved with $\lambda \leq -\frac{c(\Lambda-1)(1-p)}{p(V-\gamma v_B)-c}$. If this condition holds, then b will not be aggrieved following the experiment as they agree, ex ante, with the exploitation decision. However, suppose that this condition held for $T(\Lambda - 1, 1)$ but not for $T(1, \Lambda - 1)$ (meaning that the experimental choice impacted on expected aggrievement). Then, I's expected payoff to $T(1, \Lambda - 1)$ is:

$$P\Big(V + (1 - \theta(\gamma - 1))v_A - (2 + \theta)c\Big) + (2 - \Lambda)(1 - P)\Big(\gamma(v_A + v_B) - (1 + \theta)2c\Big)$$
$$+(\Lambda - 1)(1 - P)\gamma(v_A + v_B)$$

And its payoff to $T(\Lambda - 1, 1)$:

$$(\Lambda - 1)P\Big(V + (1 - \theta(\gamma - 1))v_A - (2 + \theta)c\Big) + ((1 - P) + (2 - \Lambda)P)\gamma(v_A + v_B)$$

$T(1, \Lambda - 1)$ is preferred to $T(\Lambda - 1, 1)$ if:

$$P(V - \gamma v_B - (1 + \theta)(\gamma - 1)v_A + \theta c) > 2(1 + \theta)c$$

Despite the fact that it does not avoid b's aggrievement, I finds it still optimal to choose $T(1, \Lambda - 1)$ if $P > \frac{(1+\theta)2c}{V - \gamma v_B - (1+\theta)(\gamma-1)v_A + \theta c}$. Otherwise it chooses $T(\Lambda - 1, 1)$ and avoids b's aggrievement.

5 Comparing Entrepreneurs and Incumbents

If they did not have to deal with other agents, visionary entrepreneurs and incumbents would choose experiments biased towards generating positive news (i.e., '👍') and a clear signal if they should not exploit the technological opportunity; i.e., $T(1, \Lambda - 1)$. In this case, we would observe similar rates of exploitation and also the success/failure of exploitation (see Gans (2021)).

Having to deal with other agents changes the experimental choices of visionaries. However, the impacts are distinct for entrepreneurs and incumbents. For entrepreneurs, the experimental choice is driven by a need to persuade independent B resource holders to take equity in return for deploying those resources to the new opportunity. For incumbents, the experimental choice is potentially driven by the stifling effect of internal divisions on the incumbent visionaries exploitation threshold that, in turn, changes the information they seek from experiments. In each case, the experimental choice can move towards being more biased towards negative ('👎') news and a clear signal that the opportunity should be exploited. However, there is a sense in which this effect is stronger for a visionary entrepreneur than a visionary incumbent as it impacts their choice regardless of how visionary (in terms of P) they are.

5.1 Relative Impact of Shared Vision

To compare visionary entrepreneurial and incumbent experimental choices we need to consider like-with-like. In particular, thusfar, our analyses of these have focussed on the case where E does not have a shared vision with R (i.e., $p_R = p$) while I does have a shared vision with b (i.e., $p_b = P$). These differences could be explained if I had an easy way to explain their vision within an incumbent firm than E might have across a market.

For our purposes here, it is useful to separate out the shared and non-shared vision cases. First, suppose that $p_R = p_b = P$ and that R and b shared the vision of an E and

I respectively. In this case, E will choose $T(1, \Lambda - 1)$ and so will exploit with probability $P + (1 - P)(2 - \Lambda)$. For I, the experimental choices are as in Proposition 2.

By contrast, if $p_R = p_b = p$, there is no shared vision in either case. E will choose $T(\Lambda - 1, 1)$ and so will expect to exploit with probability $(\Lambda - 1)P$ while I will choose $T(1, \Lambda - 1)$ for $P > \frac{(1+\theta)2c}{V-\gamma v_B-(1+\theta)(\gamma-1)v_A+\theta c}$ and $T(\Lambda - 1, 1)$ otherwise. In the former case, I expects to exploit with probability $P + (1 - P)(2 - \Lambda)$; a higher rate than for E.

Thus, there is a sense in which a move from a non-shared vision to a shared vision has a greater impact on E's pre-disposition to exploit and its incentives to choose an experiment slanted towards '👍' rather than one slanted towards '👎'. There is a similar impact on I but potential internal aggrievement raises their exploitation threshold when the vision is not shared internally. Either way, the degree to which visions are shared beyond the decision-maker impacts on the type of experiments chosen and relative exploitation rates.

5.2 Visionary or not?

The focus here has been on the beliefs held by decision-makers and others and how these generate incentives to choose certain types of experiments that may affirm or counter those beliefs. In particular, visionary decision-makers – whether it be an entrepreneur or an incumbent firm leader – have been characterised simply as ones who are, initially at least, relatively optimistic about the prospects that might arise from exploiting a new technological opportunity. While it has been shown how these beliefs translate into experiments that inform exploitation decisions, the ex post success or failure of those decisions cannot be evaluated without further assumptions regarding the validity of beliefs held.

The perspective we take here is of an observer who has no special information with regard to particular beliefs and, indeed, cannot observe them directly. However, the observer can view the experiments chosen, exploitation decisions made and the context (by an entrepreneur or incumbent). Based on the theory here, those observations could, in principle, inform an outside of the particular beliefs that may have been held by agents being examined. But is it possible to make inferences regarding the overall efficiency of outcomes?

To explore this, let's consider two extreme cases regarding ground truth in this environment. In the first case, suppose that the visionary is, in fact, visionary and that the true probability of success of the technological opportunity is P. What does this mean for the observed consequences of exploitation choices by visionary incumbents as opposed to entrepreneurs?

Assuming that the visionary beliefs, P, are, in fact, correct, in our base case, with relatively high P, E will exploit with probability $(\Lambda - 1)P$ while I will be more likely to exploit with probability $P + (2 - \Lambda)(1 - P)$. In addition, conditional on exploiting the opportunity, E will never fail in doing this while I will fail with probability $(2 - \Lambda)(1 - P)$ and incur disruption costs ($2c$) without any return. Nonetheless, the probability that I successfully exploits the new opportunity is higher than the probability that E does so. For relatively low P, I will switch their experimental choice and, thus, we will observe similar consequences in exploitation between E and I.

What this illustrates is that a visionary incumbent is, in some sense, freer than a visionary entrepreneur to pursue that vision. Using authority alone, the visionary incumbent can divert resources to the new opportunity (sometimes with an internal push rather than internal resistance). In contrast, a visionary entrepreneur must persuade resource owners to redeploy resources in service of their vision. This, in turn, causes them to choose an experiment that sends a clearer signal that exploitation is, in fact, a worthwhile choice. Thus, their success rate, conditional on being able to exploit the opportunity will be higher than incumbent firms although their overall success rate will be lower. The difference is ultimately a difference in the ability of incumbents to use authority rather than persuasion.

In the second case, suppose that, in fact, the visionary beliefs are incorrect and that the reference belief, p is reflective of ex ante ground truth. This will not alter the experimental choices of either E or I but may change their exploitation rates and their observed success or failure. In our base case, E will exploit with probability $(\Lambda - 1)p$ while I will still be more likely to exploit with probability $p + (2 - \Lambda)(1 - p)$. The difference between the two is unchanged at $2 - \Lambda$. Again, E will never fail in doing this while I will fail at a higher rate of $(2 - \Lambda)(1 - p)$. The probability that I successfully exploits is p which remains higher than E's at $(\Lambda - 1)p$.

This raises the question how both expected profits and expected surplus change with p if experimental choices and decisions are based on P. For E, expected profit is $(\Lambda - 1)p(V - v_B - c)$ and expected surplus is $(\Lambda - 1)p(V - c) + (1 - (\Lambda - 1)p)v_B$. Both of these have the same derivative, $(\Lambda - 1)(V - v_B - c)$ with respect to p. For I, expected profit and expected surplus are the same at $p(V + v_A - \theta(\gamma - 1)v_A) + (2 - \Lambda)(1 - p)\gamma(v_A + v_B) - (p + (2 - \Lambda)(1 - p))(2 + \theta)c + (1 - (p + (2 - \Lambda)(1 - p)))\gamma(v_A + v_B)$. The derivative of this with respect to p is $V + v_A - \gamma(v_A + v_B) - (\Lambda - 1)2c - \theta((\gamma - 1)v_A - (\Lambda - 1)c)$. Thus, as p falls, the difference in both expected profits and surplus between E and I increases.

6 Conclusion

At the core of disruption is conflict over the deployment of resources in the face of divergent beliefs regarding the efficacy of a technological opportunity. Visionaries, who are optimistic about a technology's prospects, will use experiments, not only to inform their own technology exploitation choice but to persuade others. This paper has examined how such persuasion motives alter the type of experiments entrepreneurial firms (who are resource constrained) and incumbent firms (who face internal disagreement costs) choose.

This analysis gives rise to several key conclusions:

- Experiments have a persuasive role as well as an informative role when important resources are controlled or managed by multiple agents.
- Visionaries, who are optimistic regarding a technological opportunity would, if they did not have to persuade others, choose 'best foot forward' experiments that provide clear signals that an opportunity should not be exploited
- Entrepreneurial firms that are resource constrained will choose 'raise the bar' experiments that provide clear signals an opportunity should be exploited in order to persuade resource holders to allocated resources to them.
- Incumbent firms can use authority to direct resources but these create disagreement costs that can reduce their pre-disposition to exploit new technologies. They might choose a non-visionary experiment to manage those costs.
- If visionaries are, in fact, correct in their optimism, incumbent firms will more likely successfully exploit technological opportunities than entrepreneurial firms. If visionaries are, in fact, incorrect, then entrepreneurial firms will perform better than incumbent firms in terms of not exploiting technologies that end up failures.

Because the adoption of disruptive technologies necessarily takes place in the midst of uncertainty, these conclusions may only be partially revealed in anecdotal case studies. The purpose of providing a theory here is to inform potential empirical analyses of exploration and exploitation choices of entrepreneurial and incumbent firms.

There are many directions that could be undertaken to build on this model in future work. First, competition could be explicitly modelled between entrepreneurial and incumbent firms including a more general equilibrium construct to determine the allocation of resources. Second, resources are deployed together or separately. The model here was high level which leaves open the possibility that a more specific model of how resources are bundled could yield further insights. Finally, dynamics could be made explicit which might lead to further analyses of what might trigger reversals in disruptive vision and also sharper predictions of the relationship between adoption decisions and firm performance.

7 Appendix

7.1 Proof of Proposition 1

Substituting in the constraint for the minimum equity offered R, i.e., $\underline{\alpha}$, E's expected profit is:

$$(1-\underline{\alpha})\Big(\lambda PV + (1-P)(1-\Lambda+\lambda)v_B\Big)$$

The first derivative of this with respect to λ is:

$$\Big(1 - \frac{(\lambda-(1-p)(\Lambda-1))(v_B+c)}{p\lambda V + v_B(1-p)(1-\Lambda+\lambda)}\Big)\Big(PV + (1-P)v_B\Big)$$

$$-\frac{(\Lambda-1)(1-p)p(v_B+c)(V-v_B)}{(p\lambda V + v_B(1-p)(1-\Lambda+\lambda))^2}\Big(\lambda PV + (1-\Lambda+\lambda)(1-P)v_B\Big)$$

While the second derivative is:

$$\frac{2(\Lambda-1)^2(1-p)pVv_B(v_B+c)(P-p)(V-v_B)}{((1-p)v_B(1-\Lambda+\lambda)+\lambda pV)^3} > 0$$

Thus, only extreme experiments will be optimal. For $\lambda = 1$, E's expected profit is:

$$\frac{PV + (1-P)(2-\Lambda)v_B}{pV + (1-p)(2-\Lambda)v_B}\Big(p(V-v_B) + ((\Lambda-1)(1-p)-1)c\Big)$$

while for $\lambda = \Lambda - 1$, it is:

$$P(\Lambda-1)(V-v_B-c)$$

Note that these expected profits are equal at $\Lambda = 2$. Moreover, the derivative of E's profits when $\lambda = \Lambda - 1$ less those profits when $\lambda = 1$, is negative when $\Lambda < 2$ whenever $p(V-v_B) < c$ as we have assumed. This proves the proposition.

7.2 Proof of Proposition 2

First, note that with $T(1, \Lambda-1)$, b will not be aggrieved if I chooses not to exploit the opportunity as, in this case, $\theta\big(0(V-\gamma v_B)-c\big) < 0$. Similarly, I will choose not to exploit the opportunity as:

$$0\Big(V + (1-\theta(\gamma-1))v_A - \gamma(v_A+v_B)\Big) < 2c$$

In this case, given that I will exploit if the signal is ‘👍’ and not otherwise, it’s expected profit is:

$$\lambda_V P\Big(V + (1-\theta(\gamma-1))v_A - (1+\theta)c - c\Big)$$
$$+(1-\lambda_0)(1-P)\Big(\gamma(v_A+v_B) - (1+\theta)c - c\Big) + (\lambda_0(1-P) + (1-\lambda_V)P)\gamma(v_A+v_B)$$

Substituting in $\lambda_V = \lambda$ and $\lambda_0 = \Lambda - \lambda$ it can easily be seen that the derivative with respect to λ is positive so long as $P \geq \frac{(2+\theta)c}{V-\gamma v_B-(1+\theta)(\gamma-1)v_A}$. Thus, expected profits in this case are maximised with an experiment of $T(1, \Lambda-1)$.

Second, note that with $T(\Lambda-1, 1)$, b will not be aggrieved if I chooses not to exploit the opportunity if:

$$\frac{(2-\Lambda)P}{(1-P)+(2-\Lambda)P}(V-\gamma v_B) \leq c \implies P \leq \frac{c}{(2-\Lambda)(V-\gamma v_B)+c(\Lambda-1)}$$

Note that, if $P < \frac{(2+\theta)c}{V-\gamma v_B-(1+\theta)(\gamma-1)v_A}$, then the derivative of expected profits (without b aggrievement) with respect to λ is negative and so I will choose $T(\Lambda-1, 1)$. Thus, for $P \leq \min\{\frac{(2+\theta)c}{V-\gamma v_B-(1+\theta)(\gamma-1)v_A}, \frac{c}{(2-\Lambda)(V-\gamma v_B)+c(\Lambda-1)}\}$, $T(\Lambda-1, 1)$ is optimal.

These two cases are situations where I and b’s preferences are congruent. If $P < \frac{(2+\theta)c}{V-\gamma v_B-(1+\theta)(\gamma-1)v_A}$ and $P > \frac{c}{(2-\Lambda)(V-\gamma v_B)+c(\Lambda-1)}$, b may be aggrieved if I chooses not to exploit based on a negative signal from a $T(\Lambda-1, 1)$ experiment.

If I anticipates aggrievement from b if they choose not to exploit, their expected profits are:

$$\lambda_V P\Big(V + (1-\theta(\gamma-1))v_A - (1+\theta)c - c\Big)$$
$$+(1-\lambda_0)(1-P)\Big(\gamma(v_A+v_B) - (1+\theta)c - c\Big)$$
$$+(\lambda_0(1-P) + (1-\lambda_V)P)\left(\gamma(v_A+v_B) - \theta\Big(\frac{(1-\lambda_V)P}{\lambda_0(1-P)+(1-\lambda_V)P}(V-\gamma v_B) - c\Big)\right)$$

Substituting in $\lambda_V = \lambda$ and $\lambda_0 = \Lambda - \lambda$ it can easily be seen that the derivative with respect to λ is positive as $P > \frac{(1+\theta)2c}{(1+\theta)(V-\gamma v_B)-(1+\theta)(\gamma-1)v_A}$ by the definition of P. Thus, I optimally sets $\lambda = 1$.

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