Organization and Innovation under Costly Information [*]

Fei Ding[†] and Peter MacKay[‡]

Hong Kong University of Science and Technology

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Abstract

We model organization and innovation when project owners either seek funding as standalone firms or compete for resources within a cash-rich conglomerate. Project productivity, discovery costs, internal competition, and innovation potential interact to yield a wealth of outcomes: Conglomerates are likely to dominate standalones when internal competition is keen or mild. High (low) productivity and high (low) potential favor conglomerates (standalones), regardless of innovative effort. But conglomerates foster (stifle) innovation if productivity is low (high) and potential is high (low); conversely for standalones. Our analysis sheds new light on innovation incentives and explains mixed empirical findings relating innovation to organization

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[†]Department of Economics, School of Business and Management, HKUST, (852) 2358-7626, feiding@ust.hk.

[‡]Department of Finance, School of Business and Management, HKUST, (852) 2358-8319, pmackay@ust.hk.

1. Introduction

How should firms organize? When should productive assets be combined or run separately? What are the boundaries of the firm? What drives innovation? Huge literatures address each of these questions.[1] However, the interaction of organization and innovation remains largely unexplored despite important implications for decision-making and economic policy.

We examine the joint choice of organizational form, information intensity, and innovative effort when productivity is costly to assess. In our setting, project owners can organize their venture in one of two ways: by forming a standalone firm that faces external investors, or by joining a cash-rich conglomerate where projects compete for internal resources. We solve for organization-innovation optima as a function of productivity priors, internal allocation policies, information costs, and the cost and benefit of innovation.

Information technology takes the form of a surplus-sharing intermediary (headquarters, HQ) who can privately screen out bad projects (productivity < 0), investigate the promising ones, and credibly communicate its findings. The intensity of HQ's costly research determines the probability of discovering true project productivity. If the investigation fails, skeptical priors prevail and the project is not funded, at least not for standalone firms. In contrast, conglomerates channel resources (financial, human, etc.) to all projects under management, even if productivity is uncertain or relatively low, to reflect synergies or allocation policies. The downside to joining a conglomerate is that projects might not attract as much resources internally as they would in a successful (but riskier) appeal to external capital markets

Innovation technology determines the costly effort project owners must expend to enhance initial productivity and the scope for productivity enhancement – the gains to innovation. Innovation is costly only in that the owner faces an opportunity cost on human capital, i.e., we assume that financial capital is used to fund production capacity, not innovation costs.

[1] These questions date back to Berle and Means (1932), Coase (1937), or even Adam Smith (1795), and are central to industrial organization (ex. Spengler, 1950, Demsetz, 1973, Klein et al., 1978, Williamson, 1975, 1985) and the theory of the firm (ex. Alchian and Demsetz, 1972, Demsetz, 1973, Aoki, 1986, Grossman and Hart, 1986, Hart and Moore, 1990, Holmstrom and Milgrom, 1994, Mullainathan and Scharfstein, 2001). In financial economics, these questions have spurred research on corporate diversification (ex. Lang and Stulz, 1994, Campa and Kedia, 2002, Lamont and Polk, 2002), internal capital markets (ex. Almeida and Wolfenzon, 2006, Gomes and Livdan, 2004, Lamont, 1997, Maksomivic and Phillips, 2002, Schoar, 2002, Stein, 1997, 2002), mergers and acquisitions, corporate governance (Rajan and Zingales, 1998, 2001), and other areas.

Our model stylizes key aspects of external and internal capital markets and the choices and incentives facing entrepreneurs. Fund-raising by standalones is a hit-or-miss process, where external investors must be convinced to fund a project solely based on its absolute merits. Projects entrusted to conglomerates are funded based on their contribution to firm surplus, reflecting relative merits (own productivity compared to the conglomerate's other projects), interactions with other projects, and internal allocation policies ("corporate benevolence"). Thus, the resources a project attracts within a conglomerate can exceed – or fall short of – the resources it might raise in the external capital markets. Both funding channels present uncertainty and the expected net benefits determine which organizational form dominates.

The decision is complicated by the costs and benefits entrepreneurs derive from innovation. Indeed, the propensity to innovate is closely tied to organizational form. For standalones, who face all-or-nothing external-capital funding, innovation only benefits the entrepreneur by raising surplus if the project is funded – not the odds of funding. But for conglomerates, innovation raises expected surplus in two ways: 1) by increasing the return on capital, and 2) by improving the odds of beating rival projects within the conglomerate (a beauty contest) and attracting more funding than otherwise (internally or externally). It is the interaction of these organizational and innovation characteristics that our framework allows us to analyze.

Our analysis reveals that even in a simple setting, devoid of agency and truth-telling issues, organization and innovation interact in complex ways. In some cases, organizational form and innovative effort are separable (but not independent). For instance, when both prior productivity and innovation potential are high, conglomerates are preferred and these might or not foster innovation. When both prior productivity and innovation potential are low, standalones are preferred and these might or not foster innovation. In other cases, organization and innovation are co-determined and polarized: rising innovation costs can cause the optimum to switch from innovative conglomerate to non-innovative standalone or, under different conditions, from innovative standalone to non-innovative conglomerate. In short, the set of optimal organization-innovation pairs span a full range of configurations.

Our most striking finding arises when project productivity is low and innovation potential is high: Project owners who entrust their projects to conglomerates optimally choose to innovate but those who opt for the standalone form optimally choose not to innovate. Reversing the parameters settings (high prior productivity and low innovation potential) also reverses these outcomes: project owners who prefer the conglomerate form decide not to innovate but those who opt for the standalone form choose to innovate. These results serve to qualify assertions that conglomerates necessarily stifle innovation or that standalone firms necessarily spur innovation. It's not as straightforward as that. Our analysis illustrates how underlying economic factors can easily modify any such conclusion.

Another dimension of interest concerns the internal allocation rules within conglomerates, which we allow to vary from highly accommodating, where all projects under management receive equal resource allocations (corporate benevolence), to highly discriminating, where all resources are diverted to the most productive project (corporate capitalism). We find that conglomerates are most likely to dominate when internal competition is very keen (capitalism), because project owners are drawn by the large allocation should they win the internal beauty contest, or very mild (benevolence), because a smaller, safe allocation beats a larger, risky allocation in the external capital market. But the calculus changes as internal competition deviates from these poles and the standalone form becomes more attractive. In each case, the propensity to innovate or not depends on the remaining parameters.

Finally, we examine the special case where the cost of investigation (intermediary costs) go to zero, which means that project productivity is discovered without error (type is revealed). In that case, the external market is advantaged over the internal market because the former is free of information asymmetry. The remaining unknown is how a project will stack up against other conglomerate projects. Interestingly, similar equilibrium partitions emerge. The case of innovative-standalones / non-innovative conglomerates vanishes but the case of innovative- conglomerates / non-innovative standalones can still arise.

Our research contributes to the growing literature on innovation and finance by reconciling disparate empirical findings. For instance, Chemmanur et al. (2014) report more innovation in corporate venture-capital (CVC) firms ("conglomerates") than in independent venture-capital (IVC) firms ("standalones"), which they ascribe to better technological fit and greater tolerance for failure in CVC than in IVC. In contrast, Seru (2014) finds that innovative activity drops in firms acquired in diversifying mergers, especially in conglomerates characterized by active internal allocation markets. Similarly, Bernstein (2015) finds that firms who go public substitute external innovation for internal innovation. This finding is echoed in Bena and Li (2014), who find that firms with large patent portfolios (and low R&D) tend to acquire firms with high R&D and low patent growth, and that innovation synergies spur acquisitions. By integrating internal and external organization and innovation markets, our model delivers a variety of outcomes that can account for the diversity of findings reported in the literature.

Other work examines how the ability to raise external capital (Giroud and Mueller, 2015), channel resources internally (Lamont, 1997, Tate and Yang, 2015), and disgorge funds (Inderst and Mueller, 2003) condition the relative merits of conglomerates and standalones, also with a mixed message.

Our results have several empirical implications. First, dispersion in fundamentals, such as productivity, discovery costs, and conglomerate characteristics, can explain cross-sectional diversity in organizational form and the propensity to innovate. Second, changes in fundamentals can explain corporate events such as mergers and acquisitions, divestitures and spin-offs, asset trades, and internal re-organizations as firms adapt to new conditions.

More specifically, conglomerate resources, such as cash balances (unused credit lines, untapped debt capacity, low payout ratios) and managerial talent, can attract (or repel) acquisition targets and leverage project productivity. We can also explain why conglomerates build cash balances and operate internal capital markets in the first place or even why conglomerates emerge as an organizational form alongside standalones.

We would expect to observe changes in R&D intensity as productive-asset ownership passes from standalone to conglomerate (or vice-versa) and incentives to innovate are altered.

Finally, take-over premia should depend on returns to innovation, bidder characteristics (conglomerate or standalone, identification skills, internal resources and organizational fit), and the characteristics of contending bidders.

The rest of the paper proceeds as follows. Section two presents the modeling assumptions. Section three presents the equilibrium analysis. Section four recasts our results when the cost of investigation is zero - there are still implications for organization and innovation. Section five concludes. Selected proofs are provided as an appendix.

2. Model

A risk-neutral, wealth-constrained entrepreneur has a project with positive productivity, $v > 0$, which is private knowledge. We assume that investors are skeptical, and the common prior on v is such that $E(v) < 0$ so that the entrepreneur cannot costlessly raise capital. It is common knowledge that if financed, the project yields outputs according to a linear productivity function, Y, proportional to project productivity and the capital committed to it. We focus our attention to the fund-raising problem of this positive-productivity project, either through external financing as a standalone firm, or through internal capital markets by joining a cash-rich conglomerate with existing projects.

We assume that the entrepreneur lacks the ability to communicate v to outside investors. For instance, the project may be too specialized or technical for the general population to understand its merit, or the entrepreneur may lack the expertise in producing "hard" information [as in Stein (2002)] regarding project productivity. Instead, intermedaries, which we refer to as "headquarters" or HQs hereafter, exist in the market, who take on the role of bridging information between the entrepreneur and investors. HQs are risk neutral, perfectly competitive (so that they do not create additional agency problems), and are able to costlessly "sense" good ($v > 0$) and bad ($v < 0$) projects through an initial encounter with the entrepreneur. Nonetheless, the outcome of this rough screen is "soft" information, and cannot be communicated directly to the external market.

In order to obtain external financing as a standalone firm, the hired HQ must "harden" information regarding project productivity into a communicable form by performing another costly, in-depth investigation. The success of such information transfer depends on the intensity of HQ's effort, $0 \leq \phi \leq 1$, so that the exact v can be discovered and communicated to the outside investors with probability ϕ. In this case, the project will then get a fixed capital injection $k > 0$.[2] With probability $1 - \phi$, the HQ fails to either discover or communicate v to the external market, and the

[2] It is a straightfoward modification to make external capital k dependent on project productivity v. However, our main purpose here is to compare external and internal financing for a given project with the same v. For the simplicity and ease of exposition, we make k an exogenous parameter of the model without loss of generality.

project will not be financed. Either way, the HQ incurs quadratic costs of effort, $c_{hq}\phi^2/2$, which must be compensated by the entrepreneur, either through output-sharing or via a fixed payment to the HQ.[3] Note that it is the entrepreneur who ultimately controls the likelihood of obtaining external financing. By paying the HQ $c_{hq}/2$ in exchange for $\phi = 1$, the entrepreneur can guarantee that his project will always get financed successfully. On the other hand, the project will for sure not be financed if the entrepreneur does not provide the HQ for additional investigation, i.e., $\phi = 0$. In equilibrium, the entrepreneur will balance the cost and benefit of HQ's investigative effort to determine the optimal level of investigation. Since this decision is privately observed by the entrepreneur and the HQ only (via a contract between the two parties, for instance), bad projects can and will hide themselves and pool with good projects by hiring HQs as well, but providing zero incentive for HQ's investigative effort. Thus, a separating (or revealing) outcome for standalone firms seeking external financing does not exist.

Alternatively, the entrepreneur can choose to seek financing by joining a cash-rich conglomerate and competing with its existing projects for internal capital. The conglomerate HQ can costlessly discern positive- and negative-productivity projects just like standalone HQs described above, but unlike standalone HQs (which are indifferent), it refuses to work with a project with negative productivity. It is thus a revealing action to be able to join a conglomerate. We assume that the entrepreneur is bound to the mode of financing he chooses, such that he cannot join a conglomerate to signal his type then change to seek external financing. Another crucial difference between conglomerate and standalone HQs is that, rather than serving as information intermediary, the conglomerate HQ controls and allocates internal resources to its competing projects according to a pre-announced allocation rule (described below). Without loss of generality, we assume that there is one existing project in the conglomerate with productivity u, which is known to the HQ but not to the entrant entrepreneur. The entrepreneur may hold the same common belief regarding u as outside investors (i.e., $u > 0$), or know more through close interactions with the conglomerate. We do not specifically model the entrepreneur's belief to avoid un-necessary complications in our

[3] We will show the two payment schemes are equivalent under this simple setup.

analysis. Rather, we define a function

$$W(v,\cdot) \equiv \Pr(v > u | beliefs) \tag{1}$$

to denote the likelihood of winning the competition perceived by the entrepreneur, and require that $W_v(v,\cdot) > 0$.

We further assume that the conglomerate has a deep pocket with a total of $2k$ capital, among which $(1+\delta)k$ is allocated to the winning project while the losing project receives $(1-\delta)k$. The parameter $0 < \delta < 1$ characterizes the nature of the conglomerate or the harshness of internal competition. For instance, a δ close to zero corresponds to a benevolent or socialistic conglomerate in which all of its (positive-productivity) projects receive more or less equal resources regardless of their relative merits, while a δ close to 1 refers to a highly competitive environment where winner takes all. [can incorporate some of footnotes 2 and 4 from introduction here???]

In order to implement the pre-announced allocation rule, conglomerate HQ must discover the exact v by performing costly investigation in the same spirit as described above for standalone HQs. The project with productivity v receives the winner allocation if and only if v has been successfully discovered (with probability ϕ) and $v > u$. Note that it is again the entrepreneur who determines the intensity of HQ's investigation. If the perceived winning chance is low, the entrepreneur in a relatively benevolent conglomerate may choose $\phi = 0$ and just accept the default $(1-\delta)k$ capital for his project. Figure 1 depicts both the outcomes and the associated probabilities when the entrepreneur chooses to raise funds externally and internally. Note that our simple setup can be easily generalized to any conglomerates with $(N-1)$ existing projects of various productivies and a total capital of Mk.

In addition to the choice between seeking external and internal finance for his project, the entrepreneur can also choose to put in fixed effort $c_{in} > 0$ to improve the project productivity from v to $(1+a)v$, where $0 < a < 1$.[4] We can interpret a as the innovative potential of the project, which strictly improves the outputs produced by the project if the project is financed. This decision

[4] As in the case of external capital injection k, we can also make the project's innovative potential a dependent on v. We choose not to do so for the simplicity of exposition. Rather, we treat a as an exogenous parameter of the model for comparative statics analysis.

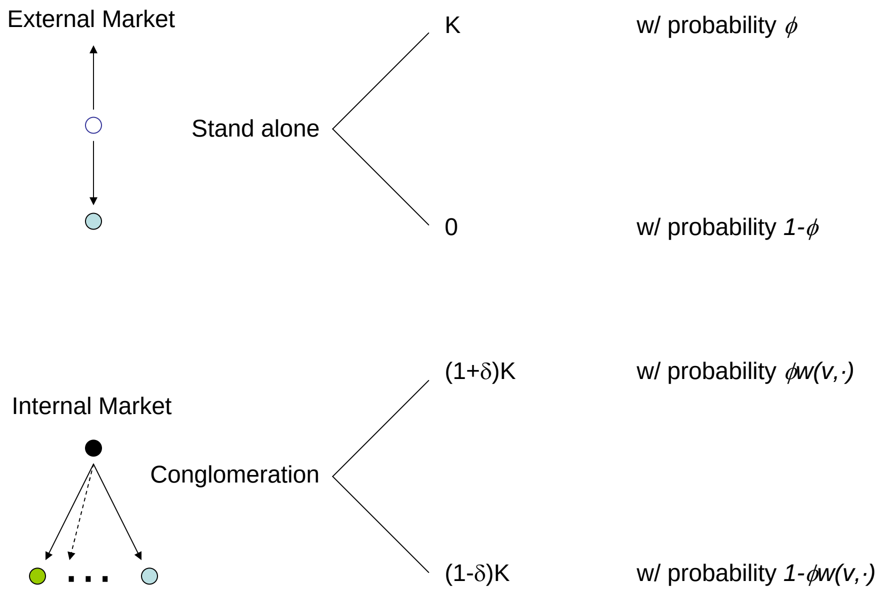

Figure 1: External vs. internal financing outcomes. This figure illustrates the financing outcomes and the associated probabilities when the entrepreneur chooses to raise funds externally and internally.

to innovate must be made before capital allocation is realized from either the external or internal markets. Thus, the entrepreneur must take into consideration the uncertainty of financing outcomes while making innovative decisions. Note that innovation does not earn the project any more external or internal capital, but it improves the entrepreneur's chance of winning internal competition in a conglomerate.

2.1. Timeline

The sequence of events is depicted as follows.

(1) Revelation of allocation rules: external capital (k), internal capital ($2k$), and the harshness of internal allocation (δ) are announced.

(2) Organizational form: the entrepreneur decides whether to seek external financing as a standalone firm or to join a conglomerate and compete with existing projects for internal resources, i.e., $O \in \{SA, CG\}$.

(3) Innovation: after an organizational form is chosen, the entrepreneur decides whether or not

to innovate, $I \in \{0,1\}$.

(4) Fund raising: the entrepreneur determines the intensity of HQ's investigation (ϕ) by providing the HQ with a form of payment, either through fixed payment (FP) or output sharing (OS). The HQ then exerts the desired effort to seek finance for the project. Note that once the HQ discovers v successfully with probability ϕ, he can then rationally and correctly infer the entrepreneur's innovative decision.

(5) Capital allocation is revealed. Production takes place, and outputs are realized.

All agents in our model are intrinsically honest and diligent, and act as risk-neutral expected-profit maximizers. We purposely remove all agency conflicts and focus on a single market imperfection, namely, that the flow of information across agents is inhibited, and that completing the information set is possible but costly. The exact process by which informative signals are acquired and communicated is central to our analysis.

3. Equilibrium Analysis

An equilibrium consists of (1) an optimal organizational structure (or financing scheme) $O \in \{SA, CG\}$ chosen by the entrepreneur, (2) an optimal innovation choice $I \in \{0,1\}$ under the chosen organizational form, and (3) the optimal level of HQ's investigative effort ϕ under a certain payment scheme.

To find the equilibrium, we fix an organizational form (standalone or conglomerate) and calculate overall output surplus generated by the project. Under a fixed-payment scheme to the HQ, this surplus function is given by

$$E\left(surplus^{FP}\right) = (1 + aI)\, vE\,(capital) - \frac{c_{hq}\phi^2}{2} - c_{in}I, \tag{2}$$

depicting expected outputs generated by the project less payment to the HQ, and net of the entrepreneur's innovative cost if any. Working backwards, we first find HQ's optimal investigative effort for any given organization and innovative decisions, then the entrepreneur's optimal innovative decision given the organization, and lastly, the best organization which yields highest surplus in expectation.

If the entrepreneur chooses to compensate the HQ by a fraction of the project outputs instead of fixed payment, the surplus function becomes

$$E\left(surplus^{OS}\right) = (1 - fee)\,(1 + aI)\,vE\,(capital) - c_{in}I \tag{3}$$

such that

$$fee\,(1 + aI)\,vE\,(capital) = \frac{c_{hq}\phi^2}{2}. \tag{4}$$

Note that the two payment schemes are equivalent under risk neutrality of our model.

For the rest of our analysis, we assume fixed payment to the HQ to derive the equilibrium. We further assume $c_{hq} > 2\,(1 + a)\,vk$ hereafter to rule out the trivial case in which the HQ is always well-paid to exert the maximum effort ($\phi = 1$), and that the project type always gets fully revealed to either the external or internal markets. We will return and discuss the equilibrium outcomes under this special case in subsection 4.1.

3.1. Standalone external financing

It is straightfoward to solve for the entrepreneur's optimal choices in an external fund-seeking standalone firm. The outcome is a hit-or-miss process in which the HQ's investigative effort alone determines the likelihood of success. Expected capital injection is simply ϕk, regardless of whether the project gets innovated or not. The following lemma summarizes the equilibrium outcome in such a standalone firm.

Lemma 1 *In a standalone firm seeking external financing, the entrepreneur innovates if and only if $c_{in} < B^{SA}$ where*

$$B^{SA} \equiv \frac{v^2k^2}{2c_{hq}}\left[(1 + a)^2 - 1\right]. \tag{5}$$

The HQ's optimal level of investigative effort is

$$\phi^{SA} = \frac{\left(1 + aI^{SA}\right)vk}{c_{hq}}, \tag{6}$$

and expected project surplus is

$$SA = \frac{\left(1 + aI^{SA}\right)^2 v^2 k^2}{2c_{hq}} - c_{in} I^{SA}, \tag{7}$$

where $I^{SA} \in \{0, 1\}$ denotes the entrepreneur's optimal innovative decision in such standalone firm.

The results are quite intuitive. Innovation is desirable only when the benefits it creates outweight its costs. Innovative benefits are realized only when the project is financed. Thus, gains to innovation under standalone external financing increase with the amount of external capital it could attract, increase with both the project's productivity and its innovative potential, and decrease with HQ's cost of investigation. Equation (5) defines the break-even innovative cost which must equal the benefits created by innovation, B^{SA}. Intuitively, such innovative benefits reflect the difference in expected surplus generated by the project with and without innovation.

3.2. Conglomerate internal financing

By joining a conglomerate, the entrepreneur can guarantee an injection of $(1 - \delta) k$ capital for his project, which is lower than what he could have gotten in a successful external financing compaign. In order to get more, he must win the competition against the existing project in the conglomerate, and takes into consideration such winning probability in making innovative decisions. Note that the perceived winning chance for the entrepreneur becomes $W[(1 + aI) v, \cdot]$, which increases in both v and a. Expected capital allocation for the project thus becomes $(1 - \delta) k + 2\delta k \phi W[(1 + aI) v, \cdot]$, where the first term is the guaranteed allocation while the second term depicts expected gain in resources by winning the competition. Plugging this expression into the surplus function given by Equation (2), we can analyze the equilibrium outcome of internal financing in such a conglomerate.

Lemma 2 *In joining a conglomerate and competing for internal resources, the entrepreneur innovates if and only if $c_{in} < B^{CG}$ where*

$$B^{CG} \equiv a(1 - \delta) vk + \frac{2\delta^2 v^2 k^2}{c_{hq}} \left\{(1 + a)^2 W^2 [(1 + a) v, \cdot] - W^2 (v, \cdot)\right\}. \tag{8}$$

The HQ's optimal level of investigative effort is

$$\phi^{CG} = 2\delta W\left[\left(1 + aI^{CG}\right)v, \cdot\right]\frac{\left(1 + aI^{CG}\right)vk}{c_{hq}}, \tag{9}$$

and expected project surplus is

$$CG = \left(1 + aI^{CG}\right)(1 - \delta)vk + \frac{2\left(1 + aI^{CG}\right)^2\delta^2v^2k^2W^2\left[\left(1 + aI^{CG}\right)v, \cdot\right]}{c_{hq}} - c_{in}I^{CG}, \tag{10}$$

where $I^{CG} \in \{0, 1\}$ *denotes the entrepreneur's optimal innovation decision in such a conglomerate.*

Clearly, the conglomerate equilibrum is complicated by the internal competition for resources. Specifically, two addtional forces are at play here, namely, the harshness of competition reflected by the difference in capital allocation between the winner and the loser, and the entrepreneur's perceived likelihood of winning with and without innovation.

The optimal level of HQ's investigative effort is determined by offsetting the costs of investigation with its benefits. Such benefits derived from standalone HQs are simply reflected by the outputs produced by the successfully financed project, as a failed attempt results in no capital injection and no production whatsoever. On the other hand, the benefits deriving from conglomerate HQs are reflected by the *difference in outputs* generated by the project under the winner verses loser allocation. Therefore, both the difference in capital allocation between the winner and loser (i.e., competition harshness) and the perceived winning probability directly determine the conglomerate HQ's investigative effort, in addition to the usual parameters already discussed in the standalone case. As a result, an entrepreneur with the same project may provide very strong incentive to motivate investigation by a competitive conglomerate HQ if he is confident in defeating his competitor, and provide very little incentive to investigate in a benevolent conglomerate while perceiving a low winning chance.

As expected, innovative benefits in conglomerates increase when the entrepreneur's perceived winning chance improves significantly through innovation. It is very intuitive and deserves no further elaboration. Yet, the decision of whether or not to innovate is further baffled by the fact that innovative benefits are not monotonically related to the harshness of competition within the conglomerate. Specifically, gains to innovation come from two channels, reflected by the two terms of B^{CG} given in Equation (8). First, innovation improves project outputs under the guaranteed (base or loser) allocation. Since this guaranteed allocation decreases in competition harshness, so does innovative benefits. Second, innovation improves both the project outputs under the winner allocation and the probability of receiving the winner allocation. Here, competition harshenss increases innovative benefits, as it improves the allocation the winner receives. The combination of these two opposing forces determines the overall effect of competition harshness on innovation.

Lemma 3 *There exists a critical level of competition harshness within conglomerate firms*

$$\overline{\delta} \equiv \frac{a}{\left\{(1+a)^2 W^2\left[(1+a)v,\cdot\right] - W^2(v,\cdot)\right\}} \frac{c_{hq}}{4vk}, \tag{11}$$

such that innovative benefits increase with harshenss in relatively harsh conglomerates (i.e., $\delta > \overline{\delta}$), and decrease with harshness in relatively benevolent conglomerates (i.e., $\delta < \overline{\delta}$).

One implication of this result is that the entrepreneur is more likely to innovate in either very competitive or very benevolent conglomerates. We can think about why this is the case by taking a closer look at the benefits derived from innovation under these two extreme forms of conglomeration.

Innovative benefits in a very benevolent conglomerate approach avk, which is purely the incremental gain in outputs with and without innovation given a fixed capital injection k. Note that such a conglomerate guarantees all its projects more or less the same allocation, thus saving the HQ's effort on costly investigation and relieving the entrepreneur's concern of winning the tournament. On the other hand, innovative benefits in very competitive conglomerates include 1) how innovation improves the entrepreneur's chance of receiving the winner allocation, and 2) how innovation increases project outputs for any given level of allocation. Unlike in benevolent conglomerates, HQ's investigative costs are quite important in competitive conglomerates as it is crucial to differentiate among competing projects. Therefore, more benevolent conglomerates may attract innovation when HQ's investigation becomes very costly, while more competitive conglomerates may attract innovation when expected gains to the winner improve significantly through innovation.

3.3. What structure spurs more innovation?

We have explicitly derived the innovative benefits and the conditions for the entrepreneur to innovate in both the standalone and conglomerate structures. We now ask which particular structure, standalone or conglomerate, is more likely to result in innovation. The key to answer this question is to find out which structure, for the same cost to the entrepreneur, delivers higher innovative benefits. We compare the two innovative conditions given in Equation (5) and Equation (8), and summarize our results in the following proposition.

Proposition 1 *Define* $\Delta W^2(a, v, \cdot) \equiv W^2[(1+a)v, \cdot] - W^2(v, \cdot)$. *There is a critical condition*

$$(C1) : \frac{vk}{2c_{hq}} \left\{ (2+a)\left[1 - 4\delta^2 W^2(v, \cdot)\right] - \frac{(1+a)^2}{a} 4\delta^2 \Delta W^2(a, v, \cdot) \right\} + \delta < 1 \tag{12}$$

under which conglomerate structure results in more innovation than standalones when it holds, and standalone structure results in more innovation than conglomerates when it fails.

First, the condition holds automatically when the expression within the braces is negative, i.e., when the conglomerate is sufficiently competitive such that

$$\delta > \frac{1}{2\sqrt{W^2(v, \cdot) + \frac{(1+a)^2}{a(2+a)} \Delta W^2(a, v, \cdot)}}. \tag{13}$$

Intuitively, competitive conglomerates motivate innovation more than standalones due to the attraction of their abundant winner allocation, as opposed to the fixed amount of external capital that standalones may or may not successfully raise. Unlike in standalones, innovation in conglomerates improves not only overall outputs of the project but also perceived likelihood of receiving the winner allocation. The more the winner receives relative to the loser, the higher the incentive to innovate. Note that this is a rather strong, i.e., sufficient condition, under which (competitive) conglomerates would for certain cultivate, rather than stiffle, innovation compared to standalone firms.

We now turn to the non-trivial case in which Equation (13) fails, and that the conglomerate environment is relatively benevolent. Here, condition $(C1)$ is more likely to hold, and that conglomerate structure is more innovation-spurring, when HQs' investigative costs are high ($c_{hq} \uparrow$), external capital is limited ($k \downarrow$), perceived winning chance pre-innovation is high [$W(v, \cdot) \uparrow$], and when innovation significantly improves such winning chance $\left[\Delta W^2(a, v, \cdot) \uparrow\right]$. Intuitively, innovative benefits can be realized only when the project is financed so that it can be put into production. Under standalone external fund-seeking, HQ's investigation is critical in determining the financing outcome of this hit-or-miss process. Such investigation is also important in a conglomerate in identifying the winning project, but not as critical here because even the loser project receives some funding through which the benefits of innovation can still be realized. Therefore, higher costs of HQ's investigation will suppress the entrepreneur's incentive to innovate in standalone firms more than in conglomerates. Limited external capital has a similar effect in reducing the benefits of innovation in standalones more than it does in conglomerates. Note however, that these effects of c_{hq} and k depend critically on the relative benevolence of the conglomerate structure. Indeed, results will *reverse* when conglomerates become competitive enough to validate Equation (13) again.

The effects of project productivity (v) and innovative potential (a) are indeterminate. They have not only direct but also indirect effects through their influence on the winning probabilities, and the compounding effect can go in either direction. All we can say is that, for the same v and a, higher perceived winning chance pre-innovation [steeper $W(v, \cdot)$ w.r.t. v] and more significant improvement in winning probability through innovation [steeper $W[(1+a)v, \cdot]$ w.r.t. a] will increase conglomerates' attraction to innovation, as the entrepreneur is more likely to receive the winner allocation and capture higher benefits through innovation.

Lastly, as already discussed in the previous section, the effect of conglomerate competitiveness (δ) on innovative benefits is non-monotonic. Innovation is most likely in either very benevolent or very competitive conglomerates.

3.4. Better way to finance: Standalone or conglomerate?

After analyzing the entrepreneur's best responses under both standalone and conglomerate structures, we now compare the surplus functions to determine the optimal structure under which the entrepreneur seeks financing.

Proposition 2 *Define two more conditions*

$$(C2) \quad : \quad (1+a)\frac{vk}{2c_{hq}}\left\{1-4\delta^2 W^2\left[(1+a)v,\cdot\right]\right\}+\delta<1, \textit{ and} \tag{14}$$

$$(C3) \quad : \quad \frac{vk}{2c_{hq}}\left[1-4\delta^2 W^2(v,\cdot)\right]+\delta<1. \tag{15}$$

(Ia) The entrepreneur always chooses conglomerate internal financing when both conditions $(C2)$ *and* $(C3)$ *hold, and innovates if and only if* $c_{in} < B^{CG}$.

(Ib) The entrepreneur always chooses standalone external financing when both conditions $(C2)$ *and* $(C3)$ *fail, and innovates if and only if* $c_{in} < B^{SA}$.

(IIa) When condition $(C2)$ *holds but* $(C3)$ *fails, the entrepreneur chooses conglomerate internal financing and innovates when* $c_{in} < \overline{c}$, *and chooses standalone external financing and no innovation when* $c_{in} > \overline{c}$.

(IIb) When condition $(C2)$ *fails but* $(C3)$ *holds, the entrepreneur chooses standalone external financing and innovates when* $c_{in} < \overline{\overline{c}}$, *and chooses conglomerate internal financing and no innovation when* $c_{in} > \overline{\overline{c}}$.

No other cases are possible. The critical bounds $\overline{c}$ *and* $\overline{\overline{c}}$ *are given by*

$$\overline{c} \equiv (1+a)(1-\delta)vk+\left\{4(1+a)^2\delta^2 W^2\left[(1+a)v,\cdot\right]-1\right\}\frac{v^2k^2}{2c_{hq}}, \textit{ and} \tag{16}$$

$$\overline{\overline{c}} \equiv \frac{v^2k^2}{2c_{hq}}\left[(1+a)^2-4\delta^2 W^2(v,\cdot)\right]-(1-\delta)vk. \tag{17}$$

The first two results, (Ia) and (Ib), describe situations under which only conglomerate and only standalone structures are always preferred, respectively, regardless of innovation decisions. The underlying logic is that if one structure is preferred over the other when the entrepreneur innovates under both structures, and the same structure is preferred again when the entrepreneur does not innovate under both structures, then this structure must be optimal even when the entrepreneur chooses to innovate under one and not under the other structure. This logic holds true regardless of which structure results in higher innovative benefits or whether condition $(C1)$ holds or fails. The relevant conditions here are the dominance of one structure under innovation and the same dominance under no innovation, i.e., whether conditions $(C2)$ and $(C3)$ hold together (for conglomerate dominance) or fail together (for standalone dominance). In accordance with previous findings, we find that conglomerate is more likely to dominate over standalone structure when perceived winning chances pre- and post-innovation are high, and when the conglomerate's internal competition gets either very harsh or very benign. Moreover, benevolent conglomerates are more likely to dominate over standalones when HQ's investigative costs are high and external capital is limited, while competitive conglomerates are more likely to dominate standalones when the reverse are true.

Note that a special case within (Ia) arises when $2\delta W(v,\cdot) > 1$, under which all three conditions $(C1-3)$ hold automatically. In other words, when the entrepreneur's perceived winning chance is sufficiently high (at least higher than one-half) pre-innovation, seeking internal financing in a sufficiently competitive conglomerate $\left[\delta > \frac{1}{2W(v,\cdot)}\right]$ is always more optimal than seeking external financing as a standalone firm, and more so the more competitive the internal competition gets. Of course, this is a rather strong case in which all other influencing parameters cease to matter. Intuitively, we can think of it as a reflection of "perceived-winner's pride" in choosing the way the project gets financed.

Naturally, whether or not the entrepreneur would innovate under the dominant/optimal structure is governed by the condition given in either Equation (5) or Equation (8), as discussed previously.

The remaining two scenarios, (IIa) and (IIb), are the most interesting because no single structure is always dominant, and the optimal financing structure is bundled together with a particular innovation decision under each equilibrium outcome.

Specifically, item (IIa) describes what happens when innovative conglomerates dominate innovative standalones [condition $(C2)$ holds], but non-innovative standalones dominate non-innovative conglomerates [condition $(C3)$ fails]. Together they imply

$$\delta > \sqrt{\frac{a}{4\left\{(1+a)\,W^2\left[(1+a)\,v,\cdot\right] - W^2\,(v,\cdot)\right\}}}, \tag{18}$$

and thus this scenario only applies to the comparison between standalone structure and relatively competitive conglomerates. Indeed, more conglomerates would be subject to this scenario when innovation improves perceived winning chance significantly, as Equation (18) is more likely to hold when $\Delta W^2(a, v, \cdot)$ rises sharply.

When the entrepreneur chooses to innovate under one and not under the other structure, either innovative conglomerate or non-innovative standalone could become optimal depending on which structure yields higher expected surplus for the entrepreneur. Equation (16) depicts the critical cutoff for innovative cost, $\bar{c}$, below which innovative conglomerates dominate and above which non-innovative standalones dominate. As expected, the dominating region for innovative conglomerates grows as the project's innovative potential increases and when innovation improves perceived winning chance significantly. It also grows when the conglomerate becomes either more benevolent [within the range of Equation (18)] or more competitive, as higher innovative benefits can be realized as the degree of internal competition moves towards these two extremes. Furthermore, the dominance of benevolent (innovative) conglomerates over (non-innovative) standalones grows as HQ's investigative costs increase, so that the project can get reasonable financing without too much costly investigation. At the same time, the dominance of competitive (innovative) conglomerates over (non-innovative) standalones grows as HQ's investigative costs decrease, so that the winning project can be identified and funded more easily and cheaply. The effects of project productivity and capital abundance are ambiguous when comparing benevolent conglomerates against standalones, while they strictly enlarge the dominance of competitive conglomerates over standalones.

In contrast, case (IIb) describes the opposite situtation in which innovative standalones dominate innovative conglomerates [condition $(C2)$ fails], but non-innovative conglomerates dominate non-innovative standalones [condition $(C3)$ holds]. This scenario applies to the comparison between standalone structure and relatively benevolent conglomerates violating the condition given in Equation (18). More conglomerates would potentially fall into this category when innovation cannot improve perceived winning chance too much. Now, either innovative standalones or non-innovative conglomerates could become the optimal structure, depending on whether innovative cost is lower or higher than the critical cutoff given in Equation (17).

With relatively benevolent internal allocation and small improvement in perceived winning chance through innovation, this is indeed the region under which innovative benefits are lower in conglomerates than in standalones. Not surprisingly, larger innovative potential enlarges the dominating region of innovative standalones, and so does lower perceived winning chance under conglomeration. On the other hand, higher degree of benevolence, limited external capital, and more expensive HQ investigation improve the dominance of (non-innovative) conglomerates over (innovative) standalones, while project productivity has an ambiguous effect.

Finally, it is straightforward to verify that case (IIa) automatically implies the validity of condition $(C1)$, under which innovative benefits are higher under conglomeration. This is the scenario in which conglomerates with relatively competitive internal competition cultivate innovation more than standalones, and more so the more competitive they get. In contrast, case (IIb) automatically implies the failure of condition $(C1)$, under which innovative benefits are higher under the standalone structure. This is the opposite situation in which standalone firms motivate innovation more than conglomerates with more benevolent internal allocations, but less so the more benevolent they get. Our model thus demonstrates the existence of an equilibrium region in which conglomeration does stifle innovation relative to the standalone structure, but without relying on any of the usual agency-conflict arguments. Figure 2 illustrates the various dominating regions of the equilibrium outcomes, and how they move as the modelling parameters change.

4. Disucssion

4.1. Contrast with free-investigation benchmark

Since we intentionally abstract our analysis from any agency conflicts, the key "friction" or imperfection in our model comes from the costs of investigation that HQs incur in performing their intermediation or allocation roles. Indeed, this investigative cost is the cause of imperfect information in both external and internal financing processes. We now compare our results with a benchmark scenario in which HQ's investigation is costless to obtain and communicate, such that c_{hq} approaches zero and ϕ is thus always one. We can interpret this benchmark as a limiting case under our model framework as HQs become more and more cost-efficient in performing their investigative and intermediation tasks.

The most significant change under this zero-cost benchmark is the fact that the merit of the project will always be revealed to the external or internal markets perfectly. Thus, external financing will always be successful with an injection of capital k without uncertainty. Conglomerate internal financing, on the other hand, ex ante still faces a stochatic outcome, receiving either $(1+\delta)\,k$ or $(1-\delta)\,k$, depending on the entrepreneur's perceived likelihood of winning the internal competition with or without innovation. Note that the two financing outcomes become increasingly alike as the conglomerate becomes more and more benevolent. In the limit as δ approaches zero, these two ways of financing produce identical outcomes. It is straightforward to derive and compare the entrepreneur's innovation decisions under both financing schemes as summarized below.

Proposition 3 *The entrepreneur innovates in a standalone firm under external financing if and only if*

$$c_{in} < B_Z^{SA} \equiv avk, \tag{19}$$

and innovates in a conglomerate if and only if

$$c_{in} < B_Z^{CG} \equiv vk \left\{a\,(1-\delta) + 2\delta\left[(1+a)\,W\left[(1+a)\,v,\cdot\right] - W\,(v,\cdot)\right]\right\}. \tag{20}$$

There is a critical condition

$$(C1_Z) : a < 2\,(1+a)\,W\left[(1+a)\,v,\cdot\right] - W\,(v,\cdot) \tag{21}$$

under which conglomerate structure results in more innovation than standalones when it holds, and standalone structure results in more innovation than conglomerates when it fails.

These results follow the same intuitions and trends as discussed previously. In particular, condition $(C1_Z)$ gives us the comparison of innovative benefits in standalones and in conglomerates under costless HQ investigation. In contrary to its counterpart, condition $(C1)$, the harshness of internal allocation within the conglomerate ceases to matter, along with other influencing parameters such as project productivity and capital abundance. Essentially, the comparison here boils down to how much more expected capital that each structure can attract through innovation and how much more outputs it can produce. Notably, conglomerates would yield lower innovative benefits than standalones only when the project cannot win internal competition and thus only receiving $(1-\delta)\,k$ for production. With the δk less capital, a potential $av\delta k$ amount of outputs from innovation is lost compared to standalone financing. On the other hand, winning the competition would provide the project with $2\delta k$ additional capital, with which the difference in expected outputs (i.e., winning chance times productivity) it can produce before and after innovation determines the overall benefits of innovation. Since δ, v, and k all cancel out from the comparison, we are left with the simple expression of condition $(C1_Z)$, in which the left-hand-side represents the incremental gain to innovation in standalones while the right-hand-side that for conglomerates.

As always, gains to innovation are higher under conglomeration when innovation improves perceived winning chance significantly. Higher innovative potential (a) improves innovative benefits in conglomerates more than it does in standalones if and only if the perceived winning chance post-innovation, $W[(1+a)\,v,\cdot]$, is higher than half, so that more capital injection is expected in conglomerate than in standalone financing.

We also find that more competitive conglomerates are more likely to innovate when condition $(C1_Z)$ holds, while more benevolent conglomerates are more likely to innovate when it does not. This result is not surprising once we realize that internal financing in benevolent conglomerates resembles standalone financing more and more as the allocation becomes increasingly even.

Proposition 4 *The equilibrium outcomes under free HQ investigation are summarized as follows.*

(IaZ) When $W(v,\cdot) > \frac{1}{2}$, the entrepreneur always chooses conglomerate internal financing, and innovates if and only if $c_{in} < B_Z^{CG}$.

(IbZ) When $W[(1+a)\,v,\cdot] < \frac{1}{2}$, the entrepreneur always chooses standalone external financing, and innovates if and only if $c_{in} < B_Z^{SA}$.

(IIZ) When $W(v,\cdot) < \frac{1}{2}$ but $W[(1+a)\,v,\cdot] > \frac{1}{2}$, the entrepreneur chooses conglomerate internal financing and innovates when $c_{in} < \bar{c}_Z$, and chooses standalone external financing and no innovation otherwise,

where the critical bound $\overline{c}_Z$ *is given by*

$$\overline{c}_Z \equiv vk \left\{ 2\delta W \left[(1+a) v, \cdot \right] (1+a) + (1+a)(1-\delta) - 1 \right\}. \tag{22}$$

Again, the key is to determining which structure offers higher expected capital to the project. Compared to standalone external financing which delivers k for certain, conglomerates with various degrees of competitive allocation would provide more capital than k in expectation if and only if the entrepreneur has a better-than-even perceived likelihood of winning the competition. If such perceived winning chance is greater than half pre-innovation, it will be even higher post-innovation, which would for sure guarantee the dominance of conglomeration as depicted in case (IaZ) of the proposition. In contrary, if the entrepreneur's perceived winning chance is worse-than-average even after innovation, it will be even lower pre-innovation, which would for certain suggest the dominance of standalone structure as stated in case (IbZ). If perceived winning chance is less-than-even pre-innovation but better-than-even post-innovation, either innovative conglomerates or non-innovative standalones could become the optimal structure. This interesting case is presented in item (IIZ), in which a critical level of innovative cost, $\overline{c}_z$, is defined to divide the two regions. As expected, the dominating region of innovative conglomerates grows with higher project productivity, capital abundance, innovative potential, and perceived winning probability post-innovation. It also grows as the conglomerate becomes more and more competitive, which increases expected capital allocation given the better-than-average chance of winning the competition post-innovation. Figure 3 depicts the equilibrium regions of this costless investigation benchmark, and how they move with modelling parameters.

Compared to the results analyzed earlier in Proposition 2, some equilibrium regions under costly investigation notably get crowded out as HQ's investigation becomes cost-free. In particular, there will not be any scenarios under which the entrepreneur chooses innovative standalones when the cost of innovation is low, but switches to non-innovative conglomerates as innovation becomes costly. Recall that this situation, as described in item (IIb) of Proposition 2, can only arise when conglomerate allocation is relatively benevolent and innovation cannot improve perceived winning chance sufficiently. Since gains from innovation in conglomerates are rather limited, the entrepreneur is better off innovating as a standalone firm facing the uncertainty of external financing when it is cheap to do so. When innovation gets expensive, however, despite higher innovative benefits under the standalone structure, joining the conglomerate without innovation and taking advantage of its benevolent allocation become the entrepreneur's optimal choice. As external financing is no longer risky under costless HQ investigation, there is no reason to switch preference from standalones to (benevolent) conglomerates, and this scenario disappears completely.

Furthermore, since higher degree of benevolence merely resembles standalone financing under costless investigation by the HQ, it will not increase the attractiveness of conglomerates relative to standalone financing at all as in the costly investigation setup.

5. Conclusion

We investigate how productive assets should be organized and developed by modeling the interaction of organizational form and innovative effort. We propose a simple model, devoid of behavioral problems, where project owners choose organizational form (standalone or conglomerate), information intensity, and innovative effort (innovate or not) when private productivity is costly to communicate. Organization-innovation optima hinge on productivity priors, internal allocation policies, information costs, and the cost and benefit of innovation.

We conclude that organization and innovation interact in complex ways. In some cases, organizational form and innovative effort are dissociable: Conglomerates and standalones are alternately preferred and either form optimally might or not foster innovation. In other cases, organization and innovation are co-determined and the set of optimal organization-innovation pairs is exhaustive: innovative conglomerates, non-innovative standalones, innovative standalones, and non-innovative conglomerates all can arise in equilibrium. Our analysis qualifies simple conjectures on the link between organization and innovation.

Our research contributes to the growing literature on innovation and finance by reconciling disparate empirical findings. The diversity of outcomes we document and the sensitivity of our results and the comparative statics to the basic parameters have two major implications for empirical research. First, the range of findings reported in prior work might well reflect the complexities that underlie the organization and innovation choice. Second, our set up suggests productive avenues for structuring future tests and desirable control variables.

Reference

Alchian, Armen, and Harold Demsetz, 1972, Production, Information Costs, and Economic Organization, *American Economic Review* 62, 777-795.

Aghion, Philippe, and Jean Tirole, 1997, Formal and real authority in organizations, *Journal of Political Economy* 105, 1–29.

Aoki, Masahiko, 1986, Horizontal vs. Vertical Information Structure of the Firm, *American Economic Review* 76 (5), 971-983.

Almeida, Heitor, and Daniel Wolfenzon, 2006, Should business groups be dismantled? The equilibrium costs of efficient internal capital markets, *Journal of Financial Economics* 79, 99-144.

Arrow, Kenneth J., 1962a, The economic implications of learning by doing, *The Review of Economic Studies* 29, 155-173.

Arrow, Kenneth J., 1962b, Economic welfare and the allocation of resources for invention, in *The Rate and Direction of Inventive Activity* (Princeton University Press), for NBER, 609-626.

Bena, Jan, and Kai Li, 2014, Corporate Innovations and mergers and acquisitions, *Journal of Finance* 69, 1923-1960.

Berger, Philip, and Eli Ofek, 1995, Diversification's effect on firm value, *Journal of Financial Economics* 37, 39-65.

Berger, Allen, Nathan Miller, Mitchell Petersen, Raghuram Rajan, and Jeremy Stein, 2005, Does function follow organizational form? Evidence from the lending practices of large and small banks, *Journal of Financial Economics* 76, 237-269.

Berkovitch, Elazar, Ronen Israel, and Efrat Tolkowsky, 2006, The boundaries of the firm: The choice between stand-alone and integrated firms, *Journal of Economics and Management Strategy* 15, 821–851.

Berle, Adolf, and Gardiner Means, 1932, Th*e Modern Corporation and Private Property* (Macmillan, New York).

Bernstein, Shai, 2015, Does going public affect innovation?, *Journal of Finance* 70, 1365-1404.

Boutin, Xavier, Cestone, Giacinta, Fumagalli, Chiara, Pica, Giovanni, and Nicolas Serrano-Velarde, 2013, The deep-pocket effect of internal capital markets, *Journal of Financial Economics*

109, 122–145.

Campa, Jose, and Simi Kedia, 2002, Explaining the diversification discount, *Journal of Finance* 57, 135-160.

Chemmanur, Thomas J., Elena Loutskina, and Xuan Tian, 2014, Corporate Venture Capital, Value Creation, and Innovation, *Review of Financial Studies*, 27 (8), 2434-2473.

Coase, R. H., 1937, The Nature of the Firm, *Economica* 4, 386-405.

Demsetz, Harold , 1973, Industry Structure, Market Rivalry, and Public Policy, *Journal of Law and Economics* 16, 1-9.

Demsetz, Harold , 1983, The Structure of Ownership and the Theory of the Firm, *Journal of Law and Economics* 26, 375-390.

Demsetz, Harold, and Kenneth Lehn, 1985, The Structure of corporate cwnership: Causes and consequences, *Journal of Political Economy* 93, 1155-1177.

Ferreira, Daniel, Gustavo Manso, and Andre Silva, 2014, Incentives to Innovate and the Decision to Go Public or Private, *Review of Financial Studies* 27, 256-300.

Ganuza, Juan-Jose, and Jose S. Penalva, 2010, Signal orderings based on dispersion and the supply of private information in auctions. *Econometrica*, 78, 1007-1030.

Gertner, Robert H., David S. Scharfstein, and Jeremy C. Stein, 1994, Internal versus external capital markets, *Quarterly Journal of Economics* 109, 1211-1230.

Giroux, Xavier, and Holger M. Mueller, 2015, Capital and labor reallocation within firms, *Journal of Finance* 70, 1767-1837.

Gomes, Joao, and Dimitry Livdan, 2004, Optimal diversification: Reconciling theory and evidence, *Journal of Finance* 59, 507-535.

Graham, John, Michael Lemmon, and Jack Wolf, 2002, Does corporate diversification destroy value, *Journal of Finance* 57, 695-720.

Grossman, Sanford J., and Oliver D. Hart, 1986, The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration, *Journal of Political Economy* 94, 691-719.

Hart, Oliver, and John Moore, 1990, Property rights and the nature of the firm, *Journal of Political Economy* 98, 1119–1158.

Hart, Oliver, 1995, *Firms, Contracts, and Financial Structure*, Oxford University Press.

Hopenhayn, Hugo, 1992, Entry, exit, and firm dynamics in long run equilibrium, *Econometrica* 60, 1127-1150.

Holmstrom, Bengt, and Paul Milgrom, 1994, The firm as an incentive system, *American Economic Review* 84, 972–991.

Holmstrom, Bengt, 1999, The firm as a subeconomy, *Journal of Law Economics and Organization* 15, 74–102.

Hubbard, R. Glenn, 1998, Capital-market imperfections and investment, *Journal of Economic Literature* 36, 193-225.

Inderst, Roman, and Holger M. Mueller, 2003, Internal versus external financing: An optimal contracting approach, *Journal of Finance*, 58, 1033-1062.

Klein, Benjamin, Robert Crawford, and Armen Alchian, 1978, Vertical Integration, Appropriable Rents, and the Competitive Contracting Process, *Journal of Law and Economics* 21, 297-326.

Jensen, Michael C., and Richard S. Ruback, 1983, The market for corporate control: The scientific evidence, *Journal of Financial Economic*s, 11, 5-50.

Lamont, Owen A., 1997, Cash flow and investment: Evidence from internal capital markets, *Journal of Finance* 52, 83-109.

Li, David, and Shan Li, 1996, A theory of corporate scope and financial structure, *Journal of Finance* 51, 691-709.

Lamont, Owen, and Chistopher Polk, 2002, Does diversification destroy value? Evidence from industry shocks, *Journal of Financial Economics* 63, 51-77.

Lang, Larry, and Rene Stulz, 1994, Tobin's q, corporate diversification, and firm performance, *Journal of Political Economy* 102, 1248-1280.

Maksimovic, Vojislav, and Gordon Phillips, 2002, Do conglomerate firms allocate resources inefficiently across industries?, *Journal of Finance* 57, 721-767.

Manne, Henry G., 1965, Mergers and the market for corporate control, *Journal of Political Economy* 73, 110-120.

Manso, Gustavo, 2011, Motivating Innovation, *Journal of Finance* 66, 1823-1869.

Matsusaka, John, 2001, Corporate diversification, value maximization, and organizational capabilities, *Journal of Business* 74, 409-431.

Mullainathan, Sendhil, and David Scharfstein, 2001, Do firm boundaries matter?, *American Economic Review Papers and Proceedings* 91, 195–199.

Rajan, Raghuram, Henri Servaes, and Luigi Zingales, 2000, The cost of diversity: The diversification discount and inefficient investment, *Journal of Finance* 55, 35-80.

Rajan, Raghuram, and Luigi Zingales, 1998, Power in a theory of the firm, *Quarterly Journal of Economics* 113, 387–432.

Rajan, Raghuram, and Luigi Zingales, 2001, The firm as a dedicated hierarchy: a theory of the origins and growth of firms, *Quarterly Journal of Economics* 116, 805–851.

Rotemberg, Julio J., and Garth Saloner, 1994, Benefits of Narrow Business Strategies, *American Economic Review* 84 (5), 1330-1349.

Scharfstein, David, and Jeremy Stein, 2000, The dark side of internal capital markets I, *Journal of Finance* 55, 2537-2564.

Schoar, Antoinette, 2002, Effects of corporate diversification on productivity, *Journal of Finance* 57, 2379-2403.

Seru, Amit, 2014, Firm boundaries matter: Evidence from conglomerates and R&D activity, *Journal of Financial Economics* 111, 381–405.

Servaes, Henri, 1996, The value of diversification during the conglomerate merger wave, *Journal of Finance* 51, 1201-1225.

Shin, Hyun-Han, and Rene M. Stulz, 1998, Are internal capital markets efficient?, *Quarterly Journal of Economics* 113, 531-552.

Smith, Adam, 1795, *Essays on philosophical subjects.* Oxford: Oxford University Press, 1980 (originally published 1795).

Spengler, Joseph J, 1950, Vertical integration and antitrust policy, *Journal of Political Economy* 58, 347-352.

Stein, Jeremy, 1997, Internal capital markets and the competition for corporate resources, *Journal of Finance* 52 (1), 111-133.

Stein, Jeremy, 2002, Information production and capital allocation: Decentralized versus hierarchical firms, *Journal of Finance* 57, 1891-1921.

Stulz, Rene M., 1988, Managerial control of voting rights: Financing policies and the market for corporate control, *Journal of Financial Economics* 20, 25-54.

Tate, Geoffrey, and Liu Yang, 2015, The bright side of corporate diversification: Evidence from internal labor markets, *Review of Financial Studies* 28, 2203-2249.

Wernerfelt, Birger, and Cynthia A. Montgomery, 1988, Tobin's q and the importance of focus in firm performance, *American Economic Review* 78, 246-250.

Williamson, Oliver E, 1975, *Markets and hierarchies: Analysis and antitrust implications*, (New York: Free Press).

Williamson, Oliver E, 1985, *The economic institutions of capitalism* (Simon and Schuster).

Williamson, Oliver E., 1988, Corporate finance and corporate governance, *Journal of Finance* 43, 567–591.

Whited, Toni, 2001, Is it inefficient investment that causes the diversification discount?, *Journal of Finance* 56, 1667-1691.

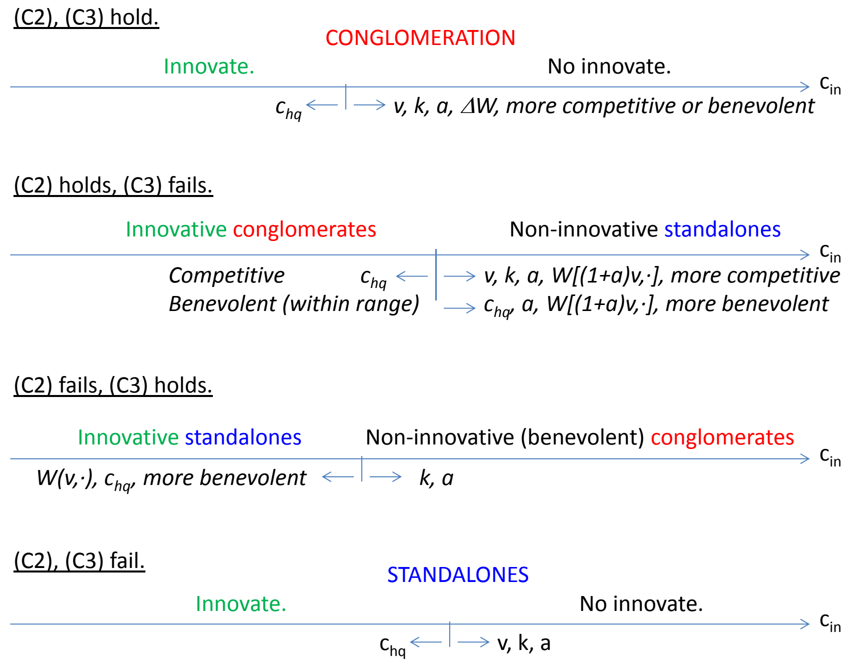

Figure 2: Optimal financing and innovative decisions. This figure demonstrates the entrepreneur's optimal financing and innovative decisions under various regimes, and how each equilibrium region shifts as modelling parameters change.

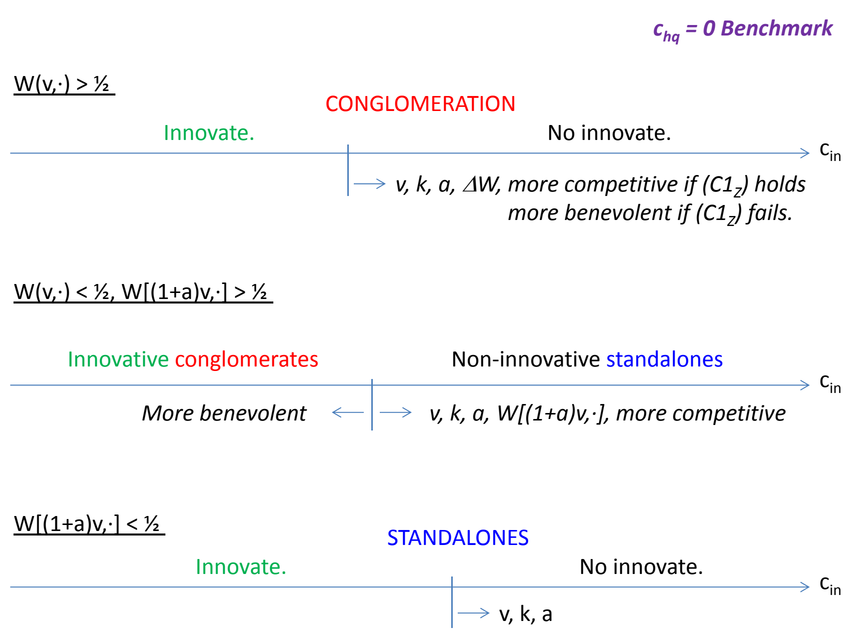

Figure 3: Optimal financing and innovative decisions under HQs' free investigation. This figure demonstrates the entrepreneur's optimal financing and innovative decisions under various regimes when HQs' investigation is free, and how each equilibrium region shifts as modelling parameters change.

Selected Proofs

Proofs of Lemma 1 and Lemma 2

Plugging $E\left(capital\right) = \phi k$ under standalone external financing into Equation (2), we obtain

$$SA^{FP} = \left(1 + aI\right) v\phi k - \frac{c_{hq}\phi^2}{2} - c_{in}I. \tag{23}$$

Taking first-order-condition w.r.t. ϕ yields the standalone HQ's optimal level of investigative effort depicted in Equation (6). Plugging it back to the surplus function, we can obtain the condition for innovation in standalone firm by comparing surplus with and without innovation.

Similarly, plugging $E\left(capital\right) = \left(1 - \delta\right) k + 2\delta k\phi W\left[\left(1 + aI\right) v, \cdot\right]$ under conglomerate internal financing into Equation (2) and taking first-order-condition w.r.t. ϕ gives us the conglomerate HQ's optimal investigative effort. We then plug this optimal effort level back to the surplus function, and obtain the condition for innovation in conglomerate by comparing surplus with and without innovation.

Proof of Proposition 1

We have found that the entrepreneur innovates in a standalone firm when $c_{in} < B^{SA}$, while he innovates in a conglomerate when $c_{in} < B^{CG}$. It is straightforward to see that if $c_{in} < \min\left(B^{SA}, B^{CG}\right)$, innovation will take place regardless of the structure that the entrepreneur chooses because the cost of innovation is so small compared to its benefits. Conversely, if $c_{in} > \max\left(B^{SA}, B^{CG}\right)$, the entrepreneur will not innovate in either structure as the cost is too high compared to the benefits it creates under either structure. Thus, the most interesting case, in which the organizational structure does make a difference in the entrepreneur's innovation decision, is when the cost of innovation falls in between the two benefit terms, B^{SA} and B^{CG}. Specifically, when $B^{SA} < c_{in} < B^{CG}$, the entrepreneur will innovate in conglomerates but not in standalone firms; when $B^{CG} < c_{in} < B^{SA}$, the entrepreneur will innovate in standalone firms but not in conglomerates. The critical deciding factor is whether innovative benefits are higher in standalones or in conglomerates, i.e., whether B^{SA} is higher or lower than B^{CG}. This is the condition depicted in Equation (12) of the proposition.

Proof of Proposition 2

We divide our analysis into three cases: low cost of innovation, medium cost of innovation, and high cost of innovation.

1) When innovative costs are low such that $c_{in} < \min\left(B^{SA}, B^{CG}\right)$, the entrepreneur will innovate under either structure. Comparing the overall surplus functions under innovation for both structures gives us condition $(C2)$ given in Equation (14), i.e., the condition under which innovative conglomerate dominates over innovative standalone structures.

2) When innovative costs are high such that $c_{in} > \max\left(B^{SA}, B^{CG}\right)$, the entrepreneur will not innovate under either structure. A straightforward comparison of surplus functions under no innovation for both structures yields condition $(C3)$ given in Equation (15), which is the condition under which non-innovative conglomerate dominates non-innovative standalone structures.

3) The more complicated case is when innovative costs are somewhere in the middle, in which we have two sub-cases.

3a) When condition $(C1)$ holds such that $B^{SA} < c_{in} < B^{CG}$, we compare the surplus function of an innovative conglomerate with that of a non-innovative standalone firm. It is straightforward to verify that innovative conglomerate structure dominates when $c_{in} < \bar{c}$, while non-innovative standalone structure dominates when $c_{in} > \bar{c}$. The critical bound $\bar{c}$ given in Equation (16) is obtained by equating the two surplus functions. Furthermore, it can be easily verified that $(C3) \iff B^{CG} < \bar{c}$, which automatically implies $c_{in} < \bar{c}$ and the dominance of conglomeration. It can also be shown that $!\,(C2) \iff \bar{c} < B^{SA}$, which automatically implies $c_{in} > \bar{c}$ and the dominance of standalones. Evidently, $(C2)$ cannot fail together with $(C3)$ holding true – an impossibility given condition $(C1)$ holds.

3b) When condition $(C1)$ fails and $B^{CG} < c_{in} < B^{SA}$, we compare the surplus function of a non-innovative conglomerate with that of an innovative standalone firm. Again, we can verify after some algebraic manipulations that non-innovative conglomerate structure dominates when $c_{in} > \bar{\bar{c}}$, while innovative standalone structure dominates when $c_{in} < \bar{\bar{c}}$, where the critical bound $\bar{\bar{c}}$ is depicted in Equation (17). Moreoever, it is easy to show that $(C2) \iff \bar{\bar{c}} < B^{CG}$, which automatically implies $\bar{\bar{c}} < c_{in}$ and the dominance of conglomeration. Similarly, we also find $!\,(C3) \iff B^{SA} < \bar{\bar{c}}$, which automatically implies $c_{in} < \bar{\bar{c}}$ and the dominance of the standalone structure. Combining these two findings, it is clear to see that $(C2)$ cannot hold together with $(C3)$ failing – another impossibility ruled out by the violation of condition $(C1)$.

We have now analyzed all possible cases and thus completed the proof. All results are combined and summarized in the proposition.

Proof of Proposition 3

Under standalone external financing with costless investigation, project productivity is known to the external market, and the project always gets a fixed capital injection k. Plugging $E(capital) = k$ into Equation (2) and comparing the resulting surplus functions with and without innovation yield Equation (19).

For conglomerate internal financing, the project either gets $(1+\delta)k$ with probability $W[(1+aI)v,\cdot]$, or $(1-\delta)k$ with probability $\{1 - W[(1+aI)v,\cdot]\}$. Thus, expected capital allocation becomes $E(capital) = (1-\delta)k + 2\delta k W[(1+aI)v,\cdot]$. Plugging this expression into Equation (2) and comparing surplus functions with and without innovation yield the condition given in Equation (20).

It is straightfoward algebra to compare the two innovative benefits under standalones and conglomerates, B_Z^{SA} and B_Z^{CG}, and obtain condition $(C1_Z)$.

Proof of Proposition 4

We first compare surplus functions when the entrepreneur innovates under both structures. It is easy to verify that innovative conglomerates dominate innovative standalones if and only if $W[(1+a)v,\cdot] > \frac{1}{2}$. We then compare the two surplus functions when the entrepreneur does not innovate under both structures. It is straightfoward to see that non-innovative conglomerates dominate non-innovative standalones if and only if $W(v,\cdot) > \frac{1}{2}$.

Following the same logic as in previous analysis, we can conclude that conglomerate structure is always preferred over standalones when both conditions hold, i.e., $W(v,\cdot) > \frac{1}{2}$. Similarly, standalone structure always dominates conglomerates when neither condition holds, i.e., $W[(1+a)v,\cdot] < \frac{1}{2}$.

There is only one case left, namely, when $W(v,\cdot) < \frac{1}{2}$ but $W[(1+a)v,\cdot] > \frac{1}{2}$, under which either non-innovative standalones or innovative conglomerates could be the optimal structure. Comparing the surplus functions under these two structures, we obtain the critical level of innovative cost given in Equation (22), under which innovative conglomerates dominate and above which non-innovative standalones dominate. This completes the proof.