Governance of collective entrepreneurship

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A B S T R A C T

This paper studies optimal allocation of control rights in collective organizations where members are heterogeneous across their opportunity costs and knowledgeability (expertise). Three results are established. First, members' heterogeneity is costly as it makes communication coarse and hampers decision making. Second, efficient allocation of control rights entails granting the decision rights to the members who are more (less) inclined to implement projects when the market is (not) ripe with profitable projects. This result, however, requires that members with the control rights are highly knowledgeable. Third, governance structure determines who bears the cost of heterogeneity, whereas the market determines who benefits from it. Members shouldering the costs should be compensated to be willing to join the collective organization. Governance structure and the market are therefore intertwined. Consequently, efficient allocation of control rights might not be viable. One implication is that it is unlikely that junior members have decision authority in heterogeneous partnerships. Another implication is that the viability of collective entrepreneurships is problematic in many settings.

1. Introduction

Worldwide there are around 580 million entrepreneurs running their own business (Global Entrepreneurship Monitor). Many of them are not only incorporated as a sole proprietorship, but also as a member and an owner of a collective organization. Examples of these organizations are professional partnerships in the legal, financial and advisory professions, cooperatives in agriculture, franchises in restaurants, lodging, retail, and distribution, and teams of enterpreneurers regarding new ventures. The literature on collectives mainly focused on the role of income sharing for the existence and functioning of collectives (Levin and Tadelis 2005; Garicano and Santos 2004), but paid little attention to the aspect of control rights allocation. As a result, there are still a number of open questions about this topic. For example, why do seemingly similar partnerships allocate control rights in different ways? Why do we observe heterogeneous partnerships only in some industries? This paper aims to address these questions. We specifically focus on heterogeneous collectives and investigate the efficient allocation of control rights. In addition, we explore the viability of efficient allocation of control rights when members have outside options and junior members are wealth constrained.

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Collective entrepreneurship is defined as an association of entrepreneurs. The distinguishing feature of a collective entrepreneurship is that ownership or control rights is shared rather than individually allocated (Baker et al., 2008). Shared control implies that a collective decision making procedure is needed in order to aggregate individual opinions into an organizational decision. This is where heterogeneity becomes a challenge. According to the homogeneity hypothesis of Hansmann (1996), efficient ownership of enterprises requires control be granted to a group of stakeholders having homogeneous interests. Shared control by heterogeneous stakeholders would result in too many influencing activities for the organization to be viable. This problem is expected to be more pronounced in collectives due to shared control. For instance, if partners differ on their outside options, then a candidate business project might be attractive to one member but unattractive to another member of the partnership. Therefore, heterogeneity is expected to destabilize collective entrepreneurships. This is, however, at odds with the omnipresence of heterogeneous collectives in various industries, such as professional partnerships consisting of junior and senior members and agricultural cooperatives consisting of high and low quality farmers. As a result, we need to better understand the organization of collective entrepreneurships and, more specifically, how control rights are allocated in heterogeneous collectives. In order to address shared ownership, we distinguish two (classes or types of) members: junior (J) and senior (S). Members are heterogeneous along two dimensions: opportunity costs, which are higher for Senior than for Junior, and knowledgeability/expertise, which is modeled as the probability of learning the true value of projects. In addition, Juniors are wealth constrained, i.e., they are not able to raise money beyond the value of their outside option. Based on these two sources of heterogeneity, we formulate a unified account of the costs and benefits of member heterogeneity in collective entrepreneurships. We follow Hart and Moore (1990) by determining which subset of the membership is most suitable to take the organizational decisions.

In our model, both classes of members investigate a project independently and then communicate with each other. The difference between the opportunity costs implies that member types might disagree on whether they should undertake the project. In this case of disagreement, the type with the decision (control) rights will make the final decision. In this setting, we derive three main results. First, we show that as heterogeneity increases, members' interests diverge and this in turn makes communication noisy as members transmit information strategically. In addition, conflicting interests breed disagreement and decisions cannot be made unanimously. This is the peril of heterogeneity that has been emphasized in the ownership literature (Hansmann, 2013). Second, the efficient governance structure that generates the highest total surplus, is determined by the attractiveness of the market, the opportunity costs of the members, and their expertise (cognitive ability). Each member errs in decision making from the perspective of the organization as a whole, but the nature of the errors depends on the type of agent. The member with the lowest (highest) opportunity cost accepts (rejects) more projects than a member with high opportunity cost, and is therefore relatively good at minimizing the costs of omission (commission). We establish that the efficient governance structure puts decision power in the hands of Junior (Senior) when the market is characterized by many good (bad) projects, and Junior (Senior) has a sufficiently high probability of learning the value of the project. The requirement of the sufficiently high probability of learning reflects that the decision by Junior (Senior) is based on learning. Third, the efficient governance structure is not always viable. Viability requires that both member types' participation constraints are satisfied. We show that Junior being wealth constrained implies that members cannot compensate each other by side payments and, therefore, the participation constraints have to be satisfied solely from their payoff of implementing projects. In other words, Coasian bargaining does not restore efficiency. The participation constraint of the member holding the control right is always satisfied as that member never implements a project whose value (or expected value) is below the value of her outside option. The participation constraint of the member not holding the decision rights should also be satisfied in one way or the other. This is where communication plays a role. Heterogeneous members benefit from communicating with each other. However, the benefits of communication are not symmetric, i.e., only one type (or neither types) benefits depending on the market. Therefore, the market determines who benefits from communication. The member who does not benefit from communication should necessarily hold the control rights, otherwise her participation constraint is not satisfied. As a result, different markets require different governance structures for a heterogeneous collective entrepreneurship to be viable. Market and governance structure are therefore intertwined.

The rest of the article is organized as follows. The next section reviews the relevant literature. In Section 3 we introduce the model and define its ingredients. Section 4 analyzes the communication between partners. Next, in Section 5 we determine the governance that generates the highest total surplus in each market. Section 6 reviews the individual rationality constraints of partners to show which partnership is viable in each market type. Finally, Section 7 summarizes and concludes the article.

2. Literature review

Collective entrepreneurship is characterized as an association of members. The members share the joint payoffs according to some principles, mostly equal-sharing, and have to adopt a collective decision making rule. There is an extensive literature addressing how the practice of profit sharing affects the behavior of members in collectives. The classic article by Wilson (1968) explores how sharing rules affect the efficiency and stability of partnerships. Another notable article in this line of research is Farrell and Scotchmer (1988). It shows that equal-sharing results in inefficient partnerships as more able members are reluctant to accept less able members despite the existence of economies of scale. Following Holmström (1982), a vast literature explores moral hazard in partnerships and various mechanism to solve or alleviate them. For example, Plambeck and Taylor (2006) analyze how repeated interactions can be exploited to improve the free rid-

ing problem in a manufacturing partnership. Kandel and Lazear (1992) explore the effect of peer pressure and social norms on free riding.

Partnership is an important institution for businesses in which the application and transfer of soft knowledge is critical. For example, Levin and Tadelis (2005) show that partnerships signal their human resource quality to the potential clients by sharing the payoffs with partners. Morrison and Wilhelm (2004,2008) argue that a partnership can be the appropriate institution for transferring tacit knowledge because the reputational concern of the senior partner and the career concern of the junior partner counteract the bilateral moral hazard inherent in transferring tacit knowledge. This article is different since in the model partners do not take actions such as investment or transfer of knowledge. As a result, moral hazard is not an issue. Instead, we analyze how the allocation of decision rights affects the surplus generated in the partnership and when the efficient allocation of decision rights is viable.

Our discussion on the allocation of decision rights rests on the assumption that contracts are incomplete (Grossman and Hart, 1986; Hart and Moore, 1990). Incompleteness of contract matters because if parties were able to write complete (contingent) contracts, then decision rights would be a trivial issue as parties would efficiently contract decision rights in any possible contingency. A notable difference between our model and one based on incomplete contracts is that in the latter the allocation of decision rights, i.e., the ownership rights, matters because it affects ex post bargaining position of parties and therefore their ex-ante investment incentives. As mentioned earlier, in our model parties do not invest, and thus the allocation of decision rights does not create inefficiency per se. Inefficiency arises when the efficient allocation of decision rights results in one party's payoff falling below the value of her outside option. That is, the efficient allocation of decision rights might not be viable. In this sense our paper is close to Hart and Moore (1996) and similar articles, in which outside options feature prominently (De Meza and Lockwood (1998); Chiu (1998)).

We identify three streams of literature that are relevant for our analysis of governance structure, communication and decision making. The first stream addresses the relationship between the architecture of the enterprise and decision making. Sah and Stiglitz (1986) compare how a hierarchical decision system differs from a polyarchical, or parallel decision system in terms of committing type I and type II errors. A number of articles extended their framework. For example, Christensen and Knudsen, 2010 analyze decision making in hybrid organizational structures. Another notable article is Csaszar and Eggers (2013) that considers members that are different in terms of knowledge. In line with these articles, we address the efficiency of collective entrepreneurship. However, we differ in terms of decision makers having different outside options, partners having private information and the explicit communication between the decision makers.

Second, the literature regarding the effect of costless communication (Crawford and Sobel, 1982), i.e. cheap talk, on centralization is also relevant for our model. An important result is that the truthfulness of information depends on the divergence of interests of the involved parties. The effect of cheap talk on organizational structure has been analyzed by Dessein (2002). He studies the setting where an uninformed principal has to choose between delegating decision making to an informed agent or retaining the decision rights and communicating with the agent.[2] The cheap talk literature is characterized by a principal-agent setting, where only the agent becomes informed and the decision is always made by the principal. We think this type of principal-agent modelling does not reflect the decision making process in collective entrepreneurship well as all members can be more or less informed about an upcoming issue.

Finally, we highlight the difference between this article and the literature on decision making in committees and strategic voting (Li and Suen, 2004; Gerling et al., 2005; Li et al., 2001; Feddersen and Pesendorfer, 1999; Gerardi, 2000; Oraiopoulos and Kavadias, 2020). The canonical issue of these articles is the effect of decision (voting) rules, committee compositions and various concerns of members on the working of committees and the ensuing outcomes. The problem in our article also considers the decision rule of majority voting. However, issues regarding strategic voting do not arise in our model because each governance structure assigns the right of implementation to a certain group of members.

3. The model

A collective entrepreneurship consists of two types of members: Senior and Junior. We assume that all Senior members are identical and all Junior members are also identical. Therefore, when analyzing the decision making, we assume there is a representative agent for each member type. In the rest of the article we use the term partnership to refer to a collective entrepreneurship.

The partnership considers implementing projects with the objective of producing new products or delivering new services. The revenue $\theta \in [0, 1]$ of these projects is stochastic with CDF $F(\theta)$ that is common knowledge. If the project is implemented, then each member type receives θ. Otherwise, each type receives its outside option.

The costs of implementing a project is fixed and normalized to zero. Availability of outside options, however, implies an opportunity cost for each type. The values of outside options are common knowledge and denoted by $k_i \in [0, 1]$, $i \in \{J, S\}$, where $k_J < k_S$. The subscripts J and S refer to Junior and Senior, respectively. There are two categories of projects: a good project, G_i, for member type i is a project whose return matches or exceeds the value of the outside option of that type, that is, $\theta \geq k_i$. A bad project, B_i, for type i, instead, is a project whose return is lower than the value of the outside option
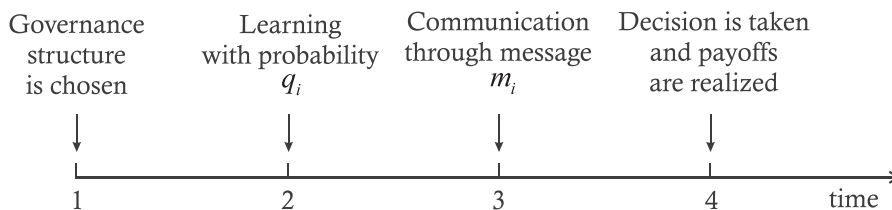

Fig. 1. Sequence of events.

of that type, $\theta < k_i$. The difference between k_S and k_J reflects the divergence of interests between Senior and Junior, i.e., the wider the gap, the higher the likelihood of disagreement. Define $\Delta \equiv k_S - k_J$, and consider it as the measure of cost heterogeneity.

Finally, we need to define the notion of governance structure. A governance structure allocates decision rights to one of the two member types. That is, the governance structure determines which member type makes the project implementation decision. We consider two governance structures: J-partnership in which Junior has the decision rights and S-partnership wherein Senior has the decision rights.

The sequence of events is represented in Fig. 1. At time 1, the governance structure is selected. At time 2, nature chooses θ and member type i learns θ with probability q_i, i.e., each type i either learns θ, which happens with probability q_i, or does not learn θ, which happens with probability $1 - q_i$. Probabilities of learning, q_i, are common knowledge, but neither type observes whether the other type has learned θ. At time 3, each type i sends a message, $m_i \in \mathbb{R}^+$, to the other type. The messages are exchanged simultaneously. Finally, at time 4, the type having the decision rights makes the implementation decision which determines the payoffs from the project.

Our solution concept is perfect Bayesian equilibrium. It is adopted to capture the two ways in which beliefs about revenue θ can be updated: learning at time 2 and communication at time 3.

As beliefs, both prior and posterior, are pivotal for the analysis, it is insightful to categorize prior beliefs according to the ways that they affect the implementation decision. For this purpose, we define three market types based on $E(\theta)$.

Definition 1. The market for the projects of the partnership is called

1. **Mature** if $E[\theta] \leq k_J$
2. **Mixed** if $k_J < E[\theta] \leq k_S$, and
3. **Nascent** if $E[\theta] > k_S$.

The mature (nascent) market is replete with bad (good) projects for both types. In the mixed market, there are a lot of good projects from Junior's perspective but bad from Senior's perspective. Henceforth, we will use the subscripts Ma, Mi, and Na to refer to the mature, mixed, and nascent market, respectively.

4. Messages and implementation

The communication between member types consists of an exchange of messages $m_i \in \mathbb{R}^+$. We demonstrate that the equilibrium strategies of the communication game entail sending only messages "Yes (Y)" or "No (N)", to mean that the sender is either in favor of or against implementing the project, respectively. In addition, the receiver interprets Y (N) as an indication that the return or its expectation is higher (lower) than the sender's outside option.

Proposition 1. *Truth telling cannot be supported as an equilibrium strategy in the communication game. The equilibrium message of both member types takes the form of a simple Yes (Y) or No (N), indicating whether the sender is in favor of or against implementing the project, respectively. The receiver's belief upon receiving Y entails that θ or its expectation is at least as high as the sender's outside option. The receiver's belief upon receiving N entails that θ or its expectation is less than the sender's outside option.*

The result of Proposition 1 should not be surprising given that the interests of Senior and Junior are not fully aligned. It is well known from the cheap talk literature (Crawford and Sobel, 1982) that when parties' interests diverge, communication becomes noisy. Our setting is different as the receiver (decision maker) might learn the true θ and therefore ignore the message of the sender. This potential learning, however, does not affect the incentives of the sender in engaging in strategic communication.

A message m_i can be either default or non-default for type i. A default message is one that is consistent with a type's prior. For example, in the mature market the default message of both types is N because $E(\theta) < k_J < k_S$. A non-default message is a message that is inconsistent with the sender's prior. In the mature market, Y is non-default as neither type sends Y based on priors. In the mixed market, Y is the default message for Junior but non-default for Senior. The importance of a non-default message is that it implies learning. This result is formalized in the following lemma.

Lemma 1. *Sending a non-default message entails learning by the sender.*

The result in Lemma 1 is straightforward. Based on the priors, each type would always send a default message; hence, the only rationale for a non-default message is that the sender has learned the true value of θ.

Next, we analyze the decision making in partnerships. Let the partnership members be heterogeneous across the opportunity costs, i.e. $k_J < k_S$. Recall that the message of a player takes the form of either Y or N. As a consequence, there are four possible compositions of the messages: YY, YN, NY and NN, where the first letter refers to the message of Junior and the second to the message of Senior.

We show that only one of these messages leads to a different decision in a J than an S-partnership. The cases NN and YY are straightforward to analyze. Regardless of the governance structure, a project gets implemented whenever the message composition is YY and is rejected whenever it is NN. The case NY also leads to the same decision in both governance structures. This is because $k_J < k_S$ implies that the message NY cannot be sent if neither type has learned or if both types have learned. In fact, if neither type has learned, then NY means $E(\theta) < k_J$ (given the N by Junior) and $E(\theta) > k_S$ (given the Y by Senior), which is impossible due to $k_J < k_S$. In the same vein, if both types have learned the revenue, then NY implies $k_S < \theta < k_J$, which is also impossible. Therefore, NY could only originate from a scenario of asymmetric learning, where one type learns whereas the other does not. Suppose it is Junior who learns; then, the N message implies that $\theta < k_J$ and therefore $\theta < k_S$. As a result, neither type would like to implement the project. If, on the other hand, it is Senior who has learned, then his Y message will imply $\theta > k_S$ and $\theta > k_J$. Therefore, Junior will also implement the project in a J-partnership. As a consequence, the only case in which Junior and Senior would take a different decision about project implementation is when the message exchange is YN. The following proposition states this result.

Proposition 2. *When $k_J < k_S$, the implementation decision in an S-partnership might be different than in a J-partnership if and only if the message exchange is YN, where Y is sent by Junior and N by Senior.*

The result of Proposition 2 highlights the importance of the message composition YN for distinguishing the two governance structures in terms of their implementation decisions. However, it is silent about the level of heterogeneity that is needed to have a difference. The remainder of this section shows how this level of heterogeneity has to be above a certain threshold.

Consider the mature market. The default message for both types is N; thus, the Y by Junior reveals that he has learned that $\theta \geq k_J$. As a result, the project gets implemented in a J-partnership as it is profitable from Junior's perspective. In the S-partnership, instead, the implementation of the project depends on whether Senior has learned θ. If Senior has learned θ, then his message N entails that $k_J < \theta < k_S$, and thus the project is not implemented. However, if Senior has not learned θ, then he has to update his belief about θ based on the message received from Junior. Specifically, under message YN Senior approves the project iff he did not learn and

$$E(\theta \mid \theta \geq k_J) - k_S \geq 0. \tag{1}$$

Note that if the heterogeneity of member types is very low, i.e. $\Delta = k_S - k_J$ is close to zero, then (1) is always satisfied. On the other hand, for a given k_J, if k_S is close to 1 then (1) does not hold. As a result, there exists a threshold Δ_{Ma}^* for heterogeneity such that (1) holds if and only if $\Delta < \Delta_{Ma}^*$. In particular, the implementation decision is different for the two member types only for $\Delta > \Delta_{Ma}^*$. This result is crucial, as it determines a minimum threshold of cost heterogeneity between the members of the partnership such that the choice of the governance structure is relevant only for higher heterogeneity. In other words, the allocation of decision authority is irrelevant unless there is sufficiently high heterogeneity between the two member types.

Next, consider the nascent market. In a nascent market, YN implies that Senior has learned that $\theta < k_S$, otherwise he would not send this message. Therefore, Senior does not implement the project in an S-partnership. Junior, on the other hand, has or has not learned θ. If he learned θ, then he would implement the project in a J-partnership. If he did not learn, then he would update his belief about θ. Specifically, Junior implements the project in the J-partnership when he does not learn if

$$E(\theta \mid \theta < k_S) - k_J \geq 0. \tag{2}$$

Therefore, there is a threshold Δ_{Na}^* for heterogeneity such that if heterogeneity is higher than that threshold, then (2) always holds and the project is implemented in the J-partnership, but not in the S-partnership.

Finally, consider the mixed market. Contrary to the mature and nascent markets, the message YN can emerge from learning or not learning by either type. In fact, in a mixed market the default message of Junior is Y whereas the default message of Senior is N. Therefore, there are four cases regarding the learning possibilities. If the type that has the decision rights learns θ then that type will ignore the message of the other type. However, if the decision maker does not learn θ, then he will form a belief according to the Bayes formula. For example, if Senior does not learn in the S partnership, he will not implement a project following YN if

$$q_J E(\theta \mid \theta \geq k_J) + (1 - q_J) E(\theta) < k_S. \tag{3}$$

As heterogeneity increases, (3) becomes more likely to hold. That is, Senior is less likely to implement the project when heterogeneity increases.

Junior implements a project in the J-partnership when he does not learn θ and the message composition is YN if

$$q_S E(\theta \mid \theta < k_S) + (1 - q_S) E(\theta) \geq k_J. \tag{4}$$

From (3) and (4) it can be seen that if k_S and k_J are close enough, i.e. heterogeneity is low, then Senior implements the project in the S-partnership and Junior does not implement the project in the J-partnership. That is, the implementation decision does not depend on the governance structure. If, however, heterogeneity is sufficiently large then the implementation decision will always be different in the two governance structures.

Lemma 2. *In each market* j, $j \in \{Ma, Mi, Na\}$, *when the message exchange between the two types is YN, there exists a threshold* $\Delta_j^* \geq 0$ *such that the implementation decision is different in the J- vs. S-partnership if and only if* $\Delta_j > \Delta_j^*$.

Lemma 2 entails that when heterogeneity is low, the interests of Senior and Junior are sufficiently close to each other that any project that is profitable for one type will also be profitable for the other type and vice-versa. Consequently, if the heterogeneity is low, the final decision regarding implementing projects will be identical in the S- and J-partnership. To ensure that the choice of governance structure implies different implementation decisions, we make the following assumption.

Assumption 1. $\Delta > \max\limits_{j \in \{Ma, Mi, Na\}} \Delta_j^*$.

5. Efficiency of governance structure

We have demonstrated that for sufficiently heterogeneous member types the project implementation decision can be different across governance structures only when the message exchange is YN. Such an exchange entails that the project is implemented only by the J-partnership. As a result, if the sum of the payoffs to Junior and Senior of implementing a project following YN is positive, then the J-partnership will generate a higher total surplus than the S-partnership , and will therefore be the efficient governance structure. Otherwise, the S-partnership structure will be efficient. In this section, we first show how to determine the total surplus of implementing a project following YN. Then, we determine the conditions of efficiency for each governance structure.

Consider the mature market. YN could only occur if Junior learned θ, as Y is the non-default message for Junior (see Lemma 1). As a result, it is certain that θ is at least as large as k_J. Senior might or might not learn θ. The expected total surplus of implementing the project in a mature market, conditional on YN, is

$$E_S^{Ma} = 2(1 - q_S)\left[E(\theta \mid \theta \geq k_J) - \frac{k_J + k_S}{2}\right] + 2q_S\frac{F(k_S) - F(k_J)}{1 - F(k_J)}\left[E(\theta \mid k_J \leq \theta \leq k_S) - \frac{k_J + k_S}{2}\right].$$

Note that the first term reflects the event that Senior does not learn θ, whereas the second term refers to the case when Senior learns that θ is less than k_S. This happens with probability $q_S\frac{F(k_S) - F(k_J)}{1 - F(k_J)}$.

The following notation simplifies the next results and related discussions.

$$E_L \equiv E(\theta \mid \theta \leq k_S), E_M \equiv E(\theta \mid k_J \leq \theta \leq k_S), E_H \equiv E(\theta \mid \theta \geq k_J),$$
$$\bar{k} \equiv (k_J + k_S)/2.$$

Notice that $E_H > E_M > E_L$.

Using this notation, E_S^{Ma} can be restated as

$$E_S^{Ma} = 2(1 - q_S)[E_H - \bar{k}] + 2q_S\frac{F(k_S) - F(k_J)}{1 - F(k_J)}[E_M - \bar{k}]. \tag{5}$$

The following assumption simplifies the analysis and proofs.

Assumption 2. The probability distribution function of θ, $f(\theta)$, is strictly quasi concave in all markets.

Assumption 2 ensures that $f(\theta)$ is increasing before its mode and decreasing afterwards. The following proposition characterizes the efficient governance structure in a mature market.

Proposition 3. *In a mature market, the uniquely efficient governance structure is the S-partnership when* $E_H < \bar{k}$. *If* $E_H \geq \bar{k}$, *then there exists a* q_S^* *such that the efficient governance structure is the S-partnership if and only if* $q_S > q_S^*$.

Fig. 2 depicts Proposition 3. To understand this proposition note that the difference between the J- and the S-partnership arises only when the message composition is YN. In the mature market, the message Y of Junior implies learning but the message N of Senior does not necessarily imply it. As a result, the message composition YN means that the expected surplus of the project is either $E_H \equiv E(\theta \mid k_J \leq \theta)$, when Senior did not learn, or $E_M \equiv E(\theta \mid k_J \leq \theta < k_S) < E_H$, when Senior did learn. The case $E_H < \bar{k}$ means the market is very unfavorable such that projects that are profitable for Junior are inefficient in expectation. That is, they do more harm to Senior than they benefit Junior. As a result, the S-partnership is the efficient governance structure as it does not implement such projects.

The case $E_H \geq \bar{k}$ implies a better market, where projects that are profitable for Junior are on average efficient (they might or might not be profitable for Senior). However projects that are *only* profitable for Junior (unprofitable for Senior) are inefficient in expectation. As a result, when the message N of Senior is highly likely to be grounded in learning, i.e., q_S is high, projects are on average inefficient and the S-partnership is the efficient governance structure as it does not implement such projects.
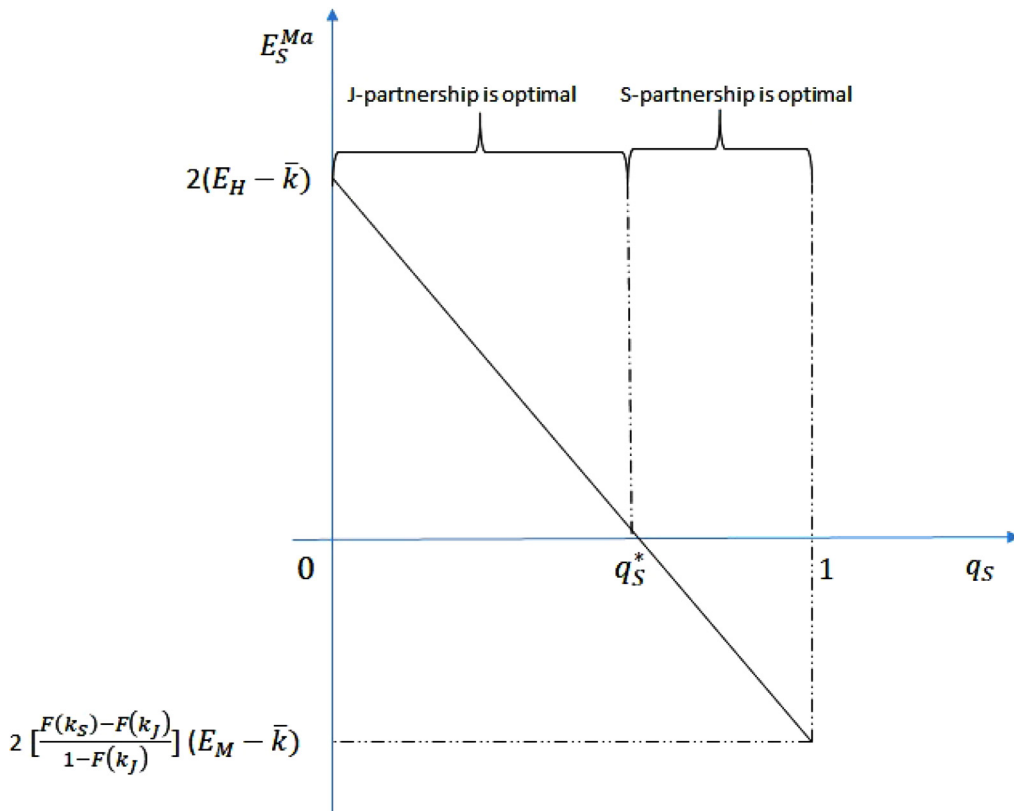
Fig. 2. Efficient Governance Structure in the Mature Market.

A similar analysis can be done for the nascent market, which results in the following proposition.

Proposition 4. *In a nascent market, the uniquely efficient governance structure is the J-partnership when $E_L \geq \bar{k}$. If $E_L < \bar{k}$ then, there exists a q_J^* such that the efficient governance structure is the J-partnership if and only if $q_J \geq q_J^*$.*

Proposition 4 for the nascent market can be interpreted in a similar way as Proposition 3 for the mature market. The difference is that in the nascent market the message YN implies that Senior learned, i.e., $\theta < k_S$. The expected return of the project would be either $E_L \equiv E(\theta \mid \theta < k_S)$ if Junior learned, or $E_L < E_M \equiv E(\theta \mid k_J \leq \theta < k_S)$ otherwise. The case $E_L \geq \bar{k}$ implies an extremely favorable market where even projects that are unprofitable for Senior are efficient in expectation. That is, they benefit Junior more than they hurt Senior. Not surprisingly, the J-partnership is efficient as it implements the project. The case when $E_L < \bar{k}$ means the market is not as favorable as in the previous case. A project is efficient only when the message Y of Junior is grounded in learning, because $E_M \geq \bar{k}$. This happens with probability q_J. Therefore, in expectation implementing projects following YN is efficient when it is highly likely that the message Y of Junior implies learning.

Finally, the mixed market is a special case as the message YN does not necessarily imply learning by any type. This is because Junior sends Y even if she/he does not learn θ. The same also applies to Senior with the difference that he sends N when he does not learn. Therefore, we need to distinguish four cases regarding learning, where neither type learns, only one type learns, or both types learn θ and θ falls between k_J and k_S. We analyze this case in the appendix. The results are qualitatively similar to other markets.

We can summarize the main insight of this section in the following way. The partnership type that generates the highest total surplus is determined by three factors: the attractiveness of the market, the opportunity costs of the members, and their expertise (cognitive ability). When the market is extremely favorable (unfavorable), i.e., a very favorable nascent (unfavorable mature) market, the efficient governance depends only on the first two factors, so that it will be efficient to assign decision authority to the member with lower (higher) opportunity cost. This member, in fact, is more likely to accept (reject) projects, and these projects are expected to be efficient (inefficient). On the contrary, when the market is neither extremely favorable nor extremely unfavorable, the efficient governance also requires the decision maker to have sufficiently high cognitive ability.

We analyzed the efficient allocation of decision rights. A critical question to be answered is whether the efficient allocation of decision rights is viable or not. This is especially relevant because members have outside options and the efficient allocation of decision rights might result in the payoff of one type falling below the value of her outside option. A Coasian

argument can be put forward in favor of viability of the efficient governance structure. Given that the efficient allocation of decision rights generates the highest total surplus, it should be possible to compensate a member whose payoff has fallen below the value of her outside option given that side payment is possible. It is indeed possible to design a simple mechanism that implements the socially optimum decision in Bayesian Nash equilibrium. The mechanism works as follows. Recall from Proposition 2 that the only message composition that results in conflict is YN. Any time the message composition is YN, Junior and Senior are asked if they agree that Junior pays k_S to Senior, the project is implemented and all the proceeds go to Junior. The project will be implemented only if they both agree. It is straightforward to check that this simple mechanism is incentive compatible[3], and results in implementing projects that yield at least $\bar{k}$ in the mature and nascent market and projects that yield at least $\bar{k}$ in expectation in the mixed market.[4] Therefore, the mechanism implements the interim efficient decision in the mature and nascent market and ex-ante efficient decision in the mixed market. Such a mechanism, however, requires Junior to be able to pledge k_S in advance, i.e., before implementing the project. If Junior is wealth constrained then such a mechanism can not be implemented. In our model, Junior is characterized by having a less valuable outside option as compared to Senior. A low value outside option implies worse economic opportunities, and therefore a lower saving and less access to credit. Real world examples include new graduates in law partnerships and small farmers in cooperatives. As a result, assuming that Junior is wealth constrained is not unrealistic and matches the general framework of our model.

Assumption 3. Junior is wealth constrained.

A direct implication of Assumption 3 is that the efficient governance structure might not be viable. Therefore, we need to check the participation constraints of both types to ensure that both member types are willing to join the partnership.

6. The choice of governance structure

Heterogeneity is usually considered to be a challenge in partnerships as it engenders conflict and hampers the decision making process. Investor-owned firms are often praised on the premise that all owners agree that profit maximization is the ultimate goal of the firm and all decisions are evaluated on the basis of their financial returns. This unanimity, however, does not always hold when owners have divergent interests as in heterogeneous partnerships (Hansmann (1996) and Holmström (1999)). Despite this, heterogeneous partnerships are observed in sectors such as agriculture, professional services firms, consulting, and so on. Therefore, heterogeneous partnerships have offered benefits to lure partners to join the partnerships. In other words, participation (individual rationality) constraints of partners have been somehow satisfied. In the following section, we characterize the parameters space where the participation constraints of both types are satisfied. The parameter space, therefore, shows when a heterogeneous partnership is viable.

In Section 4 we demonstrated that the message composition YN results in conflict because Junior would like the project to be implemented, whereas Senior prefers to avoid it. In addition, this is the only message composition with such an effect. The cost from this disagreement only accrues to the partner without decision rights as the other partner with the decision rights makes the final decision. As a result, it is sufficient to derive the expected loss to the partner without the decision rights in order to calculate the costs of heterogeneity. We also showed, in Section 4, that the message composition NY is the only occasion where the messages of Junior and Senior are initially in conflict, but then after updating become the same message. Therefore, the benefit of joining the partnership can be calculated by analyzing the benefits to partners resulting from NY.

A heterogeneous partnership is viable when the individual rationality constraints of both Junior and Senior are satisfied. It implies that a heterogeneous partnership is viable when the expected benefits to partners, resulting from NY, is at least as large as the expected costs accruing to them from YN. To illustrate, consider the mature market. The message NY necessarily implies that Senior has learned that θ is larger than k_S, whereas Junior has not learned. As a result, only Junior benefits from the learning by Senior. The only way to meet the individual rationality constraint of Senior is to allocate control to Senior, i.e., the S-partnership. Such a governance structure safeguards Senior against the risk of implementing a project whose revenues are lower than k_S. Therefore, the equilibrium governance structure in the mature market is the S-partnership.

Consider the S-partnership in the mature market. The expected payoff to Junior, due to NY, is

$$(1 - q_J)q_S(1 - F(k_S))[E(\theta \mid \theta \geq k_S) - k_J], \tag{6}$$

where the first three terms represent the probability that NY occurs. The expected loss to Junior of not implementing the project following YN in the mature market is

$$q_J(1 - F(k_J))[q_S \frac{F(k_S) - F(k_J)}{(1 - F(k_J))}(E_M - k_J) + (1 - q_S)(E_H - k_J)]. \tag{7}$$

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[3] The authors are grateful to Jens Prüfer for commenting on the incentive compatibility of the mechanism in an earlier version of the manuscript.

[4] Note that when the project is implemented, each member receives θ separately (as said explicitly in page 9). The mechanism implies that when the message is YN, Junior can pay Senior its outside option and then implement the project and receive all the proceeds. That is, Junior pays k_S to Senior and then receive 2θ. Therefore, Junior would implement a project when $2\theta - k_S \geq k_J$ which means when $\theta \geq \bar{k}$. So, the mechanism results in implementing a project only if it is efficient. Suppose $k_J = 40$, $k_S = 60$, then the mechanism implies that if Junior would like to implement the project, she has to pay 60 to Senior and then receive 2θ. As a result, Junior would implement the project only when he learns that $2\theta - 60 \geq 40$ or $\theta \geq (60 + 40)/2$.
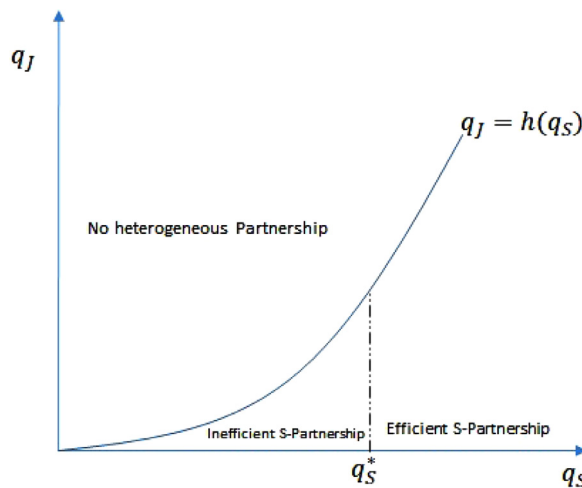
Fig. 3. Emergence and Efficiency of the S-partnerships in the mature market.

To understand (7), note that Junior sends Y in the mature market only if he has learned that $\theta \geq k_J$. It happens with probability $q_J(1 - F(k_J))$. The expected payoff of Junior can then be conditioned on whether Senior has learned. The first term in the square brackets reflects the expected payoff of Junior when Senior has learned. The second term reflects the expected payoff of Junior when Senior has not learned.

Individual rationality implies that the expected benefit to Junior should be at least as large as the expected cost. Therefore, by comparing (6) and (7), we can derive an upper bound for q_J, as a function of q_S, such that Junior's expected payoff exceeds her expected loss only if q_J is lower than that upper bound. Denote the lower bound function by $h(q_S)$. J-partnerships can emerge only if $q_J \leq h(q_S)$. Otherwise, the heterogeneous partnership does not emerge in equilibrium. Therefore, we have the following proposition.

Proposition 5. *The heterogeneous J-partnership does not emerge as the equilibrium governance structure in the mature market. The S-partnership is the equilibrium governance structure if and only if $q_J \leq h(q_S)$.*

Fig. 3 summarizes the results regarding governance structure and efficiency in the mature market. From Proposition 5 we know that the S-governance structure emerges only if $q_J \leq h(q_S)$. This is the area below the curve $h(q_S)$ in Fig. 3. In addition, from Proposition 3 we know that the S-partnership is the efficient governance structure only if $q_S \geq q_S^*$. Therefore, the area to the right of q_S^* shows the combination of q_S and q_J where S-partnerships are both efficient and viable. The area to the left of q_S^* depicts combination of q_S and q_J where an S-partnership is viable but inefficient.

A similar analysis for the nascent market results in Proposition 6. The lower bound function for the nascent market is denoted by $g(q_J)$.

Proposition 6. *The S-heterogeneous partnership does not emerge as the equilibrium governance structure in the nascent market. The J-partnership is the equilibrium governance structure if and only if $q_S \leq g(q_J)$.*

Fig. 4 summarizes our results regarding efficiency and governance structure in the nascent market. According to Proposition 6, we should not expect to observe the S-partnerships in the nascent market. In addition, the J-partnership is viable only if q_S is below the curve $g(q_J)$. Finally, Proposition 4 implies that J-governance is efficient only when q_J is sufficiently large, i.e., greater than q_J^*.

Finally, consider the mixed market. Contrary to the mature and nascent markets, the message NY cannot emerge in the mixed market as it requires both types to learn the return. But then NY implies that θ is larger than k_S and lower than k_J, which is not possible. As a result, we don't expect to see heterogeneous partnerships in the mixed market as neither type benefits from learning.

Proposition 7. *The heterogeneous partnership does not emerge in the mixed market.*

The core results of this section can be formulated as follows. Heterogeneity results in conflict in decision making as partners do sometimes disagree on the courses of actions the partnership should take. Governance structure resolves this conflict by giving one partner the authority to make the final decision following disagreement. The resolution of conflict, however, comes at the cost of the non-deciding partner who is always overruled, and aggrieved, following disagreement. The governance structure, therefore, determines who bears the cost of heterogeneity. The partner who bears the cost of heterogeneity will not join the partnership unless he is compensated. This is where learning kicks in. Learning is asymmetric in the partnership, i.e., only one type benefits from it. In the mature market, it is only Junior who benefits from learning
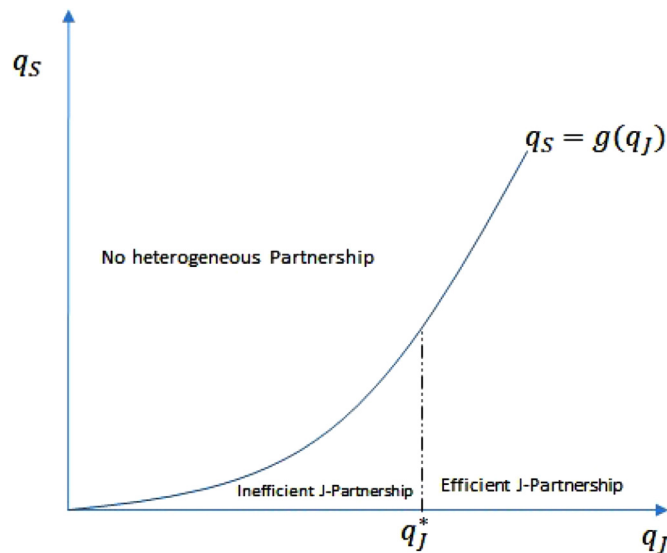
Fig. 4. Emergence and Efficiency of J-partnerships in the nascent market.

whereas in the nascent market it is only Senior who benefits from learning. As a consequence, in the mature market Junior can bear the cost of heterogeneity and being compensated by the benefits of learning. Senior, however, does not benefit from learning and so cannot bear the cost of heterogeneity. This is why only the S-partnership is viable in the mature market. A symmetric analysis implies that in the nascent market only the J-partnership is viable. In the mixed market, neither Junior nor Senior benefit from learning. Therefore, neither one is willing to shoulder the cost of heterogeneity and a heterogeneous partnership is not viable.

Next, for the participation constraints of partners to be satisfied, the expected magnitude of the benefits should be at least as large as the expected magnitude of costs of heterogeneity. These costs, resulting from disagreement, increase with the expertise (knowledgability) of the partner without the decision rights whereas the benefits from learning decreases with it. This is due to the fact that an expert is more likely to discover the true return of projects and, consequently, discover what is in her best interests on her own. It implies that a partner is willing to join a partnership, without holding the decision rights, only if her expertise is below a certain level.

According to the homogeneity hypothesis of Hansmann (1996), efficient ownership of enterprise requires that control is granted to a group of stakeholders having highly homogeneous interests. Shared control by various stakeholders would result in too many influencing activities for the organization to be viable. Our model, however, shows that a heterogeneous enterprise can be both efficient and viable given the market and the expertise of the owners. Therefore, it is worthwhile to see how the predictions of the model match with the partnerships in practice.

First, consider professional partnerships. Our analysis implies that a J-partnership is not likely to emerge as it requires Senior to be less knowledgeable than Junior. That is, the partner who has more attractive outside options is less knowledgeable than the other partner. This is quite unlikely given the structure of most modern economies where the human capital is a key factor determining the demand for labor. This is consistent with the structure of most professional partnerships such as law partnerships, accountants and investment banking where it is the seniors who are in charge of decision making. For example, consider law partnerships. Big law firms can be reasonably assumed to operate in mature markets. Law partnerships have both senior and junior lawyers. The profile of senior lawyers with years of experience and junior lawyers who just graduated from law schools suggest a relatively high q_S and low q_J. As a result, Fig. 3 predicts that S-partnerships emerge, which seems consistent with the way law partnerships operate in reality. In fact, most legal partnerships have two types of workers other than the partners. The first type consists of secretaries, accountants and other employees who support lawyers. The second type, associates, are junior lawyers with the prospect of moving up the ladder and becoming a partner. The associates have to work much like an employee for some years before becoming a partner, if they make it at all. That is, junior lawyers (to-be partners) have to defer to the leadership of senior lawyers (partners). Management consulting firms also exhibit a similar pattern of giving control to senior members. As noted by Richter and Schroder (2006) "Assigning ownership to a narrowly confined group of senior employees as partners helps limit the governance costs that are associated with this assignment."

Next, consider agricultural cooperatives. Member heterogeneity is a major concern in agricultural cooperatives. It is at the origin of many challenges facing cooperatives: free-riding problem, horizon problem, portfolio problem, control problem, and influence costs problem (Cook, 1995). Members of traditional cooperatives are farm producers who are its patrons. They focused on organizing and marketing of raw farm commodities. The development of final product markets in terms

of product differentiation resulted in increasing member heterogeneity because a substantial number of farmers responded by developing a stronger market orientation in order to capture a larger share of the food dollar. However, the changing orientation of a subset of the members may be at odds with the one-member-one-vote principle in agricultural cooperatives when the majority of farmers has only a focus on the farm. The viability of the cooperative may therefore be at stake.

The emergence of new generation cooperatives in the United States of America during the 1990s can be viewed as a response of these more market oriented members. They exited traditional cooperatives and formed new generation cooperatives, which are characterized by closed membership and a number of other policies to reduce member heterogeneity. Grashuis and Cook (2018) characterize the emergence of these new generation cooperatives as the formation of a homogeneous group of relatively large producers. Another way to respond to the final product market developments is to change the internal payment policies. The fruit and vegetable cooperative The Greenery (Hendrikse, 2011) faced the departure of a substantial number of innovative farmers. They formed their own cooperative (with a fairly homogeneous membership). They returned to The Greenery when the income rights structure was adjusted. Other cooperatives do not wait with adjustments in their internal structure till after the exit of members. Some cooperatives adopt payment policies such that the farmers having only a farm focus leave the cooperative voluntarily. The departure of these members entails that the heterogeneity of the remaining membership is reduced.

7. Summary and further research

This article studies the viability and efficiency of heterogeneous collective entrepreneurships. It analyzes communication and decision making in these organizations by adopting a stylized model of collective entrepreneurship consisting of a Junior and a Senior member. The governance structure determines which member is granted the decision rights. The difference between the opportunity costs of the two member types reflects the divergence of interests, or heterogeneity of the collective entrepreneurship. The two types of members are also distinguished by having a different chance of learning or expertise.

We show that the divergence of interests between member types makes communication noisy as members transmit information strategically. In addition, when the divergence of interests exceeds a threshold, i.e., heterogeneity becomes large, then the final implementation decision is not always consensual. Therefore, the implementation decision depends on which partner has the decision rights and this in turn is determined by the governance structure. Our analysis of efficiency shows that the governance structure that generates a higher total surplus is determined by three factors: the market attractiveness, the opportunity costs of the members and their expertise. When the market is extreme, i.e., very favorable or very unfavorable, the members' expertise does not play a role in determining the efficient governance. The decision authority is allocated to the members with low opportunity cost for a very favorable market and to those with high opportunity cost for a very unfavorable market. However, when the market is not extreme, the decision makers should also have a sufficiently high expertise for the governance structure to be efficient.

Next, when members' interests diverge and decision making is not consensual, the member who does not have the decision rights is aggrieved because some projects he likes are not implemented and some other projects that he does not like are implemented. This in turn implies that the member without the decision right will not join unless he is compensated in one way or the other. This compensation takes the form of learning as members can learn from each other. The learning, however, is not symmetric, i.e., only one member type benefits from it and the identity of that member is determined by the market. If the aggrieved member is compensated by the benefits of learning, then a heterogeneous collective entrepreneurship becomes viable. The asymmetry of learning implies that market and governance structure are intertwined. We establish that the size of costs and benefits to the non-deciding member, depends on the level of expertise of the member. The higher the level of expertise the lower the benefits and the higher the cost. Therefore, a member without the decision right is willing to join the collective entrepreneurship only if she/he does not have a high level of expertise.

Finally, we establish, in the extension, that if partners interact repeatedly, then they will be able to have more informative, finer communication when they are sufficiently patient. Finer communication in turn allows them to increase their payoff and hence, increase the parameter space of viable collective entrepreneurship.

There are a number of limitations and possibilities for future research. First of all, we assumed an equal distribution of returns among members. In many cases, senior and junior members do not share the returns equally. This assumption allows us to analyze important cases where the return is mainly an increase in the human capital of members, such as in professional partnerships. However, future research could analyze the case where the returns are endogenously distributed. Secondly, we abstracted from the nature of outside options heterogeneity and reduced it to the difference between opportunity costs of members. In some types of collective entrepreneurship, like cooperatives, the problem with heterogeneity is not merely about the financial returns of projects, but more often about how the business course of the entrepreneurship affects the future power and position of members. For example, milk processing cooperatives usually consist of farmers who deliver milk with different qualities. A cooperative might be able to produce a new lucrative product that makes use of only high quality milk. Farmers who are unable to produce high volumes of high quality milk might veto the launch of the new line despite benefiting from its revenue. We believe that these types of heterogeneity are more problematic than what we assumed and are worth further researching. Last, but not least, future research could consider incorporating the political and institutional factors in analyses of collective entrepreneurship. This is especially relevant in developing countries lacking well-functioning institutions such as independent courts, professional police, economic and political freedom and so on (Bai et al., 2014).

8. Extension: Improving communication by repeated interactions

In Section 4, we proved that the equilibrium messages are either a Yes (Y) or No (N). In this section we explore whether communication can be improved when interactions are repeated over time.

Repeated Interactions

Proposition 1 shows that the messages exchanged by the two types in a one period game is a simple Yes or No and member types cannot ex-ante commit to revealing their private information truthfully. This credibility problem is in part due to the fact that in a one-period game there is no consequence, or "punishment", for untruthful information revelation. However, when types have repeated interactions, they may find the right incentives to truthfully communicate the value of θ, as the long term benefits of more informative and trustworthy communication could overcome the short term gains of strategic and untruthful information revelation (Fudenberg and Maskin, 1986).

The possibility of finer communication via relational contracts is analyzed when the messages are YN. Relational contracts are informal, self-enforcing contracts that rely on the ongoing relationship between the parties involved. We define a specific type of relational contract, i.e., *partial revelation* (PR).

Definition 2. In a repeated game, partial revelation (PR) entails that:

- Senior reveals the true value of θ in a J-partnership when he learns that $\theta < k_S$, Junior believes Senior and acts accordingly,
- Junior reveals θ truthfully in a S-partnership when he learns that $\theta \geq k_J$, Senior believes Junior and acts accordingly.

Consider the first case. If Senior truthfully reveals θ when he learns that $\theta < k_S$, then Junior will not have any incentive to deviate from PR. Therefore, we only need to check whether PR is an equilibrium for Senior. Senior will stick to PR if there is a credible punishment available to Junior. Junior, however, cannot punish Senior upon deviating by any means other than reverting to the equilibrium of the one-shot game. In the second case, Junior truthfully informing Senior when $\theta \geq k_S$ behoves him to reveal truthfully whether he has learned, and if so what the true value of θ is. Similar to the previous case, Senior will not have an incentive to deviate if Junior acts this way.

In order to analyze the emergence of PR we need to check whether the sum of the discounted future gains exceeds the maximum temptation of deviation, i.e., the general logic of relational contracts. We do this for the mature market here and verify it for the nascent market in the Appendix. Recall from Section 6 that in the mature market only the S-partnership can emerge. Therefore, projects that yield less than k_J are not implemented at all. It is, however, possible for Junior to learn $\theta \geq k_S$ and relay it to Senior. The present value of the expected benefit of sticking to PR for Junior is

$$\frac{\delta}{(1-\delta)} q_J (1-q_S)(E(\theta \mid \theta \geq k_S) - k_J)(1 - F(k_S)), \tag{8}$$

where δ is the discount rate. To understand (8), note that the benefit of PR to Junior occurs when the message is YN (more precisely θN), θ is equal or larger than k_S and only Junior learns. This event occurs with probability $q_J(1-q_S)(1-F(k_S))$. The one-time gain to Junior of deviating from PR is at most $k_S - k_J$. That is, Junior can misinform Senior and claim that $\theta \geq k_S$ when θ is in fact between k_J and k_S. Junior will honor PR if the benefit of honoring the relational contract exceeds the gains of deviating from it. It is given by

$$k_S - k_J < \frac{\delta}{(1-\delta)} q_J (1-q_S)(E(\theta \mid \theta \geq k_S) - k_J)(1 - F(k_S)). \tag{9}$$

Note that (9) holds if δ is sufficiently large. It is straightforward to verify that there exists a threshold for δ such that (9) holds if and only if δ is equal or larger than the threshold. Therefore, PR will be sustainable in the S-partnership if Junior is sufficiently patient.

In the Appendix, we show that the same result applies also to the nascent market. Therefore, we have proved the following proposition.

Proposition 8. *Partial revelation can be sustained if members are sufficiently patient.*

Proposition 8 implies that when members are sufficiently patient the prospect of higher benefits in the future enables them to resist the temptation for short term gains and, therefore, communicate in a more informative way. The improved communication, in fact, increases the expected payoffs of both types. As a result, one would expect that repeated interactions increase the overall efficiency of the partnership and also the willingness of members to join the partnership. We show that this is indeed true by analyzing how the results of Section 5 and Section 6 change in a repeated game.

Consider an S-partnership in the mature market. Recall that, in an S-partnership, Junior incurs a loss when the message is YN as the project is not implemented. Some of these projects yield more than k_S. That is, they are good for both types but Senior cannot verify this due to strategic communication. PR enables the partnership to implement the projects that are good for both types. Consequently, the expected loss to Junior of not implementing some profitable projects becomes

$$q_J (F(k_S) - F(k_J))(E_M - k_J). \tag{10}$$

It is straightforward to check that (10) is smaller than the expected loss to Junior in the one period game given by (7). Therefore, PR decreases the expected costs of heterogeneity for Junior. The benefit of learning does not change with PR as NY results in a unanimous decision in the one period setting. As a result, PR increases the willingness of Junior to join the partnership. More formally, the upper bound for q_J in Proposition 5 changes from $h(q_S)$ to $h'(q_S) > h(q_S)$. That is, the possibility of formation of a heterogeneous S-partnership increases with PR. In addition, by implementing more good projects, the total surplus generated by the partnership increases when members interact repeatedly. As we show in the Appendix, the same result also applies to the J-partnership in a nascent market.

Proposition 9. *Partial revelation increases the viability of the J-partnership in the nascent market, and the S-partnership in the mature market. In addition, the total surplus generated by partnerships increases when partial revelation emerges in equilibrium.*

Recall from Section 6 that a heterogeneous partnership is not viable in the mixed market if members interact only once. One might wonder whether repeated interactions can make a heterogeneous partnership viable in the mixed market by improving communication as in other types of markets. We show that this is possible. This requires to define partial revelation in the mixed market.

Definition 3. *Partial revelation* in the mixed market requires that

- Both types truthfully reveal θ when they learn it;
- Projects are implemented only when θ is equal or larger than either k_J or k_S.

The definition entails that Senior and Junior have two options to agree: Implementing a project whenever it is good for both (k_S) or when it is good for Junior (k_J).

Suppose projects are implemented only if they are good for both types, that is, $\theta \geq k_S$. In this case, Senior has no incentive to deviate from PR as the partnership only implements projects that are good from Senior's perspective. PR enables Senior to benefit from good projects when θ is learned only by Junior and so would not have been implemented if Senior had operated as a standalone firm. As a result, Senior adheres to PR in both the S- and J-partnership. Consider the J-partnership. The maximum punishment available to Senior, to inflict upon deviation by Junior, is reverting to the equilibrium messages Y and N. As a result, Junior honors PR and is willing to participate in the partnership only if her one time temptation plus her expected payoff upon deviation is less than or equal to her expected payoff with PR. Juniors' expected payoff upon deviation is just her expected payoff in a standalone firm. Her expected payoff in a standalone firm can be derived by partitioning θ in three ranges; from 0 to k_J, from k_J to k_S and from k_S to 1. It is then given by

$$(1 - q_J)(E(\theta \mid \theta < k_J - k_J)F(k_J) + [E_M - k_J](F(k_S) - F(k_J)) + [E(\theta \mid \theta \geq k_S - k_J](1 - F(k_S)). \tag{11}$$

We denote (11) by E_{ST} where the subscript ST stands for standalone. The expected payoff of Junior with PR, denoted by E_{PR} equals

$$(1 - (1 - q_S)(1 - q_J))E(\theta \mid \theta \geq k_S - k_J)(1 - F(k_S)). \tag{12}$$

Junior abides by PR if and only if

$$(k_S - k_J) + \frac{\delta}{1 - \delta}E_{ST} \leq \frac{1}{1 - \delta}E_{PR}. \tag{13}$$

Note that the last term in (11) is larger than the term in (12). As a result, in order for (13) to hold, the sum of the first and second terms in (11) should be negative. It implies that

$$q_J < \frac{[E_M - k_J](F(k_S) - F(k_J)) - E(\theta \mid \theta < k_J - k_J)F(k_J)}{[E_M - k_J](F(k_S) - F(k_J))}. \tag{14}$$

Denote the right hand side of (14) by q_J^*. Finally, for (13) to hold, we derive a lower bound for q_S as a function of q_J:

$$q_S \geq \frac{(1 - \delta)(k_S - k_J) + \delta E_{ST} - q_J E(\theta \mid \theta \geq k_S - k_J)(1 - F(k_S))}{(1 - q_J)E(\theta \mid \theta \geq k_S - k_J)(1 - F(k_S))}. \tag{15}$$

Denote this lower bound by an increasing and convex function $y(q_J)$. We showed that the J-partnership becomes viable in the mixed market by repeated interactions if two conditions are met: $q_J < q_J^*$ and $q_S \geq y(q_J)$.

The S-partnership becomes also viable in the mixed market by repeated interactions with less stringent conditions. In fact, it can be proved that if $q_J < q_J^*$ and $q_S \geq x(q_J)$, where $x(q_J)$ is increasing and convex and $x(.) < y(.)$ for all q_J, then the S-partnership also becomes viable. Therefore, if $q_J < q_J^*$ and $q_S \geq y(q_J)$, then both governance structures are viable. This result is surprising because both governance structures implement the same type of projects with PR. That is, in both governance structures projects are implemented only when at least one type learns that θ is equal or larger than k_S. The stricter requirement for the J-partnership is due to the fact that the maximum punishment Senior can inflict upon deviation by Junior, is much weaker in the J-partnership compared to the S partnership as Junior has the decision rights in the former but not in the latter. As a consequence, the reward required to keep Junior honoring PR is also higher in the J-partnership.

Proposition 10. *Suppose members interact repeatedly and PR involves implementing projects only if at least one type learns $\theta > k_S$. There is a q_J^* and functions $y(q_J)$ and $x(q_J) < y(q_J)$ such that the*
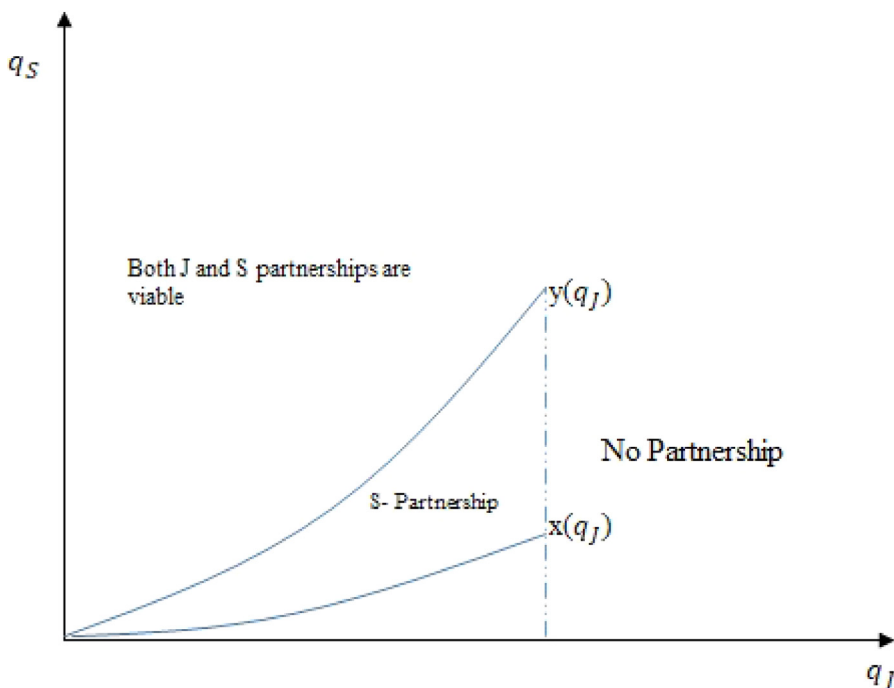
Fig. 5. Viability of heterogeneous partnerships in the mixed market with repeated interactions.

- *J-partnership is viable in the mixed market if and only if $q_J < q_J^*$ and $q_S \geq x(q_J)$;*
- *J and S-partnerships are both viable in the mixed market if and only if $q_J < q_J^*$ and $q_S \geq y(q_J)$.*

The intuition behind proposition 10 is better understood by considering the fact that neither Senior nor Junior is willing to join the partnership in the one-period game as they are better off running separate firms. Repeated interactions allows them to implement projects that are good for both types. Therefore, Senior is strictly better off as he benefits from implementing some good projects he would not have implemented had he operated as a standalone firm. This is not the case for Junior as she/he would have implemented all the projects that the partnership implements had she/he operated independently. In addition, Junior incurs a loss as some projects that are good for her are not implemented in the partnership. But for Junior, the advantage of the partnership over a standalone firm is that the former does not implement projects that yield less than k_J, i.e., bad projects are not implemented in the partnership. As a result, for Junior to be willing to join the partnership, it should be the case that Junior would implement a lot of bad projects if operated in a standalone firm, i.e., q_J is low, the partnership does not miss a lot of good projects and q_S is high.

Finally, the required reward to Junior is lower in the S- than the J-partnership as the allocation of decision rights to Senior enables him to inflict a harsher punishment on Junior upon deviating from PR. In the S-partnership, Senior can stop implementing all projects upon YN if Junior deviates from PR once. In the J-partnership, all Senior can do is reverting back to the equilibrium of the one period game. The stronger stick in the S-partnership, allows a weaker carrot to sustain PR compared to the J-partnership. Fig. 5 depicts the result.

We can show that a heterogeneous partnership is also viable if PR entails implementing projects that only benefit Junior, i.e., $k_J \leq \theta < k_S$. This requirement, however, is more demanding compared to the previous case where PR entailed implementing projects that benefits both types. This is due to the fact that, contrary to the previous case, Senior is not always willing to join the partnership as PR implies some bad projects for him are implemented. Despite this fact, he is willing to join the partnership if the expected benefits from PR outweigh the costs associated with joining the partnership. The following proposition summarizes the result for this case.

Proposition 11. *Suppose members interact repeatedly and PR involves implementing projects only if at least one type learns $\theta > k_J$. There is a q_J' such that the partnership is not viable if $q_J \leq q_J'$. Otherwise if $q_J > q_J'$ and $E_H > k_S$ and the below inequality holds, then both the J- and S-partnerships might be viable in the mixed market when members types are sufficiently patient.*

$$\frac{q_J[E_H - k_S](1 - F(k_J))}{q_J[E_H - k_S](1 - F(k_J)) - [E_M - k_S]F(k_S) - F(k_J)} > \frac{[E_H - k_J](1 - F(k_J)) + E(\theta \mid \theta < k_J - k_J)F(k_J)}{[E_H - k_J](1 - F(k_J))}. \tag{16}$$

The logic behind this proposition can be explained in the following way. Note that implementing projects when either type learns $\theta > k_J$ implies that projects are implemented as long as they are good for Junior. Some of these projects

might not be good for Senior. So Senior incurs a loss. Senior, however, benefits from the possibility of identifying (and implementing) some good projects by Junior that he would not have been able to identify had he operated independently. Consequently, for Senior to be willing to join the partnership, the expected benefits should outweigh the expected loss. It entails that q_J should be sufficiently high and q_S should not be too high. In addition, his average payoff, resulting from implementing projects when $\theta > k_J$, should be positive. This explains the lower bound on q_J and $E_H > k_S$. Finally, note that Junior also makes a loss as some projects that are good for her are not implemented. In return, the partnership allows her to avoid some bad projects that she/he would have implemented had she/he operated independently. For Junior to be willing to join the partnership, the expected benefits should outweigh the expected loss. It requires q_S to be sufficiently high. Therefore, the incentive compatibility constraint of Senior determines an upper bound for q_S and the incentive compatibility constraint of Junior determines a lower bound on q_S. The inequality (16) ensures that the upper bound is higher than the lower bound.

Acknowledgments

Appendix A

Proof of Proposition 1

First note that if the receiver has learned θ, then she/he will ignore the message and the sender is indifferent between sending any message. Of course, the sender does not know whether the receiver has learned or not. In addition, when the sender has the decision rights, she/he is indifferent between sending any message as the receiver's belief does not affect the implementation decision. Therefore, the relevant cases happen when the sender does not have the decision rights, i.e., Senior in J-partnerships and Junior in S-partnerships. Consider the case when Senior learns that $k_J \leq \theta < k_S$ in the J-partnership. If Senior truthfully reveal it to Junior and Junior believes it, then Junior would implement the project. But Senior can do better by claiming θ is less than k_J whenever $k_J \leq \theta < k_S$. As a result, Senior has an incentive not to reveal θ truthfully when $\theta < k_S$. Knowing this, Junior does not believe Senior whenever the latter claims that $\theta < k_J$ and interprets this message as an indication that $\theta < k_S$. As a result, when Senior learns that $\theta < k_S$, any message claiming $\theta < k_J$ induces the same belief in Junior. Therefore, the equilibrium strategy of Senior entails claiming $\theta < k_J$ whenever she/he learns that $\theta < k_S$. It is evident that any message claiming $\theta < k_J$ is equivalent to sending no (N) to express a negative opinion on the project. If, on the other hand, Senior learns that $\theta \geq k_S$, then it is in the best interest of Senior to reveal the true θ as it leads to implementing the project by Junior in J-partnerships. Again, sending any message implying $\theta > k_J$ is equivalent to sending a simple yes (Y). Finally, when Senior does not learn θ, she/he relies on her prior and sends a message based on the expected value of θ. In case the expected value of θ is larger than k_S, she/he is indifferent between sending any message implying $\theta \geq k_J$ and sending a yes (Y) as both induce the same belief in Junior. In case the expected value of θ is less than k_S, Senior is indifferent between sending any message implying that $\theta < k_J$ and No (N) as both induce the same belief in Junior. As a result, the equilibrium communication strategy of Senior entails:

- Sending Y whenever she/he learns that $\theta \geq k_S$ or when she/he does not learn and the expected value of θ is equal or more than k_S;
- Sending N whenever she/he learns that $\theta < k_S$ or when she/he does not learn and the expected value of θ is less than k_S.

The equilibrium belief of Junior entails believing that θ or its expected value is equal or larger than k_S when the message is Y and believing that θ or its expected value is less than k_S when the message is N.

A symmetric argument shows that Junior does not truthfully reveal θ when he learns that $\theta > k_J$ because if he does so and Senior believes it, then Senior does not implement the project when $k_J \leq \theta < k_S$ in the S-partnership. So, Junior is better off claiming $\theta > k_S$ when $k_J \leq \theta < k_S$. Given this fact, Senior does not believe Junior when the latter claims $\theta > k_S$. Following the same line of argument as for the case of Senior, the equilibrium communication strategy of Junior entails:

- Sending Y whenever he learns that $\theta \geq k_J$ or when he does not learn and the expected value of θ is equal or more than k_J;
- Sending N whenever he learns that $\theta < k_J$ or when he does not learn and the expected value of θ is less than k_J.

The equilibrium belief of Senior entails believing that θ or its expected value is equal or larger than k_J when the message is Y and believing that θ or its expected value is less than k_J when the message is N.

Finally, the communication game has a babbling equilibrium in which the sender sends a random message and the receiver ignores it. Q.E.D.

Proof of Proposition 3

In a mature market Assumption 2 implies that $E_M < \bar{k}$ since $f(\theta)$ is decreasing between k_S and k_J. Therefore, if $E_H \leq \bar{k}$ then $E_S^{Ma} < 0$. So, the S-partnership partnership is uniquely efficient. If $E_H > \bar{k}$ then the first term in

$$E_S^{Ma} = (1 - q_S)[2E_H - k_S - k_J] + q_S \frac{F(k_S) - F(k_J)}{1 - F(k_J)}[2E_M - k_S - k_J]$$

is positive. The expression then shows that if $q_S = 1$ the first positive term cancels whereas if $q_S = 0$ the first negative term cancels. As a result, there is a q_S^* such that E_S^{Ma} becomes positive if and only if $q_S < q_S^*$.

Proof of Proposition 4

Following YN, the J-partnership implements the project but the S-partnership does not (due to assumption 1). All other combinations of messages result in the same implementation decision in either governance structure. Note that the message N from Senior in this market implies learning. The surplus that goes to type $i \in \{L, C\}$ after implementing such a project, given message YN, is

$$E_S^{Na} = (1 - q_J)[(E(\theta \mid \theta \leq k_S) - k_i] + q_J \frac{(F(k_S) - F(k_J))}{F(k_S)}[E(\theta \mid k_J \leq \theta \leq k_S) - k_i]. \tag{17}$$

The first term in (17) reflects the event that the Y message from Junior relies on the prior belief, i.e., Junior did not learn θ. The N from Senior, however, implies learning. That's why the expectation is conditional on $\theta \leq k_S$. If Senior learns but Junior does not, all that can be extracted from YN is $\theta \leq k_S$. The second term reflects the complementary event that Y from Junior stems from learning θ. When both Junior and Senior learn and send YN, it implies that θ is between k_S and k_J. That's why the expectation is conditional on $k_J \leq \theta \leq k_S$. The overall expected surplus, conditional on YN, can be stated as

$$(1 - q_J)[2(E(\theta \mid \theta \leq k_S) - k_S - k_J] + q_J \frac{(F(k_S) - F(k_J))}{F(k_S)})[2E(\theta \mid k_J \leq \theta \leq k_S) - k_J - k_S].$$

We can now rewrite (17) as

$$E_S^{Na} = 2(1 - q_J)[E_L - \bar{k}] + 2q_J \frac{(F(k_S) - F(k_J))}{(F(k_S)}[E_M - \bar{k}] \tag{18}$$

If (18) is positive, then the J-partnership is more efficient than the S-partnership since the overall surplus generated by implementing projects following YN is larger than zero. The total expected surplus of implementing a project following YN is given by (18). Since the project is implemented only in a J-partnership, it is sufficient to examine the sign of (18) to determine the efficient governance structure. Note that assumption 2 implies that $2E_M - k_S - k_J$ is positive. This follows since by this assumption $f(\theta)$ is increasing between k_J and k_S. Therefore, the second term in

$$E_S^{Na} = (1 - q_J)[2E_L - k_J - k_S] + q_J(F(k_S) - F(k_J))[2E_M - k_J - k_S]$$

is always positive by assumption 2. If the first term is also positive then $E_S^{Na} > 0$, so J-partnership governance is uniquely efficient. This completes the proof of first part. For the second part note that if $E_L \leq \bar{k} = \frac{k_J + k_S}{2}$, then the first term in E_S^{Na} is negative. Examining E_S^{Na} we see that if $q_J = 0$ then the second term cancels so E_S^{Na} becomes negative. If $q_J = 1$ then the first terms cancels so E_S^{Na} becomes positive. Therefore there must be a q_J^* such that $E_S^{Na} \geq 0$ if and only if $q_J \geq q_J^*$.

Analysis of Efficiency in the Mixed Market

The expression for the expected surplus in the mixed market given message YN is

$$\begin{aligned} E_S^{Mi} = &\, 2q_S q_J (F(k_S) - F(k_J))[E_M - \bar{k}] + 2(1 - q_S)q_J(1 - F(k_J))[E_H - \bar{k}] + \\ &\, 2q_S(1 - q_J)[E_L - \bar{k}] + 2(1 - q_S)(1 - q_J)[E(\theta) - \bar{k}]. \end{aligned} \tag{19}$$

The following proposition characterizes the efficient governance structure.

Proposition 12. *In a mixed market the efficient governance structure is*

- *J if $E_L \geq \bar{k}$;*
- *S if $E_H < \bar{k}$.*

If $E_L < \bar{k} < E_H$, the efficient governance structure is

- *J if one of the following conditions is satisfied: 1a) $E_M \geq \bar{k}$ and q_J is sufficiently high; 1b) if $E_M < \bar{k}$, q_S sufficiently low and q_J is sufficiently high;*
- *S if one of the following conditions is satisfied: 2a) $E_M < \bar{k}$ and q_S is sufficiently high; 2b) if $E_M > \bar{k}$, q_S is sufficiently high and q_J is sufficiently low.*

Proof. Assumption 2 does not readily imply $E_M < \bar{k}$. Therefore, we need to distinguish more cases compared to the nascent and mature markets. Note that E_S^{Mi} in (12) shows that if $E_H \leq \bar{k}$ then $E_S^{Mi} < 0$ since all other terms are less than E_L. Symmetrically, if $E_L \geq \bar{k}$ then $E_S^{Mi} > 0$ since all other terms are larger than E_L. On the other hand, if $E_L < \bar{k} < E_H$ then we need to distinguish between cases based on whether $E_M < \bar{k}$ or not. Suppose $E_M < \bar{k}$ as q_S approaches 1 the expression of E_S^{Mi} can be stated as

$$q_J(F(k_S) - F(k_J))[2E_M - k_S - k_J] + (1 - q_J)F(k_S)[2E_L - k_S - k_J].$$

Since both terms are negative we have $E_S^{Mi} < 0$. Therefore, there exist a q_S^* such that if $q_S > q_S^*$. The S-partnership is efficient. Consider the symmetric case when q_J approaches 1. This time the expression of E_S^{Mi} can be stated as

$$q_S(F(k_S) - F(k_J))[2E_M - k_S - k_J] + (1 - q_S)(1 - F(k_J))[2E_H - k_S - k_J].$$

In the above expression, the first term is negative but the second term is positive. As a result, there exist a q_S'' such that when $q_S < q_S''$ the expression is positive, otherwise it is negative. Therefore, we can summarize the result for the case $E_M < \bar{k}$ as: if q_S is sufficiently high then the S-partnership partnership is efficient. If q_S is sufficiently low and q_J is sufficiently high then the J-partnership partnership is efficient. Finally, suppose $E_M > \bar{k}$. A similar reasoning leads to the following result: if q_J is sufficiently high then the J-partnership partnership is uniquely efficient. $\square$

Proof of Proposition 6

Consider now the nascent market. A similar analysis as for the mature market shows that NY messages only benefit Senior and not Junior since in the nascent market Junior sends N only if she/he has learned θ. Therefore, in order for Junior to be willing to participate in the partnership, she/he should not incur the cost of heterogeneity. It implies that Junior does not participate in a S-partnership. The J-partnership is the only viable form of heterogeneous partnership in the nascent market. For Senior to be willing to participate in a J-partnership, his expected benefit must outweigh his expected loss due to heterogeneity. The expected benefit to Senior is given by

$$(1 - q_S)q_J F(k_J)[k_S - E(\theta \mid \theta \leq k_J)]. \tag{20}$$

The first three terms reflect the probability of occurrence of NY. The expected loss of Senior in a J-partnership relates to implementing projects following the YN messages, and is given by

$$q_S F(k_S)[q_J \frac{(F(k_S) - F(k_J))}{F(k_S)}(k_S - E_M) + (1 - q_J)(k_C - E_L)]. \tag{21}$$

Comparing (20) with (21) we can derive the necessary and sufficient condition for Senior to participate in the partnership, i.e., his expected benefit has to be at least as large as his expected loss due to heterogeneity. This boils down to an upper bound for q_S as a function of q_J denoted by $g(q_J)$

$$g(q_J) = \frac{q_J F(k_J)[k_S - E(\theta \mid \theta k_J)]}{q_J F(k_J)[k_S - E(\theta \mid \theta k_J)] + F(k_S)[q_J \frac{F(k_S) - F(k_J)}{F(k_S)}(k_S - E_M) + (1 - q_J)(k_S - E_L)]}.$$

and it is verified that $g(q_J)$ is increasing and convex in q_J.

Proof of Proposition 8

Consider the nascent market. Recall that only the J-partnership emerges in the nascent market and the project is implemented following YN. Therefore, PR involves Senior truthfully informing Junior when $\theta < k_J$. The present value of the expected benefit to Senior of sticking to PR is given by

$$q_S(1 - q_J)E(k_S - \theta \mid \theta \leq k_J)F(k_J).$$

On the other hand, Senior can lie and misinform Junior when he learns that $k_J \leq \theta \leq k_S$, and avoid a loss of at most $k_S - k_J$ once. However, he loses the future benefits of partial revelation since Junior will not believe him any longer after the first lie. As a result, Senior honors partial revelation if

$$k_S - k_J < \frac{\delta}{(1 - \delta)}q_S(1 - q_J)E(k_S - \theta \mid \theta \leq k_J)F(k_J)$$

The above inequality holds if δ is sufficiently large.

Proof of Proposition 9

With repeated interaction and PR, the implementation decision is identical to the one period setting for all message compositions but YN. Recall that the project is not implemented following YN in the S-partnership. PR enables the S-partnership

to implement projects if they yield more than k_S following YN. Therefore, the expected total surplus of implementing a project in the S-partnership following YN is

$$2[E(\theta \mid \theta \geq k_S) - \bar{k}](1 - q_S) > 0. \tag{22}$$

Therefore, the total surplus generated with PR is higher than the total surplus in the one period game and both Junior and Senior are better off. In addition, the increased payoff to Junior implies that Junior is now willing to join the S-partnership in a larger parameter space compared to the one shot game.

Next, consider a J-partnership in the nascent market. Senior incurs a loss when the message exchange is YN, as Junior implements projects that are unprofitable for Senior. If PR is possible, projects that yield less than k_J will not be implemented following YN. Therefore, the expected loss to Senior is

$$q_S(F(k_S) - F(k_J))(k_S - E_M). \tag{23}$$

Obviously, (23) is lower than the expected loss to Senior in the one period game. Since the expected benefit to Senior does not change from what it was in the one period setting, we can conclude, similar to the previous case, that the upper bound required to satisfy Senior's individual rationality constraint (Proposition 6) changes from $g(q_J)$ to $g'(q_J) > g(q_J)$. It implies that the possibility of formation of a heterogeneous J-partnership increases with PR in an ongoing relationship. Avoiding projects that yield less than k_J increases the total surplus of the J-partnership. Q.E.D.

Proof of Proposition 10

Consider the S-partnership. Junior sticks to PR only if her one time temptation is less than the continuation value of PR, i.e.,

$$k_S - k_J < \frac{\delta}{(1-\delta)}(1 - (1 - q_S)(1 - q_J))E(\theta \mid \theta \geq k_S - k_J)(1 - F(k_S)). \tag{24}$$

If Junior is sufficiently patient, then (24) holds and, therefore, PR is sustainable in the S-partnership.

An important question still needs to be addressed: is Junior willing to join the partnership in the first place? Note that Junior incurs a loss as none of the projects that are only good for her ($k_J \leq \theta < k_S$) are implemented with PR. To answer this question, we need to compare the expected payoff of Junior in the S-partnership under PR with her expected payoff in a standalone firm. Her expected payoff in the S-partnership with PR equals the right hand side of (24) without the discounting factor ratio, i.e.,

$$(1 - (1 - q_S)(1 - q_J))E(\theta \mid \theta \geq k_S - k_J)(1 - F(k_S)). \tag{25}$$

Her expected payoff in a standalone firm can be derived by partitioning θ in three ranges; from 0 to k_J, from k_J to k_S and from k_S to 1. It is then given by

$$(1 - q_J)(E(\theta \mid \theta < k_J - k_J)F(k_J) + [E_M - k_J](F(k_S) - F(k_J)) + [E(\theta \mid \theta \geq k_S - k_J](1 - F(k_S)). \tag{26}$$

Junior is willing to join the partnership if and only if (25) $\geq$ (26). Note that the last term in (26) is larger than the only term in (25). As a result, the necessary condition for (25) to be larger than (26) is that the sum of the first and second terms in the latter is negative. It implies that

$$q_J < \frac{[E_M - k_J](F(k_S) - F(k_J)) - E(\theta \mid \theta < k_J - k_J)F(k_J)}{[E_M - k_J](F(k_S) - F(k_J))}. \tag{27}$$

Given (27), the sufficient condition for (25) $\geq$ (26) can be derived as

$$q_S \geq \frac{(1 - q_J)\{E(\theta \mid \theta < k_J - k_J)F(k_J) + E(\theta \mid \theta \geq k_S - k_J)(1 - F(k_S))\} + [E_M - k_J](F(k_S) - F(k_J))}{(1 - q_J)[E\theta \mid \theta \geq k_S - k_J](1 - F(k_S))}. \tag{28}$$

Note that (28) is a function of q_J. So we can state (28) as $q_S \geq x(q_J)$, where $x()$ is increasing in q_J. If (27) and (28) are satisfied, then a heterogeneous S-partnership becomes viable in the mixed market by repeated interactions. We established that Senior sticks to PR in either governance structures as long as Junior abides by PR. In the S-partnership partnership, the maximum punishment Senior can inflict is refusing to implement projects following YN.

Proof of Proposition 11

Contrary to the previous case, Senior is not always willing to join the partnership as PR entails implementing some projects that are not good from his perspective (when $k_J < \theta < k_S$). The same is true also for Junior as projects whose θ is not learned are not implemented. Therefore, we need to check the participation constraints of both types. Senior is willing to join the partnership if his expected payoff with PR is at least as large as his expected payoff in a standalone firm. It requires

$$q_S[E(\theta \mid \theta \geq k_S - k_S)](1 - F(k_S)) \leq (1 - (1 - q_S)(1 - q_J))[E_H - k_S](1 - F(k_J)) \ . \tag{29}$$

The left hand side of (29) is positive. The right hand side should also be positive for (29) to hold. It implies $E_H > k_S$. If this is the case, then we get from (29) an upper bound for q_S as a function of q_J

$$q_S < \frac{q_J[E_H - k_S](1 - F(k_J))}{q_J[E_H - k_S](1 - F(k_J)) - [E_M - k_S](F(k_S) - F(k_J))}. \tag{30}$$

Senior sticks to PR if his deviation temptation is less than his expected payoff under PR. The deviation temptation depends on the governance structure. It is straightforward to check that in the J-partnership , Senior does not deviate from PR since he would be worse off when Junior responds by reverting to the one-period equilibrium. In the S-partnership , the deviation temptation is a one time gain of $k_S - k_J$ plus the expected payoff of the standalone firm. That is, Senior honors PR if

$$(1 - \delta)(k_S - k_J) + \delta q_S[E(\theta \mid \theta \geq k_S - k_S)](1 - F(k_S)) < (1 - (1 - q_S)(1 - q_J))[E_H - k_S](1 - F(k_J)) . \tag{31}$$

Comparing (31) with (29) shows that if δ is sufficiently large, then (31) holds whenever (29) holds. That is, if Senior is sufficiently patient, then he sticks to PR whenever he joins the J-partnership . Therefore, we established that if $E_H > k_S$ and (30) holds, then Senior is willing to join a S-partnership and honors PR. In addition, if he is sufficiently patient, he is also willing to join a J-partnership and honors PR. Consider Junior. Junior is willing to join the partnership and honors PR if her expected payoff under PR is at least as large as her expected payoff with PR. It implies

$$(1 - (1 - q_S)(1 - q_J))[E_H - k_J](1 - F(k_J)) \geq [E_H - k_J](1 - F(k_J)) + (1 - q_J)E(\theta \mid \theta < k_J - k_J)F(k_J). \tag{32}$$

With a little bit of algebra (32) can be stated as

$$q_S \geq \frac{[E_H - k_J](1 - F(k_J)) + E(\theta \mid \theta < k_J - k_J)F(k_J)}{[E_H - k_J](1 - F(k_J))}. \tag{33}$$

Finally, we need to check whether Junior honors PR or not. It is straightforward to check that Junior has no incentive to deviate from PR in a S-partnership as the response from Senior (equilibrium of one-period game) makes her worse off. In a J-partnership Junior honors PR if her one time gain $(k_S - k_J)$ plus the expected payoff in a standalone firm is less than her expected payoff with PR. It means

$$(1 - (1 - q_S)(1 - q_J))[E_H - k_J](1 - F(k_S)) \geq (1 - \delta)(k_S - k_J) + \delta\{[E_H - k_J](1 - F(k_J)) + (1 - q_J)E(\theta \mid \theta < k_J - k_J)F(k_J)\}. \tag{34}$$

Comparing (34) with (32) shows that if δ is sufficiently large, i.e., Junior is patient, then (34) holds whenever (32) holds. That is, if Junior is willing to join either type of partnership, then she/he will always honor PR in a S-partnership. Junior honors PR also in the J-partnership if she/he is sufficiently patient.

If the heterogeneous partnership is viable, then the participation constraints of both Junior and Senior should be satisfied. It entails that q_S should be such that both (30) and (33) are satisfied simultaneously. It can happen only if the right hand side of (30) is larger than the right hand side of (33) for a given q_J. If $q_J = 1$, then (30) > (33) implies

$$E(\theta) - k_J > \frac{F(k_J)E(\theta \mid \theta < k_J - k_J) \cdot [E_H - k_S](1 - F(k_J))}{[E_M - k_S](F(k_S) - F(k_J))}. \tag{35}$$

In addition, since (30) is an increasing function of q_J, there exist a q'_J such that (30) > (33) does not hold whenever $q_J < q'_J$. That is, a heterogeneous partnership is not viable in the mixed market if $q_J < q'_J$.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jebo.2021.02.012.

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