Who chooses whom?
Syndication, skills and reputation

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Abstract: Syndication, which is a joint realization of one project/one investment by several capital providers, is a long existing phenomenon that plays a central role in many financial market segments. Within this paper we develop a theoretical model focusing on the dynamic aspect of syndication, namely the know-how transfer between syndication partners and their ability to learn. The core of the analysis checks whether repeated relationships and, thus, reputational concerns outweigh the temptation to renege on a given contract.

Throughout the paper, we investigate two key topics. The first consists of the conditions under which investors syndicate their deals. The second focuses on who chooses whom. We show that experienced financiers may partner with either other experienced investors (in order to raise the success probability of a project) or with unskilled investors (who can gain knowledge). We further demonstrate that sometimes the syndication is impeded because the financier believes that his partner has strong incentives to either renege on a contract (hold-up problem) or to shirk (moral hazard problem).

JEL Codes: D83, G32, L14

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1 Introduction

The joint realization of one project or one investment by several capital providers has a very long tradition in many segments of financial markets. In the underwriting business, for example, the origins of syndication can be found in the 18th century. During this time, so called loan contractors jointly guaranteed the sale of French and British government debts (see Carosso, 1970). In addition, the cooperation among financial intermediaries dealing with equity offerings has also existed for an extensive amount of time. As early as 1870, a syndicated offering of Pennsylvania Railroad's shares took place. Syndicated equity offerings continued to happen during the end of the 19th and the beginning of the 20th century (see Galston, 1925). The roots of loan syndication can be traced back to the 1960s (see Rhodes, 2000). However, during the past few years, a radical expansion of syndicated loans has been noticed worldwide (see e.g. Jones et al. (2002), Dennis/Mullineaux (2000) or Armstrong (2003)). Last but not least, deals are usually syndicated in private equity and venture capital markets (see e.g. OECD, 1996).

In theoretical literature, risk diversification and risk sharing are often assumed to be the reasons why investors may syndicate (e.g. Chowdhry/Nanda (1996) or Wilson (1968)). Moreover, information sharing can be another motive for investors to syndicate a deal (Millon/Thakor, 1985). The willingness of another financier to participate in a promising company may also constitute the basis for a financier's decision to invest. Detrimental investment decisions may be prevented by a bundling of experience of several capital providers (see Sah/Stiglitz, 1986). For Biais/Perotti (2003), complementary information held by different investors plays a decisive role in such decisions. Casamatta/Haritchabalet (2003) model an economy, in which different financiers receive different signals. The quality of a signal depends on the know-how of the investor. They conclude that experienced capital providers syndicate exclusively with other experienced partners because they possess good assessment skills. However, most skilled financiers rely on their own judgement and invest alone in order to retain all of the revenue for themselves.

Several empirical investigations analyze the reasons for syndicating as well. Brander et al. (2002) argue that syndication in the venture capital market leads to more management support for portfolio companies than stand-alone investments. As a consequence, syndicated deals generate larger returns. The same result is found by Cumming/Walz (2004). Another reason for syndicating is proposed by Lakonishok et al. (1991) who show that pension funds are often not involved in an investment until its success is apparent. Even if, while pursuing this strategy, they do not share extraordinary returns that were realized by incumbent investors in the past, they benefit from the investee's popularity and use it for their own marketing purposes.

An important economic benefit from syndicating is the know-how transfer between partners resulting from their ability to learn. In particular, if one financier has less expertise in a specific business area, he may benefit from the skills and competencies of his partner. These dynamic features of syndication play a crucial role in many areas of financial markets. This is particularly true in segments that are in the early stages of their development or that are in the process of expanding. In these markets, young investors may benefit from the know-how and expertise of their established counterparts. Thus, know-how transfer is a decisive determinant for the further evolution of such markets. Hereby, reputational aspects can mitigate potential conflicts. From this point of view it is very surprising that the mechanisms of know-how diffusion and reputation building have not yet been profoundly investigated in theoretical research. Therefore, this paper aims to offer insight into these issues.

In contrast to what is found in a static setting by Casamatta/Haritchabalet (2003), namely that skilled investors only partner with other experienced investors, heterogenous syndicates can also be found within financial markets. We argue that one reason why experienced investors syndicate with unskilled investors, who cannot push project returns the same way experienced investors can, is the dynamic aspect of such deals. Due to the know-how transfer between partners and reputation building, inexperienced investors accept comparably worse conditions with respect to their payoff. The central topic of our analysis is to investigate under which circumstances investors syndicate their deals. Is syndication always feasible? How does the structure of a syndicated deal look with respect to investors' know-how and their payoffs?

Apart from the benefits of syndicating, it also incurs costs. The financier who syndicates his deal must share the profit with his partner. Moreover, the asymmetry of information causes moral hazard problems. When the effort of each investor is neither observable nor verifiable, they may shirk. Among others, Alchian/Demsetz (1972) or Holmström (1982) analyze this free-rider problem within a team. Furthermore, hold-up problems may emerge. Biais/Perotti (2003) argue that investors do not syndicate the most profitable deals because they are afraid that their partner might steal the project idea and exploit it on his own account.

Within this paper, we develop a simple theoretical model in which the temptation of reneging on a contract is mitigated through a dynamic setting. Similarly, Pichler/Wilhelm (2001) and Chowdhry/Nanda (1996) look at the syndication of underwriters and the role that reputation and repeated relationships play. In our model, opportunistic behavior incurs costs because after reneging, the investor loses his reputation and potential future profits. Even for market entrants fraud is costly because they lose the chance to gain reputation and know-how. If these reneging costs exceed the benefits of cheating, which consist of a one-time gain, the reputation effect can compensate for the potential partner's lack of information. The core of the analysis is to check whether reputational concerns in fact outweigh the temptation to renege on a given contract. We show that sometimes the joint investment is impeded because the financier believes that his partner has either strong incentives to renege on the contract or is not sufficiently motivated to exert enough effort. Reputational concerns do not always prevent a non-optimal outcome. In order to keep our model simple and the number of its parameters within manageable limits, we abstain from considering other costs, such as negotiation and organizational costs of syndication, and only deal with agency costs.

The remainder of this paper is divided into four parts. Section 2 describes the setup of the model. The syndicate structures are explored in section 3. Some comparative statics results are presented in section 4. Finally, section 5 concludes.

2 The Model

We consider an economic environment consisting of investors and of projects that need external funding. The model has two periods and each project lasts for one period. It may either be financed by a single investor or by a syndicate of two. The investors differ in their skills and reputation. In particular, the investor either has reputation (skills) or not. The reputation is lost when the investor reneges on a contract and steals the project from his partner. Investors are risk neutral and share the interest rate $r \epsilon [0, 1]$ per period. Thus, there is a discount factor of $\frac{1}{1+r}$ per period. Moreover, each project requires a monetary investment of $I > 0$.

There are two types of risk neutral investors: E and N. A type E investor is an experienced (skilled) investor with reputation. He has a good track record and he has not reneged on a contract in the past. He may enhance the success probability of the investment if he exerts high effort. A type N investor is an inexperienced (unskilled) financier (a newcomer or an investor from another sector). He is unable to raise the success probability of a project. He may gain know-how and reputation by syndicating with an experienced investor.

Each project generates two possible outcomes, good ($R > 0$) or bad (0). Their probabilities depend on the experience and the effort of the investor(s). There are two levels of effort: low (0) and high ($\epsilon > 0$). The effort of type N has no impact on the project's success. Type E may increase the probability of a good outcome if his effort is high. With the help of better information sharing, more intensive management support and project monitoring, the joint investment of two Es exerting high efforts further increases the probability of a good outcome. In particular, a good outcome (R) is reached with the probability p_H (low effort),

$p_H + \epsilon$ (high effort of one E) or $p_H + 2\epsilon$ (high effort of two Es). Exerting high effort, however, creates costs of $c > 0$ for the investor whereas exerting low effort is costless.

Project owners, who need external financing, look for high-quality investors. They ask only renowned financiers for funding. Concretely, in each period, one project is revealed to each type E whereas type N lacks direct access to projects. Type N may only participate in a deal when an experienced investor with a reputation shares his project with him. (In this case they either can form a syndicate or type N may steal the project of type E and finance it on his own.) The decision whether to syndicate or not is made by investors who have direct access to projects. Thus, each investor who obtains a project (= type E) may either ask another investor to form a syndicate with him or, alternatively, invest alone in this particular project. If he chooses to syndicate, he may then select the type of investor he wants to syndicate with and offer him a contract. The potential partner (type E or N) may accept or reject the offer or steal the project. So, type E may be involved in "his own" project and, at the same time, participate as a partner in a "foreign" project.

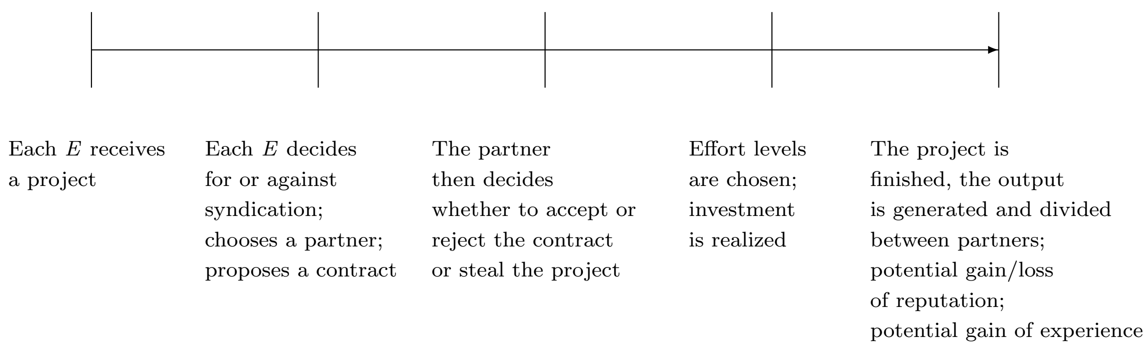
If type N is invited to join a syndicate, he gains know-how and reputation when he accepts the offer and does not renege. As a result, he becomes type E at the end of the period. The success probability of the investment, however, is no higher than without syndicating because N cannot add any value to the project. Only type E who exerts high effort increases the success probability of a project.

In a syndicate, moral hazard and hold-up problems can emerge due to information asymmetry. On the one hand, the effort of those involved is neither observable nor verifiable, and, thus, investors may be inclined to shirk (moral hazard). In particular, experienced investors, whose high effort contributes to the increased success probability of a project, may have incentives to exert low effort when high effort would be optimal. On the other hand, the syndication partner may steal the project after it is presented to him and pursue it on his own (hold-up). In contrast to the effort level exerted, which is unobservable, market participants know when an investor steals a project. Hereby, the dynamic aspect of the model plays a decisive role for both types of investors in mitigating the temptation to renege on a contract: Firstly, if a renowned investor steals a project, he will lose his reputation. Secondly, an investor without any reputation wants to build up his credibility. If he reneges, he will miss the chance to gain reputation.

The paper analyzes what is gained as a result of a good reputation. It compares the amount of payoff different types of investors receive depending on whether or not they have reneged on a contract. Type N may acquire experience in a particular sector by investing with type E. Furthermore, type N can gain reputation if he participates in a project and does not renege on the initial contract with his partner. If type N gains know-how and reputation in the first period, he becomes type E at the end of this period and, thus, is offered a project at the beginning of the next period. Hence, the value of reputation in our model is endogenized. Hereby, the discounted expected value of the future potential profit, which results from the direct access to a project during the second period, is compared to a one-time gain resulting from cheating. If an investor reneges on a contract in one period, he loses the possibility to gain a direct access to projects and is debarred from the market.

The time structure of the actions in one period is provided in Figure 1.

Figure 1: Time Line – One Period



The net value of the project for different effort levels of type E is as follows:

$$\begin{aligned} \text{Low effort} &: \quad p_H R - I \ . && (1) \\ \text{High effort of one experienced investor} &: \quad (p_H + \epsilon)R - I - c \geq 0 \ . && (2) \\ \text{High effort of two experienced investors} &: \quad (p_H + 2\epsilon)R - I - 2c \geq 0 \ . && (3) \end{aligned}$$

We define parameters φ (marginal revenue from high effort) and λ:

$$\begin{aligned} \varphi: &= \epsilon R \ , && (4) \\ \lambda: &= (p_H + \epsilon)R - I \ . && (5) \end{aligned}$$

With $\epsilon > 0$ and $R > 0$, we have $\varphi > 0$. Furthermore, (2) and $c > 0$ imply $\lambda > 0$. We assume that

$$c \leq \varphi \frac{\lambda}{\varphi + \lambda} \ . \tag{6}$$

This implies $\varphi > c$ (and, thus, $\varphi - c > 0$) because $\frac{\lambda}{\varphi+\lambda} < 1$.

After subtracting (1) from (2) and (2) from (3), respectively, we obtain $\varphi - c$. Thus, (1) < (2) and (2) < (3). We can now establish the following axiom.

Axiom 1 (Optimal syndication and effort with type *E*) *The high effort exerted by type E generates a higher net value than when type E exerts low effort. The syndication of two Es exerting high efforts generates a higher net value than if only one E exerts high effort.*

Since effort costs are assumed to be "not very high" (condition (6)), (joint) high effort increases the efficiency.

Moreover, we assume that the necessary monetary investment I is sufficiently high.

$$I \geq \frac{1}{1+r}(\lambda - c) + \varphi - \lambda \ . \tag{7}$$

The parameters and the structure of the model are known to all investors.

3 Syndicate Structures

In this section, which constitutes the central part of the paper, we investigate under which circumstances syndication occurs, who the syndicate partners are and how revenues and costs are divided between them. We start the analysis with the second period and solve the model backwards.

3.1 The Second Period

Since the second period is the final period, knowledge transfer and reputational status at the end of this period do not play a role. Within this framework, we analyze whether type E (who obtains a project) decides to syndicate or not at the beginning of the second period. He does not invest in the project with type N since this type of investor cannot improve the project's profitability nor can he benefit from acquiring skills and reputation. Therefore, the total amount of net value achieved by syndicating with type N in the second period is no higher than that from investing alone.[1] Thus, the experienced investor (also called the "original investor") selects one of two alternatives. He chooses either to syndicate with another skilled investor (who can contribute to the project's success with his effort) or invest in the project alone. If he decides to syndicate his project, which is the optimal solution when both investors exert high efforts (see Axiom 1), the other investor (also called the "syndication partner") participates in the investment with a share of $1 - \alpha$. The tradeoff for the original investor is that, on the one hand, he profits from the increased expected revenue induced by the high effort of his syndication partner while, on the other hand, he has to share this output with his partner in order to motivate him to participate, to exert high effort and to avoid a hold-up.

[1] As we will show in section 3.2, syndication between type N and type E is only possible with a nonlinear financing structure. Given this, the impossibility of syndicating with type N in the second period could as well be clarified by the following rationale: Type N will not participate in a syndicate because he cannot enjoy the benefit of the knowledge transfer as a compensation for an "unfair" share policy.

The expected profit of the original investor who syndicates his deal depends on his share α. His optimal α is given by

$$max_\alpha \ \ \alpha(\lambda+\varphi)-c = max_\alpha \ \ \alpha \tag{8}$$

$$\begin{aligned} \textbf{s.t.} \ \ PC_2 &: (1-\alpha)(\lambda+\varphi)-c \geq 0 \\ IC_2 &: (1-\alpha)(\lambda+\varphi)-c \geq (1-\alpha)\lambda \\ H_2 &: (1-\alpha)(\lambda+\varphi)-c \geq \lambda - c \\ PC_1 &: \alpha(\lambda+\varphi)-c \geq \lambda - c \\ IC_1 &: \alpha(\lambda+\varphi)-c \geq \alpha\lambda \\ & \ \ \ \ \alpha \ \epsilon \ \langle 0,1 \rangle \end{aligned}$$

$PC/IC/H$ refer to the participation constraint and incentive constraints with respect to high effort and the avoidance of a hold-up. Subscript "1" indicates the original investor and subscript "2" refers to his syndication partner. The syndication partner participates in the deal if he receives, at a minimum, his reservation utility, which is normalized at 0 (PC_2).[2] He is motivated to exert high effort if his expected payoff is higher than if he exerts low effort (IC_2). He will not steal the project if his expected profit from the syndicated deal exceeds that from stealing the venture and carrying it out on his own (H_2). The original investor syndicates when it is more profitable for him than investing alone (PC_1). He exerts high effort when it is more profitable than exerting low effort (IC_1). Additionally, each investor must obtain a non-negative share of the expected revenue, which is stated in the last condition.[3]

[2]At this point, the profit received from the syndication partner's "own project", which is independent of his role as a syndication partner, was subtracted from both sides of the inequality. PC_2 is only concerned with the decision to invest in an additional project as a syndication partner.

[3]For some investors, e.g. venture capitalists, control may be a decisive issue. In this case a narrower constraint on α can be assumed. The original investor may want to keep a certain minimum fraction, $\widehat{\alpha}$, of the venture to guarantee his control (i.e. $\alpha \ \epsilon \ \langle \widehat{\alpha}, 1 \rangle$). Given this additional restriction, syndication can be impeded if the original investor wishes to retain "too much" control.

When satisfied, PC_1 and H_2 imply $\frac{\lambda}{\lambda+\varphi} \leq \alpha \leq \frac{\varphi}{\lambda+\varphi}$. Since $\lambda > 0$ and $\varphi > 0$, we have $\alpha \in \langle 0, 1 \rangle$. In other words, both investors must receive a non-negative fraction of output in order to participate (investor 1) and not to hold-up (investor 2).

To ensure the syndication partner participates, a non-negative expected profit from the deal is sufficient enough for him (PC_2). However, if the original investor wants his partner to work hard, a larger payment is necessary (IC_2). Thus, if the constraint IC_2 is fulfilled, then PC_2 also holds. Formally, this result is derived from $1 - \alpha \geq 0$ and $\lambda > 0$.

Moreover, pursuant to (6), IC_2 results from H_2 and IC_1 from PC_1, respectively. From H_2, we get $(1-\alpha)\varphi \geq \alpha\lambda$. Therefore, $\alpha \leq \frac{\varphi}{\varphi+\lambda}$, which can be rewritten as $1 - \alpha \geq \frac{\lambda}{\varphi+\lambda}$. With (6), the inequality $\frac{\lambda}{\varphi+\lambda}\varphi - c \geq 0$ holds. IC_2 can be rewritten as $(1-\alpha)\varphi - c \geq 0$. Furthermore, from H_2, we get $(1-\alpha)\varphi - c \geq \frac{\lambda}{\varphi+\lambda}\varphi - c \geq 0$. This proves that IC_2 holds. Similarly, IC_1 results from PC_1. Thus, in maximization problem (8), only two constraints, H_2 and PC_1, remain. If these two constraints are met, the other four constraints hold as well.

In order to maximize α, the hold-up constraint of the syndication partner (H_2) will be satisfied with equality. Hence,

$$\alpha = \frac{\varphi}{\varphi + \lambda} \ . \tag{9}$$

The larger the amount of revenue expected from stealing the project (λ), the more the syndication partner must be compensated. This implies a lower share α for the original investor. Thus, α is decreasing in λ. On the contrary, the larger the marginal revenue from the high effort executed by the second investor (φ), the larger the joint output. In this case, the syndication partner is satisfied with a lower fraction of expected revenue. Thus, α is increasing in φ.

Substituting (9) into PC_1 indicates that PC_1 is met when $\varphi \geq \lambda$. If $\varphi < \lambda$ and, thus, the original investor's expected profit from the high effort for a syndicated invest-

In maximization problem (8), syndication would not take place if $\widehat{\alpha} > \frac{\varphi}{\varphi+\lambda}$ (see (9)). In order to avoid further constraints and, thus, keep the model simple, we do not consider this issue.

ment is lower than that for a non-syndicated investment, the participation constraint of the original investor (PC_1) is not satisfied. Therefore, he prefers investing alone.

Proposition 1 (Second period) *If $\varphi < \lambda$, type E invests alone in the second period and exerts high effort. His expected profit is $\lambda - c$. If $\varphi \geq \lambda$, he syndicates with another type E and obtains a fraction of $\alpha = \frac{\varphi}{\varphi+\lambda}$. His expected profit is $\varphi - c$. In this case, both financiers exert high effort.*

The optimal outcome in the second period is a syndication of experienced investors exerting high effort (see Axiom 1). However, it can be shown that it is impossible to achieve this result if $\varphi < \lambda$; not even with a nonlinear financing structure, where the fraction of the investment an investor bears and his share of the realized revenue differ.[4]

3.2 The First Period

The next section is devoted to the investigation of the first period. Here, the investors' behavior depends on what they expect to happen in the second period. We begin analyzing the case when syndication in the second period is not anticipated.

3.2.1 No Syndication in the Second Period ($\varphi < \lambda$)

Firstly, we investigate the joint investment between two experienced investors in the first period. Secondly, we look at syndication between an experienced original investor and an inexperienced syndication partner. In order to identify the most profitable strategy for the original investor in the first period, we conclude by comparing his profits from these two alternatives to those from a non-syndicated investment.

An Experienced Syndication Partner in the First Period ($\varphi < \lambda$)

[4] A similar outcome holds for the first period, which is analyzed in section 3.2. Formal proofs can be obtained from the author.

If $\varphi < \lambda$ and, thus, in the second period syndication is not expected, in the first period the maximization problem of type E wanting to syndicate his project with another type E is as follows:

$$max_{\alpha} \;\; \alpha(\lambda + \varphi) - c = max_{\alpha} \;\; \alpha \tag{10}$$

$$\begin{aligned}
\textbf{s.t.} \;\; PC_2 &: \;\; (1-\alpha)(\lambda+\varphi) - c \geq 0 \\
IC_2 &: \;\; (1-\alpha)(\lambda+\varphi) - c \geq (1-\alpha)\lambda \\
H_2 &: \;\; (1-\alpha)(\lambda+\varphi) - c \geq \lambda - c - \frac{1}{1+r}(\lambda - c) \\
PC_1 &: \;\; \alpha(\lambda+\varphi) - c \geq \lambda - c \\
IC_1 &: \;\; \alpha(\lambda+\varphi) - c \geq \alpha\lambda \\
& \;\;\;\; \alpha \; \epsilon \; \langle 0, 1 \rangle
\end{aligned}$$

The constraints of this optimization problem are the same as those defined in (8). The only difference is the hold-up constraint of the syndication partner (H_2) because, in contrast to the final period, reputational concerns play a role during the first period. If the syndication partner reneges on a contract, he loses his reputation and, thus, the opportunity to realize a gain in the second period, which amounts to $\lambda - c$ (see Proposition 1) discounted by $\frac{1}{1+r}$.

With $\varphi < \lambda$ the participation constraint of the original investor in the second period does not hold (as shown in section 3.1). Therefore, the original investor prefers investing alone in the second period. However, in the first period the syndication partner faces a tougher hold-up constraint and, thus, compared to the second period, a smaller fraction of the revenue prevents him from reneging on the contract. So, syndication may be preferred by the original investor. The reason for this is, that if the syndication partner reneges in the first period, he loses reputation and, hence, a profit in the second period. On the contrary, hold-up in the second period has no negative future consequences for the partner.

Lemma 1 (Type *E* in the 1st and alone in the 2nd) *If syndication in the second period is not expected ($\varphi < \lambda$) and type E syndicates with another type E in* *the first period, he retains a fraction of* $\alpha = min\{\frac{\varphi+\frac{1}{1+r}(\lambda-c)}{\lambda+\varphi}, \frac{\varphi-c}{\varphi}\}$ *and his expected profit reaches* $\pi = min\{\varphi + \frac{1}{1+r}(\lambda - c) - c, \frac{\varphi-c}{\varphi}(\lambda + \varphi) - c\}$*. Both investors exert high effort.*

Lemma 2 (Choice of α if type E in the 1st and alone in the 2nd)
$\alpha = \frac{\varphi+\frac{1}{1+r}(\lambda-c)}{\lambda+\varphi}$ *if* $r > \frac{c\lambda}{\varphi\lambda-c(\varphi+\lambda)}$*;* $\alpha = \frac{\varphi-c}{\varphi}$ *if* $r \leq \frac{c\lambda}{\varphi\lambda-c(\varphi+\lambda)}$.

See Appendix A for the proof.

An Inexperienced Syndication Partner in the First Period ($\varphi < \lambda$)

Syndicating with type N does not increase the success probability of a project. Therefore, if a nonlinear financing structure[5] is not allowed, syndication between an experienced and an inexperienced investor does not take place. This is because the original investor cannot be better off with type N than with a non-syndicated investment.

In the following we analyze whether syndication is possible under a nonlinear financing structure where the share of the investment cost type N bears is larger ($1 - \alpha + \beta$ with $\beta > 0$) than his participation on the realized returns ($1 - \alpha$). In this way, type E can be compensated for letting type N participate in financing a project. The dynamic aspect of our model plays a central role here. Since he gains both reputation and experience, type N may be interested in syndicating with type E in the first period, even if he realizes a loss. In the second period, he profits both from the direct access to a project and the know-how acquired in the first period, which leads to an increase in the success probability of his investment.

Under the securities design described above, the maximization problem of type E wanting to syndicate with type N in the first period is as follows:

[5] Under a linear structure, the syndication partner finances a fraction $1 - \alpha$ of the investment and obtains the same fraction of revenue.

$$
\begin{aligned}
max_{\alpha,\beta} \;\; \alpha\lambda - c + \beta I & & (11) \\
\textbf{s.t.}\;\; PC_2 &: (1-\alpha)\lambda - \beta I + \frac{1}{1+r}(\lambda - c) \geq 0 \\
H_2 &: (1-\alpha)\lambda - \beta I + \frac{1}{1+r}(\lambda - c) \geq \lambda - \varphi \\
PC_1 &: \alpha\lambda - c + \beta I \geq \lambda - c \\
IC_1 &: \alpha\lambda - c + \beta I \geq \alpha(\lambda - \varphi) + \beta I \\
& \alpha \; \epsilon \; \langle 0, 1\rangle \\
& \alpha - \beta \; \epsilon \; \langle 0, 1\rangle
\end{aligned}
$$

The participation and incentive constraints in (11) differ in many ways from those in (8) and (10). There is no incentive constraint on the effort executed by type N (IC_2), since his effort is not value-enhancing. Furthermore, type N overproportionally finances the investment I. Thus, if he does not steal the project, his expected profit in the first period amounts to $(1-\alpha)\lambda - \beta I$. Additionally, he gains experience and reputation. As a consequence, he expects to receive $\lambda - c$ in the second period. This profit is discounted by the factor $\frac{1}{1+r}$. His reservation utility of *0* and his expected profit of $\lambda - \varphi$ from stealing the project (see (1)), determine the constraints PC_2 and H_2, respectively.

The participation constraint of the original investor (PC_1) reflects the trade off between sharing the revenue (syndication) and having larger investment costs (investing alone). If the incentive constraint (IC_1) is fulfilled, he exerts high effort.

Both partners must receive a non-negative fraction of the output and bear a non-negative fraction of the investment costs. These restrictions are reflected in the last two constraints.

Lemma 3 (Type *N* in the 1st and alone in the 2nd) *If syndication in the second period is not expected ($\varphi < \lambda$) and type E syndicates with type N in the first period, he exerts high effort and his expected profit reaches $\pi = \varphi + \frac{1}{1+r}(\lambda - c) - c$.*

See Appendix B for the proof.

The Decision in the First Period ($\varphi < \lambda$)

Now we will show that, when syndication in the second period is not expected ($\varphi < \lambda$), type E never syndicates with another type E in the first period. We will further demonstrate under which conditions type E syndicates with type N and when he prefers investing alone.

We distinguish between two cases, which depend on whether PC_1 from the maximization problem (11) holds (see Appendix B, constraint (a)). In other words, we first analyze whether the original investor's expected profit from syndicating with an inexperienced partner (see Lemma 3) is higher than his expected profit from investing alone.

Case 1 (PC_1 satisfied): $\varphi + \frac{1}{1+r}(\lambda - c) - \lambda \geq 0$

From satisfying PC_1 immediately follows that syndication with type N is no less profitable for the original investor than investing alone.

The expected profit of the original investor who partners with type N in the first period amounts to $\varphi + \frac{1}{1+r}(\lambda - c) - c$ (see Lemma 3). Due to relatively low marginal revenue from high effort exerted by a second type E investor ($\varphi < \lambda$), this value is no lower than the original investor's maximum expected profit from his syndicated deal with type E (see Lemma 1). Thus, syndicating with type N is no less profitable for the original investor than syndicating with type E.

Proposition 2 (Decision in the 1st if alone in the 2nd (*Part 1*)) *If syndication in the second period is not expected ($\varphi < \lambda$) and at the same time $\varphi + \frac{1}{1+r}(\lambda - c) - \lambda \geq 0$, then type E will syndicate with type N in the first period.*

Case 2 (PC_1 not satisfied): $\varphi + \frac{1}{1+r}(\lambda - c) - \lambda < 0$

In this case, syndication with type N does not take place in the first period because type E prefers investing alone. To put it differently, it is impossible to find any combination of α and β that would induce the original investor to syndicate with type N in the first period.

It remains to be seen whether syndicating with type E is better for the original investor than investing alone. We distinguish between two subcases (see Lemma 2):

Subcase 2.1: $\quad r > \frac{c\lambda}{\varphi\lambda - c(\varphi+\lambda)}$ and, thus, $\varphi + \frac{1}{1+r}(\lambda - c) - c < \frac{\varphi - c}{\varphi}(\lambda + \varphi) - c$

In the first period, syndication with type E does not happen because investing alone is more profitable for type E since the participation constraint PC_1 in (10) is not satisfied. The left-hand side is equal to $\varphi + \frac{1}{1+r}(\lambda - c) - c$, which is lower than the right-hand side $\lambda - c$ (due to the condition valid for Case 2).

Subcase 2.2: $\quad r \leq \frac{c\lambda}{\varphi\lambda - c(\varphi+\lambda)}$ and, thus, $\varphi + \frac{1}{1+r}(\lambda - c) - c \geq \frac{\varphi - c}{\varphi}(\lambda + \varphi) - c$

With this and the condition valid for Case 2, we have

$$\frac{\varphi - c}{\varphi}(\lambda + \varphi) - c \leq \varphi + \frac{1}{1+r}(\lambda - c) - c < \lambda - c \; .$$

Therefore, investing alone generates a larger expected profit $(\lambda - c)$ than syndicating with type E $(\frac{\varphi - c}{\varphi}(\lambda + \varphi) - c)$.

In both subcases, the condition valid for Case 2 implies that the marginal revenue from the "second" high effort is very low (not only is $\varphi < \lambda$, but even $\varphi < \lambda - \frac{1}{1+r}(\lambda - c)$ also). As a consequence, investing alone not only in the second period but in the first as well is more profitable than syndicating with type E.

Proposition 3 (Decision in the 1st if alone in the 2nd (*Part 2*)) *If* $\varphi + \frac{1}{1+r}(\lambda - c) - \lambda < 0$, *type E invests alone in both periods.*

3.2.2 Syndication in the Second Period ($\varphi \geq \lambda$)

In this section we analyze the original investor's decision in the first period when syndication in the second period is expected. We proceed analogously to 3.2.1. For this reason, we leave out detailed explanations on the methodology and intuition. If necessary, the reader can consult the preceding section.

An Experienced Syndication Partner in the First Period $(\varphi \geq \lambda)$

If $\varphi \geq \lambda$ and, thus, syndication is expected in the second period, the maximization problem of type E wanting to syndicate his project with another type E in the first period is as follows:

$$
\begin{aligned}
& max_\alpha \;\; \alpha(\lambda+\varphi) - c = max_\alpha \;\; \alpha \qquad (12)\\
\textbf{s.t. } PC_2 &: (1-\alpha)(\lambda+\varphi) - c \geq 0 \\
IC_2 &: (1-\alpha)(\lambda+\varphi) - c \geq (1-\alpha)\lambda \\
H_2 &: (1-\alpha)(\lambda+\varphi) - c \geq \lambda - c - \frac{1}{1+r}(\varphi - c) \\
PC_1 &: \alpha(\lambda+\varphi) - c \geq \lambda - c \\
IC_1 &: \alpha(\lambda+\varphi) - c \geq \alpha\lambda \\
& \alpha \;\epsilon\; \langle 0, 1 \rangle
\end{aligned}
$$

Lemma 4 (Type *E* in both periods) *If syndication in the second period is expected ($\lambda \leq \varphi$) and type E syndicates with another type E in the first period, he retains a fraction of $\alpha = min\{\frac{\varphi+\frac{1}{1+r}(\varphi-c)}{\lambda+\varphi}, \frac{\varphi-c}{\varphi}\}$ and his expected profit reaches $\pi = min\{\frac{2+r}{1+r}(\varphi-c), \frac{\varphi-c}{\varphi}(\lambda+\varphi)-c\}$. Both investors exert high effort.*

Lemma 5 (Choice of α if type *E* in both periods) *If $r \leq \frac{\varphi^2-\varphi\lambda+c\lambda}{\varphi\lambda-c(\varphi+\lambda)}$ then $\alpha = \frac{\varphi-c}{\varphi}$, otherwise $\alpha = \frac{\varphi+\frac{1}{1+r}(\varphi-c)}{\lambda+\varphi}$.*

See Appendix C for the proof.

An Inexperienced Syndication Partner in the First Period $(\varphi \geq \lambda)$

Corresponding to the situation without syndication in the second period (see (11)), a nonlinear financing structure must be used in order to make the participation of type N possible. Type E has the following maximization problem:

$$
\begin{aligned}
&max_{\alpha,\beta} \;\; \alpha\lambda - c + \beta I \qquad\qquad (13)\\
&\textbf{s.t.} \;\; PC_2 \;:\; (1-\alpha)\lambda - \beta I + \frac{1}{1+r}(\varphi - c) \geq 0\\
&\qquad H_2 \;:\; (1-\alpha)\lambda - \beta I + \frac{1}{1+r}(\varphi - c) \geq \lambda - \varphi\\
&\qquad PC_1 \;:\; \alpha\lambda - c + \beta I \geq \lambda - c\\
&\qquad IC_1 \;:\; \alpha\lambda - c + \beta I \geq \alpha(\lambda - \varphi) + \beta I\\
&\qquad \alpha \;\epsilon\; \langle 0, 1\rangle\\
&\qquad \alpha - \beta \;\epsilon\; \langle 0, 1\rangle
\end{aligned}
$$

Lemma 6 (Type *N* in the 1st and type *E* in the 2nd) *If syndication in the second period is expected ($\lambda \leq \varphi$) and type E syndicates with type N in the first period, he exerts high effort and his expected profit reaches $\pi = \lambda + \frac{1}{1+r}(\varphi - c) - c$.*

See Appendix D for the proof.

The Decision in the First Period ($\varphi \geq \lambda$)

If syndication with type E in the second period is profitable, a joint investment with him in the first period is no less profitable for the original investor. The reason for this is, that the syndication partner can be satisfied with the same or even a lower fraction of revenue in the first period due to his tougher hold-up constraint. Thus, the original investor would never invest alone. The lower the interest rate r, the higher the utility of type N from syndication because the present value of his future profit is higher. Therefore, we expect that for low values of r, syndicating with type N may be preferred to syndicating with type E in the first period.

Formally, by syndicating with type E, the original investor's expected profit indicated in Lemma 4 is generated. We distinguish between two cases (see Lemma 5):

<u>Case 1:</u> $r > \frac{\varphi^2 - \varphi\lambda + c\lambda}{\varphi\lambda - c(\varphi+\lambda)}$ (and, thus, $\frac{1}{1+r} < \frac{\lambda\varphi - c(\lambda+\varphi)}{\varphi^2 - c\varphi}$)

The expected profit of type E from syndicating with another type E amounts to $\frac{2+r}{1+r}(\varphi - c)$, which is no less than the expected profit gained from investing alone or from syndicating with type N.

<u>Case 2:</u> $r \leq \frac{\varphi^2-\varphi\lambda+c\lambda}{\varphi\lambda-c(\varphi+\lambda)}$ (and thus, $\frac{1}{1+r} \geq \frac{\lambda\varphi-c(\lambda+\varphi)}{\varphi^2-c\varphi}$)

The expected profit of type E from syndicating with another type E reaches $\frac{(\varphi-c)(\lambda+\varphi)}{\varphi} - c$, which is no less than the expected profit gained from investing alone. Whether type E or type N is chosen as syndication partner depends on the value of r. If $\frac{1}{1+r} < 1 - \frac{c\lambda}{\varphi(\varphi-c)}$, syndicating with type E is more profitable and vice versa.

See Appendix E for the proof.

Proposition 4 (Syndication in the 1st if syndication in the 2nd) *If syndication in the second period is expected ($\lambda \leq \varphi$), type E syndicates in the first period as well. He never invests alone.*

Proposition 5 (Syndicate structure in the 1st if syndication in the 2nd) *If syndication in the second period is expected ($\lambda \leq \varphi$), then*

1. *if* $\frac{1}{1+r} \epsilon \left[0, \frac{\lambda\varphi-c(\lambda+\varphi)}{\varphi(\varphi-c)}\right)$, *type E syndicates with another type E and his expected profit is* $\frac{2+r}{1+r}(\varphi - c)$,
2. *if* $\frac{1}{1+r} \epsilon \left[\frac{\lambda\varphi-c(\lambda+\varphi)}{\varphi(\varphi-c)}, 1 - \frac{c\lambda}{\varphi(\varphi-c)}\right)$, *type E syndicates with another type E and his expected profit is* $\frac{(\varphi-c)(\lambda+\varphi)}{\varphi} - c$,
3. *if* $\frac{1}{1+r} \epsilon \left[1 - \frac{c\lambda}{\varphi(\varphi-c)}, 1\right]$, *type E syndicates with type N and his expected profit is* $\lambda - c + \frac{1}{1+r}(\varphi - c)$.

In the first period, more deals are syndicated than in the final period. The reason is that the dynamic environment promotes syndication since it diminishes incentives for a hold-up. Furthermore, the transfer of knowledge in the dynamic setting enables the participation of inexperienced investors, which would be impossible in a static setting and, thus, does not emerge in the second period. As expected, for those values of the interest rate r that are under a certain level, syndicating with type N is more profitable for the original investor than syndicating with type E.

4 Comparative Statics

Table 1 summarizes the results of our analysis with respect to the syndicate structure (see propositions 1 to 5). Depending on the parameter constellations, we have four possible combinations of actions in the first and in the second period. Type E may invest alone in both periods. Alternatively, he can syndicate with another type E in both periods. Furthermore, he may invest with type N in the first period and with type E or alone in the second period.

Table 1: Syndication partner of type E

Conditions	**1st period**	**2nd period**
$\frac{1}{1+r} < \frac{\lambda-\varphi}{\lambda-c}$	alone	alone
1. $\varphi < \lambda$ 2. $\frac{1}{1+r} \geq \frac{\lambda-\varphi}{\lambda-c}$	syndication with N	alone
1. $\varphi \geq \lambda$ 2. $\frac{1}{1+r} < 1 - \frac{c\lambda}{\varphi(\varphi-c)}$	syndication with E	syndication with E
1. $\varphi \geq \lambda$ 2. $\frac{1}{1+r} \geq 1 - \frac{c\lambda}{\varphi(\varphi-c)}$	syndication with N	syndication with E

Syndicating in the first period is more attractive than in the second one because of learning and reputational concerns. In the following, we discuss the impact of various parameters on syndication and its structure.

Interest rate: A high interest rate r implies high discounting of future revenues and, thereby, diminishes the value of reputation and learning. Hence, in the first period, the participation of inexperienced investors is hindered. The higher the discounting, the lower the present value of their potential future returns. Thus, a high interest rate motivates a hold-up and decreases the willingness of inexperienced investors to overproportionally finance the investment in the first period. Concretely, syndicating with type N does not take place if $r > \frac{\varphi - c}{\lambda - \varphi}$ (for $\varphi < \lambda$) or if $r > \frac{c\lambda}{\varphi(\varphi - c) - c\lambda}$ (for $\varphi \geq \lambda$).

Effort costs: High effort costs c impede syndication on general and syndication with an experienced financier in particular. Type E invests alone in the first period if $c > \varphi + r\varphi - r\lambda$ and $\varphi < \lambda$. When $\varphi \geq \lambda$, type E does not syndicate with another type E in the first period if $c \geq \frac{\varphi^2 r}{\varphi r + \lambda + \lambda r}$.

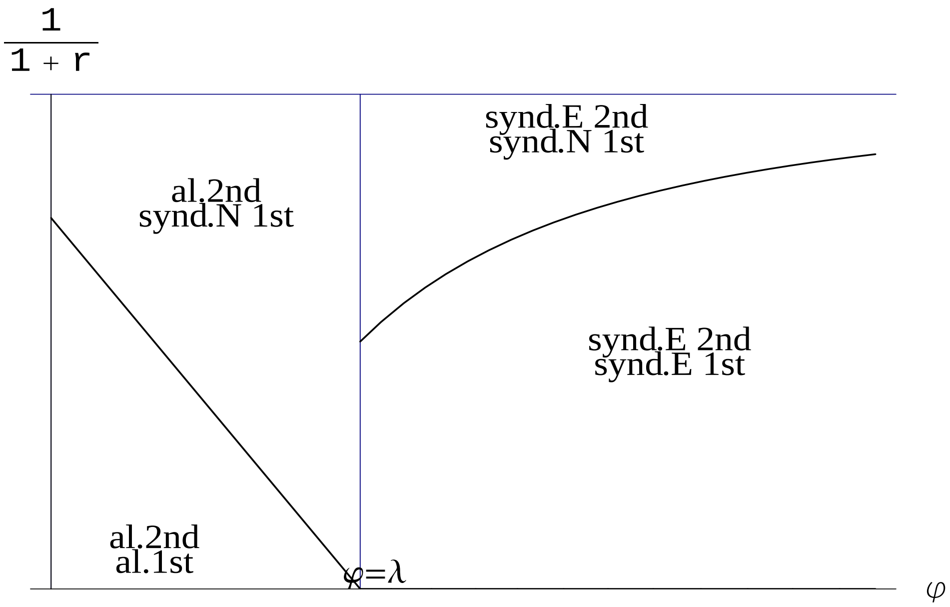
Revenue from high effort: High marginal revenue from high effort (φ) facilitates syndication in both periods. If φ reaches a certain level (λ), syndication in both periods takes place. If it remains below this level, syndication does not happen in the second period. However, if $\varphi \geq \lambda - \frac{1}{1+r}(\lambda - c)$ syndication (with type N) in the first period occurs.

Numerical example: Figure 2 depicts the four combinations of syndicate structures and the impact the parameters φ and r have on them (for a given level of $\lambda = 0.3$ and two different levels of effort costs c: 0.1 (Part A) and 0.01 (Part B)). For sufficiently large values of φ, syndication among experienced investors in the second period takes place. For sufficiently low values of r and, thus, high values of reputation and learning, syndication with an inexperienced investor in the first period occurs.

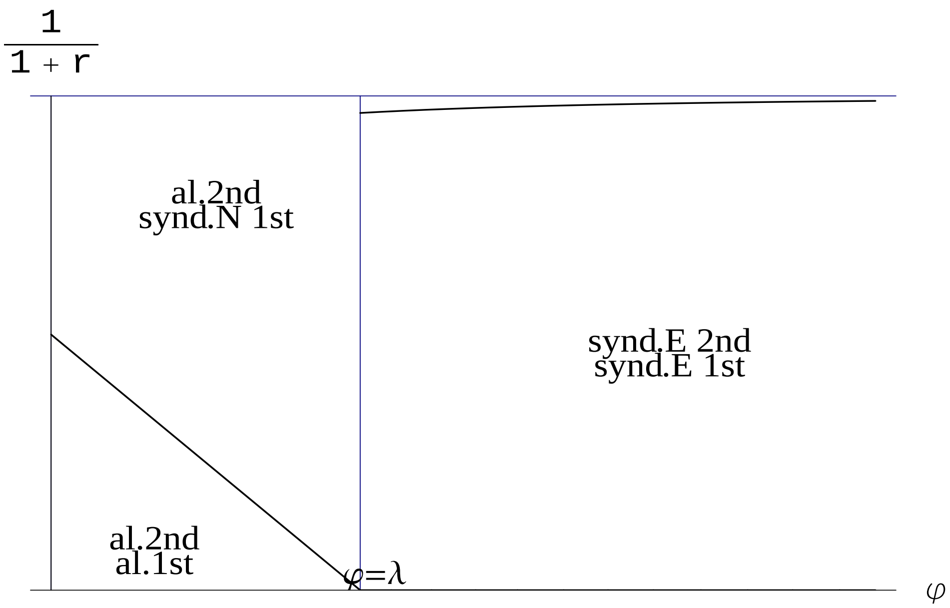
In both left quadrants in each figure (no syndication in the second period, i.e. $\varphi < \lambda$), for a given r, syndication with type N in the first period occurs for "large values" of φ. The opposite is true in both right quadrants (syndication in the second period, i.e. $\varphi \geq \lambda$). The reason is that the respective expected payoffs have different structures. When $\varphi < \lambda$, a higher φ implies higher potential profits in the second period for type N. Therefore, a higher interest rate is acceptable. As a result $\frac{1}{1+r}$ is decreasing in φ. In both right quadrants ($\varphi \geq \lambda$), the curve demarcating the two possible outcomes in the first period has an opposite slope. The situation here is different from both of the left quadrants because the original investor chooses between syndicating with type N and syndicating with type E. A higher φ implies higher profits in the second period for type N. But, a higher φ also leads to higher profits from syndicating with

Figure 2: A syndication partner of type E at different levels of φ, r and c (λ given)

PART A (high c): $\lambda = 0.3$ and $c = 0.1$



PART B (low c): $\lambda = 0.3$ and $c = 0.01$



Remarks: al.=alone, 1st=1st period, 2nd=2nd period, synd.=syndication, E=type E, N=type N

type E in the present period. Because the former effect occurs in the second period, it must be discounted. Thus, if φ increases and other parameters remain unchanged, the rise in the profitability of syndication is higher with type E than with type N. If syndicating with type N should remain the more profitable strategy, a decrease in the interest rate r is necessary. Therefore, when $\varphi \geq \lambda$, $\frac{1}{1+r}$ is increasing in φ.

5 Conclusion

Joint financing by several capital providers is quite common in many financial market segments, such as loan provision, reinsurance, underwriting of securities or venture capital and private equity financing. We observe very different syndicate structures with respect to the experience of syndicate members. In this paper, we have modelled an economy in which syndication among experienced and even with inexperienced investors may be advantageous. On one hand, the active participation of experienced investors, who contribute to the project's success with their knowledge and expertise, increases the expected project value. On the other hand, young financiers may gather valuable know-how for future deals when they invest in a project together with skilled partners. Whereas the vast majority of existing literature on syndication deals with the analysis of gains and costs in a static setting, we have considered a dynamic environment which enables the transfer of knowledge to take place and in which reputational aspects play a central role. Our model leads to the following empirically testable implication: In a syndicate, financiers with different reputations accordingly receive different financing contracts. Furthermore, the contracts for a certain financier should change (be less "unfair" to him) with time, as he gains experience and builds his reputation.

Reputational aspects mitigate incentives for a hold-up. The transfer of know-how and skills precipitates the learning processes that may be decisive for the diffusion of new financing instruments in an economy. This fact is notably important mainly for those market segments that are in the early stages of their development and where many inexperienced investors can be found. The recent rapid development of venture capital and private equity markets in continental Europe can serve as an example. Here, young inexperienced domestic venture capital and private equity funds have often formed syndicates with skilled financiers from abroad (mainly the United States or the United Kingdom). They have profited from these deals by gaining helpful skills and good reputation, which have contributed to the further development of these markets in Europe. This paper has demonstrated why such heterogenous syndicate structures emerge and has shown under which circumstances experienced investors are interested in these kind of deals.

Factors that facilitate syndication include deep interest rates, a high efficiency of the investors' effort and low effort costs. According to our model, for a chance to participate in a syndicate, unskilled financiers have to accept worse financing conditions than experienced ones. Thus, particularly in a young market with inexperienced investors, securities design plays a central role. In order to support the diffusion of new financing instruments and knowledge transfer, the institutional setting must allow the implementation of such securities, which enable an overproportional involvement of inexperienced financiers on investment costs.

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A Type E in the First Period and No Syndication in the Second

The solution to the maximization problem in (10) is derived below. PC_1 implies firstly that $0 \leq \frac{\lambda}{\lambda+\varphi} \leq \alpha$ and secondly that IC_1 holds because from PC_1 and (6), we get

$$c \leq \frac{\lambda}{\lambda+\varphi}\varphi \leq \alpha\varphi \ .$$

After a few rearrangements of the inequality $c \leq \alpha\varphi$ (subtracting c from and adding $\alpha\lambda$ to both sides) we obtain the condition IC_1.

Furthermore, PC_2 holds if IC_2 is met and $1-\alpha$ is non-negative. If H_2 is met, then (after a few rearrangements of H_2)

$$\alpha \leq \frac{\varphi + \frac{1}{1+r}(\lambda - c)}{\lambda+\varphi} = \underbrace{\frac{\varphi + \frac{1}{1+r}\lambda}{\lambda+\varphi}}_{<1} - \underbrace{\frac{\frac{1}{1+r}c}{\lambda+\varphi}}_{>0} < 1 \ .$$

In other words, in order to prevent a hold-up by the syndication partner, his share of the expected revenue $1-\alpha$ must be positive. Thus, H_2 and IC_2 imply PC_2.

Furthermore, following the argumentation above, if H_2 and PC_1 both hold then $\alpha \ \epsilon \ \langle 0, 1\rangle$ is satisfied. Thus, in the maximization problem (10), three constraints (IC_2, H_2 and PC_1) remain. When all of them hold, the other three are also met.

When maximizing α under both incentive constraints of the syndication partner (IC_2 and H_2), we obtain

$$\alpha = min\{\frac{\varphi + \frac{1}{1+r}(\lambda - c)}{\lambda+\varphi}, \frac{\varphi - c}{\varphi}\} \ .$$

Thus, $\alpha = \frac{\varphi+\frac{1}{1+r}(\lambda-c)}{\lambda+\varphi}$ if $\frac{\varphi+\frac{1}{1+r}(\lambda-c)}{\lambda+\varphi} < \frac{\varphi-c}{\varphi}$. After a few rearrangements of this inequality, we get

$$\lambda\varphi - c\varphi < (1+r)(\lambda\varphi - c\lambda - c\varphi)$$
$$\frac{c\lambda}{\lambda\varphi - c(\lambda+\varphi)} < r$$

Otherwise, $\alpha = \frac{\varphi - c}{\varphi}$.

Furthermore, the participation constraint of the original investor (PC_1) must be satisfied for these two values of α. This implies that $\varphi + \frac{1}{1+r}(\lambda - c) \geq \lambda$ when $\alpha = \frac{\varphi + \frac{1}{1+r}(\lambda - c)}{\lambda + \varphi}$ and $c \leq \frac{\varphi^2}{\lambda+\varphi}$ when $\alpha = \frac{\varphi - c}{\varphi}$. If the original investor's participation constraint holds and he syndicates with type E, his expected profit in the first period amounts to

$$\pi = \alpha(\varphi + \lambda) = min\{\varphi + \frac{1}{1+r}(\lambda - c) - c, \frac{\varphi - c}{\varphi}(\lambda + \varphi) - c\}\ .$$

B Type *N* in the First Period and No Syndication in the Second

The solution to the maximization problem in (11) is derived below. Since $\varphi < \lambda$, H_2 implies PC_2. Thus, H_2 is binding. Therefore, we have

$$\alpha = \frac{\frac{1}{1+r}(\lambda - c) - \beta I + \varphi}{\lambda}\ . \tag{14}$$

We substitute this value into the remaining four constraints.

(a)	$\varphi + \frac{1}{1+r}(\lambda - c) - \lambda \geq 0$	:	PC_1
(b)	$\beta \leq \frac{-c(\frac{1}{1+r}\varphi + \lambda) + \varphi(\varphi + \frac{1}{1+r}\lambda)}{\varphi I}$	:	IC_1
(c)	$\beta \leq \frac{\frac{1}{1+r}(\lambda - c) + \varphi}{I + \lambda}$	:	$\alpha - \beta \geq 0$

The latter condition and (14) jointly imply that $\alpha \geq 0$.

(d)	$\beta \geq \frac{\frac{1}{1+r}(\lambda - c) + \varphi - \lambda}{I}$	:	$\alpha \leq 1$

The latter and the first condition jointly imply that $\beta \geq 0$ and, thus, $\alpha - \beta \leq 1$.

If these four conditions are met and α is given by (14), all constraints indicated in the maximization problem (11) are satisfied.

It can be shown that it is possible to find at least one β that satisfies all three constraints concerning this parameter ((b), (c) and (d)).

Firstly, we show that (c) and (d) do not contradict. Hence, our aim is to prove that

$$\frac{\frac{1}{1+r}(\lambda - c) + \varphi - \lambda}{I} \leq \beta \leq \frac{\frac{1}{1+r}(\lambda - c) + \varphi}{I + \lambda}\ .$$

Pursuant to (7), $\frac{1}{1+r}(\lambda - c) + \varphi \leq I + \lambda$. After a few rearrangements, we get the desired inequality.

$$\begin{aligned}
(\frac{1}{1+r}(\lambda - c) + \varphi)\lambda &\leq \lambda(I + \lambda) \\
(\frac{1}{1+r}(\lambda - c) + \varphi)(I + \lambda) - \lambda(I + \lambda) &\leq (\frac{1}{1+r}(\lambda - c) + \varphi)I \\
(\frac{1}{1+r}(\lambda - c) + \varphi - \lambda)(I + \lambda) &\leq (\frac{1}{1+r}(\lambda - c) + \varphi)I \\
\frac{\frac{1}{1+r}(\lambda - c) + \varphi - \lambda}{I} &\leq \frac{\frac{1}{1+r}(\lambda - c) + \varphi}{I + \lambda} \ .
\end{aligned}$$

Secondly, we show that (b) and (d) do not contradict. We prove that

$$\frac{\frac{1}{1+r}(\lambda - c) + \varphi - \lambda}{I} \leq \beta \leq \frac{-c(\frac{1}{1+r}\varphi + \lambda) + \varphi(\varphi + \frac{1}{1+r}\lambda)}{\varphi I} \ .$$

Pursuant to (6), $c \leq \varphi$. After several steps, we obtain the inequality indicated above.

$$\begin{aligned}
-\varphi\lambda &\leq -c\lambda \\
-\varphi\lambda + \frac{1}{1+r}\lambda\varphi - \frac{1}{1+r}c\varphi + \varphi^2 &\leq -c\lambda + \frac{1}{1+r}\lambda\varphi - \frac{1}{1+r}c\varphi + \varphi^2 \\
\varphi(\frac{1}{1+r}(\lambda - c) + \varphi - \lambda) &\leq -c(\lambda + \frac{1}{1+r}\varphi) + \varphi(\frac{1}{1+r}\lambda + \varphi) \\
\frac{1}{1+r}(\lambda - c) + \varphi - \lambda &\leq \frac{-c(\frac{1}{1+r}\varphi + \lambda) + \varphi(\varphi + \frac{1}{1+r}\lambda)}{\varphi} \\
\frac{\frac{1}{1+r}(\lambda - c) + \varphi - \lambda}{I} &\leq \frac{-c(\frac{1}{1+r}\varphi + \lambda) + \varphi(\varphi + \frac{1}{1+r}\lambda)}{\varphi I} \ .
\end{aligned}$$

So, if (d) is fulfilled with equality, both (b) and (c) hold. Thus, β has at least one solution that satisfies all three conditions (b), (c) and (d), namely

$$\beta = \frac{\frac{1}{1+r}(\lambda - c) + \varphi - \lambda}{I} \ .$$

The value of α is given by (14). Thus, one of the possible solutions to the optimization problem in (11) is (if PC_1 is satisfied)

$$\{\alpha, \beta\} = \left\{1, \frac{\frac{1}{1+r}(\lambda - c) + \varphi - c}{I}\right\} \ . \tag{15}$$

In this case, type E receives all of the revenue from the project, but finances only a part of investment I. Other solutions may exist where α is lower (β higher) than in (15) and the expected profits remain unchanged.

In contrast to the final period where syndication with type N cannot take place, the dynamic aspect makes such agreements possible in the first period (when PC_1 is satisfied). Whether or not PC_1 holds, only depends on the parameters of the model and not on the values of α and β (see condition (a)).

When PC_1 is satisfied, then the expected profit of the experienced investor in the first period amounts to (after substituting (14) in (11))

$$\pi = \frac{1}{1+r}(\lambda - c) + \varphi - c \ .$$

When PC_1 is not satisfied, type E prefers investing alone rather than syndicating with type N in the first period.

C Type $\boldsymbol{E}$ in the First Period and Syndication in the Second

The solution to the maximization problem in (12) is derived below. We proceed analogously to Appendix A, where the solution to the maximization problem in (10) has been shown.

If IC_2 holds then α is lower than 1 and PC_2 is met. PC_1 implies that $\alpha \geq 0$ and, because of (6), that IC_1 also holds. Thus, the more restrictive of the two incentive constraints of the syndication partner (IC_2 or H_2) is binding. We get

$$\alpha = min\{\frac{\varphi + \frac{1}{1+r}(\varphi - c)}{\varphi + \lambda}, \frac{\varphi - c}{\varphi}\} \ .$$

If $\frac{\varphi+\frac{1}{1+r}(\varphi-c)}{\varphi+\lambda} < \frac{\varphi-c}{\varphi}$, then $\alpha = \frac{\varphi+\frac{1}{1+r}(\varphi-c)}{\varphi+\lambda}$. After a few rearrangements of this inequality, we obtain

$$\begin{aligned}
\varphi^2 + \frac{1}{1+r}\varphi(\varphi - c) &< \varphi^2 - c\varphi + \lambda\varphi - c\lambda \\
\frac{1}{1+r} &< \frac{\varphi\lambda - c(\varphi + \lambda)}{\varphi^2 - c\varphi} \\
r &> \frac{\varphi^2 - c\varphi - \varphi\lambda + c\varphi + c\lambda}{\varphi\lambda - c(\varphi + \lambda)} \\
r &> \frac{\varphi^2 - \varphi\lambda + c\lambda}{\varphi\lambda - c(\varphi + \lambda)}
\end{aligned}$$

We show that the participation constraint of the first investor (PC_1), i.e. $\alpha \geq \frac{\lambda}{\varphi+\lambda}$, is satisfied for both values of α.

(a) If $\alpha = \frac{\varphi+\frac{1}{1+r}(\varphi-c)}{\varphi+\lambda}$ then $\alpha \geq \frac{\lambda}{\varphi+\lambda}$ because

$$\begin{aligned} \varphi &\geq \lambda \\ \varphi + \frac{1}{1+r}(\varphi - c) &\geq \lambda \\ \alpha = \frac{\varphi + \frac{1}{1+r}(\varphi - c)}{\varphi + \lambda} &\geq \frac{\lambda}{\varphi + \lambda} \ . \end{aligned}$$

(b) If $\alpha = \frac{\varphi-c}{\varphi}$ then $\alpha \geq \frac{\lambda}{\varphi+\lambda}$ because, pursuant to (6) and $\varphi \geq \lambda$, $c \leq \frac{\varphi^2}{\varphi+\lambda}$. We rearrange the last inequality to get the desired relationship. In the first step, we multiply both sides of the inequality with $(\varphi + \lambda)$ and add $(-c\varphi - c\lambda + \varphi\lambda)$.

$$\begin{aligned} \varphi^2 - c\varphi - c\lambda + \varphi\lambda &\geq \varphi\lambda \\ (\varphi - c)(\lambda + \varphi) &\geq \varphi\lambda \\ \alpha = \frac{\varphi - c}{\varphi} &\geq \frac{\lambda}{\lambda + \varphi} \ . \end{aligned}$$

The expected profit of the experienced investor in the first period reaches

$$\pi = min\{\frac{2+r}{1+r}(\varphi - c), \frac{\varphi - c}{\varphi}(\lambda + \varphi) - c\} \ .$$

D Type N in the First Period and Syndication in the Second

The solution to the maximization problem in (13) is derived below. We proceed analogously to Appendix B, where the solution to the maximization problem in (11) has been shown. Since $\lambda - \varphi \leq 0$, PC_2 implies H_2. Thus, PC_2 is binding. We get

$$\alpha = \frac{\frac{1}{1+r}(\varphi - c) - \beta I + \lambda}{\lambda} \ . \tag{16}$$

We show that for this α, PC_1 is satisfied. PC_1 indicates that $\alpha \geq \frac{\lambda-\beta I}{\lambda}$. Thus, we must show that

$$\frac{\frac{1}{1+r}(\varphi - c) - \beta I + \lambda}{\lambda} \geq \frac{\lambda - \beta I}{\lambda} \ .$$

After a few rearrangements we obtain

$$\frac{1}{1+r}(\varphi - c) \geq 0 \ , \qquad \text{which is true.}$$

Furthermore, if the three conditions listed below are met, all remaining constraints of the maximization problem (13) are fulfilled as well.

(a) $\beta \leq \frac{(\varphi-c)(\frac{1}{1+r}\varphi+\lambda)}{\varphi I}$: IC_1

(b) $\beta \leq \frac{\frac{1}{1+r}(\varphi-c)+\lambda}{I+\lambda}$: $\alpha - \beta \geq 0$

The latter condition and (16) jointly imply that $\alpha \geq 0$.

(c) $\beta \geq \frac{\frac{1}{1+r}(\varphi-c)}{I}$: $\alpha \leq 1$.

The latter condition and (16) jointly imply that $\alpha - \beta \leq 1$.

Firstly, we show that (b) and (c) do not contradict. Hence, our aim is to prove that

$$\frac{\frac{1}{1+r}(\varphi - c)}{I} \quad \leq \quad \frac{\frac{1}{1+r}(\varphi - c) + \lambda}{I + \lambda} \ .$$

Since $r \geq 0$, we know that

$$\varphi - \lambda \quad \geq \quad \frac{1}{1+r}(\varphi - \lambda) \ .$$

After rearranging, we obtain

$$\begin{aligned} \varphi - \lambda \quad &\geq \quad \frac{1}{1+r}\varphi - \frac{1}{1+r}\lambda - \frac{1}{1+r}c + \frac{1}{1+r}c \\ \frac{1}{1+r}(\lambda - c) + \varphi - \lambda \quad &\geq \quad \frac{1}{1+r}(\varphi - c) \ . \end{aligned}$$

Pursuant to (7)

$$\frac{1}{1+r}(\lambda - c) + \varphi - \lambda \leq I \ .$$

Combining the last two inequalities, we get

$$\begin{aligned} I \quad &\geq \quad \frac{1}{1+r}(\varphi - c) \\ I\lambda \quad &\geq \quad \frac{1}{1+r}\lambda(\varphi - c) \\ I\lambda + \frac{1}{1+r}(\varphi - c)I \quad &\geq \quad \frac{1}{1+r}\lambda(\varphi - c) + \frac{1}{1+r}(\varphi - c)I \\ \frac{\frac{1}{1+r}(\varphi - c) + \lambda}{I + \lambda} \quad &\geq \quad \frac{\frac{1}{1+r}(\varphi - c)}{I} \ . \end{aligned}$$

Secondly, we can easily show that (a) and (c) do not contradict

$$\begin{aligned}\frac{1}{1+r}\varphi &\leq \frac{1}{1+r}\varphi+\lambda\\ \frac{\frac{1}{1+r}\varphi(\varphi-c)}{I} &\leq \frac{(\frac{1}{1+r}\varphi+\lambda)(\varphi-c)}{I}\\ \frac{\frac{1}{1+r}(\varphi-c)}{I} &\leq \frac{(\frac{1}{1+r}\varphi+\lambda)(\varphi-c)}{\varphi I}\ .\end{aligned}$$

Thus, β has at least one solution

$$\beta=\frac{\frac{1}{1+r}(\varphi-c)}{I}\ .$$

This β leads to $\alpha=1$.

For all βs that fulfill the constraints given above, the expected profit of type E in the first period amounts to (after substituting (16) in (13))

$$\pi=\frac{1}{1+r}(\varphi-c)+\lambda-c\ .$$

E The Decision in the First Period if Syndication in the Second

Case 1: Firstly, we show that the expected profit from syndication with type E is no lower than that from investing alone, i.e. $\frac{2+r}{1+r}(\varphi-c)\geq\lambda-c$. From $\lambda\leq\varphi$ (and $r>0$, $\varphi>0$, $\lambda>0$) immediately follows

$$\frac{2+r}{1+r}(\varphi-c)=\varphi-c+\frac{1}{1+r}(\varphi-c)>\lambda-c\ .$$

Secondly, we demonstrate that the expected profit from syndication with type E is no lower than that from syndication with type N, i.e. $\frac{2+r}{1+r}(\varphi-c)\geq\frac{1}{1+r}(\varphi-c)+\lambda-c$. With $\lambda\leq\varphi$, we have

$$\frac{2+r}{1+r}(\varphi-c)=\varphi-c+\frac{1}{1+r}(\varphi-c)\geq\frac{1}{1+r}(\varphi-c)+\lambda-c\ .$$

Case 2: Firstly, we show that the expected profit from syndication with type E is no lower than that from investing alone, i.e. $\frac{(\varphi-c)(\lambda+\varphi)}{\varphi} - c \geq \lambda - c$. With (6) and $\lambda \leq \varphi$, we get $c \leq \frac{\varphi^2}{\varphi+\lambda}$. After rearranging, we obtain the desired inequality.

$$\begin{aligned} c &\leq \frac{\varphi^2}{\varphi+\lambda} \\ \lambda\varphi &\leq \varphi^2 - c\varphi - c\lambda + \lambda\varphi \\ \lambda &\leq \frac{(\varphi-c)(\lambda+\varphi)}{\varphi} \ . \end{aligned}$$

Secondly, we demonstrate that the decision between syndication with type N and syndication with type E depends on the interest rate r. Syndication with type E is better for the original investor than syndication with type N if $\frac{(\varphi-c)(\lambda+\varphi)}{\varphi} - c > \lambda + \frac{1}{1+r}(\varphi - c) - c$. From this inequality, we obtain the following condition for r:

$$\frac{1}{1+r} < 1 - \frac{c\lambda}{\varphi(\varphi-c)} \ .$$