Equity-settled Share-based Payments and their (Stategic) Use under Asymmetric Information

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Abstract

Share-based payments are of widespread use in today's economy. Consulting firms are increasingly accepting equity compensation for their services (particularly from startups) and many governments provide fiscal incentives to support this choice. Likewise, profit-sharing licensing is an on-trend business practice by innovative firms and patent holders when transferring their technology to interested adopters. This paper unveils strategic considerations according to which an agent/seller designs its optimal policy in regard to the equity share to request in exchange for its service, technology or trademark. The model assumes a fringe of interested users/customers differentiated by both the support they need from the seller and the value of the underlying relationship; and also holding an informational disadvantage on their own types. Given the seller's cost configuration, equilibrium outcomes entail entering a profit-sharing relationship either with the high-type customers only; or with all customers, but in this case based on equity-based payment claims that –for rent extraction purposes– are common (i.e., *not* differentiated) across types.

JEL codes: L24, D82, D83, O30.

Keywords: Technology transfer, Profit-sharing licensing, Consulting for equity, Information asymmetry, Perfect Bayesian equilibrium

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1 Introduction

One of the most novel trends in the business world is that an increasing number of organizations have begun exploring alternative payment schemes and solutions for regulating their transactions. In this regard, share-based payments are gaining particular salience. This type of arrangements entails an equity stock as a form of compensation, in place of traditional cash pay. Firstly observed in the 1960s limited to the U.S. market, this form of payment has recently taken root among business companies, particularly in two distinct areas.

The first one involves intellectual-property transfers, specifically, the transfer of software, hardware, and know-how from an innovator (possibly a patent holder) to one or more interested adopters. More and more often, traditional licensing based on fees and revenue-based royalties gives way to alternative technology transfer mechanisms and settlements, involving the licensor (transferor) to take equity positions in the licensee (transferee) company. There are some real-world examples commonly mentioned in the economic literature (see Colombo et al., 2021; Hsu et al., 2019; Niu, 2017; San Martín and Saracho, 2010; Vishwasrao, 2007). One refers to the deal finalized by Microsoft in 2006, when a stake of about 10% in a London start-up, called Skinkers, was accepted in exchange for the use of its proprietary Internet-publishing technology. In 2005, the Australian Government agency responsible for scientific research (CSIRO) licensed new medical polymer technologies to the device company PolyNovo, receiving equity participation in return. In 2000 Motorola licensed rights for its organic light-emitting diode (OLED) technologies to Universal Display Corporation (UDC), a provider of services to the display and lighting industries, again in exchange for a minority equity stake in UDC. We could even include in this category of agreements the historical one signed in 2009 between Fiat SpA and Chrysler Group, according to which the former took a 35% stake in the latter, basically in return for sharing its green powertrain technologies.[1] The most recent examples of profit-sharing agreements are observed in sectors in which technology advancements are primarily intended to improve efficiency in production, while granting environmental sustainability and climate-smart economic growth. For instance, a medical company, Medcolcanna Organics, announced in 2021 a licensing and processing services agreement with Herbolea Biotech, a bio-technology company, for the extraction and preservation of cannabis from newly harvested or dried material. Likewise, the clean-tech company, OptiCept, has entered in 2022 in a equity-sharing agreement with the leading olive oil producer, namely Uniò, with the purpose to offer efficient green cutting-edge solutions in the areas of FoodTech and PlantTech.

The second relevant scope of share-based payments is the one relating to the so-called startup companies. Consulting-for-equity is indeed an increasingly popular avenue taken by business organizations in their early stages. When working with a consultant or entering a

[1] Such agreement was the preamble of a subsequent merge of the two players, clearly intended to go far beyond a pure licensing of technology.

contract with a strategic partner, startups are generally well disposed to offer part of their equity in payment for the services received, particularly when they are cash-strapped. In this way, they can preserve limited cash reserves for fueling their business plans and expansion strategies. The practice of consulting-for-equity has undergone a significant diffusion in particular in the context of licensing to university spin-offs, and a specific literature has developed, accordingly.[2] Moreover, some Governments have started supporting explicitly this practice, mostly by means of tax incentives or exemptions. One relevant example is the Decree-Law N. 179/2012 (the "Startup Act"), further extended by Decree-Law N. 3/2015, approved by the Italian Goverment, according to which payments received in the form of equity are tax-free for both fiscal and contributory purposes; and must therefore be excluded from the taxable income of suppliers and consultants.

Despite such recent trends, equity-settled share-based arrangements have received so far limited attention from academic scholars, with the only exception of two specific strands of economic literature. One is the just recalled line of research focusing on university spin-offs. Several authors (including Feldman et al., 2000; Bray and Lee, 2000; and Jensen and Thursby, 2001) have stressed a series of reasons for academic institutions to prefer equity over royalties and/or fees, other than liquidity preservation, e.g., the superior profitability of this particular licensing scheme in the long-run.[3] Savva and Taneri (2015) have instead assessed the coexistence of equity, royalty and fixed fees in university licensing agreements, building on the premise that licensees generally hold an information advantage over the level of demand for the commercialized product. In this case, combining royalties and equity allows a less-informed licensor to elicit private information from the counterpart.

A second strand of literature has instead analyzed licensing based on *ad-valorem* profit royalties in connection to market structure and the presence of strategic incumbents and entry. Again, most of the extant works have focused on the firm's choice to adopt this alternative licensing scheme in lieu of more traditional revenue-based royalties and/or fixed fees, particularly in the context of Cournot oligopolies in which the licensor is either an incumbent firm competing with the potential licensees (e.g. San Martín and Saracho, 2010; Hsu et al., 2019) or an outsider, i.e., an external entity not directly in competition with its licensees (e.g. Colombo et al., 2021).[4] While some of these studies confirm that profit-sharing has the potential to out-

[2]Several studies (e.g. Geuna and Nesta, 2006) have documented that in recent times, U.S. academic institutions –and European ones, even to a lesser extent– have increasingly resorted to equity-based licensing to commercialize their innovations by way of a considerable number of startup companies, sparking a lot of debate about universities' entrepreneurial activities and conformity with their statuary mission (see Blumenthal 1994; Slaughter and Leslie, 1997; and Bray and Lee, 2000, among others).

[3]More specifically, Feldman et al. (2000) show that equity provides universities with the opportunity to share in start-ups' fortunes, rather than the fortunes of a single technology; and it also guarantees a better alignment between the interests of licensors and licensees. Bray and Lee (2000) show that, on average, equity is more profitable than fixed fees and royalties, even more so in the long run. Finally, Jensen and Thursby (2001) point out that equity is superior to royalties in creating incentives for scholars and researchers to continue supporting their spin-offs.

[4]Looking at an incumbent innovator in a Cournot duopoly with linear demand, San Martín and Saracho (2010) and Wang (1998) show that ad-valorem royalties are preferred over unit royalties and fixed fees, respectively. Their

perform revenue-based royalties and fixed fees, some others detect equivalence of per-unit and ad-valorem royalties, thereby arguing that the exact ranking among licensing schemes crucially depends on the specification of the underlying model (Colombo and Filippini, 2015).

Summing up, the extent literature has so far investigated –more or less extensively– the *motives* according to which economic agents may want to be paid with equity, whereas too little has been said in regard to the *design* of the equity-settled share-based agreements, i.e., on the way innovators and professional service companies optimally choose the equity stake to request in exchange for their technology or service. Motivated by missing research on such utterly unexplored dimension, this paper proposes a theoretical investigation which may contribute to shed some light on this specific strategic choice. Our work builds on insights from both Colombo et al. (2021) and Savva and Taneri (2015). As in the former, we consider here an outsider with a certain number of (non rival) buyers of its technology, or trademark, or professional service (share-based agreements are modeled here in a sufficiently generic form to encompass a wide array of applications, including franchising, technology licensing, and consulting). Analogously to the latter, we introduce asymmetric information between the parties, even though the asymmetry is here in favor and not to the detriment of the licensor (or consultant, or service provider).[5]

More specifically, we assume that the latter –which we refer to as the *seller*– is faced with a pool of potential *customers*, who can be imagined as licensees, franchisees, or startups, depending on the preferred interpretation. While they are all interested in the same type of asset or service, customers are heterogeneous in terms of the support or treatment they need and the benefits they reap from their relationship with the seller. For the sake of simplicity, we assume two types of customers, namely the *high* and *low* types. The former (labeled with H) requires the seller to undertake a milder effort in the relationship, for instance in terms of support to technology adoption by part of the licensee, or solutions to solve client's problems, when considering professional services. The H-type also derives a larger utility from its relationship with the seller. In turn, the low types (labeled with L) obtain a lower utility and entail greater efforts by the seller. We take the seller's decision to deal with customers based on profit-sharing agreements as given, so as to focus on the equity stake that the seller may request in payment from the two types for the service, technology or trademark.

Against this backdrop, the seller has three options. The first is to select the H-types and enter an equity-settled share-based relationship with them only, while discarding the L-types. The second option is to choose to deal with both types by taking different equity positions across them. The third option is to engage in profit-sharing agreements with both types, yet

analysis is generalized by Hsu et al. (2019) for a more general demand system. In turn, Colombo et al. (2021) show that these schemes are equivalent for outside innovator with a finite number of buyers of its innovation.

[5] This assumption differentiates our work from Savva and Taneri (2015) and other previous theoretical contributions relating to licensing of university technology and thus focusing on the commercialization of new ideas. In all these studies, informational asymmetry is generally introduced in favor of the spin-off, i.e., the licensee (the customer, in our terminology).

requesting the same equity-settled share-based payment to all types. We unravel the main strategic considerations according to which the seller may prefer one option or an alternative one, and we derive the exact conditions under which any of these strategies may emerge as a *Perfect Bayesian Equilibrium* (PBE) of the game. As hinted above, the analysis is carried out by assuming that the seller holds an informational advantage over the type of the counterpart, i.e., it can better infer from preliminary talks the amount of effort it must undertake to satisfy the specific needs of the customer and hence the value that the latter derives from the relationship.

The most striking result we get under this assumption is that, when taking equity positions in its customers, a patent holder –or, for the matter, a consulting firm– never has an incentive to request different equity shares across types. The reason is that the seller has the ability to extract a larger surplus from both types by offering a single contract. In particular, proposing two different contracts to the customers would require meeting the participation constraints of both types at a lower profit, than offering a unique contract which leaves customers uncertain about their own profile, thereby ensuring larger rent extraction to the proposer.

The only exception is when the effort requested by the low types (L) is very costly. Under this circumstance, the equilibrium strategy of the seller implies rejecting this specific type of customers, as a profitable relationship can be established with the high types (H) only. We define in particular the *absorptive capacity* of the customer as the ability of a specific type to adopt a given technology and use it without the need for additional cost or investment by the seller. Offering a contract to the low type implies, for the seller, a larger cost of supporting technology adoption than the high type. In the specific case mentioned above, a licensor may therefore decide to engage in profit-sharing licensing only with licensees that are more absorptive (as they are less costly), whereas a share-based agreement is denied to all other interested users. Likewise, if the services requested by low-type startups are particularly expensive to provide, then only customers that need turn-key solutions –sufficiently easy and cheap to implement– will ever be selected to enter a consulting-for-equity relationship with a professional service company.

When instead the cost of the effort associated with the L-types is sufficiently limited, then a profitable share-based agreement can be signed with both the H- and L-types. As hinted above, the dominant strategy turns into the seller's decision to request a common equity share to all customers for the same type of technology/service. This way, the licensor/consulting firm trades off full-rent extraction at the expense of the high-type customers with the possibility to extract a rent from both types, particularly for the low-types, who are left with a negative *ex-post* surplus. In light of the solution concept (PBE) applying here, a request of different ownership shares across types would prevent the possibility of fully extracting surplus from one type, while having the other type willing to accept the proposed settlement terms.[6]

The result is empirically confirmed by Lafontaine and Blair (2009). Their study documents that franchisors/manufacturers typically propose a contractual arrangement in the form of a share of profit, while adopting unique contracts across franchisees at a certain point in time within their chains. Similar contracts can be observed into automobile dealerships, gasoline service stations, and soft-drink bottlers; i.e., in industries characterized by an informational advantages of the seller about the customers/agents' needs. As a matter of fact, a franchisor typically sells a way of doing business including the entire business format and plan operating manuals and standards or quality control process, thereby supporting each of its franchisees. Our formal result on the common equity share to all types proves robust even to the introduction of a second informational advantage of the seller concerning its own type, i.e., the assumption of private information over higher or lower performances in consulting service provision or the support of technology adoption.

The paper contributes to two different streams of literature. On the one hand, it innovates compared to the extant research on equity-based licensing of university technology (see the references above) by exploring the strategic considerations which lead a licensor to request common or different equity positions as payments for licensing a given technology. The analysis is carried out by assuming that potential licensees are non rival and of different types regarding their absorptive capability. It also differentiates from previous related studies by changing the source of informational asymmetry, no longer identified in the level of demand for the commercialized innovation, but in the absorptive skills of the licensee, and thus in the effort requested to transfer the know-how and support technology implementation.

On the other hand, the paper contributes to the literature on asymmetric information in professional and consulting services. To mention just a few relevant examples, Dawson et al. (2016) study how bilateral information asymmetry enhances co-production between the consultant and the client for the delivery of information systems or services. Watson et al. (2017) discuss how social norms and legal systems may constraint the resulting opportunistic behavior, along the lines traced by Dawson et al. (2010) with their analysis of the interplay between signaling and screening, knowledge type and contract specificity. Lastly, Akan et al. (2011) adopt a mechanism-design approach to demonstrate that two-part tariff schemes may induce full-information solutions whenever information asymmetry combines with economies of scale in service contracting. We innovate in this literature by introducing the (increasingly popular) use of equity-settled share-based agreements; and exploring a completely new line of research relating to the optimal policy of a consultant with respect to the equity share to request as a payment across different clients.

The rest of the paper is organized in three chapters. In Section 2 we justify our assump-

[6] We are not considering here cross-subsidization equilibria or alternative structures of noisy signals, such that the customers may update their beliefs. Although none of the two mechanisms is explicitly modeled in this paper, an extended model variant with noisy signals is available upon request.

tions and lay out the theoretical model. In section 3 we derive the equilibrium strategies of the game, first in the baseline setup, then by introducing ad additional informational advantage of the seller, in the form of private information about its own nature. Section 4 reports the conclusions.

2 Setup

2.1 Basic Setting

We consider here the case of a company (the 'seller') with specific know-how and different *non-rival* customers highly interested in this knowledge. The know-how is embedded into a physical or immaterial asset (think of a technology production or a trademark) or into consulting or other professional services; and transferred through a licensing or consulting agreement. All potential customers are symmetric *ex-ante*. To take advantage of its know-how, the seller aims at signing the agreement with the largest number of interested customers.

We assume that the seller's preferred policy involves taking equity participation in the client firms as compensation for the service provided, the licensed technology, or the like. Several strategical considerations may support this choice, among those briefly hinted above.[7] We do not discuss the reasons for equity-settled share-based payments being preferred over other forms of share-based contracting, such as cash-settled agreements (where payments usually take the form of share appreciation rights) or a more traditional combination of fixed fees and royalties.[8] We refer the reader to a companion paper (Bolatto and Pignataro, 2022) for a comparison among royalty-based, equity-based, and royalty-plus-fees arrangements. An interesting result of this analysis is that in the case of the seller's information advantage about the customer, a larger rent extraction is always feasible by adopting a common payment scheme across types. This is true independently of the specific share-payment scheme that is adopted, as in the example of the franchising industry. We also show the existence of a substantial equivalence (conditional on the required investment) between two-part tariff contracts and pure equity or royalty mechanisms, along the line of reasoning of Colombo et al. (2021).[9]

[7] See Feldman et al. (2000) or Bray and Lee (2000), among others.

[8] Cash-settled share-based payments are mainly used as compensation for employees in many industries.

[9] Starting from Teece (1986), a large bulk of the literature has analyzed the optimal design of a license agreement, revising the reasons for using fixed fees versus royalties (typically specified as a percentage of the licensee's revenue) or even a combination of the two. Some authors have unveiled the inefficiency induced by contingent payments, either in the form of distorted production (Jensen and Thursby, 2001) or decelerated diffusion within networks (Sun et al., 2004). Others have shown that combining royalties with fixed fees can help cope with adverse selection (Gallini and Wright, 1990; Beggs, 1992; Sen, 2005) or moral hazard problems (Choi, 2001; Jensen and Thursby, 2001). Due to their contingent nature, royalties can indeed prove useful to (*i*) extract information from the counterpart via signaling or screening; and (*ii*) better align the licensor and the licensees' interests and efforts. Finally, Colombo (2014) have studied preferences for fees versus royalties in spatial models, depending on the locational disadvantage that a licensor may face *vis-à-vis* the potential licensee. To the best of our knowledge, all extant research on these aspects has so far neglected the alternative option represented by equity-based licensing, the only exception being Savva and Taneri (2015).

This choice of the seller involves a series of mutual obligations. On one hand, by taking an equity position in the customer, the seller makes a strong commitment to assist and support technology adoption by the counterpart, to secure the effective and successful delivery of the finished product on the marketplace; or implement *ad hoc* solutions for a series of problems which the client requires consultancy for. Whatever the preferred interpretation, the seller's investment is costly and time-consuming and has a clear opportunity cost. On the other hand, the customer obtains the know-how, preserves its cash reserves, and finds a strategic partner who might be crucial to fuel the company's growth along several dimensions. Yet, it gives up a certain part of its equity and challenges itself with all necessary adaptations in the production process and/or the internal organization in order to implement the licensed technology or the solutions devised by the consultant.

The seller may have higher or lower costs in transmitting its know-how to every client and supporting its adoption. Such costs include the budget for regulatory and legal fees (including non-disclosure agreements, quality, and manufacturing services agreements); the time spent on functional team meetings (necessary to share information, develop project requirements and timelines, and approve documentation); and communication costs, particularly when the know-how of the seller is not possible to codify nor embody in tradeable physical assets.[10] We denote with $i \in \{h, l\}$ the type of seller, based on two possible levels of these costs. Specifically, the high-type (h) seller performs better and thus enjoys a cost advantage over the low-type (l) when dealing with the same customer. For convenience, we express the seller's cost *per unit of profit* of the customer firm, and we label it as $I_{ij} \in \{I_{hj}, I_{lj}\}$, where j denotes the client, and $I_{lj} > I_{hj} \geq 0$.[11]

While all potential customers appears symmetric *ex-ante*, we assume that they differ *ex-post*, i.e., when they get in contact with the seller. More specifically, they differ in their capacity to use the company's know-how. This can be either because they have higher or lower absorptive skills (e.g., they already have preliminary notions or a knowledge base to manage the seller's know-how) or need more or fewer adjustments in their organization. As a result, the seller is requested to make more or less effort to provide the service or transfer the licensed technology, and support the subsequent adoption, depending on the nature of the counterpart. Accordingly, we pose $j \in \{H, L\}$. The seller's effort is milder when dealing with a high-type customer (labeled as H) and considerably greater when the customer is instead of the L-type.

[10] For instance, Keller and Yeaple (2013) document a standard gravity pattern in technology transfer across borders, the effect of distance via communication costs being more influential and pronounced in R&D and knowledge-intensive industries.

[11] In words, we pose $I_{ij} = \mathcal{I}/\pi_j$, where $\mathcal{I}_{ij}$ is the *resource cost* faced by seller i to transfer his know-how to customer j and support its subsequent operations, whereas π_j denotes the profit of customer j upon successfully implementing the licensed technology or taking advantage of the consultancy of i.

2.2 Agents' types

The type of customer $j \in \{H, L\}$ has clear implications for the effort that a seller must undertake in its relationship with the counterpart, given its own nature $i \in \{h, l\}$. If potential customer j is a H-type, the seller's effort is somewhat limited, compared to the one requested for the same type of activity when rendered to a L-type. We assume $I_{iH} < I_{iL}$ for all $i \in \{h, l\}$. It is natural to conjecture that larger equity participation will then be requested as compensation by any seller i, when dealing with the L-type customers. Provided that $\beta_{ij} \in [0, 1]$ is the share of *ownership* that seller i claims as payment from customer j, we impose a binding restriction in the form of $\beta_{iL} > \beta_{iH}$ for all $i \in \{h, l\}$. This means that the equity-settled shared-based payment to a certain seller is higher, the greater the effort this seller has to undertake in its relationship with the customer.

We now introduce two fundamental assumptions of our game. The first follows from the fact that L-type customers require more effort by the seller than the H-types, in light of the superior support they need to adopt the new technology or implement organizational changes. This has clear repercussions over the total cost that a customer faces in implementing all necessary adjustments and developmental leaps, with the L-types incurring higher costs than the H-types, overall. All else being equal, this will imply –in comparative terms– a more limited increase in their profitability, upon entering the relationship with the same seller.

To incorporate this aspect in our model, let us denote with $\pi^* \geq 0$ the outside option of each customer, i.e., its firm value before entering a relationship with the seller. Due to *ex-ante* symmetry, this value can be regarded as common to all potential customers, unconditionally from their type j which is revealed only *ex-post*.[12] Should a generic customer j not finalize an agreement with the seller for any reason, then π^* persists as a firm j's value. In turn, should the agreement be signed, customer j attains a new level of profitability $\pi_j > \pi^*$, with $\pi_j \in \{\pi_H, \pi_L\}$ and $\pi_H > \pi_L > 0$.

The second key assumption that we introduce is the asymmetric information between the two parties. The seller's type $i \in \{h, l\}$ may correspond to either private or public information. Hereafter, we consider both cases. The type of customer is instead at the core of our analysis. While we assume that a customer $j \in \{H, L\}$ discloses its own nature only *ex-post* (i.e., after entering the relationship with the seller), the seller may infer here the counterpart's type *ex-ante*, i.e., before the agreement terms are finally established and the contract executed. Based on the licensed technology, a licensor is plausibly more aware of all notions, skills, and expertise that a licensee must possess to master its technology. It may therefore realize whether the counterpart may require greater or milder support in technology adoption, just after preliminary talks arranged in anticipation of the possible deal. This appears as

[12] For concreteness, consider a fringe of early-age startups, which perhaps differ in their potential, but are all unable to consolidate their presence in the market without the know-how of a specific consulting company or service provider.

a plausible feature in the case of professional services by consulting firms to startups or even trademark licensing by part of a franchiser, who may have superior information over the franchisee regarding the level of local demand. This is possible, for instance, because it disposes of a qualified staff, able to perform very detailed analyses of the local market proposed by the potential franchisee.

Summing up, we may outline the participation constraints of the two players as follows. Given the equity share claimed by the seller, a generic customer j is willing to accept the proposed agreement if and only if

$$(1 - \beta_{ij})\pi_j \geq \pi^*.$$

In turn, seller i makes such proposal to j only conditional on

$$\beta_j \geq I_{ij},$$

where I_{ij} is the overall effort that the seller has to make in its relationship with the customer. First, irrespective of its profile i, a seller can always decide to deal with both types of customers, or discriminate between them by excluding the L-types and dealing with the H-types exclusively, in light of the lower effort they entail. This prompts us to clarify the circumstances under which one policy is preferred over the other. Second, assuming that the seller can profitably engage in a relationship with both types of customers, its optimally-chosen strategy may alternatively involve taking different equity shares across types or taking a common equity stock, depending on which option corresponds to the most profitable one.

Since customer's types are heterogeneous in terms of their *ex-post* firm value, to make reasonable comparisons across types we reformulate the players' participation constraints per unit of expected profit. The net payoff that seller i derives from its relation with client j reads

$$\Pi_{i|j} = \beta_{ij} - I_{ij}, \tag{1}$$

implying that its participation constraint reduces to $\Pi_{i|j} > 0$, and provided that $I_{iL} > I_{iH}$ holds for any $i \in \{h, l\}$. In turn, the corresponding net (per unit) payoff of client j is

$$\Pi_{j|i} = (1 - \beta_{ij}) - \pi^*/\pi_j,$$

or, written in a more convenient and compact form,

$$\Pi_{j|i} = V_j - \beta_{ij}, \tag{2}$$

where $V_j \equiv (\pi_j - \pi^*)/\pi_j$ is a measure of the value, from the perspective of customer j, of its relationship with i, i.e., the value of technology adoption or the value of the professional service provided by the seller. We immediately observe that $\pi_H > \pi_L$ implies $V_H > V_L$. Any equity-based agreement proposed by the seller is therefore accepted by j on the condition that $\Pi_{j|i} > 0$ holds in expected terms. Specifying the net payoff functions of the two agents as in eqs. (1) and (2) emphasizes the role of the equity payment claim β_{ij} as the price of the licensed technology, or trademark, or consulting service; and it allows us to compare the participation constraints of players i and j more readily.

2.3 Timing and equilibrium concept

There are two scenarios to envisage. In the first one, the seller's type is common knowledge. In this case, potential clients presumably know the cost incurred by the seller when transferring its technology or providing its consultant service for given characteristics of the counterpart. In other words, customers are fully aware that the seller they face is of type l or h. This implies that the only source of uncertainty is limited to their own needs regarding the support they must receive to successfully implement the proposed solutions and/or adopt the new technology. By contrast, in the second scenario the seller's type corresponds to private information and potential customers therefore face a double informational disadvantage over the counterpart, over both its profile and their own type. Consequently, they assign a probability $\gamma \in [0, 1]$ that the seller is of the l-type; and the residual probability $(1 - \gamma)$ that it is instead of the h-type.[13]

Regardless of the scenario, we pose that, *ex-ante*, none of the potential customers knows its profile with certainty and hence it can simply form an expectation. The expected value of the relationship with the seller is $\mathbb{E}(V) = \rho V_H + (1 - \rho)V_L$, where $\rho \in [0, 1]$ is the probability assigned of being a client of the H-type. The timing of the events is portrayed in Figure 1 and can be summarized as follows:

- First, *Nature* determines the type of any agent. A potential customer $j \in \{H, L\}$ is of the H-type with probability ρ; and of the L-type with probability $(1 - \rho)$. In turn, the generic seller i evaluates its unit costs in the relationship with a generic customer j, finding out that it will be of the l-type (low unit costs) with probability γ; and of the l-type (high unit costs) with probability $(1 - \gamma)$.

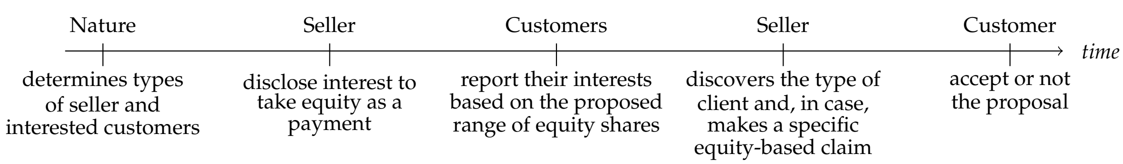
- Second, seller $i \in \{h, l\}$ discloses its interest to provide professional/consulting services or license its technology/ trademark through equity-settled share-based agreements, specifying a *range* of possible equity-share claims. Given $I_{iH} < I_{iL}$, the lower bound of this range is meant for a customer of the H-type, whereas the upper bound is meant for the L-type. Proposing a range of ownership shares allows for more degrees of freedom in each party's actions, irrespective of the seller's type $i \in \{h, l\}$.

[13]Intuitively, this second scenario better describes the cases in which the technology to transfer is more pioneering or breakthrough, or it is hard to codify and embed in physical assets. Under these circumstances, for clients it becomes more difficult to predict the amount of resources that the seller will need invest in support provision.

- Third, interested customers report their interest to enter a relationship with the seller, accepting to transfer part of their equity as payment. The seller receives a given number of expressions of interest and preliminary meetings are arranged between the parties. On that occasion, the seller learns more about the counterpart's needs and gets a more precise idea about the investment to support technology adoption by part of the licensee, or provide the requested service to the startup. In other words, the seller infers whether the client is of type H or L. It then puts forward an equity-based payment claim corresponding to some ownership share β_{ij}, included in the range above. Alternatively, it may decide to reject the candidate partner.

- Fourth and last, based on the equity share β_{ij} specified in the offer, the potential client updates the beliefs about its own type (and the type of licensor, in the case in which this corresponds to private knowledge) and finally decides whether to accept or not the proposal. We analyze here the design of the equity-settled share-based arrangement and the resulting implications regarding the observed matching between types, i.e., what kind of agreements are mutually accepted and between what type of agents. Whatever happens next in the relationship between the two parties is not modeled here, as the outcome of our interest is unaffected.

Figure 1: Timing of the game



We search for *Perfect Bayesian Equilibria* (PBE), which consists of (*i*) the type and the strategies of the seller, as well as the type and the strategies of the potential customers with their respective per unit profit payoffs (i.e., their surplus); and (*ii*) the customers' beliefs about the seller's type $i \in \{h, l\}$ and their own types $j \in \{H, L\}$. We restrict our attention to the range of positive ownership shares for the seller. Its strategy involves the exact equity share to claim and the likelihood of proposing terms, *ex-ante*, that the other party can agree upon. The seller makes the offer after discovering information on the counterpart's profiles. The customer's strategy, in turn, is a mapping from the equity-settled payment claimed by the seller, namely β_{ij}, to the binary decision of accepting or rejecting the proposed agreement.[14]

[14] We do not allow here for further bargaining on β_{ij}. The seller makes take-it-or-leave-it offers, by reason of the considerable bargaining power that a new technology owner holds *vis-à-vis* the interested adopters, or similarly, the one that a large, well-established consulting firm enjoys *vis-à-vis* any startup company.

Note that, based on the equilibrium concept applied here, no seller has incentives to reject a customer's declaration of interest at the game's third stage. First, the PBE requires the seller to offer a contract to any potential partner whenever a positive surplus is expected to accrue from the relationship. In principle, this could be possible even when dealing with the L-type customer, at least for mild levels of effort requested to the seller.[15] Lastly, we assume that potential customers observe whether the seller has signed an equity-settled share-based agreement for the same service/licensed technology to other similar firms, and whether the equity stock taken in the other firms is higher or lower than the one requested in the received draft agreement. This kind of information is indeed generally and widely available to the public.

Benchmark. Our model has novel results based on the observation that in some cases, it is the seller (e.g. the licensor or the franchisor) that can obtain more precise information about the types of customers upon interacting with them. Empirical evidence –largely mentioned above– confirms this hypothesis in the case of manufacturing or service sectors in which the competencies of the licensees and/or the franchisee are not well-defined and emerge during the relationship with the main partner.

As a benchmark for our analysis we indicate here the results of the model in which are he customers to dispose of more precise information about their own types, implying that the seller cannot exploit the advantage associated with the information obtained in step 4 in Figure 1. The effect would be that of a conventional screening model, in which the principal (the seller, in this case) tries to satisfy the incentives of the H-type agents by guaranteeing them a higher informational rent, while associating a binding constraint for the L-types, so as to ensure their participation. Different equity payments across types would therefore be requested, whenever the conditions are satisfied. In the next section, we will demonstrate how the outcome changes sharply, when introducing a seller's informational advantage over the counterparts.

3 Analysis

Before unraveling the equilibrium analysis for our model, a couple of introductory remarks are essential. In the second stage of the game, seller i defines a range of possible equity positions it takes in return for its proprietary technology, trademark, or professional service. The share-based agreement is offered to an interested customer, only on the condition that $\beta_{ij} \geq I_{ij}$. Due to imperfect information, the receiver of such offer will accept only if $\beta_j \leq \mathbb{E}(V)$. We can define the set of possible settlement offers by the seller as reported in Lemma 1.

[15] Licensing agreements or consulting for equity contracts are indeed not activated unilaterally at the licensor/consultant's instance, but require some positive actions from both sides of the market.

Lemma 1. *In any possible equilibrium, a seller $i \in \{h, l\}$ will profitably finalize an equity-settled share-based agreement with both types of customer H and L, either:*

i) by taking different equity positions $\{\beta_{iL}, \beta_{iH}\}$ across types, such that $\beta_{iH} \in [I_{iH}, V_H]$ and $\beta_{iL} \in [I_{iL}, V_L]$;

ii) by taking a unique, common equity stock as payment in the range $\beta_i \in [I_{iL}, \mathbb{E}(V)]$.

Proof. See Appendix A. □

Upon meeting the participation constraint of both types of customers, the seller has a clear incentive to set β_{ij} as high as possible. This value tends to be close at the upper bound of the corresponding range in Lemma 1. As both seller's strategies described above can in principle be admitted, the question becomes under what conditions the first strategy dominates the second one, and vice versa. We show in the aftermath that such conditions depend on the effort that the seller must undertake in its relationship with the client, as determined by the nature of the two partners. There are three relevant cases to consider.

a. The effort of the seller is relatively limited in comparison with the value of the relationship from the perspective of the customer; and this holds true, regardless of the seller's type (h or l) and the client's type (H or L). Formally, this entails $I_{iL} < \mathbb{E}(V)$ for all i and j, so that the nature of the two players does not play any role in driving the emerging equilibrium outcome.

b. For both types of seller (H and L), the effort is larger when dealing with the L-type customers, i.e., the type that needs more support or treatment. It is instead sufficiently limited with the H-type. This means that $I_{iH} < \mathbb{E}(V) < I_{iL}$ for all $i \in \{h, l\}$. The customer's type therefore turns pivotal.

c. The effort undertaken by the seller is relatively high, but only when the relationship involves a low-type of seller and customer, since the former has high cost in delivering its service or transferring its technology, whereas the latter needs more support and/or treatment. In formal terms, this implies $I_{iH} < \mathbb{E}(V) < I_{iL}$ for $i = h$, while $I_{ij} < \mathbb{E}(V)$ for all $j \in \{h, l\}$ when $i = l$. When this is the case, also the seller's type $i \in \{h, l\}$ comes into consideration for the emergence of the equilibrium.

The rest of this section illustrates, in any of the cases listed above, how the seller optimally designs the agreement with its customers, choosing between the schemes with differentiated or common equity positions, and selecting the specific equity share(s) to request as payment, so as to maximize profit. We first unravel this inquiry in a simplified environment where seller i's type is common knowledge. We then replicate the analysis by considering the alternative scenario in which such information is private, thereby showing how the seller deals with this additional source of information advantage.

3.1 Knowledge of the seller's type

Let us assume that customers have somewhat an idea of the effort that seller $i \in \{h, l\}$ must undertake to transmit its know-how successfully –either in form of professional service provision or licensed technology– given the type of support or treatment requested. Therefore, for customers, the source of uncertainty concerns their own type, that is, whether they need less or more of this support in technology adoption or adjustments in their internal organization. This information is fully disclosed only at the *ex-post* stage of the game, provided that a deal with the seller has been finalized based on a common equity claims across types. Under differentiated offers, the equity claims put forward by the seller would indeed provide some information to customers. Upon observing that different equity positions are taken across clients, any of them would infer its own nature (high or low type), depending on receiving a claim involving a lower or higher share-based payment compared to other agents. Bayesian updating would then lead any customer L to infer its profile correctly thus preventing the seller from exploiting its informational advantage.

We might think of this setting also in terms of the result of a seller's incentive –if any– to reveal its profile. Alternatively, it may constitute the most natural environment for studying strategic equity-based contracts for a more standardized type of professional services for which the effort of the seller is more easily predictable and quantifiable; or for marginal innovations in technology, primarily codified or embedded in physical goods, ready to be transferred. Whatever the preferred narrative, we prove that, in this scenario, taking differentiated equity positions $\{\beta_{iL}, \beta_{iH}\}$ across customers never happens to be the seller's optimal strategy over the alternative configurations of investment costs listed in Section 3.

We establish this general result as

Proposition 1. *When the seller's type is common knowledge, the equilibrium outcome is:*

a. *if $I_{ij} < \mathbb{E}(V)$ for all $i \in \{h, l\}$ and $j \in \{H, L\}$, then every seller i will propose agreements based on a unique, common equity payment claim $\beta = \mathbb{E}(V)$ to all customers $j \in \{H, L\}$;*

b. *if $I_{iH} < \mathbb{E}(V) < I_{iL}$ for all $i \in \{h, l\}$, then every seller will make settlement offers to the H-type customers only, based on a equity payment claim $\beta = V_H$, while all the L-types are rejected;*

c. *if $I_{ij} > \mathbb{E}(V)$ only for $i = l$ and $j = L$, then the l-type seller will deal with customers of the H-type only, requesting a equity-settled payment $\beta = V_H$. In turn, the h-type seller will deal with both types of customers, based on a common equity claim at $\beta = \mathbb{E}(V)$.*

All draft agreements received by customers are accepted at the selected equilibrium.

Proof. See Appendix A. □

To make sense of the above results, it is worth considering –one by one– any of the relevant configurations of the seller's levels of effort in its relationship with the customers, corresponding to the cases labeled as a, b and c in Proposition 1.

Case a**.** This case implies that transmitting knowledge and assisting further developments in technology adoption by part of the licensees is relatively easy and cheap for the licensor. This is true whatever its unit costs in transferring the relevant know-how, and even in the worst-case scenario in which the licensee displays low absorptive capabilities. Analogously, we could think of consulting firms providing professional services based on consolidated routines at negligible costs, so that even low-performance firms make a mild effort when assisting customers in need of more support or treatment.

Given these premises, the seller has the opportunity to obtain a positive surplus from the relationship with both types of customers. However, case a takes the explanation of the result one step further, by noting that –whenever the seller has an informational advantage, as in stage 4 of Figure 1– rent extraction is lower under two different equity payment claims. Intuitively, this happens because offering a different contract –requesting a larger equity share to H-types– would violate their participation constraint. The high types indeed make inferences about the different equity payments requested to the two types. Accordingly, they would never accept to give up an equity share β_{ij} larger than the one required to the low types; otherwise, their incentives in being high types (more absorptive) would be completely eroded. The maximum return of seller i therefore comes from a unique equity payment claim, which leaves a lower return margin for the higher types, than for the low types. This agreement scheme indeed maximizes (on aggregate) the overall rent extraction that i can inflict across the two types of customers.[16]

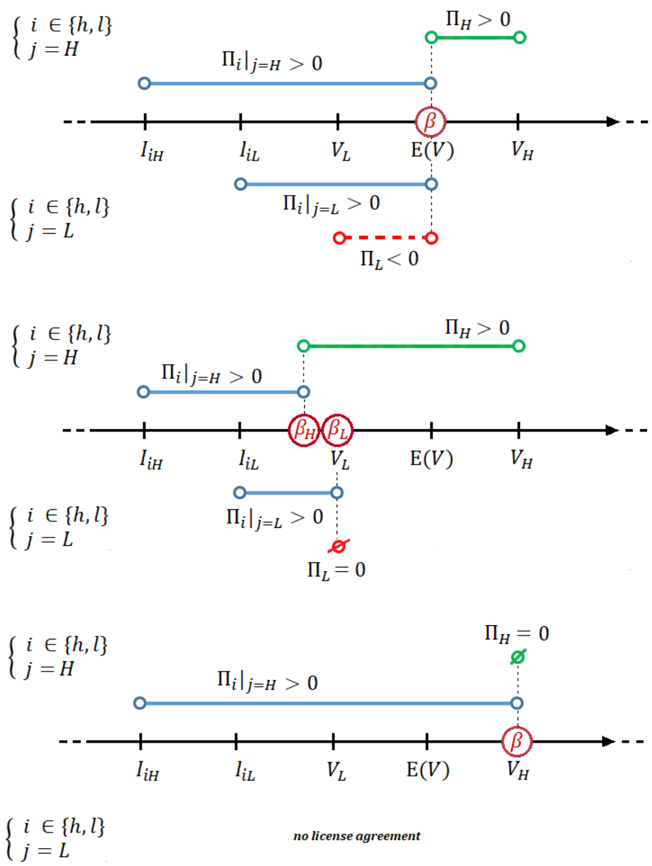
Formally, the PBE of the game involves dealing with any interested partner, as long as the seller's participation constraint is always satisfied. Figure 2 illustrates the surplus accruing *ex-post* to any customer, according to the different strategies that the seller may pursue.[17] The lower panel of the figure reports the potential surplus partition if the seller decides to deal with the H-types only, thereby rejecting the L-types. This strategy would imply full rent extraction on the H-type customers through a settlement request at $\beta = V_H$.[18] This strategy never qualifies as a PBE of the game. Indeed, it would imply the seller giving up the opportunity to conduct profitable deals, even when faced with customers requesting a mild effort. Since the PBE of the game implies that draft agreements must be proposed to both types of customers in equilibrium, the true question is whether profit maximization requires the seller to claim a common equity share $\beta \in [I_{iL}, \mathbb{E}(V)]$; or alternatively, to put forward differenti-

[16]As shown in Figure 2, a contract with a unique equity claim applying to both types in fact allows the seller to appropriate the entire customer's expected surplus, leaving the low types with a negative payoff, *ex-post*.

[17]In the figure, we pose $I_{iL} < V_L$; yet, assuming $I_{iL} \in [V_L, \mathbb{E}(V)]$ would not alter the resulting equilibrium.

[18]Bayesian updating based on the exclusion of the L-types would however lead the H-types to accept the proposal, their participation constraint being satisfied at the margin.

Figure 2: *Ex-post* surplus partition in the equilibrium outcome of Proposition 1 (case a).



ated equity shares $\{\beta_L, \beta_H\}$ across types, compliant with the constraints $\beta_{iH} \in [I_{iH}, V_H]$ and $\beta_{iL} \in [I_{iL}, V_L]$ identified in Lemma 1. This second option must obey the additional restriction that $\beta_L > \beta_H$, otherwise any reasonable form of Bayesian updating would be disrupted.[19]

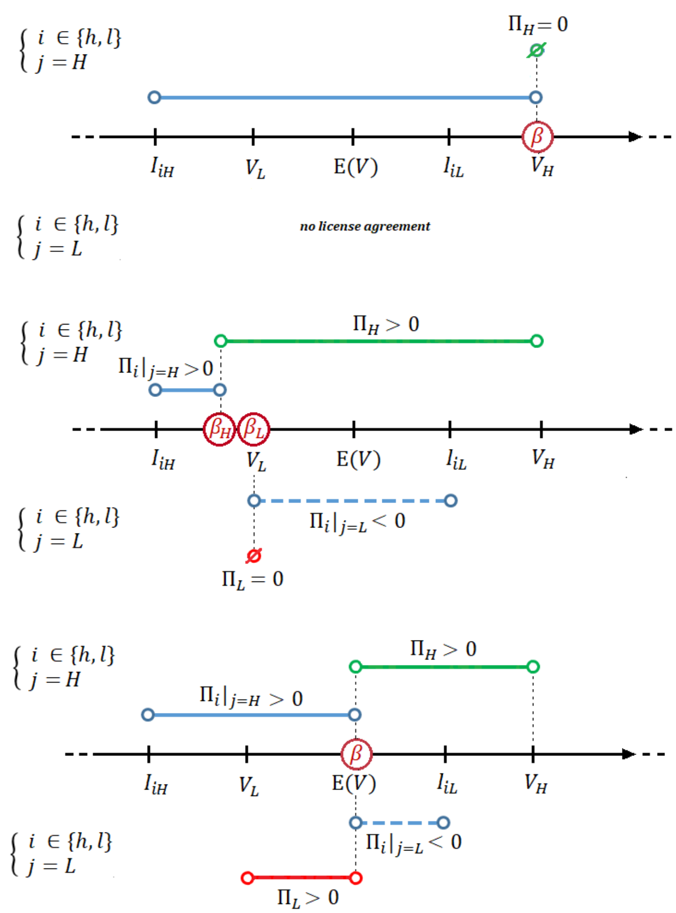
If aimed at differentiating offers across types, the seller could only request $\beta_L = V_L$ to the L-types; and $\beta_H \in [I_{iH}, V_L]$ to the H-types. As shown by the comparison between the two upper panels in Figure 2, this strategy is however strictly dominated by the alternative option, that is, taking a common equity position across customer types. From the figure we also note that, by setting $\beta = \mathbb{E}(V)$ for all customers, the seller gives up with full rent extraction on the H-types. Nonetheless, it over-compensates by extracting a considerable amount of surplus from the L-types, with a negative *ex-post* payoff for the latter. In brief, the equilibrium strategy that emerges in this context shifts surplus extraction for customers which requires less support or treatment towards those with superior needs (i.e., those that are more challenging to deal with). Requesting a common equity claim to all is the only way to have both customers' type

[19]If $\beta_L < \beta_H$ holds, the H-types would misconceive their nature and make choices under the wrong belief of being of the L-type, and vice versa. This proves highly detrimental to the seller's profits.

into a relationship, thus preventing the L-types from pulling out.

Case b. We now consider the case in which dealing with a low-type customer is overall very costly for the seller, regardless on its own profile. The reason could be that there is a type of licensee with very limited absorptive capabilities, which therefore request considerable support for adopting the new technology; or there are some franchisees that need considerable investments in advertising in their local area to sustain their sales or even there are startups requiring drastic adjustments in their organization and internal processes.

Figure 3: The *ex-post* surplus partition in the equilibrium outcome of Proposition 1 (case b).



In formal terms, we assume $I_{ij} > \mathbb{E}(V)$ for $j = L$ and $I_{ij} < \mathbb{E}(V)$ for $j = H$. Again, we may save on notation by disregarding index i, as the seller's type is no relevant in the case under consideration. Meeting the L-type's participation constraint in addition to the one of the H-types would imply a negative payoff for the seller, i.e., $\Pi_{i|L} < 0$. As a consequence, there is no room for equity-settled share-based agreements open to both types of customers. This point is clearly illustrated in Figure 3, where we depict the *ex-post* surplus distribution characterizing the seller's strategy for the case of our interest.[20]

The equilibrium outcome is straightforward. A common equity share β would imply a negative payoff for the seller, when dealing with the L-types. According to Lemma 1, this share necessarily lies in the range $\beta \in [I_L, \mathbb{E}(V)]$, and even $\beta = \mathbb{E}(V) < I_{iL}$ is not sufficient for the seller to break even. By the same argument, we also exclude differentiated equity-based payments across types, i.e., a combination $\{\beta_L, \beta_H\}$.

The only viable strategy for the seller consists of selecting the H-type customers only and setting $\beta = V_H$, hereby achieving total rent extraction at the expense of the counterpart, while meeting their participation constraint at the margin.[21]

Case c**.** The type of seller $i \in \{h, l\}$ here turns crucial to disentangle between the cases a and b analyzed above. More specifically, a seller of type h (hence with low costs and high performances in transferring technology, or providing a professional service) naturally falls into case a, provided that $I_j < \mathbb{E}(V)$ holds for this seller, unconditionally on $j \in \{H, L\}$. The optimal policy of this seller therefore consists in dealing with both types of customer, based on a common equity claim at $\beta = \mathbb{E}(V)$. At odds, a seller of l-type (hence one facing higher costs in its relationship with the customer) will find itself in case b, as long as its relevant investment cost configuration is such that $I_H < \mathbb{E}(V) < I_L$. The only viable option for seller l therefore reduces to exclusive dealing with the H-type customers, i.e., those requesting milder efforts to sustain the relationship.

The most interesting aspect of the case under examination is that different strategies may coexist in an industry equilibrium, as long as the different nature of the extant licensors, consultants, or franchisors allows them to pursue different policies in regard to their profit-sharing agreements. Low-performance (high-cost) firms will cherry-picking the customers to start a relationship with, in such way to avoid the costlier ones (i.e., those requesting larger efforts). They will then extract all of the surplus from their counterparts, requesting as compensation a share $\beta = V_H$. In turn, high-performance (low-cost) firms will finalize share-based agreements to all interested customers, based on a common equity claim for their service, at a lower level, i.e., $\beta = \mathbb{E}(V) < V_H$. Under this particular cost configuration, the PBE of the game is trivial, as it nests the two equilibrium outcomes emerging in case a and b, respectively.

3.2 Private information on the seller's type

We now go beyond the assumption that the seller's type $i \in \{h, l\}$ is public information, to assess how the equilibrium outcomes depicted in Proposition 1 vary when introducing a second source of informational advantage for the seller. We assume here that customers

[20]The figure plot assumes that $I_H < V_L$ and $I_L > V_H$. However, opposite rankings are admissible and deliver qualitatively similar results.

[21]This result corroborates the findings reported in Niu (2017), according to which "the optimal ad-valorem royalty rate is the one in which the licensee obtains its reservation payoff, which is its profit without a license".

have no clue whether the seller has high or low costs in performing its activity. This might be the case when the licensed technology is hard to include in physical assets and is highly innovative, so the modes of the technology transfer are largely unknown by the transferees. Alternatively, we could think of startup companies requesting consultancy for solving a series of specific problems which are unsolvable based on ready-made options. The point is that now customers have no information about their profile, and neither do they have information on the seller's type $i \in \{h, l\}$, as this corresponds to private knowledge.

Intuitively, this form of double information asymmetry makes it more difficult for the seller to maximize its payoff by proposing the same agreement terms to all candidate partners at $\beta_i = \mathbb{E}(V)$. This result might appear counter-intuitive at first glance. However, it derives from the greater care taken by customers when coming to the last stage of the game, i.e., the moment of the final decision to accept or reject the terms of the draft agreement proposed by the seller. In other words, the awareness of a double informational disadvantage over the counterpart may induce a more conservative attitude in all customers, independently from their own type $j \in \{H, L\}$. To grasp the intuition, consider the case in which a seller of generic type i puts forth a proposal based on the same equity payment claim $\beta_{ij} = \mathbb{E}(V)$. Conditional on receiving such offer, the customer revises its belief and undercuts the probability of being a H-type, compared to its prior ρ. The additional informational disadvantage that the customer held *vis-à-vis* the counterpart reduces its propensity to accept the seller's offer. It follows that $\beta_{ij} = \mathbb{E}(V)$ will never be accepted due to Bayesian updating, which induces customer j to decrease the value it expects from the relationship with the seller, i.e., $\mathbb{E}(V|_{\beta_{ij}=\mathbb{E}(V)}) \leq \mathbb{E}(V)$.

The implications of this analysis are profound and lead us to exclude again equilibrium strategies characterized by differentiated equity claims across customer types, irrespectively of whether the seller is of type h and l. The emergence of equilibria featuring either selection of the sole H-types or common equity claims applying to all is therefore robust to the introduction of a double informational asymmetry, in the form of seller's private information on its own type. This second general result is summarized as

Proposition 2. *When the seller's type is private information, the equilibrium outcome is such that*

a. *if $I_{ij} < \mathbb{E}(V)$ for all $i \in \{h, l\}$ and $j \in \{H, L\}$, then each seller i will propose draft agreements based on a unique, common equity claim $\beta_{ij} \in [V_L, \hat{\mathbb{E}}(V)]$ to all customers $j \in \{H, L\}$, where $\hat{\mathbb{E}}(V) \equiv \mathbb{E}(V|_{\beta_{ij}=\mathbb{E}(V)})$;*

b. *if $I_{iH} < \mathbb{E}(V) < I_{iL}$ for all $i \in \{h, l\}$, then each seller will engage in share-based agreements with the H-type customers only, requesting them a equity share $\beta_{iH} \in [\mathbb{E}(V), V_H]$, whereas all L-types will be rejected;*

c. *if $I_{ij} > \mathbb{E}(V)$ for $i = h$ and $j = L$, then both h and l sellers will deal with the H-type customers only, requesting them an equity share $\beta_{iH} = V_H$, provided that for the customers the probability of being a H-type is sufficiently low, i.e., for $\rho < \rho^*$, where*

$$\rho^* \equiv \frac{\mathbb{E}(V) - I_{hL}}{V_H - I_{hL}}. \tag{3}$$

In turn, for $\rho > \rho^*$, a h seller will prefer to offer a draft agreement at $\beta_{hj} = \mathbb{E}(V)$ to the customers of both H- and L- types, thus adopting a different strategy than a l seller, who keeps selecting the H-type customers only.

All draft agreements received by customers will be accepted at the selected equilibrium.

Proof. See Appendix B. □

To explain the results established in Proposition 2, we proceed by revising separately all possible seller's cost configurations.

Case a. We start again from the scenario where the effort made by the seller to support its customer is relatively low, whatever the type of the two parties, i.e., $I_{ij} < \mathbb{E}(V)$ for all $i \in \{h, l\}$ and $j \in \{H, L\}$. In full analogy with the corresponding case of common knowledge about the seller's type (see Proposition 1), a profitable agreement is viable with both types of customers. No seller has therefore reason to reject any potential client, including the L-types. The only question is whether the additional source of informational asymmetry introduced in this paragraph erodes the seller's incentive to take common equity positions across customers, as it is prescribed in the case of public information.

By the same line of reasoning developed in Section 3.1, we may prove that the equilibrium outcome of the game still involves a common agreement with both customers H and L. The mechanism of rent extraction by part of the seller –described in the previous section– remains valid even in the case of private information, the overall surplus accruing to the seller being larger under a common equity payment claim, rather than under the alternative scheme in which the seller discriminates equity claims across customer types. The only difference with the case of public information is that the optimal equity-settled payment requested by the seller is not necessarily $\beta_{ij} = \mathbb{E}(V)$, but can take any value in the interval $[V_L, \mathbb{E}(V)]$, i.e., $\mathbb{E}(V)$ is just the upper bound in this case. While the seller has a clear incentive to set β_{ij} at its highest possible level (hence at $\beta_{ij} = \mathbb{E}(V)$, precisely as in the case with public information), we note that a slightly lower equity claim might be desirable, here, to incentivize the desired participation of both the H- and L-types of customer.

To fix ideas, let us suppose for a while that all customers receive an offer implying an equity-settled payment equal to $\beta_{ij} = \mathbb{E}(V)$. By Bayesian updating, this request induces any potential customer j to update the beliefs about its own type. More specifically, customer j will revise this belief downward, at $\hat{\mathbb{E}}(V) \equiv \mathbb{E}(V|_{\beta=\mathbb{E}(V)}) < \mathbb{E}(V)$. The seller may therefore accept to slightly undercut its gain, so as to meet the participation constraint of the counterpart. In particular, extracting more rent from the L-types requires the seller to settle for a lower equity position in each customer, independently from the profile of the two players.

Case b**.** Similar considerations hold when the L-type customers are particularly costly to deal with, independently from the seller's type. Provided that $I_{iH} < \mathbb{E}(V) < I_{iL}$ for all $i \in \{h, l\}$, when the seller's type is public information the admissible equilibrium entails the selection of the H-type customers only, whereas all $L-$types are rejected by the seller. Such strategy persists in the equilibrium under private information, even though –again– with a small reduction (compared to the case of public information) in the equity share that the seller requests to the selected H-type customers.

To clarify this point, note that a generic seller i cannot meet the participation constraint of both types of customers at once, without disrupting its incentive to engage in such relationships. Having to reject one type, the seller will then choose to deny any agreement with the L-types, which are costlier to support. At odds with the previous case of public information, the selection of the H-types does not trigger here full rent extraction to their detriment. The reason is that customers do not observe the counterpart's profile. Hence, they will discount their informational gap when forming expectations about their own profile, which possibly drives the equity share requested by the seller a bit down, namely at the level V_L corresponding to the reserve value of the H-types. Intuitively, the seller may decide to give up something in terms of rent extraction over the counterpart in such way to fully meet the participation constraint of the H-types. The seller's double informational advantage can be said, again, to 'play against' the seller itself, suggesting a possible reduction of the equity claim β_{iH}.

Case c**.** We finally consider the case in which the supplier's type is key to determine its choice between the rejection of the L-type customers and the decision to deal with both types. Since $I_{ij} > \mathbb{E}(V)$ only for $i = l$ and $j = L$, a seller of l-type will have no other option than rejecting all customers of type L, which are too costly to support or treat. It consequently falls into case b discussed above, and behaves accordingly. In contrast, seller h enjoys a positive surplus from the relationship with both customers H and L; and its surplus is again maximized when taking common equity positions across types.

We would therefore expect the PBE for case c to be analogous to the corresponding equilibrium under public information, with sellers h and l adopting different strategies in equilibrium. However, we note from Proposition 2 that this happens to be the case only when a specific condition applies, that is, when customers have a high probability ρ of being of the type H. More specifically, the condition reads $\rho > \rho^*$, where ρ^* is the threshold specified in Proposition 2, that we characterize hereinafter. In turn, when the probability is low, i.e., $\rho < \rho^*$, sellers h ad l may choose to pursue the very same strategy, as the former does no longer deal with both types and starts selecting the H-types only, precisely as seller l does. To fully grasp the intuition, consider a seller of type h, hence with low unit costs in the relationship with a generic customer j. Based on the analysis developed so far, its optimal strategy should involve a common equity claim across customers, in such way to inhibit Bayesian revision and leave their prior unaffected. Compared to the case of public information, the surplus that can be extracted from the L-types decreases, since the equity claim of the seller is no longer $\beta_{ij} = \mathbb{E}(V)$, but $\beta_{ij} = \hat{\mathbb{E}}(V) < \mathbb{E}(V)$, as a result of Bayesian updating. At the same time, the surplus left to the H-type customers becomes larger by the same argument. When the proportion of H-types is large, this strategy is therefore no longer consistent with profit maximization. The total amount of surplus obtained from the L-types indeed proves not sufficient to outweigh the one forgone, left to the H-types.

In sum, a seller of type h (low unit costs, high performances) gives up the chance to profitably take equity positions in customers of type L, so as to maximize rent extraction over the other customers (the H-types) that are overall less costly to treat. Under public information on the seller's type, this strategy is instead strictly dominated, as the higher equity share that can be requested in payment, namely $\beta_{ij} = \mathbb{E}(V)$, grants a more balanced distribution of surplus extracted (or not extracted) from the L- and H-types.

To conclude, we characterize here the threshold ρ^* that disentangles between the admissible equilibria (the one in which different types of seller adopt the same strategy, and the one in which they differentiate their strategies). We first note that such threshold increases with the value that the customer expect from its relationship with the seller, namely $\mathbb{E}(V)$. At the same time, it decreases with both the seller's investment costs I_{hL} and the value V_H, i.e., the value that the H-type customer derives from its relationship with the seller. For concreteness, consider an increase in $\mathbb{E}(V)$ for *given* level of V_H. This would necessarily correspond to an increase in the value V_L that the L-type customer attaches to its relationship with seller h. Looking at the upper panel in Figure 2, we observe that holding fixed I_{hL}, any increase in the value of both $\mathbb{E}(V)$ and V_L tends to enlarge the amount of surplus that the seller may extract from customer L, thereby raising the incentive of the former to propose share-based agreements also to this type of customers.

The opposite occurs when V_H increases, holding $\mathbb{E}(V)$ constant. In this case a larger amount of surplus can be extracted from the H-type customers, setting $\beta_{hH} = V_H$ in order to meet their participation constraint at the margin, while dispensing the L-types. This strategy becomes more rewarding and dominates the alternative one over a wider range of (relatively low) values of ρ, implying that the threshold ρ^* increases. Finally, for given values of V_H and $\mathbb{E}(V)$, consider an increase in the effort I_{hL} that seller h must undertake when dealing with a customer of type L. This reduces the net payoff of the seller its relationship with the L-types, thereby reducing the incentive to stick to $\beta_{hj} = \mathbb{E}(V)$ for all customers. The threshold ρ^* again increases, inducing the seller to prefer (over a wider interval of ρ) the strategy involving the rejection of the L-types, and thus the selection of the H-types only.

4 Concluding Remarks

Taking inspiration from observational evidence of the growing popularity of equity-settled share-based payments in several industries, we have proposed a simple theoretical model, sufficiently generic to accommodate a wide range of interesting applications of such payment schemes, including consulting services to startups, technology licensing, franchising, and many others.

A few remarks are in order. First, our model has been specifically designed to address a completely unexplored question, concerning the optimal policy that a company may pursue when accepting equity from their customers in exchange for a given service, technology, or trademark. We have characterized, in particular, the equity payment claims the seller puts forward when faced with some potential non-rival clients who differ in the amount of support they need to receive from the seller. To shed light on this specific point, we have focused here on the implications of the seller's strategy to accept equity in return for its asset or service, without investigating the reasons that might justify its preference for this settlement mode *vis-à-vis* other payment schemes, either more traditional (e.g., royalties, fees, etc.) or even more convoluted (e.g., cash-settled share-based transactions, or hybrid schemes). Several authors have identified a series of general arguments in favor of this business practice, but only few have proposed a comprehensive analysis based on a specific set of assumptions and a proper theoretical framework. Further research on this topic is then highly desirable, particularly on the comparison among equity-based and royalty-based licensing or even standard two-part tariffs, based on the setting outlined in this paper.

Second, our model hinges on the assumption that customers appear *ex-ante* symmetric and only differ *ex-post* (i.e., upon entering a relationship with the seller) based on the effort they request to the seller upon the relationship is finally established. The latter holds an informational advantage on this point, accrued during the preliminary meeting between the parties (i.e., before final agreement terms are contracted). The seller can make a take-it-or-leave-it offer to every customer, as we rule out subsequent negotiations. Under such restrictive assumption, we have shown that the seller's preferred strategy crucially depends on the effort it must undertake in the relationship with the L-type customer, i.e., the one in need of larger support and/or treatment. When this effort becomes too costly, the seller will prefer to deal with the H-types only, implying that less absorptive customers will be denied the chance to sign profit-sharing agreements with the seller. At the opposite, when entering a relationship with the L-type customer entails milder efforts, the seller has clear incentive to deal with both types of clients. It therefore sets a common equity payment claim for the service/technology provided, without discriminating across types. Under no circumstances the seller deals with both types based on differentiated equity-based settlements.

One plastic representation of this result comes from the franchising industry. As pointed out by Lafontaine and Blair (2009), while "economic theory suggests that franchisors should tailor their franchise contract terms for each unit and franchisee in a chain", the extant empirical evidence documents that –at any point in time and within the same chains– "contracts are remarkably uniform across franchisees", despite the heterogeneity of their individual, outlet, and specific market conditions.[22] Several studies have investigated the motives for such uniformity, mainly invoking legal considerations or simply the desire of the franchisors to grant consistency and fairness toward franchisees (presumably in the fear that reduced perception of equity induces more free-riding and hurts performance, see Sawant et al., 2021). Our analysis offers a new economic explanation based on strategic considerations related to rent extraction maximization by part of the franchisor. In our narrative, by means of this strategy the licensor trades-off full rent extraction at the sole expenses of a selected type of licensees, with the possibility to extract surplus from both types.

This general result also resonates well with evidence documented in the management literature, that consulting is gradually becoming a more standard service (Momparler et al., 2015), which makes it more difficult for a consulting firm to justify different equity-based payment claims for a certain professional service across its clients. Moreover, consulting firms are used to provide homogeneous services for which they charge relatively high consulting fees (Lassala et al., 2016). Although these facts refer to the evidence available on standard consulting fees –and not equity-settled share-based payments–, we may find some support for our arguments based on an isomorphism of our model. The profit-sharing contracts that we analyze here can indeed be easily recasted as more traditional combinations of lump-sum fees and royalties.[23] Our model suggests that when discriminating equity-claims across customer's types, the requested equity share ranges –according to types– from below up to V_L, i.e., the value that $L-$type customers attach to their relationship with the seller. In turn, when equity-claims are not differentiated across types, their level tends to be higher, as it corresponds to average value of the relationship for the two types (the value for the $H-$types, namely V_H, being higher than V_L). The level of the equity claims increase even more whenever the seller's adopted policy is such that only the H-types are selected, as the equity share requested by the seller finally attains the value V_H.

There is a couple of mechanisms that have been ignored in our model, which might create room for a seller's equilibrium strategy involving different equity positions across customers. The first would be allowing for cross-subsidization, so that the seller may incur losses when dealing with one type of customer, on the condition that the profits derived from the relationship with the other type are sufficiently large to compensate. This would entail going beyond the analysis of the Perfect Bayesian equilibria, so as to consider other solution concepts in a more sophisticated variant of our game. A second possible mechanism is the structure

[22] Using survey data collected among franchisors, the authors report that "42% of her respondents offered their contracts on a take-it-or-leave-it basis, while 38% allowed for some negotiations, although limited to non-monetary terms".

[23] This point is well-addressed in Bolatto and Pignataro (2022).

of noisy signals. Further calculations (not reported here but available upon requests) proves that, when introducing this mechanism, the seller could profitably discriminate across clients, by taking different equity positions across types. One could imagine, for instance, that before any settlement offer some of the potential customers receive information about their own nature, although with noise (i.e., signals might be distorted). Intuitively, requesting different equity shares across types would allow the seller to take advantage of the distorted signals.

One further extension of our model would include a market with more licensors and/or consulting firms that offer alternative equity payment schemes to their potential partners. The customers receive a list of distinct offers, which they inspect until they find one, if any, that suits their preferences. In this case, the bargaining power of the customers is larger, by reason of the larger number of options available on their side. The resulting equilibrium in a competitive market first depend on the simultaneity or sequentiality of the offers that the sellers can support. In particular, by making simultaneous offers sellers would break even in a typical Bertrand setting, with every seller putting forward settlement offers covering its cost *per unit of profit*, based on the customer type. As a result, the possibility of making a unique, common equity payment claim across types disappears. In turn, under sequential offers, the first-move advantage could induce a virtuous mechanism according to which the first seller may restore a unique contract (not differentiated across types) through backward induction, thereby appropriating a larger rent of its partners. This could be the case of crowdsourcing marketplaces –such as Amazon Ads or Mechanical Talks– that make it easier for consulting services to outsource their processes and jobs to a distributed workforce, who can perform these tasks virtually. Despite the prominence of this type of search problem (see Armstrong and Zhou, 2011; and Ding and Zhang, 2018), the extant literature has not provided yet a characterization of the equilibrium in such a context, in which the mechanism in pure strategies may easily fail to exist. Adopting a sequential search for a satisfactory offer *à la* Wolinsky (1986) might be necessary to explain the possible outcomes. Analyzing this aspect could therefore constitute a fertile ground for follow-up research.

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Appendix

A. Proofs of Lemma 1 and Proposition 1

This appendix reports the formal proofs of Lemma 1 and Proposition 1 in Section 3.1. The underlying assumption is that the seller's type $i \in \{h, l\}$ corresponds to public information.

Lemma 1.

Proof. First, we consider the viable options for potential customers at the game equilibrium. If $\beta_{iL} > V_L$, a L-type customer would certainly reject any draft agreement where the equity claim is equal of larger than β_{iL}. The same holds true for the H-type, since $\beta_{iH} > V_H$. Consider now the viewpoint of a generic seller of type $i \in \{h, l\}$. An agreement with the H-type customers can be excluded for any $\beta_{iH} < I_{iH}$; while an agreement with the L-types must be excluded for all $\beta_{iL} < I_{iL}$. As a matter of fact, $I_{iL} > I_{iH}$ necessarily implies that $\beta_{iL} > \beta_{iH}$ holds.

Given this premise, separated agreements, if any, must be designed as follows. All customers of the H-type are requested to pay $\beta_{iH} \in [I_{iH}, V_H]$, whereas the L-types receive a draft agreement at $\beta_{iL} \in [I_{iL}, V_L]$. This way, the generic seller $i \in \{h, l\}$ appropriates a positive surplus from the relationship with both types, while meeting their respective participation constraints. The alternative option is represented by a common equity-based payment claim β_i that applies to all customers, which represents a credible offer only for $\beta_i \in [I_{iL}, \mathbb{E}(V)]$. Note that no customer would ever accept to give up an equity share higher than $\mathbb{E}(V)$, as the equity-settled payment would in this case exceeds the value the customer attaches to its relationship with the seller. $\square$

As for Proposition 1, we consider all admissible cases –labeled as *a*, *b* and *c*– separately.

Case *a*: *if $I_{ij} < \mathbb{E}(V)$ for all $i \in \{h, l\}$ and $j \in \{H, L\}$, then every seller i will propose agreements based on a unique, common equity payment claim $\beta = \mathbb{E}(V)$ to all customers $j \in \{H, L\}$.*

Proof. When $I_{iL} < \mathbb{E}(V)$ for all $i \in \{h, l\}$, the seller profitably engages in share-based contracting with both types of customers, provided that $\mathbb{E}(V) > I_{iL} > I_{iH}$ holds unconditionally. Its payoff is maximized when taking common equity positions in all clients. The true question then becomes whether all of them will ever accept the proposed draft agreement terms. We observe that there is only a unique share β_i that maximizes the seller's expected profit, still compatible with the participation constraint of all customers, namely $\beta_i = \mathbb{E}(V)$. At this share, the seller's payoff amounts to $\Pi_i|_j = \rho(\mathbb{E}(V) - I_{iH}) + (1 - \rho)(\mathbb{E}(V) - I_{iL})$, with $j \in \{H, L\}$.

The alternative option would imply different equity claims across types, i.e., $\{\beta_{iL}; \beta_{iH}\}$ with $\beta_{iL} > \beta_{iH}$. In this case, the participation constraint of the customers requires $V_H > \mathbb{E}(V) > V_L \geq \beta_{iL} > \beta_{iH}$. Should this condition be violated, none of the customers would ever accept the proposed draft agreement based on its prior information. There are two rankings between equity claims and effort costs compatible with such constraint, namely $\beta_{iL} > I_{iL} > \beta_{iH} > I_{iH}$ and $\beta_{iL} > \beta_{iH} > I_{iL} > I_{iH}$.

Under the first ranking, seller i has to request β_{iL} not only to the L-types, but also to the H-types. In principle, both types could accept this terms, as the expected value of their relationship with the seller however exceeds the requested payment in terms of equity. We observe that $V_L \geq \beta_{iL}$ holds, in full compliance with the participation constraint reported above. The highest share that a customer could ever accept to dispose is then $\beta_i = \mathbb{E}(V)$, irrespective of its type $j \in \{H, L\}$. By a similar argument we can prove that the same conclusion is attained under the second admissible ranking, i.e., $\beta_{iL} > \beta_{iH} > I_{iL} > I_{iH}$. Summing up, there is no circumstance in which a generic seller i can reap larger benefits by requesting different equity-settled payments $\{\beta_{iH}; \beta_{iL}\}$ to the two types of customers, in place of a common equity share $\beta_i = \mathbb{E}(V)$. $\square$

Case b**:** *if $I_{iH} < \mathbb{E}(V) < I_{iL}$ for all $i \in \{h, l\}$, then every seller will make settlement offers to the H-type customers only, based on a equity payment claim $\beta = V_H$, while all the L-types are rejected.*

Proof. We pose that the seller's investment costs (efforts) in its relationship with the customers are such that $I_{iH} < \mathbb{E}(V) < I_{iL}$ holds, irrespective of its type $i \in \{h, l\}$. Let us assume that a generic seller i proposes draft agreements based on a common equity claim to all types of customers. Both types H and L share the same *ex-ante* evaluation of their relationship with the seller, i.e., $\mathbb{E}(V)$. Accordingly, a settlement offer will never be accepted at $\beta_i > \mathbb{E}(V)$, independently from the nature of the customer. We therefore limit our attention to the case with $\mathbb{E}(V) > \beta_i > V_L$. Given $I_{iH} < \mathbb{E}(V) < I_{iL}$, seller i will reject the L-types and enter a relationship with the H-types only, requesting them an equity payment at $\beta_{iH} \in [I_{iH}, \mathbb{E}(V)]$. The latter will accept the proposed terms only if $V_H \geq \beta_i$, which implies that the seller's payoff evaluates to $\Pi_i|_{j=H} = \rho(V_H - I_{iH})$.

The alternative strategy of the seller takes the form of a request of different equity claims across customer types, i.e., $\{\beta_{iH}; \beta_{iL}\}$ with $\beta_{iH} < \beta_{iL}$. Their participation constraint is $\beta_{iH} < V_H$ if they are of type H; and $\beta_{iL} < V_L$ if they are of type L, this second being even more severe as a restriction, provided that $\beta_{iL} > \beta_{iH}$ and $V_H > V_L$. The seller, in turn, can put forward its proposal only for $\beta_{iH} > I_{iH}$ and $\beta_{iL} > I_{iL}$. Combined together, the two conditions deliver $V_H \geq \beta_{iH} > I_{iH}$ and $V_L \geq \beta_{iL} > I_{iL}$. There is only one admissible configuration between investment costs and equity claims such that differentiated agreements across types can satisfy the constraints of the two types at once, namely $V_H > I_{iL} > \mathbb{E}(V) > V_L \geq \beta_{iL} > \beta_{iH} > I_{iH}$. Note, however, that seller i will obtain a strictly negative payoff from its relationship with the L-types under this circumstance, which is clearly not admissible. We finally conclude that the L-types will receive a proposal from the seller with zero probability. $\square$

Case *c*: *if $I_{ij} > \mathbb{E}(V)$ only for $i = l$ and $j = L$, then the l-type seller will deal with customers of the H-type only, requesting a equity-settled payment $\beta = V_H$. In turn, the h-type seller will deal with both types of customers, based on a common equity claim at $\beta = \mathbb{E}(V)$.*

Proof. We introduce here relevant differences in the investment costs (efforts) undertaken by the seller, based on its own profile. A seller of type l faces relatively high costs when dealing with a customer of type L, whereas the corresponding cost for a seller of type h is sufficiently limited. Investment costs are instead relatively low for both types of seller (h and l) when dealing with customers of the H-type. Formally, the setting we consider here is such that

$$V_H > I_{hL} > \mathbb{E}(V) > V_L > I_{hH} > I_{lL} > I_{lH},$$

with the only caveat that I_{hH} and I_{lL} could in principle be inverted, without this affecting qualitatively our results.

A seller of type l incurs losses when dealing with a L-type customer, provided that $V_L \geq \beta_{lL} > \beta_{lH}$ implies that $\beta_{lL} < I_{lL}$ even when this equity share is set at its highest possible level, namely $\beta_{lL} = V_L$. It will therefore have no other option that dealing with the H-types solely, as a relationship with the L-types is clearly unprofitable because of $\mathbb{E}(V) < I_{lL}$. It is therefore straightforward to derive the optimal contract proposed to the H-types. Seller's profit maximization indeed requires full rent extraction on the counterpart, by means of a equity claim $\beta_l = V_H$ that meets the participation constraint of the selected customers at the margin. The seller's net payoff is then equal to $\Pi_l|_{j=H}(\beta_{lH} = V_H) = \alpha(V_H - I_{hH})$.

At the contrary, a seller of type h has no reason to exclude the L-type customers, insofar as $\mathbb{E}(V) > I_{lL}$ allows for a positive payoff stemming from the relationships with these clients. Accordingly, the equity claim by seller h is the same as in case a, analyzed above, and thus corresponds to $\beta_h = \mathbb{E}(V)$. These terms are proposed without discriminating across types. When adopting this policy, seller l obtains a total profit equal to $\Pi_l|_j(\beta_{lj} = \mathbb{E}(V)) = \rho(\mathbb{E}(V) - I_{lH}) + (1-\rho)(\mathbb{E}(V) - I_{lL})$. □

B. Proof of Proposition 2

In this appendix we report the proof of Proposition 2 in Subsection 3.2. The environment is then characterized here by private information on the seller's type $i \in \{h, l\}$. As in the main text, we consider cases a, b and c in Proposition 2 separately, for ease of exposition.

Case *a*. *if $I_{ij} < \mathbb{E}(V)$ for all $i \in \{h, l\}$ and $j \in \{H, L\}$, then each seller i will propose draft agreements based on a unique, common equity claim $\beta_{ij} \in [V_L, \hat{\mathbb{E}}(V)]$ to all customers $j \in \{H, L\}$, where $\hat{\mathbb{E}}(V) \equiv \mathbb{E}(V|_{\beta_{ij}=\mathbb{E}(V)})$.*

Proof. The proof is organized into three steps. First, we analyze the behavior of a seller of type l (hence with high unit costs) to prove that taking different equity positions across customer is never a dominant strategy for this type, irrespective of the nature of customer it deals with. To this purpose, suppose that one of customer, either of type H or L, mistakenly believes that the seller is of type h (hence with low unit costs) despite its "true" type is actually l. This seller may request different equity shares $\{\beta_{iL}, \beta_{iH}\}$ such that $\beta_{iL} > \beta_{iH}$; $\beta_{iH} \leq V_H$; and $\beta_{iL} \leq V_L$. Its effort is either I_{lH} or I_{lL}, depending on the type of customer.

We now denote with $\eta \in [0,1]$ the probability that the seller decides to request an equity share $\beta_{iL} = V_L$ to the H-type customer, i.e., $\eta = \Pr(\beta_{iL}|H)$. The probability that customer H accepts this offer is $\mu \in [0,1]$. At the sub-game equilibrium, the seller should be indifferent between requesting β_{iL} or β_{iH} to customer H. This is verified when $\mu = \mu^* \equiv (V_H - I_{hL})/(V_H - I_{lL})$. The optimal equity claim turns out to be $\beta_{iL} = \mathbb{E}(V|\beta_{iL}) = V_H \Pr(H|\beta_{iL}) + V_L \Pr(L|\beta_{iL})$. Bayesian updating then delivers the following conditional probabilities:

- $\Pr(H|\beta_{iL}) = \frac{\Pr(\beta_{iL}|H)\Pr(H)}{\Pr(\beta_{iL}|H)\Pr(H)+\Pr(\beta_{iL}|L)\Pr(L)} = \frac{\eta\rho}{\eta\rho+(1-\eta)(1-\rho)}$;
- $\Pr(L|\beta_{iL}) = 1 - \Pr(H|\beta_{iL}) = \frac{(1-\eta)(1-\rho)}{\eta\rho+(1-\eta)(1-\rho)}$.

If plugged into the above expression for β_{iL}, these two expressions yields

$$\eta^* = \frac{(1-\rho)(V_L - \beta_{iL})}{(1-\rho)V_L - \rho V_H + (2\rho - 1)\beta_L}.$$

We observe that η^* turns positive only for $\rho < \tilde{\rho}$, where $\tilde{\rho} \equiv (V_L - \beta_L)/(V_H - V_L - 2\beta_L)$. In other words, the seller selects the offer to make based on the distribution of customers between the H- and L-types. Intuitively, when the H-type is more likely, the seller's dominant strategy entails selecting the H-types, while rejecting the L-types. Seller l's then payoff evaluates to:

$$\Pi_l(\beta_L, \beta_H) = \rho\eta^*\mu^*(\beta_L - I_{lH}) + \rho(1-\eta^*)(\beta_H - I_{lH}) + (1-\rho)\mu^*(\beta_L - I_{lL}).$$

It monotonically increases with β_L, while it decreases with β_H. If the seller were choosing to deal with both type, the optimal pair of equity claims would be instead $\{\beta_{iL} = V_H, \beta_{iH} = I_{lL}\}$, yielding a net payoff equal to

$$\Pi_l(\beta_{iL}, \beta_{iH}) = [V_H - (\rho I_{lH} + (1-\rho)I_{lL})]\,\frac{I_{lH}}{I_{lL}} > 0.$$

It is easily proved that this second strategy, with $\{\beta_{iL} = V_H, \beta_{iH} = I_{lL}\}$, is strictly dominated by the alternative one, based on a common equity claim β_i that applies to all customers. By setting $\beta_i = V_L$, the seller obtains a profit $\Pi_l(\beta_{iL} = V_L) = \rho(V_L - I_{lhH}) + (1-\rho)(V_L - I_{lL})$, with $\beta_{iL} \leq V_L < V_H$ and $\beta_{iL} > I_{lL}$. We note that $\Pi_l(\beta_{iL} = V_L) > \Pi_l(\beta_{iL} = V_H, \beta_{iH} = I_{lL})$.

To complete the first part of this proof, we now introduce the opposite assumption, that is, customer j correctly believes that the seller is of type l. We consider again a share-based agreement involving different equity claims across types. The seller will propose a draft agreement at β_{iL} to the H-types with probability $\mu^{**} = (\beta_L - I_{lH})/(\beta_L - I_{lL})$; and due to Bayesian updating, such terms are accepted with probability η^*. The resulting net payoff of seller l is

$$\Pi_l(\beta_{iL}, \beta_{iH}) = \rho\eta^*\mu^{**}(\beta_L - I_{lH}) + \rho(1-\eta^*)(\beta_H - I_{lH}) + (1-\rho)\mu^{**}(\beta_L - I_{lL}),$$

which proves to be monotonically increasing with β_{iL}, while decreasing with β_{iH}. Based on the same argument used above, we may conclude that, for seller l, a strategy with differentiated claims $\{\beta_{iL}, \beta_{iH}\}$ never happens to outperform the strategy implying a common equity claim $\beta_l \in [\Phi_L, \mathbb{E}(V)]$ applying to all customers.

The second step of this proof consists in investigating the optimal strategy of the h-type seller (the one with low unit costs). Very similar arguments apply. The admissible strategies of this player obey the following restriction, $I_{hH} < I_{hL} < I_{lH} < I_{lL} < V_L < \mathbb{E}(V)$. Again, we denote with $\hat{\eta}$ the probability that the seller requests β_{iL} also to the H-type customer. At the equilibrium, this customers should be indifferent between accepting or rejecting the proposal received, according to which the equity claim of the seller is $\beta_{iL} = \mathbb{E}(V|\beta_{iL}) = V_L \Pr(L|\beta_L) + V_H \Pr(H|\beta_{iL})$. Bayesian updating implies

- $\Pr(L|\beta_{iL}) = 1 - \Pr(H|\beta_{iL}) = \frac{1-\rho}{\rho\hat{\eta}+(1-\rho)}$;
- $Pr(H|\beta_{iL}) = \frac{\Pr(\beta_L|H)\Pr(H)}{\Pr(\beta_{iL}|H)Pr(H)+\Pr(\beta_{iL}|L)\Pr(L)} = \frac{\rho\hat{\eta}}{1-\rho+\rho\hat{\eta}}$,

where $\Pr(\beta_{iL}|H) = \hat{\eta}$. Plugging the above expressions into the one for β_{iL}, one gets

$$\hat{\eta} = \frac{(1-\rho)(V_L - \beta_{iL})}{\rho(\beta_{iL} - V_H)} < 0,$$

with $\beta_{iL} < V_H$. This means that there is no positive probability that seller h will use different share-based payment schemes across customers. A common equity claim, at $\beta_h \in [V_L, \mathbb{E}(V)]$, therefore applies to both customers of type H and L. The equilibrium strategy of the type $h-$type seller (low unit costs) is therefore identical to the one pursued by the $l-$type seller (high unit costs).

We conclude this proof by showing that neither seller h nor l disposes of a profitable deviation from the equilibrium strategy, whatever the customers' belief about its own profile. Such deviation is feasible when the seller's effort is relatively low, and a common equity claim across types provides the seller with a strictly positive profit, unconditionally from the customer type (H or L). Given $\beta_i \in [V_L, \mathbb{E}(V)]$, the posterior distribution of the seller's type coincides with the prior, namely $\gamma(1-\gamma)$. According to Bayes' rule, we can write

$$\Pr(l|\beta) = \frac{\Pr(\beta|l)\Pr(l)}{\Pr(\beta|l)\Pr(l) + \Pr(\beta|h)\Pr(h)} = \frac{\rho\gamma}{\rho\gamma + (1-\rho)}.$$

Upon observing that a unique equity claim β_i is requested to all customers, the latter update the beliefs about their own profile in such way that the expected value of their relationship with the seller becomes $\hat{\mathbb{E}}(V) = \mathbb{E}(V|\beta_i) \equiv V_H \Pr(l|\beta_i) + V_L \Pr(h|\beta_i)$. For sellers h and l to play the same strategy, their equity claims must not exceed $\hat{\mathbb{E}}(V)$, and must therefore lie below $\mathbb{E}(V)$, provided that $\hat{\mathbb{E}}(V) < \mathbb{E}(V)$.

Furthermore, no profitable deviation has to occur in equilibrium, given the beliefs of the potential customers. This holds true since neither seller h nor l is better off when deviating towards differentiated equity claims across types, as shown above. In other words, discriminating equity positions across clients is never an option for the seller, regardless of its own type (h or l). The resulting PBE is characterized by both seller's types taking common equity shares $\beta_i = \hat{\mathbb{E}}(V)$ across their customers, their payoffs evaluating, respectively, to

- $\Pi_l^{pool}(\beta = \hat{\mathbb{E}}(V)) = \rho(\hat{\mathbb{E}}(V) - I_{lH}) + (1-\rho)(\hat{\mathbb{E}}(V) - I_{lL})$;
- $\Pi_h^{pool}(\beta = \hat{\mathbb{E}}(V)) = \rho(\hat{\mathbb{E}}(V) - I_{hH}) + (1-\rho)(\hat{\mathbb{E}}(V) - I_{hL})$.

We easily note that $\Pi_l^{pool}(\beta_l = \hat{\mathbb{E}}(V)) > \Pi_h^{pool}(\beta_h = \hat{\mathbb{E}}(V))$. □

Case *b*. *if $I_{iH} < \mathbb{E}(V) < I_{iL}$ for all $i \in \{h, l\}$, then each seller will engage in share-based agreements with the H-type customers only, requesting them a equity share $\beta_{iH} \in [\mathbb{E}(V), V_H]$, whereas all L-types will be rejected.*

Proof. This proof is similar to the one proposed in Appendix A for the analogous case *b* in Proposition 1. When dealing with the L-type customer, the effort requested to the seller exceeds the expected value of the relationship as perceived by the customer, namely $\mathbb{E}(V)$. This is true for both sellers h and l. A draft agreement able to accommodate all potential customers cannot be admitted, insofar as (i) any offer implying an equity claim higher than $\mathbb{E}(V)$ is rejected by any of the candidate partners; and (ii) any offer with an equity claim lower than I_{hL} implies a negative payoff for the seller and must therefore to be excluded. In principle, a potential cross-subsidization between customer types could be implemented. In this setting, however, we can easily show that this mechanism is simply unfeasible, as the potential surplus extracted from the H-types would not be large enough to compensate the seller for the systematic losses incurred with the L-types at $\beta_{iL} < I_{iL}$. This holds true even if the seller were proposing draft agreements with differentiated equity claims $\{\beta_{iH}; \beta_{iL}\}$.

Summing up, whenever $I_{iH} < \mathbb{E}(V) < I_{iL}$ for all $i \in \{h, l\}$, the equilibrium strategy of the seller entails the rejection of the $L-type$ customers, and thus the selection of the h-types only; and it proves invariant with respect to the nature of the information available to customers in regard to the seller's type. In other words, this strategy stands as the equilibrium strategy of the game, regardless of whether such information is private or public. The range of equity claims over which a draft agreement proposed to the H-type customers qualify as a credible offer is $\beta_i \in [\mathbb{E}(V), V_H]$. The maximum surplus that seller i may ever reap is attained by setting $\beta_i = V_H$, which implies the seller's payoff amounts to $\Pi_i(\beta = V_H) = \rho(V_H - I_{iH})$. □

Case *c***.** *if $I_{ij} > \mathbb{E}(V)$ for $i = h$ and $j = L$, then both h and l sellers will deal with the H-type customers only, requesting them an equity share $\beta_{iH} = V_H$, provided that for the customers the probability of being a H-type is sufficiently low, i.e., for $\rho < \rho^*$, where*

$$\rho^* \equiv \frac{\mathbb{E}(V) - I_{hL}}{V_H - I_{hL}}. \tag{4}$$

In turn, for $\rho > \rho^*$, a h seller will prefer to offer a draft agreement at $\beta_{hj} = \mathbb{E}(V)$ to the customers of both H- and L- types, thus adopting a different strategy than a l seller, who keeps selecting the H-type customers only.

Proof. When dealing with customers of type L, a seller may propose alternative payment schemes based on its own type $i \in \{h, l\}$. Given $I_{hL} < \mathbb{E}(V)$, the h-type seller (low unit costs) could in principle propose agreements at $\{\beta_{hL}, \beta_{hH}\}$, rather than requesting common equity shares β_h across customers. Note that the l-type seller (high unit costs) does not have this possibility, because $I_{lL} > \mathbb{E}(V)$. Dealing with both types of customers is simply not feasible for seller l, which has clearly no option but selecting the H-type customers only.

Coming back to seller h, two possible strategies can be envisaged. Given $I_{hL} < \mathbb{E}(V)$, seller h may discriminate across customers by requesting $\{\beta_{hL}, \beta_{hH}\}$, where $\beta_{hL} \in (\beta_{hH}, V_L)$ is the equity share requested to the L-types; while $\beta_{hH} \geq I_{hL} > I_{lH}$ is the one requested to the H-types. Since the seller's type is not observed by the customer, seller h can exploit its informational advantage to maximize its surplus by setting $\beta_{hL} = V_L$ and $\beta_{hH} = I_{hL}$. The corresponding payoff amounts to $\Pi_h(\beta_{hL} = V_L, \beta_{hH} = I_{hL}) = \rho(I_{hL} - I_{hH}) + (1-\rho)(V_L - I_{hL})$. However, we note that this strategy is strictly dominated by the alternative one, hinging on a unique equity claim β_h applying to all customers. This is readily proved, as far as $\Pi_h(\beta = \mathbb{E}(V)) > \Pi_h(\beta_{iL} = V_L; \beta_{iH} = I_{hL})$ is always verified.

There is one additional option that must be taken into account. The h-type seller could decide to set $\beta_{hH} = V_H$ and deal only with the H-type customers. This way, it would obtain a profit equal to $\Pi_h(\beta_{hH} = V_H) = \rho(V_H - I_{hH})$. We observe that $\Pi_h(\beta_{hH} = V_H) > \Pi_h(\beta = \mathbb{E}(V))$ if and only if $\rho \leq \rho^* \equiv (\mathbb{E}(V) - I_{hL})/(V_H - I_{hL})$, whereas the opposite holds for all $\rho > \rho'$. The proof then follows along the lines of the proof of case a above, provided that the posterior distribution of the customer's type coincides with the prior. All customers will then accept the draft agreement received at the selected equilibrium. □