Endogenous Property Rights and the Nature of the Firm.*

Carmine Guerriero Giuseppe Pignataro
University of Bologna

DO NOT QUOTE WITHOUT PERMISSION

March 2, 2020

Abstract

While focusing on residual rights, the property rights theory—i.e., PRT—of the firm overlooks the legal protection of each party's input. We assume, instead, that the legislator selects the upstream firms' property rights, which, in turn, determine their ex post bargaining power, by maximizing the supply of projects possibly adopting the efficient full-investment profile and, conditionally on this goal being reached, minimizing less likely deviations to inefficient intermediate-investment profiles. Differently from the PRT, each party's ex ante incentives are exclusively determined by property rights, which are, in turn, entirely driven by the—absolute and relative to innovation costs—size of the default payoffs. When the latter are small and the gains from trade are large, any market structure delivers the same incentives for full-investment, and the legislator's goal becomes discouraging costly deviations by unbalancing the most the parties' investment returns. To do so, she protects more the party with the smallest default payoff in such a way that the other one receives more often its preferred ownership structure. Opposite patterns arise when investment returns are already unbalanced by one disagreement payoff being large and, thus, fostering full-investment is pivotal. Regardless of the size of the innovation costs, each party's property rights are weaker (stronger) the larger is its (partner's) default payoff. These patterns remain true when one party dominates institutional design or has a stronger impact on the project value. In the last case, property rights do not generally favor the party shaping the most the relationship value. Crucially, our conclusions are consistent with the interplay among proxies for the legal protection of the downstream firms' personal and intellectual property, firms' presence in the value chain, process and capital specificity and R&D intensity in a panel of 119 countries spanning the 2006-2018 period.
Keywords: Property rights; Vertical integration; Asset specificity; Bargaining.
JEL classification: D23; D86; L24; D02.

---

* *This paper is based upon an idea of Carmine Guerriero, who also developed the model setup, the entire institutional and empirical analyses and wrote the manuscript. Carmine Guerriero and Giuseppe Pignataro cooperated in developing the proofs.* We wish to thank Pol Antràs, Oliver Hart and Giorgio Zanarone for enlightening comments. Corresponding author: Carmine Guerriero. Address: Strada Maggiore 45, 40125 Bologna, Italy. E-mail: c.guerriero@unibo.it

1 Introduction

The property rights theory—i.e., PRT—of the firm, developed in the path-breaking contributions of Grossman and Hart (1986), Hart and Moore (1990) and Hart (1995), has emerged as the most tractable and insightful theoretical frameworks to analyze the determinants and impact of the boundaries of the firm. Its key tenet is that, by centralizing residual control rights over assets, integration strengthens the bargaining position of the principal *vis-à-vis* that of the agent increasing (decreasing) the incentives of the former (latter) to undertake ex ante non-contractible specific investment. As a result, the extent of efficiency of the final allocation can be improved by adopting the appropriate ownership structure.

While focusing on residual rights however, the PRT treats each party's ex post bargaining power as exogenous, obscuring, in this way, its impact on ex ante investment choices. In reality, the relative renegotiation power is closely linked to the legal protection of inputs. First, employers and downstream firms enjoy longer and easier to obtain unregistered intellectual property rights—i.e., trade secrets—when providing specific assets in capital-intensive sectors (Burk and McDonnel, 2007). By the same token, legal systems tend to protect these rights through "non-disclosure," "work for hire" and "non-competition" agreements provided that these clauses do not discourage employees and upstream partners from supplying specific inputs (Saxenian, 1996).[1] Second, because of the smaller default payoffs, upstream partners can obtain the compulsory licensing of downstream parties' registered intellectual property rights—i.e., patents—when the commercial terms for voluntary license are "unreasonable" (Burk and McDonnel, 2007). Finally, while employers and downstream parties can rely on "fiduciary" duties and "shop right" provisions to curb the exploitation of information closely related to their inputs,[2] employees and upstream partners can respond by exploiting "unfair contract terms" and "abuse of right" doctrines (Baudry and Chassagnon, 2018).[3] In short, commercial law heavily affects the parties' renegotiation power, regardless

[1] Non-disclosure(competition) agreements identify processes whose access should be restricted to third parties (that should not be replicated by employees in competitive enterprises), whereas a work made for hire leaves authorship of a particular innovation in the hands of the employers (Burk and McDonnel, 2007).

[2] While fiduciary duties should ensure that agents act in their principals' interests, the shop right license allows the latter to use a patented invention that the former devised (Burk and McDonnel, 2007).

[3] Contract terms are unfair if they cause large imbalances in the parties' rights, whereas a right is abused when it is exercised only to cause annoyance, harm, or injury to another party (Rose, 2019).

of the arranged ownership structure and in a way intimately related to the relative size of their default payoffs and the relative intensity of their investment activities.

To shed more light on these issues, we assume that while the parties bargain over residual rights, the legislator selects the strength of the upstream firm's property rights, which, in turn, determines his ex post bargaining power.[4] Formally, we envision an economy populated by a mass one of upstream firms and a mass one of downstream firms, which are randomly paired and can finalize a project whose value is multiplicative in a random match-specific productivity parameter and each party's investments. First, a benevolent legislator design property rights. Next, one of the two parties makes a take-it-or-leave-it offer on the ownership structure. If the offer is refused, both parties get the outside option. If instead the offer is accepted, they select simultaneously and noncooperatively the investment level, whose cost is linear. Finally, after having invested, the two parties bargain over trade, i.e., they decide whether to accept the default payoffs or to use the asset for joint production and, thus, divide the gains from trade. Since within each match, the two parties might typically select the "no-investment," "full-investment" and "intermediate-investment" profile, with the first and the last ones delivering zero payoffs, we assume that the legislator selects the protection of property rights by maximizing the supply of projects possibly adopting the efficient full-investment profile and, conditionally on this goal being reached, minimizing the less likely deviations to inefficient intermediate-investment profiles. This assumption assures uniqueness of the SPE equilibrium. Differently from the PRT, each party's investment incentives are uniquely determined by the strength of the upstream firms' rights, which, in turn, are unrelated to the identity of the party making the take-it-or-leave-it offer and entirely driven by the—absolute and relative to innovation costs—size of the default payoffs. When the latter are small and the gains from trade are large, any market structure delivers the same incentives for full-investment, and the legislator's goal becomes discouraging costly deviations by unbalancing the most the parties' investment returns. To do so, she protects more the party with the smallest default payoff in such a way that the other one receives more often its preferred ownership structure. Opposite patterns arise when investment returns

[4]We refer to the downstream firm as "she", to the upstream one as "he" and to a generic party as "it." Furthermore, we refer to the legislator as "she" since this abuse never causes confusion.

are already unbalanced by one disagreement payoff being large and, thus, fostering full-investment is pivotal. Regardless of the size of the innovation costs, each party's property rights are weaker (stronger) the larger is its (partner's) default payoff.

In the most likely case of sizable asset specificity and, thus, large gains from trade (Antràs, 2015), two are the main implications of our model. Fist, the legal protection of the upstream firms has an inverted U-shaped (U-shaped) relationship with the marginal innovation cost when the downstream firm's default payoff is the largest (smallest) and a weakly increasing (decreasing) one with the downstream (upstream) firm's default payoff. Intuitively, the upstream firm's property rights must be stronger when his investment incentives are weakened by a rise in the downstream firm's default payoff under downstream-ownership. Symmetrically, they must be weaker to incentivize the downstream firm in the face of a rise in the upstream firm's default payoff under upstream-ownership. Second, the extent of vertical integration weakly falls with the default payoffs and the marginal innovation cost, since the former reduce the investment returns of the firm operating under its least preferred ownership structure and the latter shrinks the investment returns under any ownership structure.

We reach similar conclusions if: 1. only self-investment is allowed; 2. investment is discrete; 3. investment is unilateral; 4. one party has more political influence on institutional design; 5. the party receiving the take-it-or-leave-it offer can pay the other party to get a different residual rights arrangement; 6. the impact of each party's investment on the project value is asymmetric and, in particular, the production function is Cobb-Douglas with constant return to scale. In this last case, intermediate-investment profiles have a measure zero and the legislator only cares about favoring full-investment. As a result, the upstream firm is generally more protected when the intensity of his contribution to the relationship value is limited since, then, his investment incentives are lower, and vertical integration has an inverted U-shaped link with the intensity of the downstream firm's investment effort.

To assess whether the correlations in the available data are consistent with the most innovative implications of our model, we analyze a panel of 119 countries observed between 2006 and 2018 for which the Executive Opinion Survey—EOS, hereafter—run by the World Economic Forum reports proxies, otherwise contemporaneously unavailable at the firm level (Antràs, 2015), for the strength of the downstream firm's personal and intellectual property

rights, firms' presence in the value chain, process and capital specificity, which we assume negatively related to—respectively—downstream and upstream firms' default payoffs, and R&D intensity. Conditional on country and year effects, OLS estimates suggest that the legal protection of the downstream firms' property is significantly and positively related to a proxy for the sophistication of the production processes and significantly and negatively linked to both a measure of site specificity and R&D intensity, whereas the extent of vertical integration is only significantly—and positively—connected to process specificity. To gain more insights about causality without the presumption to prove it, we report three extra results. First, our conclusions are similar when we capture process and capital specificity with—respectively—a proxy for whether unique processes are a country's competitive advantage and a measure of the severity of financial frictions and when we substitute R&D intensity with the PCT patent applications over the population in million. These patterns suggest that measurement error does not seem to be a major issue in our analysis. Second, we also condition for the other relevant determinants of property rights such as income, inclusiveness of political institutions, non-produced output and both external and internal conflicts (Guerriero, 2020). Including these observable factors together leaves the results almost intact as it does considering the proxies for process and capital specificity and the measures of property rights lead one year. This second remark excludes that the estimates are driven by reverse causation. Third, we calculate that the influence of unobservables would need to be on average more than twenty-three times than the influence of all the observables that we consider to completely explain away the OLS estimates. Accordingly, it seems unlikely that unobserved heterogeneity is driving our empirical results.

Our study is linked to five strands of literature. First, our focus on ex ante incentives intimately links our paper to the other theories of the firm and, in particular, the PRT (Gibbons, 2005). Different from the PRT however, we don't assume that the legal protection of each party's input is irrelevant for its ex post bargaining payoff—as, for instance, Grossman and Hart (1986) do—or that it exogenously shapes it via either the default payoffs or the share of contractible inputs (Hart, 1995; Antràs, 2015; Eppinger and Kukharskyy, 2019; Kukharskyy, 2020). We distinguish, instead, between the property rights on the parties' inputs, which shape their ex post bargaining power and are designed by the legislator, and residual con-

trol rights, which define the default payoffs and are selected by the parties themselves. By endogenizing both choices, our more general setup shows that the ownership structure is completely driven by the legal protection of each party and its determinants. This is not a subtle difference. To begin with, the PRT approach concludes that, as one party's default payoff under its preferred ownership structure decreases, then its willingness to integrate might either fall or rise depending on whether asset specificity shapes the marginal returns on investment or the ex post bargaining power (Whinston, 2003; Antràs, 2015). In our case instead, any rise in the default payoffs limits the extent of vertical integration by discouraging the party receiving the take-it-or-leave-it offer from accepting the ownership structure preferred by the offering party. Second, virtually all versions of the PRT conclude that the ownership structure should favor the party whose relative contribution to the relationship value is disproportionate, whereas, in our setup, it is not generally the case since, with asymmetric investment activities, the legislator only wishes to foster full-investment. Hence, a fall in a party's ex ante incentives due to a lower intensity of its investment activity must be compensated by a stronger legal protection regardless of the ownership structure.

Second, there is a close connection between our analysis and the literature on non-cooperative bargaining. This stream of research suggests that agents guiding the exchange, with larger outside options and whose relative contribution to the relationship value is more relevant enjoy a higher ex post bargaining power (Rubinstein, 1982; Roth, 1985; Antràs, 2015). These implications do not arise in our framework for two key reasons. On the one hand, since the ownership structure does not primarily shape incentives, the identity of the party guiding its selection, which for the first time we endogenize and link to its private returns, is irrelevant for the design of property rights. On the other hand, the default payoff and the relative importance of each party for the relationship are not positively correlated to its ex post bargaining power in general, since the legislator must always assure that both parties to the relationship do face the right ex ante incentives to fully invest.

Third, our paper is linked to a recent and growing literature on endogenous property rights (Segal and Whinston, 2016; Arruñada et al., 2018; Guerriero, 2016) and, in particular, to Guerriero (2020), who instead finds a negative link between the strength of the upstream firm's property rights and his default payoff but no dependence of the former on

the downstream firm's default payoff. The difference between this result and our conclusion is simply due to the fact that the former is obtained from a transaction-cost model whereas the latter emphasizes our PRT focus on each party's ex ante investment incentives.

Fourth, the tie-breaking rule that we assume to restrict the legislator's design of property rights is logically consonant with the literature on the proper equilibrium (Myerson, 1978). We extend this strand of research by envisioning that not only the parties but also the institutional designer consider both the costs and the odds of unintended strategies.

Finally, we contribute to a burgeoning empirical literature trying to assess the impact of each party's investment decision and their intensity, specificity and contractability on the extent of vertical integration.[5] First, we clarify that future research should consider both the direct and indirect—going through property rights—effects of the partnership details. Second, to overcome the challenge of the measurement of these fundamental objects, we propose to rely on a single data set on both institutions and aggregated firm characteristics.

The paper proceeds as follows. In section 2, we discuss several legal cases emphasizing the relationships between the legal protection of each firm's input and the relative ex post bargaining power. This analysis motivates the general model that we illustrate in section 3. Next, we assess how robust the model's predictions are to alternative assumptions in section 4 and whether they are consistent with cross-country data in section 5. Finally, we conclude in section 6, and we gather the proofs, figures and tables in the appendix.

2 Property Rights Outside and Inside the Firm

Intellectual property rights.—Employers and downstream firms enjoy longer and easier to obtain unregistered rights—i.e., trade secrets—when providing specific assets in capital-intensive sectors such as the software and the entertainment industries [Burk and McDonnel 2007, p. 605].[6] Intuitively, "trade secrets are [...] likely to be among the most firm-specific of intellectual assets—specialized processes, customer lists, business plans, and other information integral to the firm" [Burk and McDonnel 2007, p. 608]. By the same to-

[5] While one strand of literature has focused on the integration decisions of a handful of firms in quite specific industries (see for a review Lafontaine and Slade, [2007]), another one has relied on huge cross-sections of firms and their international internalization decisions (see for a review Antràs, [2015]).

[6] While patents are granted upon the disclosure of the invention and for twenty years, trade secrets arise upon fixation of creative work in a tangible medium and last forever [Burk and McDonnel 2007, p. 610].

ken, legal systems tend to protect these rights through non-disclosure, work for hire and non-competition agreements provided that these clauses do not discourage employees and upstream parties from supplying specific inputs. A case in point is "California, which will not treat noncompetition agreements [...] as valid at all" [Burk and McDonnel 2007, p. 628]. This decision is consonant with the large costs borne by the Silicon Valley firms in specializing their inputs (Saxenian, 1996). Turning to registered property rights, Article 31 of the TRIPS allows upstream partners to obtain the compulsory licensing of downstream parties' patents when the commercial terms for voluntary license are "unreasonable" (Rose, 2019). This is most likely the case when the upstream parties' default payoff is small.

Agency, corporate and labor law.—"The employment contract itself does not fully prejudge the type of relations engaged—an employee/employer relationship or an independent contractor relationship—in the sense that the parties cannot by contract alone determine it. Legislators and judges can legally qualify the situation according to the "salient facts" and to the abusive contract terms" [Baudry and Chassagnon 2018, p. 6]. To elaborate, employers and downstream firms can rely on fiduciary duties and shop right provisions to curb the exploitation of information intimately related to their input, whereas employees and upstream partners can respond by exploiting unfair contract terms and abuse of right doctrines (Baudry and Chassagnon, 2018). In the case of intellectual property, these provisions tend to prescribe that "information whose usefulness is specific to the firm belongs to the firm, while employees can use for themselves more general information" [Burk and McDonnel 2007, p. 597]. Consonant with this view, firms active in the biotechnology sectors try to attract specific human capital by de-emphasizing their rights on innovation and by limiting their presence in the value chain [Burk and McDonnel 2007, p. 632].

Discussion.—The legal evidence just discussed implied three stylized facts. First, commercial law heavily affects each party's renegotiation power, regardless of the arranged ownership structure. Crucially, "any provision of property rights will have simultaneous effects within firms as well as between firms" [Burk and McDonnel 2007, p. 613]. Second, the strength of the legal protection of each party's input rises (falls) with the degree of specificity of the input it (its partner) provides. Finally, the strength of each party's property rights increases with the intensity of the investment activity of its partner.

3 Theory

Next, we provide a general model of endogenous market design producing these three stylized facts. We begin with the basic setup in which the legislator is benevolent and there is perfect complementarity between the two firms' investment activities, which are continuous and have a symmetric impact on the project value. In section 4, we relax these assumptions.

3.1 Basic setup

Technology.—Consider a mass one of upstream firms U and a mass one of downstream firms D, which are randomly paired and can finalize a project of value $\Pi = \lambda\delta\omega$ upon having agreed on the ownership structure $o \in \{D, U, J\}$. While $\delta \in [0,1]$ and $\omega \in [0,1]$ are firm D's and U's non-contractible investment activities and entail a cost $c\delta$ and $c\omega$, $o = D$, $o = U$ and $o = J$ represent upstream-, downstream-, and joint ownership, respectively. λ is the within-match maximum value of the project, and it is uniformly distributed over $\left[\underline{\lambda}, \overline{\lambda}\right]$, with $l \equiv \overline{\lambda} - \underline{\lambda} > 0$, $\underline{\lambda} > 0$ and $\lambda_m \equiv \left(\overline{\lambda} + \underline{\lambda}\right)/2$. As a result, we are assuming that each firm's investment activity equally increases the odds of gaining the maximum project value.

Payoffs.—Without agreement on o, both firms obtain a zero outside option, which is the payoff that firm D (U) will get by producing in house by means of her (his) input—e.g., intangible asset/process (facility/physical asset)—only. When an agreement is reached, and after the firms have invested, they bargain over trade, i.e., they decide whether to use their assets for joint production and divide the gains from trade or to accept the default payoffs $d_i^o\delta\omega$, which denote the payoff to agent $i \in \{D, U\}$ in its next-best alternative to trading given the investment levels selected beforehand. Following Whinston (2003), we allow for a firm's investment to affect not only its own default payoff but also that of its match, i.e., we consider "self-investment" and "cross-investment" activities. In line with the PRT moreover, we assume that, in the case of sole ownership, the owner's default payoff is positive but smaller than $\overline{\lambda}\delta\omega$, while the non-owner's default payoff is zero. To illustrate, $d_U^D = d_D^U = 0$, $d_D^D = \alpha$ and $d_U^U = \beta$ with $0 < \alpha < \overline{\lambda}$ and $0 < \beta < \overline{\lambda}$, i.e., acquiring residual control rights allows only firm D (U) to improve over her (his) outside option in a way proportional to $\delta\omega$ and, under joint ownership, each firm has veto power on the other firm's decision. To avoid the analysis of trivial cases, we impose the following restriction:

Assumption 1: $\overline{\lambda} > 2c > max\{\alpha, \beta, \underline{\lambda}\}$.

While the condition $\overline{\lambda} > 2c > \underline{\lambda}$ implies that there are productive and unproductive matches, $2c > max\{\alpha, \beta\}$ allows us to focus on matches for which selecting the default payoff is not a dominant strategy and equilibrium property rights that can be positive. When the two parties decide to trade, firm U receives d_U^o plus a share γ of the gains from trade—i.e., the project value net of the sum of the default payoffs—and firm D pockets the rest. Formally, firm D's and firm U's ex post bargaining payoffs are $\pi_D^o(\gamma) \equiv d_D^o \delta\omega + (1-\gamma)(\lambda - d_D^o - d_U^o)\delta\omega - c\delta$ and $\pi_U^o(\gamma) \equiv d_U^o \delta\omega + \gamma(\lambda - d_D^o - d_U^o)\delta\omega - c\omega$, and the following rankings arise $\pi_D^D(\gamma) > \pi_D^J(\gamma) > \pi_D^U(\gamma)$ and $\pi_U^U(\gamma) > \pi_U^J(\gamma) > \pi_U^D(\gamma)$.

Interpretation.—The parameter γ captures the protection of the upstream firm's property rights on his facility/physical asset relative to that of the downstream firm's property rights on her intangible asset/process. To elaborate, γ is higher the stronger are the remedies in the upstream partner's hands—i.e., unfair contract terms and abuse of right doctrines, the more efficient is their enforcement and the longer is their prescription period, and it is, symmetrically, weaker the more intense are the legal protections granted to the downstream party, i.e., non-disclosure, work for hire and non-competition agreements and both fiduciary duties and shop right provisions (see section 2). Operationally, γ might capture the odds with which the infringement by U of D's intellectual property rights is condoned because of compulsory licensing, whereas $1-\gamma$ might pick the strength of firm D's registered and unregistered intellectual property rights. More generally, the interaction between D and U can be seen as any activity requiring cooperation between any two parties—e.g., individuals, firms and organizations—in which U's renegotiation power is fixed by the institution γ.

Timing of events.—The sequence of the institutional and economic decisions is as follows.

At time t_0, the legislator selects the protection of the upstream firm's property rights maximizing social welfare, which is the sum of the downstream and upstream firms' payoffs.

At time t_1, firms are randomly matched and, within each match, one of the two firms either picks the outside option or makes a take-it-or-leave-it offer on the ownership structure.

At time t_2 and within matches in which the offer was accepted, each firm selects simultaneously and noncooperatively an investment level.

At time t_3 and within matches in which the offer was accepted, firms bargain over trade.

Discussion.—In evaluating the generality and soundness of the basic setup, several remarks should be headed. First, the hypothesis that the impact of each firm's investment on the project value is symmetric is immaterial to our findings (see section 4.1). Second, should we either focus on self-investment, as Grossman and Hart (1986), or switch to a discrete investment technology, as in Müller and Schmitz (2016), we will obtain very similar results (see sections 4.2 and 4.3). Third, the message of our analysis will be qualitatively similar should we analyze, instead, a unilateral investment decision (see section 4.4). Fourth, since modulating property rights has only the marginal effect of determining the measure of matches that will be productive, our analysis is the same for any other continuous probability density function of λ. By the same token, we can show that our conclusions will be the same should property rights be designed by a partisan legislator (see section 4.5). Fifth, the random matching assumption can also be reinterpreted as a shock to already matched pairs making the within-match maximum value of the project random. Sixth, we characterize the equilibrium in the two cases in which the take-it-or-leave-it offer is made by either firm U or firm D. Our conclusions will be the same should we allow the parties to bargain over the ownership structure (see section 4.6). Finally, the division of the gains from trade will still be determined by γ should we envision a different ex post bargaining parameter ζ but allow the two firms to obtain that, instead, γ is enforced by filing suit at time t_3. Of course, at least one firm will be better off with γ. Then, this parameter can also be seen as the share of pro-firm U courts driven by the law (Guerriero, 2020). This view squares with the idea that courts arbitrarily evaluate the evidence when the state of the world is hard to verify and, thus, it can be interpreted and manipulated at adjudication (Gennaioli, 2013).

Equilibrium: concept and regularities.—We focus on SPE in pure strategies. Any such an equilibrium prescribes a property rights level γ^* and, for each match λ, an ownership structure o^* and possibly multiple equilibria investment levels δ^* and ω^*.

In any SPE, the two firms never strictly prefer to agree on a o and accept the default payoff since at least one of the two party will, then, select a zero investment level and the project value will be 0, whereas they will prefer the ex post bargaining payoff to the outside option—i.e., the IR constraints hold—if $\pi_D^o \geq 0$ and $\pi_U^o \geq 0$, which imply $\pi_D^o + \pi_U^o = \lambda\delta^*\omega^* - c(\delta^* + \omega^*) \geq 0$. Hence, the IR constraints hold for the "no-investment" profile prescribing

$\delta^* = \omega^* = 0$, for the full-investment profile entailing $\delta^* = \omega^* = 1$ provided that $\lambda \geq 2c$, and for the intermediate-investment profile $0 < \delta^* < 1$ and $0 < \omega^* < 1$ for $\lambda > 2c$ since this pair implies $\pi_D^o = \pi_U^o = 0$ as further discussed below. Hence, for all three investment strategies, the firms will always prefer to trade at time t_3 since $\lambda\delta^*\omega^* \geq max\{d_D^o\delta^*\omega^*, d_U^o\delta^*\omega^*\}$. For the no-investment profile, the inequality will hold as equality, whereas for the full- and intermediate-investment profile it will be strict because $2c > max\{\alpha, \beta\}$ by assumption 1.

These remarks imply the following equilibrium regularities. First, since the no- and intermediate-investment profiles always entail zero ex post bargaining payoffs, the choice of property rights will not affect these decisions and will be taken to maximize the social welfare as all the productive matches were embracing the full-investment profile. Second, the smallest productive match—i.e., one supporting also positive investment levels—will, then, be $\lambda = 2c$. Finally, since for full-investment profiles production implies profit maximization, the legislator only cares about eliciting production for $\lambda \geq 2c$ and not about the prevailing ownership structure. At $\lambda = 2c$, indeed, both firms U and D will offer the ownership structure for which production is possible since any other option makes one of the two IR constraints fail. Yet, the identity of the firm making the offer matters for the o prevailing for $\lambda > 2c$. We will exploit the inefficiency of the intermediate-investment profiles to impose a natural rule breaking the legislator's indifference between property rights levels:

Assumption 2: *If indifferent among property rights levels, the legislator will pick the one maximizing the adoption of full-investment profiles and, conditionally on this goal being reached, minimizing the adoption of the intermediate-investment profiles.*

Assumption 2 can be formally justified by recurring to the logic of the proper equilibrium refinement (Myerson, 1987). To illustrate, the legislator will expect that, whenever possible, either the no- or the intermediate-investment profiles will be played with a probability—two orders of magnitude—smaller than that with which the full-investment profile is embraced in such a way that more costly trembles are made with significantly smaller probability than less costly ones. As a result, selecting a property rights level that encourages the adoption of full-investment, in the first place, and that discourages intermediate-investment strategies, in the second place, the legislator weakly raises social welfare (see footnote 10).

3.2 Equilibrium

Being the game of perfect information, we will solve it by backward induction following three steps. First, we will find the optimal investment levels δ^* and ω^* within each λ and given γ and o. This first exercise allows us to identify the threshold λ_i^o such that the IR constraint of firm i hold for every $\lambda \geq \lambda_i^o$ and given investment levels $\delta^* = \omega^* = 1$ and such that the match $\lambda = 2c$ produces under ownership structure o. Next, we will obtain the $\gamma^o = \gamma^*$ minimizing the thresholds λ_i^o for all i and, possibly, the measure of matches for which the intermediate-investment profiles might arise. Finally, we will characterize the ownership structure prevailing for each match $\lambda > 2c$ given the optimal property rights level γ^* for the cases in which the take-it-or-leave-it offer comes from either firm D or firm U.

3.2.1 Selecting Investment

Given γ^* and o, firms D and U will select the δ and ω solving the linear programs

$$d_D^o \delta\omega + (1-\gamma^*)\left(\lambda - d_D^o - d_U^o\right)\delta\omega - c\delta + \mu_1\delta - \mu_2\left(\delta - 1\right), \tag{1}$$

$$d_U^o \delta\omega + \gamma^*\left(\lambda - d_D^o - d_U^o\right)\delta\omega - c\omega + \mu_3\omega - \mu_4\left(\omega - 1\right), \tag{2}$$

where μ_1 and μ_3 (μ_2 and μ_4) are the Karush-Kuhn-Tucker multiplier of the constraint $-\delta \leq 0$ and $-\omega \leq 0$ ($\delta \leq 1$ and $\omega \leq 1$), respectively. The two necessary first order conditions—i.e., FOCs thereafter—are $\left[\gamma^* d_D^o + (1-\gamma^*)\left(\lambda - d_U^o\right)\right]\omega^* - c + \mu_1 - \mu_2 = 0$ and $\left[(1-\gamma^*)\, d_U^o + \gamma^*\left(\lambda - d_D^o\right)\right]\delta^* - c + \mu_3 - \mu_4 = 0$ and turn out to be sufficient given the concavity of the firms' programs. Furthermore, they entail that, among the seven possible investment profiles, only three can be part of a SPE because of the mix of the complementarity in the firms' investment choices and the opposite impacts of γ on firm D's and firm U's ex post bargaining payoffs. First, $\delta^* = 0 = \omega^*$ is always part of a SPE. Second, the pairs $\{\delta^* = \frac{(1-\gamma^*)\omega^*}{\gamma^*}, \omega^*\}$, $\{\delta^* = \frac{(1-\gamma^*)c\omega^*}{\gamma^*(c-\alpha\omega^*)}, \omega^*\}$ and $\{\omega^* = \frac{\gamma^* c\delta^*}{(1-\gamma^*)(c-\beta\delta^*)}, \delta^*\}$ are part of a SPE for $o = J$ and $\lambda = \frac{c}{(1-\gamma^*)\omega^*} = \frac{c}{\delta^*\gamma^*} > 2c$, $o = D$ and $\lambda = \frac{c-\alpha\gamma^*\omega^*}{(1-\gamma^*)\omega^*} = \frac{c}{\gamma^*\delta^*} + \alpha > 2c$ and $o = U$ and $\lambda = \frac{c}{(1-\gamma^*)\omega^*} + \beta = \frac{c-\beta(1-\gamma^*)\delta^*}{\delta^*\gamma^*} > 2c$, respectively. All these interior investment profiles entail zero ex post bargaining payoffs. Finally, $\delta^* = 1 = \omega^*$ are part of a SPE for $o = J$ if $\lambda > \frac{c}{1-\gamma^*} \equiv \hat{\lambda}_D^J(\gamma^*)$ and $\lambda > \frac{c}{\gamma^*} \equiv \hat{\lambda}_U^J(\gamma^*)$, for $o = D$ if $\lambda > \frac{c-\alpha\gamma^*}{1-\gamma^*} \equiv \hat{\lambda}_D^D(\gamma^*)$ and

$\lambda > \frac{c}{\gamma^*} + \alpha \equiv \hat{\lambda}_U^D(\gamma^*)$ and for $o = U$ if $\lambda > \frac{c}{1-\gamma^*} + \beta \equiv \hat{\lambda}_D^U(\gamma^*)$ and $\lambda > \frac{c-\beta(1-\gamma^*)}{\gamma^*} \equiv \hat{\lambda}_U^U(\gamma^*)$.

3.2.2 Property Rights and Ownership Structure Design

To maximize the measure of matches $\lambda > 2c$ adopting $\delta^* = 1 = \omega^*$ and induce the $\lambda = 2c$ match to produce under $o = J$, the legislator selects the γ maximizing either

$$\int_{\hat{\lambda}_D^J}^{\overline{\lambda}} \frac{\lambda - 2c}{l} d\lambda \tag{3}$$

for $\hat{\lambda}_D^J \geq \hat{\lambda}_U^J \leftrightarrow \gamma \geq \gamma^J \equiv \frac{1}{2}$ or $\int_{\hat{\lambda}_U^J}^{\overline{\lambda}} \frac{\lambda-2c}{l} d\lambda$ otherwise. The FOCs are $-\frac{c\left[c-2c\left(1-\gamma^J\right)\right]}{l\left(1-\gamma^J\right)^3} = 0$ and $\frac{c\left(c-2c\gamma^J\right)}{l\left(\gamma^J\right)^3} = 0$, respectively. In both instances, the unique solution is $\gamma^* = \gamma^J$.[7] Intuitively, the legislator realizes that a rise in γ encourages the U firm and disincentivizes the D one and, thus, she calibrates the property rights level to convince both to pick the full-investment profile for the $\hat{\lambda}_D^J\left(\gamma^J\right) = \hat{\lambda}_U^J\left(\gamma^J\right) = 2c$ match and—*a fortiori*—for all the more profitable ones. This amounts to equally protect both sides when $o = J$ being, then, the default payoffs equal. Overall, for $\gamma^* = \gamma^J$, all the matches strictly smaller than $2c$ pick the outside option and those weakly larger can adopt the full- and no-investment profiles. Moreover, all the matches $\frac{2c}{\omega^*} = \frac{2c}{\delta^*} > 2c$—for a total of $\hat{\lambda}_D^J(\epsilon) - \hat{\lambda}_U^J(1-\epsilon) = \frac{2c}{\epsilon} - \frac{2c}{1-\epsilon}$ with $\epsilon \to 0$—can select the interior $0 < \omega^* = \delta^* < 1$. Turning to the choice of ownership structure o, the latter is irrelevant for $\omega^* < 1$ and $\delta^* < 1$ since $\pi_D^o = \pi_U^o = 0$ for every match λ. When instead $\omega^* = \delta^* = 1$, firm D offers firm U an o increasingly appealing for herself whenever she knows that such an offer will be accepted: 1. $o = J$ if $2c \leq \lambda < \hat{\lambda}_U^D\left(\gamma^J\right) = 2c + \alpha$; 2. $o = D$ if $\lambda \geq 2c + \alpha$. As any of the other thresholds inducing a change in ownership structure, $\hat{\lambda}_U^J\left(\gamma^J\right)$ entails full-investment by both firms. Considering joint ownership as a contract and both downstream and upstream ownership as instances of vertical integration V, the extent of the latter will equal $\frac{\overline{\lambda}-\hat{\lambda}_U^J\left(\gamma^J\right)}{l} \propto \overline{\lambda} - 2c - \alpha$. Intuitively, it will fall with both c and α since larger innovation costs and default payoffs reduce the ex post bargaining payoff via the investment costs and the investment returns of the firm operating under the least preferred o, respectively, making the outside option more appealing. Similarly, firm U offers firm D an o increasingly appealing for himself when he knows that such an offer will be accepted:

[7] Albeit the legislator's objective function is not concave, the left-hand side of each FOC is positive (negative) for $\gamma \leq (>)\, \gamma^J$. This pattern implies that γ^J is the unique and global equilibrium property rights level.

1. $o = J$ if $2c \leq \lambda < \hat{\lambda}_D^U\left(\gamma^J\right) = 2c + \beta$; 2. $o = U$ if $\lambda \geq 2c + \beta$. These patterns imply a $V \propto \overline{\lambda} - 2c - \beta$ and, thus, falling with c and β. Overall, the ownership structure that the legislator imposes on $\lambda = 2c$ by selecting γ^J is the residual rights allocation easing the most full-investment and most likely to arise for $\overline{\lambda}$ not too large when compared to c, α and β.

The analysis is qualitatively similar in the instances in which the legislator wishes to induce the $\lambda = 2c$ match to produce under either $o = D$ or $o = U$. Starting from the former case, the legislator selects the γ maximizing either $\int_{\hat{\lambda}_D^D}^{\overline{\lambda}} \frac{\lambda - 2c}{l} d\lambda$ for $\hat{\lambda}_D^D \geq \hat{\lambda}_U^D \leftrightarrow \gamma \geq \gamma^D \equiv \frac{c}{2c-\alpha} > \frac{1}{2}$ or $\int_{\hat{\lambda}_U^D}^{\overline{\lambda}} \frac{\lambda - 2c}{l} d\lambda$ otherwise. The FOCs are $-\frac{c-\alpha}{l(1-\gamma^D)^3}\left[c - \alpha\gamma^D - 2c\left(1 - \gamma^D\right)\right] = 0$ and $\frac{c}{l(\gamma^D)^3}\left[c + \gamma^D\left(\alpha - 2c\right)\right] = 0$, respectively. In both instances, the unique solution is $\gamma^* = \gamma^D$, which falls with c and increases with α.[8] To illustrate, a rise in α increases (decreases) firm $D(U)$'s ex post bargaining payoff from $o = D$ and, thus, calls for a larger γ^* to convince firm U to invest, whereas a rise in c has both the marginal effect of shrinking the matches realizing the project—$\overline{\lambda} - 2c$—and the inframarginal effect of decreasing the social value of the finalized projects. Being both effects negative, the legislator discourages production by incentivizing less the firm operating under the less preferred ownership structure and, thus, obtaining the lowest payoff at $\lambda = 2c$. Assumption 1 implies that $\gamma^D \geq 0$. When, however, $c < \alpha$, then $1 - \gamma^D < 0$, $\pi_U^D < 0$ at $\lambda = 2c$, and the legislator will not consider γ^D since, as we have seen before, she can always reach the maximum measure of matches possibly embracing the full-investment profile with γ^J. Turning to the interior investment choices $0 < \delta^* = \frac{(c-\alpha)\omega^*}{c-\alpha\omega^*} < \omega^* < 1$, they might arise for all the matches $\frac{2c-\alpha(1-\delta^*)}{\delta^*} = \frac{c[2c-\alpha(1+\omega^*)]}{(c-\alpha)\omega^*} > 2c$ for a total of $\hat{\lambda}_U^D(\epsilon) - \hat{\lambda}_D^D(1-\epsilon) = \frac{2c}{\epsilon} - \frac{\alpha(1-\epsilon)}{\epsilon} - \frac{2c}{1-\epsilon} - \frac{\epsilon\alpha c}{(1-\epsilon)(c-\alpha)}$ matches. For what concerns the choice of ownership structure, the latter is again irrelevant for $\omega^* < 1$ and $\delta^* < 1$, whereas, for $\omega^* = \delta^* = 1$, firm D always offers—for $\lambda \geq 2c$—her preferred ownership structure $o = D$ to firm U, who accepts. The extent of vertical integration V is now maximum and proportional to $\overline{\lambda} - 2c$. Firm U, instead, offers firm D an o increasingly appealing for himself whenever he knows that such an offer will be accepted: 1. $o = D$ if $2c \leq \lambda < \hat{\lambda}_D^J\left(\gamma^D\right) = \frac{c(2c-\alpha)}{c-\alpha}$; 2. $o = J$ if $\hat{\lambda}_D^J\left(\gamma^D\right) \leq \lambda < \hat{\lambda}_D^U\left(\gamma^D\right) = \frac{c(2c-\alpha)}{c-\alpha} + \beta$; 3. $o = U$ if $\lambda \geq \hat{\lambda}_D^U\left(\gamma^D\right)$. Hence, the extent of vertical integration equals $V \propto \overline{\lambda} - 2c - \beta$ and falls with both c and β.

[8] Albeit the legislator's objective function is not concave, the left-hand side of each FOC is positive (negative) for $\gamma \leq (>)\,\gamma^D$. This pattern implies that γ^D is the unique and global equilibrium property rights level.

When, finally, the legislator wishes to induce the $\lambda = 2c$ match to produce under $o = U$, she selects the γ maximizing either $\int_{\hat{\lambda}_D^U}^{\overline{\lambda}} \frac{\lambda - 2c}{l} d\lambda$ for $\hat{\lambda}_D^U \geq \hat{\lambda}_U^U \leftrightarrow \gamma \geq \gamma^U \equiv \frac{c-\beta}{2c-\beta} < \frac{1}{2}$ or $\int_{\hat{\lambda}_U^U}^{\overline{\lambda}} \frac{\lambda - 2c}{l} d\lambda$ otherwise. The relative FOCs are $-\frac{c}{l(1-\gamma^U)^3}\left[c + (\beta - 2c)\left(1 - \gamma^U\right)\right] = 0$ and $\frac{c-\beta}{l(\gamma^U)^3}\left[c - \beta\left(1 - \gamma^U\right) - 2c\gamma^U\right] = 0$, respectively. In both instances, the unique solution is $\gamma^* = \gamma^U$, which increases with c and falls with β.[9] To illustrate, a rise in β increases (decreases) firm $U(D)$'s ex post bargaining payoff from $o = U$ and, thus, calls for a smaller γ^* to convince firm D to invest, whereas a rise in c has both the marginal effect of shrinking the matches realizing the project and the inframarginal effect of decreasing the social value of the finalized projects. Being both effects negative, the legislator discourages production by incentivizing less the firm operating under the less preferred ownership structure and, thus, obtaining the lowest payoff at $\lambda = 2c$. Assumption 1 implies that $\gamma^U \geq 0$. When, however, $c < \beta$, then $\gamma^U < 0$, $\pi_D^U < 0$ at $\lambda = 2c$, and the legislator will not consider γ^U since she can always reach the maximum measure of matches possibly embracing the full-investment profile with γ^J. Turning to the intermediate-investment profiles $\omega^* = \frac{(c-\beta)\delta^*}{c-\beta\delta^*} < \delta^*$, they might arise for all the matches $\frac{2c-\beta(1-\omega^*)}{\omega^*} = \frac{c[2c-\beta(1+\delta^*)]}{(c-\beta)\delta^*} > 2c$ for a total of $\hat{\lambda}_D^U(\epsilon) - \hat{\lambda}_U^U(1-\epsilon) = \frac{2c}{\epsilon} - \frac{\beta(1-\epsilon)}{\epsilon} - \frac{2c}{1-\epsilon} - \frac{\epsilon\beta c}{(1-\epsilon)(c-\beta)}$ matches. For what concerns the choice of ownership structure, the latter is again irrelevant for $\omega^* < 1$ and $\delta^* < 1$, whereas, for $\omega^* = \delta^* = 1$, firm D offers firm U an o increasingly appealing for herself whenever she knows that such an offer will be accepted: 1. $o = U$ if $2c \leq \lambda < \hat{\lambda}_U^J\left(\gamma^U\right) = \frac{c(2c-\beta)}{c-\beta}$; 2. $o = J$ if $\hat{\lambda}_U^J\left(\gamma^U\right) \leq \lambda < \hat{\lambda}_U^D\left(\gamma^U\right) = \frac{c(2c-\beta)}{c-\beta} + \alpha$; 3. $o = D$ if $\lambda \geq \hat{\lambda}_U^D\left(\gamma^U\right)$. Hence, the extent of vertical integration is $V \propto \overline{\lambda} - 2c - \alpha$ and falls with c and α. Firm U, instead, always offers—for $\lambda \geq 2c$—her preferred ownership structure $o = U$ to firm D, who accepts. This time, vertical integration is such that $V \propto \overline{\lambda} - 2c$.

The three market structures supported by γ^J, γ^D and γ^U induce the no-investment profile when they induce the full-investment one. The intermediate-investment profile is, instead, most likely for $\gamma^* = \gamma^J$ and more (less) likely for $\gamma^* = \gamma^U$ than it is for $\gamma^* = \gamma^D$ if $\alpha > (<)\,\beta$. Then, indeed, the gains from trade for the party operating under the least preferred ownership structure—i.e., downstream firm under upstream(downstream)-ownership—are large (see the appendix). As a consequence, $\gamma^* = \gamma^J$ will never be selected if $\gamma^* = \gamma^D$ and/or $\gamma^* = \gamma^U$ also

[9] Albeit the legislator's objective function is not concave, the left-hand side of each FOC is positive (negative) for $\gamma \leq (>)\,\gamma^U$. This pattern implies that γ^U is the unique and global equilibrium property rights level.

deliver the optimal measure of matches possibly embracing full-investment, and the legislator prefers γ^D to γ^U (otherwise) if $\alpha > (<) \beta$ when both levels of property rights protection achieve the optimal supply of project possibly selecting the full-investment profile.

Overall, γ^* ends up to be independent of the identity of the party making the take-it-or-leave-it offer and, under assumptions 1 and 2, unique. To summarize, the legislator organizes the market in one of three ways. For $2c > \beta > c \geq \alpha$ (i) and $2c > c \geq \alpha \geq \beta$ (ii), she select a relatively strong protection of the upstream firm's property rights γ^D to induce more often downstream-ownership. This is useful to maximize the chances of full-investment and minimize inefficient intermediate-investment profiles, given that γ^U is not an option under scenario (i) and all three market structures are available under scenario (ii). For similar reasons, the legislator grants a relatively weak protection of the upstream firm's property rights γ^U to induce more often upstream-ownership for $2c > \alpha > c \geq \beta$ and $2c > c \geq \beta > \alpha$. In the residual cases $2c \geq max\{\alpha, \beta\} \geq min\{\alpha, \beta\} > c$, an equal protection of both sides and joint-ownership is the only alternative. The following proposition summarizes our analysis:

Proposition: *Under assumptions 1 and 2, the SPE is for: 1.* $2c > c \geq \alpha \geq \beta$, $\gamma^* = \gamma^D \equiv \frac{c}{2c-\alpha}$, *either* $\omega^* = \delta^* = 0$, $\delta^* = \frac{(c-\alpha)\omega^*}{c-\alpha\omega^*} < \omega^* < 1$ *or* $\omega^* = \delta^* = 1$, *and* $V \propto \overline{\lambda} - 2c\left(\overline{\lambda} - 2c - \beta\right)$ *if firm D (U) offers o; 2.* $2c > c \geq \beta > \alpha$, $\gamma^* = \gamma^U \equiv \frac{c-\beta}{2c-\beta}$, *either* $\omega^* = \delta^* = 0$, $\omega^* = \frac{(c-\beta)\delta^*}{c-\beta\delta^*} < \delta^* < 1$ *or* $\omega^* = \delta^* = 1$, *and* $V \propto \overline{\lambda} - 2c - \alpha\left(\overline{\lambda} - 2c\right)$ *if firm D (U) offers o; 3.* $2c > \alpha > c \geq \beta$, $\gamma^* = \gamma^U$, *either* $\omega^* = \delta^* = 0$, $\omega^* = \frac{(c-\beta)\delta^*}{c-\beta\delta^*} < \delta^* < 1$ *or* $\omega^* = \delta^* = 1$, *and* $V \propto \overline{\lambda} - 2c - \alpha\left(\overline{\lambda} - 2c\right)$ *if firm D (U) offers o; 4.* $2c > \beta > c \geq \alpha$, $\gamma^* = \gamma^D$, *either* $\omega^* = \delta^* = 0$, $\delta^* = \frac{(c-\alpha)\omega^*}{c-\alpha\omega^*} < \omega^* < 1$ *or* $\omega^* = \delta^* = 1$, *and* $V \propto \overline{\lambda} - 2c\left(\overline{\lambda} - 2c - \beta\right)$ *if firm D (U) offers o; 5.* $2c \geq max\{\alpha, \beta\} \geq min\{\alpha, \beta\} > c$, $\gamma^* = \gamma^J \equiv \frac{1}{2}$, *either* $\omega^* = \delta^* = 0$, $\delta^* = \omega^* < 1$ *or* $\omega^* = \delta^* = 1$, *and* $V \propto \overline{\lambda} - 2c - \alpha\left(\overline{\lambda} - 2c - \beta\right)$ *if firm D (U) offers o.*[10]

In the most likely case of $c > min\{\alpha, \beta\}$—i.e., sizable asset specificity and, thus, large

[10] Assigning—with an abuse of notation—a probability ϵ^2 to either the no- or the intermediate-investment profile being played and a likelihood $1 - 2\epsilon^2$ to the full-investment strategy, it is straightforward to see that the latter is the only proper equilibrium (Myerson, 1987). Exploiting the same logic, we can conclude that favoring the maximization of the matches possibly embracing the full-investment profile over the minimization of those inducing an interior investment is always welfare-improving being $\left(1-2\epsilon^2\right)\frac{(\alpha-c)^2}{2} > \epsilon^2(1-\epsilon)(\alpha-\beta)\left[\frac{2c}{\epsilon} - 2c - \frac{(\alpha+\beta)}{2}(1-\epsilon)\right]$ $\left(\left(1-2\epsilon^2\right)\frac{(\beta-c)^2}{2} > \epsilon^2(1-\epsilon)(\beta-\alpha)\left[\frac{2c}{\epsilon} - 2c - \frac{(\alpha+\beta)}{2}(1-\epsilon)\right]\right)$ for $\alpha > c \geq \beta$ ($\beta > c \geq \alpha$) and $\left(1-2\epsilon^2\right)\frac{(\beta-c)^2}{2} > \epsilon^2(1-\epsilon)\beta\left[\frac{2c}{\epsilon} - \frac{\beta(1-\epsilon)}{2}\right]$ $\left(\left(1-2\epsilon^2\right)\frac{(\alpha-c)^2}{2} > \epsilon^2(1-\epsilon)\alpha\left[\frac{2c}{\epsilon} - \frac{\alpha(1-\epsilon)}{2}\right]\right)$ for $\alpha \geq \beta > c$ ($\beta \geq \alpha > c$) (see also Müller and Schmitz, [2016]).

gains from trade (Antràs, 2015), the proposition produces two key implications.

First, the protection of the upstream firm's property rights has an inverted U-shaped (U-shaped) relationship with c for $\alpha > (\leq)\, \beta$ and a weakly increasing (decreasing) link with $\alpha\,(\beta)$ (see figures 1 to 3). The first pattern is due to the opposite relationships between γ^D and γ^U, on the one hand, and the marginal innovation cost, on the other hand. The intuition behind the second pattern is as follows. The legal protection of the upstream firm's property rights must be stronger when his investment returns fall under downstream-ownership because of a rise in firm D's default payoff and, symmetrically, it must be weaker when his own default payoff rises under upstream-ownership. Opposite patterns holds true for the legal protection of the downstream firm. These conclusions differ from those by Guerriero (2020), who focuses on hold-up failures and, consequently, finds a negative link between γ^* and β but no dependence on α. In addition, they contrast with the conclusions of a vast literature on endogenous bargaining power (Rubinstein, 1982; Roth, 1985). This vast strand of research stresses that the party endowed with the larger outside option should also enjoy a stronger renegotiation power. This is not the case here since, having assured that the measure of full-investment projects is maximized, the legislator manipulates property-rights protection to discourage costly deviation to the intermediate-investment profiles.

Second, the extent of vertical integration falls with c and weakly decreases with both α and β since, as seen above, all three factors make the outside option more appealing (see figures 4 to 8). This implication is at odds with some well-known results of both the PRT and transaction costs theory of the firm. Starting with the former, it claims that, whenever one party's default payoff under its preferred ownership structure falls, then its willingness to integrate might either fall or rise depending on whether asset specificity shapes its marginal return on investment or its ex post bargaining power (Whinston, 2003; Antràs, 2015). In our setup instead, any rise in the default payoffs limits the extent of vertical integration by discouraging the party receiving the take-it-or-leave-it offer to accept the ownership structure preferred by the offering party. Turning to the transaction costs theory of the firm finally, the implications of our framework are only qualitatively similar. If indeed one interprets the default payoffs as an inverse measure of firm-specific asset specificity, our results suggest that, as in the PRT, assigning residual rights does not automatically establish the first best

(Coase, 1937; Williamson, 2010). This is because no- and intermediate-investment profiles delivering a zero social welfare cannot be eliminated. More generally, if one interprets the marginal innovation cost c as an ex post transaction cost (see Müller and Schmitz, [2016]), our results also contradict the dual spirit of the Coase theorem (Coase, 1960). Regardless of the size of transaction costs, the strength of property rights always shapes the final allocation.

These differences are driven by the fact that we consider both the direct and indirect—going through property rights—impacts of the default payoffs and the innovation costs.

4 Robustness to Alternative Assumptions

Next, we document the robustness of the model to several alternative assumptions.

4.1 Asymmetric Investment

A crucial difference between our analysis and those in the PRT spirit is that the latter consistently conclude that the ownership structure should favor the party whose relative contribution to the relationship value is disproportionate (Grossman and Hart, 1986), whereas in our setup both the relative impact of each firm's investment choice on the project value and their complementarity are neutral. To see this, it is sufficient to envision that each project has a value $\Pi = \lambda\delta A\omega$ where the parameter $A > 1$ measures either the major contribution to the production of one of the two firms' investment or the degree of complementarity of investment. Except for the fact that the lowest productive match is $2c/A$, the analysis is unaffected since all the λ_i^o will be equal to those of the basic setup multiplied by a term $1/A$. Hence, γ^* and set of matches for which the intermediate-investment profiles arise are the same. An obvious objection to our approach is that it might be distorted by the Hicks-neutral nature of A. To elucidate why our conclusions are more general, we have also solved the model for a Cobb-Douglas production function with constant return to scale and the intensity of firm D's investment equal to ρ, i.e., $\pi_D^o(\gamma) \equiv d_D^o\delta^\rho\omega^{1-\rho} + (1-\gamma)(\lambda - d_D^o - d_U^o)\delta^\rho\omega^{1-\rho} - c\delta$ and $\pi_U^o(\gamma) \equiv d_U^o\delta^\rho\omega^{1-\rho} + \gamma(\lambda - d_D^o - d_U^o)\delta^\rho\omega^{1-\rho} - c\omega$ (see the appendix).

Under this scenario, incentive compatibility is more stringent than individual rationality and the intermediate-investment profiles have always a measure zero. As a result, the legislator is always indifferent among the three possible market structures when available. To

elaborate, all the matches select the full-investment profile for $\lambda \geq \frac{c}{(1-\rho)\rho} \equiv \lambda_i^o$, gain at least a positive ex post bargaining payoff and property rights are either $\gamma^J = \rho$, $\gamma^D = \frac{c\rho}{c-\alpha\rho(1-\rho)} > \rho$ and $\gamma^U = \frac{\rho[c-\beta(1-\rho)]}{c-\beta\rho(1-\rho)} < \rho$. Again, it is the strength of property rights to primarily shape the ex ante parties' incentives. To illustrate, in the most likely case in which the default payoffs are small compared to the marginal innovation costs and, thus, the gains from trade are large, γ^* always rises with the intensity of the downstream firm's investment activity ρ.[11] This pattern is inconsistent with those applications of the PRT endogenizing the choice of ex post bargaining power by the party who also picks the ownership structure (Antràs, 2015). These papers suggest that both decisions should favor the party whose relative contribution to the relationship is larger. Our more realistic assumption that the ex post bargaining power maximizes social welfare, which here entails fostering full-investment, implies that a rise in the intensity of one party's investment and a symmetric fall in the partner's investment return must be balanced by a stronger legal protection of the latter to assure that both firms face maximum investment incentives. This conclusion is logically similar to the one we reach in the basic model under the scenario of relatively small default payoffs.

Crucially, a glance at γ^* and λ_i^o suggests that the equilibrium property rights continue to weakly rise with α and fall with β and that the extent of vertical integration still decreases with both default payoffs (see the appendix). Differently from the basic setup yet, vertical integration has also a inverted U-shaped relationship with the intensity of the downstream firm's investment activity. The intuition for this novel patters is straightforward: $\rho = 1/2$ maximizes both parties' incentives to invest and, thus, to produce under integration.

4.2 Imperfect Complementarity

Following Grossman and Hart (1986), one alternative to our setup is to allow only for self-investment by assuming that firms D's and U's default payoffs are shaped only by their investment levels δ and ω, respectively. Consequently, firm D's ex post bargaining payoff is $d_D^o\delta + (1-\gamma)(\lambda\delta\omega - d_D^o\delta - d_U^o\omega) - c\delta$ and firm U's default payoff equals $d_U^o\omega + \gamma(\lambda\delta\omega - d_D^o\delta - d_U^o\omega) - c\omega$. Then, the thresholds assuring that the two IR constraints are satisfied are always weakly larger than those leading to the full-investment profile but

[11] To illustrate, $\frac{d\gamma^D}{d\rho} \propto c\left(c - \alpha\rho^2\right)$ and $\frac{d\gamma^U}{d\rho} \propto c\left[c - \beta\left(1-\rho\right)^2\right]$.

determine the same λ_i^o, γ^o and intermediate-investment profiles discussed in the basic setup (see the appendix). As a consequence, our analysis remains exactly the same.

4.3 Discrete Investment

Following Müller and Schmitz (2016), we consider here the alternative setup in which the project value λ arises only when the two firms simultaneously and noncooperatively incur the upfront payment c at time t_2 and the default payoffs are simply given by d_i^o. Then, firm D pays c only if $d_D^o + (1-\gamma)(\lambda - d_D^o - d_U^o) > c$, whereas firm U incurs the upfront cost only if $d_U^o + \gamma(\lambda - d_D^o - d_U^o) > c$. Then, the same λ_i^o and γ^o of the basic setup will arise under either no- or full-investment profile for $\lambda \geq 2c$. The absence of no intermediate-investment profiles entails that the legislator cannot break the indifference among the three possible market structures—i.e., those for which the two firms both pay c for $\lambda = 2c$ and under either joint-, downstream- or upstream-ownership—exploiting the criterion stated in assumption 2.

4.4 Unilateral Investment

An alternative tradition on the impact of residual rights on allocative efficiency has focused instead on unilateral investment (Gibbons, 2005). Our setup can be accommodated to analyze this case by assuming, without loss of generality, that only firm U invests and, thus, that the ex post bargaining payoffs are $\pi_D^o = d_D^o\omega + (1-\gamma^*)(\lambda - d_D^o - d_U^o)\omega$ and $\pi_U^o = d_U^o\omega + \gamma^*(\lambda - d_D^o - d_U^o)\omega - c\omega$, respectively. It is, then, immediate to see that both λ_i^o and γ^o will be as in the basic setup, but we will loose the refinement mechanism described in assumption 2 and assured by the existence of two investment decisions, i.e., δ and ω.

4.5 The Political Economy of Market Design

Thus far, we have examined the choice of property rights on innovation by downstream and upstream firms with equal political power. Reality is, however, much less ideal. To evaluate the positive side of market design, we follow Guerriero (2020), and we consider a situation in which the firms selecting γ can exclude the remainder from the social welfare maximization. It seems natural to think of these "insiders" as the firms involved in the matches possibly leading to the most valuable projects. This assumption incorporates into the model the idea put forward by a growing literature on endogenous lobbying that the

groups actively participating in the institutional design are those most affected by it (Felli and Merlo, 2006; Guerriero, 2016). Since, however, modulating γ has only a marginal effect on the social welfare, excluding a sufficiently small share of low- or even high-value matches does not affect the selection of property rights and the distribution of ownership structures.

4.6 Bargaining Over the Ownership Structure

In the basic setup, we maintain that trade is possible and cost-less ex post—i.e., at time t_3—but we do not allow the firm receiving the take-it-or-leave-it offer o to pay the other party at time t_1 to get a different residual rights arrangement. As discussed in the appendix, this possibility keeps intact our analysis provided that the ex ante borrowing—and, in general, transaction—costs are positive but negligible, i.e., $\nu \to 0$. Under this scenario, no deal different from the take-it-or-leave-it offer can be struck at time t_1 since any gain by one side is exactly offset by the loss of the other side and, thus, even a negligible ex ante contracting cost will forbid different agreements on the ownership structure. This remark leaves unchanged the predictions of our model. The main objection to this conclusions is that ex ante and ex post contracting costs should be equal. Yet, should we envision an ex post trade cost of ν, the only affected features of our analysis are that matches with a maximum project value slightly higher than $\lambda = 2c$ will prefer the outside option under any market structure and that γ^o will depend on ν in the same way in which it depends on c.

5 Evidence

In the most likely case in which the marginal innovation cost is large compared to any default payoff and, thus, asset specificity is large, the most innovative model implications can be restated in the form of the following two testable predictions:

Testable predictions: *1. The strength of the upstream firm's property rights weakly rises with both the specificity of his asset and the intensity of the downstream firm's investment activity and weakly falls with the specificity of the downstream firm's asset. 2. The extent of vertical integration weakly rises with the specificity of both assets and has an inverted U-shaped relationship with the intensity of the downstream firm's investment activity.*

5.1 Measurement

We analyze a panel of 115 countries surveyed by the EOS between 2006 and 2015 (see table 1).[12] The EOS is the longest-running survey of the opinions of business leaders on topics for which statistics are unreliable or nonexistent (WEF, 2015). In the case of our analysis, it provides information on the protection of each party's property rights and on the severity of asset specificity unavailable at the cross-country firm level (Antràs, 2015).

Starting with the strength of property rights, we consider two indicators ranging between one and seven and rising with the protection of generic property including financial assets—i.e., *Property-Rights*—and the defense of intellectual property rights including anti-counterfeiting measures, i.e., *IPR* (see table 2 for the definition and sources of all the variables). Since these rights are typically defined on final goods [Burk and McDonnel 2007, p. 591-594], the two indexes constitute an inverse (direct) metrics of the extent of legal protection of the rights of the upstream (downstream) firms (Guerriero, 2020).

Turning to the ownership structure, we focus on the 1-7 index *Vertical-Integration*. This indicator captures whether firms have a narrow or a broad presence in the value chain. A value of one indicates a narrow presence, primarily involved in individual steps—e.g., resource extraction or production, whereas a score of seven indicates a broad presence across the entire value chain, e.g., production and marketing, distribution, design, etc.

Regarding the relative severity of the specificity of the downstream and upstream firms' assets, we consider two indicators ranging between one and seven. First, *Process-Specificity* picks the sophistication of the production processes. A value of one suggests that it uses labor-intensive processes or an old technology, whereas a value of seven implies that it uses sophisticated and knowledge-intensive processes. As a consequence, *Process-Specificity* can be seen as a metrics of the specificity of the intangible assets and production processes typically brought about by downstream firms (Williamson, 2010). Second, *Site-Specificity* measures the state of infrastructure. A value of seven indicating an extremely underdeveloped one and a score of one pointing towards an extensive and efficient system. Accordingly, *Site-Specificity* gauges the ability of the economy to ease the provision by upstream partners

[12]The 2015 edition gathered more than 14,000 responses in 144 countries (WEF, 2015). We substitute missing observations with the closest data points. This choice is immaterial to the gist of the analysis.

of project-specific facilities and physical assets (Williamson, 2010).

Turning to the intensity of downstream firm's investment activity, we rely on an estimate of the research and development expenditure as a percentage of GDP produced by the World Bank, i.e., *R&D-Intensity*. Here, the intuition is that a more intense effort in research and development is symptomatic of a higher relative relevance of the intangible assets provided by the downstream firms in the production activities typical of a particular country.

5.2 Estimating Equation

We assess the model testable predictions by running panel regressions of the form

$$Y_{c,t} = \alpha_c + \beta_t + \gamma' \mathbf{X}_{c,t} + \delta' \mathbf{Z}_{c,t} + \varepsilon_{c,t}, \tag{4}$$

where $Y_{r,t}$ is either *Property-Rights*, *IPR* or *Vertical-Integration* in country c at time t. α_r are country fixed effects controlling for time-independent determinants of $Y_{r,t}$ such as those discussed by a recent literature on endogenous property rights, i.e., a culture of cooperation, the quality of legal enforcement, preference heterogeneity and the structural importance of transaction costs (Dari-Mattiacci and Guerriero, 2015; Guerriero, 2016, 2020). β_t incorporates year dummies picking up macro-shocks like global process innovation, financial crises and macroeconomic imbalances. $\mathbf{X}_{r,t}$ gathers *Process-Specificity*, *Site-Specificity* and *R&D-Intensity* if $Y_{r,t}$ is either *Property-Rights* or *IPR* and *Process-Specificity*, *Site-Specificity*, *R&D-Intensity*, *Property-Rights* and *IPR*, otherwise. Since we do not observe all the technological and preference determinants of asset specificity and the intensity of intangible assets and/or production processes and, in turn, of the distribution of the strength of property rights, we allow *Property-Rights* and *IPR* to directly shape the extent of vertical integration. Finally, $\mathbf{Z}_{r,t}$ possibly includes the extra controls discussed in section 5.4.1.

5.3 Basic Empirical Results

The OLS estimates reported in columns (1) to (3) of table 3 suggest that the partial correlations in our data are consistent with the model predictions and the implied effects are large. Two are the key patterns in the data. First, the protection of the downstream firm's property rights is the strongest the most severe is process specificity and the weakest

are site specificity and R&D intensity. All these relationships are significant at 10% or more. Second, the extent of vertical integration is significantly—in particular, at 1%– related only to the specificity of downstream firm's asset and the strength of the protection of intellectual property. While the first positive effect is consonant with the model implications, the second might hide the positive effect of unobservable drivers of either the specificity of intangible asset and production processes or the intensity of the upstream firm's input.

5.4 Evaluating Causality

Our OLS estimates might be attenuated by measurement errors or they may be capturing omitted variables and/or reverse causality. We evaluate the severity of these issues as follows.

5.4.1 Unobserved Heterogeneity

We follow a two-step strategy to assess whether unobservable factors are biasing our results. First, we control for the other key drivers of property rights identified by the extant literature (see table 2 for the construction of each). These are the modernization effect of economic development (Inglehart and Welzel, 2005), the limits to state predation imposed by a more inclusive political process and a smaller nonproduced output (Besley and Persson, 2009), and the stronger state capacity assured by a larger incidence of external and internal conflicts (Acemoglu and Robinson, 2000). As suggested by the estimates in columns (4) to (6) of table 3, including these observable factors hardly affects the basic results.

Second, we exploit these empirical results to calculate how much stronger selection on unobservables, relative to selection on observables, must be to completely explain away the estimates (Bellows and Miguel, 2009). To see how the index is calculated, consider a regression with a restricted set of controls and one with a full set of controls. Next, denote the estimate of the relevant coefficient from the first regression θ^R, where R stands for "restricted," and that from the second regression θ^F, where F stands for "full." Then, the index is the absolute value of $\theta^F/(\theta^R - \theta^F)$. The intuition behind the formula is as follows. The lower the absolute value of $(\theta^R - \theta^F)$ is, the less the estimate of the relevant coefficient is affected by selection on observables, and the stronger selection on unobservables needs to be to explain away the entire effect. Moreover, the higher the absolute value of θ^F is, the greater is the effect that needs to be explained away by selection on unobservables and, thus,

the higher is the index. We consider the specifications conditioning only on country and year fixed effects in table 3 as the restricted regressions and those controlling for all observables in table 3 as the full regressions. The ratios calculated when the dependent variables are either *Property-Rights*, *IPR*, or *Vertical-Integration* are reported in columns (1) to (3) of table 4, respectively. We focus on the variables testing the key model predictions. No index is lower than one, and their median (average) is 23.2 (10.1). To attribute the entire estimates to unobserved heterogeneity, selection on unobservables would have to be on average more than twenty-three times greater than selection on all observables, which is unlikely.

5.4.2 Measurement Error

To evaluate the importance of the measurement error, we consider alternative measures of asset specificity and intangible assets/process intensity. First, we substitute *Process-Specificity* with *Competitive-Advantage*, which is a 1-7 indicator identifying the competitive advantage of companies in international markets. A value of one suggests that it is low cost labor/natural resources, whereas a value of seven hints at unique products/processes. Second, we substitute *Financial-Frictions* for *Site-Specificity*. The former gauges the financial sector difficulties in providing products and services to businesses, and it is constructed as the normalized—in order to range between one and seven—first principal component extracted from two indexes ranging between 1 and 7. The first one picks the financial sector difficulties in providing financial products and services to businesses, whereas the second one captures how easy is it for start-up entrepreneurs with innovative but risky projects to obtain equity funding. As a consequence, *Financial-Frictions* will increase whenever the physical assets typically brought about by an upstream firm becomes more specific because of the inefficiencies of the financial system to provide services easing its alternative use, i.e., loans and venture capital necessary to adapt a particular machinery to another application (Williamson, 2010). Finally, we use as a proxy for intangible assets/process intensity the number of PCT patent applications over the population in million, i.e., *Patent-Intensity*. A glance at the estimates in table 5 entails that our conclusions remain very similar and measurement error does not seem to be a major issue for our empirical analysis.

5.4.3 Reverse Causality

To evaluate the possibility that the estimates are driven by reverse causation, we incorporate in $\mathbf{Z}_{r,t}$ also the variables of interest—i.e., *Process-Specificity*, *Site-Specificity*, *R&D-Intensity*, *Property-Rights* and *IPR*—lead one year. If the contemporaneous links between the drivers of either the strength of property rights and vertical integration and both these features are driven by the fact that the latter cause the former, then one will expect even stronger correlations between either the protection of the downstream firms' private and intellectual property and the presence in the value chain and lead values of their determinants (Angrist and Pischke, 2009). This is not the case in columns (1) to (3) of table 6.

6 Conclusions

We have developed and tested a theory of endogenous market design in which the legal protection of the upstream firm's asset shapes his ex post bargaining power and it is chosen by a possibly partisan legislator and residual control rights define the default payoffs and are selected by the parties themselves. Considering the endogeneity of property rights produces relationships between both asset specificity and the intensity of each party's investment activity, on the one hand, and the protection of each party's input and the extent of vertical integration, on the other hand, which are quite different from those suggested by the PRT. We close by highlighting how two central results of our analysis open key avenues for future research. First, the tendency of property rights towards optimality does not imply that the existing legal variation is irrelevant, and, thus, it does not warrant reforms. As aforementioned, an imperfect political process biases institutional design towards inefficiency. Second, more empirical research at the firm level is needed to understand the interplay among the extent of each party's asset specificity, their contribution to the relationship value, the relative protection of the property rights on their input and their vertical integration decisions.

Appendix

Proof of Proposition

Under joint ownership and given γ^*, D and U maximize $(1-\gamma^*)\lambda\delta\omega - c\delta + \mu_1\delta - \mu_2(\delta-1)$ and $\gamma^*\lambda\delta\omega - c\omega + \mu_3\omega - \mu_4(\omega-1)$, respectively. Then, there are seven possible investment profiles. First, $\delta^*=0$ and $\omega^*=0$ when the FOCs $-c+\mu_1=0 \rightarrow -c<0$ and $-c+\mu_3=0 \rightarrow -c<0$ hold. This investment profile is part of a SPE and entails 0 ex post bargaining payoffs and production. Second, $\delta^*=0$ and $\omega^*\in(0,1)$ when the FOCs $(1-\gamma^*)\lambda\omega^*<c$ and $-c=0$ hold. Since the second inequality is impossible, this investment profile is not part of a SPE. Third, $\delta^*\in(0,1)$ and $\omega^*=0$ when the FOCs $-c=0$ and $\gamma^*\lambda\delta^*<c$ hold. Since the first inequality is impossible, this investment profile is not part of a SPE. Fourth, $\delta^*\in(0,1)$ and $\omega^*\in(0,1)$ when the FOCs $\lambda=\frac{c}{(1-\gamma^*)\omega^*}$ and $\lambda=\frac{c}{\gamma^*\delta^*}$ hold. This investment profile is part of a SPE for $\delta^*=\frac{(1-\gamma^*)\omega^*}{\gamma^*}$ and entails 0 ex post bargaining payoffs, i.e., $\pi_D^J=(1-\gamma^*)\delta^*\omega^*\frac{c}{(1-\gamma^*)\omega^*}-c\delta^*=0=\gamma^*\delta^*\omega^*\frac{c}{\gamma^*\delta^*}-c\omega^*=\pi_U^J$. Fifth, $\delta^*=1$ and $\omega^*\in(0,1)$ when the FOCs $(1-\gamma^*)\lambda\omega^*>c$ and $\lambda=\frac{c}{\gamma^*}\rightarrow\frac{1-\gamma^*}{\gamma^*}\omega^*>1$ hold. Since the second inequality is impossible at $\gamma^*=\gamma^J$, this investment profile is not part of a SPE. Sixth, $\delta^*\in(0,1)$ and $\omega^*=1$ when the FOCs $\lambda=\frac{c}{1-\gamma^*}$ and $\gamma^*\lambda\delta^*>c\rightarrow\frac{\gamma^*}{1-\gamma^*}\delta^*>1$ hold. Since the second inequality is impossible at $\gamma^*=\gamma^J$, this investment profile is not part of a SPE. Notice that, when picking γ^*, the legislator does not consider not only the no- and intermediate-investment profiles but also those for which one party selects an interior effort and the other party picks 1 since they have measure 0. Finally, $\delta^*=1$ and $\omega^*=1$ when the FOCs $\lambda>\frac{c}{1-\gamma^*}$ and $\lambda>\frac{c}{\gamma^*}$ hold. This investment profile is part of a SPE.

Under downstream ownership and given γ^*, D and U maximize $\alpha\delta\omega+(1-\gamma^*)(\lambda-\alpha)\delta\omega+\mu_1\delta-\mu_2(\delta-1)-c\delta$ and $\gamma^*(\lambda-\alpha)\delta\omega-c\omega+\mu_3\omega-\mu_4(\omega-1)$, respectively. Then, there are seven possible investment profiles. First, $\delta^*=0$ and $\omega^*=0$ when the FOCs $-c<0$ and $-c<0$ hold. This is part of a SPE and entails zero ex post bargaining payoffs and production. Second, $\delta^*=0$ and $\omega^*\in(0,1)$ when the FOCs $[(1-\gamma^*)\lambda+\gamma^*\alpha]\omega^*<c$ and $-c=0$ hold. Since the second inequality is impossible, this investment profile is not part of a SPE. Third, $\delta^*\in(0,1)$ and $\omega^*=0$ when the FOCs $-c=0$ and $\gamma^*(\lambda-\alpha)\delta^*<c$ hold. Since the first inequality is impossible, this investment profile is not part of a SPE. Fourth, $\delta^*\in(0,1)$

and $\omega^* \in (0,1)$ when the FOCs $[(1-\gamma^*)\lambda + \gamma^*\alpha]\omega^* = c \rightarrow \lambda = \frac{c-\gamma^*\alpha\omega^*}{(1-\gamma^*)\omega^*}$ and $\gamma^*(\lambda-\alpha)\delta^* = c \rightarrow \lambda = \frac{c}{\gamma^*\delta^*} + \alpha$ hold. This investment profile is part of a SPE if $\delta^* = \frac{(1-\gamma^*)c\omega^*}{\gamma^*(c-\alpha\omega^*)}$ and entails $\pi_D^D = \alpha\delta^*\omega^* + (1-\gamma^*)\delta^*\omega^*\frac{c-\gamma^*\alpha\omega^*}{(1-\gamma^*)\omega^*} - (1-\gamma^*)\alpha\delta^*\omega^* - c\delta^* = 0 = \gamma^*\delta^*\omega^*\frac{c}{\delta^*\gamma^*} - c\omega^* = \pi_U^D$. Fifth, $\delta^* = 1$ and $\omega^* \in (0,1)$ when the FOCs $[(1-\gamma^*)\lambda + \gamma^*\alpha]\omega^* > c$ and $\lambda = \frac{c}{\gamma^*} + \alpha \rightarrow \left[\frac{(1-\gamma^*)c}{\gamma^*} + \alpha\right]\omega^* > c$ hold. Since the second inequality is impossible at $\gamma^* = \gamma^D$, this investment profile is not part of a SPE. Sixth, $\delta^* \in (0,1)$ and $\omega^* = 1$ when the FOCs $\lambda = \frac{c-\gamma^*\alpha}{1-\gamma^*}$ and $\gamma^*(\lambda-\alpha)\delta^* > c \rightarrow \frac{\gamma^*}{1-\gamma^*}(c-\alpha)\delta^* > c$ hold. Since the second inequality is impossible at $\gamma^* = \gamma^D$, this investment profile is not part of a SPE. Finally, $\delta^* = 1$ and $\omega^* = 1$ when the FOCs $\lambda > \frac{c-\gamma^*\alpha}{1-\gamma^*}$ and $\lambda > \frac{c}{\gamma^*} + \alpha$ hold. This investment profile is part of a SPE.

Under upstream ownership and given γ^*, D and U maximize $(1-\gamma^*)(\lambda-\beta)\delta\omega - c\delta + \mu_1\delta - \mu_2(\delta-1)$ and $\beta\delta\omega + \gamma^*(\lambda-\beta)\delta\omega - c\omega + \mu_3\omega - \mu_4(\omega-1)$, respectively. Then, there are seven possible investment profiles. First, $\delta^* = 0 = \omega^*$ when the FOCs $-c < 0$ and $-c < 0$ hold. This investment profile is part of a SPE and entails zero ex post bargaining payoffs and production. Second, $\delta^* = 0$ and $\omega^* \in (0,1)$ when the FOCs $(1-\gamma^*)(\lambda-\beta)\omega^* < c$ and $-c = 0$ hold. Since the second inequality is impossible, this investment profile is not part of a SPE. Third, $\delta^* \in (0,1)$ and $\omega^* = 0$ when the FOCs $-c = 0$ and $[\gamma^*\lambda + (1-\gamma^*)\beta]\delta^* < c$ hold. Since the first inequality is impossible, this investment profile is not part of a SPE. Fourth, $\delta^* \in (0,1)$ and $\omega^* \in (0,1)$ when the FOCs $\lambda = \frac{c}{(1-\gamma^*)\omega^*} + \beta$ and $\lambda = \frac{c-(1-\gamma^*)\beta\delta^*}{\gamma^*\delta^*}$ hold. This investment profile is part of a SPE if $\omega^* = \frac{\gamma^* c\delta^*}{(1-\gamma^*)(c-\beta\delta^*)}$ and entails $\pi_U^U = \beta\delta^*\omega^* + \gamma^*\frac{c-(1-\gamma^*)\beta\delta^*}{\delta^*\gamma^*}\delta^*\omega^* - \gamma^*\beta\delta^*\omega^* - c\omega^* = 0 = \frac{(1-\gamma^*)c\delta^*\omega^*}{(1-\gamma^*)\omega^*} - c\delta^* = \pi_U^D$. Fifth, $\delta^* = 1$ and $\omega^* \in (0,1)$ when the FOCs $(1-\gamma^*)(\lambda-\beta)\omega^* > c$ and $\lambda = \frac{c-(1-\gamma^*)\beta}{\gamma^*} \rightarrow \frac{1-\gamma^*}{\gamma^*}(c-\beta)\omega^* > c$ hold. Since the second inequality is impossible at $\gamma^* = \gamma^U$, this investment profile is not part of a SPE. Sixth, $\delta^* \in (0,1)$ and $\omega^* = 1$ when the FOCs $\lambda = \frac{c}{1-\gamma^*} + \beta$ and $[\gamma^*\lambda + (1-\gamma^*)\beta]\delta^* > c \rightarrow \left(\frac{\gamma^* c}{1-\gamma^*} + \beta\right)\delta^* > c$ hold. Since the second inequality is impossible at $\gamma^* = \gamma^U$, this investment profile is not part of a SPE. Finally, $\delta^* = 1$ and $\omega^* = 1$ when the FOCs $\lambda > \frac{c}{1-\gamma^*} + \beta$ and $\lambda > \frac{c-(1-\gamma^*)\beta}{\gamma^*}$ hold. This investment profile is part of a SPE. □

Asymmetric Investment

The FOCs for δ^* and ω^* are $[\gamma d_D^o + (1-\gamma)(\lambda - d_U^o)]\rho(\delta^*)^{\rho-1}(\omega^*)^{1-\rho} - c + \mu_1 - \mu_2 = 0$ and $[(1-\gamma)d_U^o + \gamma(\lambda - d_D^o)](1-\rho)(\delta^*)^{\rho}(\omega^*)^{-\rho} - c + \mu_3 - \mu_4 = 0$, respectively. For $o = J$ and given γ^*, there are seven possible investment profiles. First, $\delta^* = 0$ and $\omega^* = 0$ when

the FOCs $-c < 0$ and $-c < 0$ hold. This is part of a SPE and entails 0 ex post bargaining payoffs and production. Second, $\delta^* = 0$ and $\omega^* \in (0,1)$ when the FOCs $-c < 0$ and $-c = 0$ hold. Since the second equality is impossible, this investment profile is not part of a SPE. Third, $\delta^* \in (0,1)$ and $\omega^* = 0$ when the FOCs $-c = 0$ and $-c < 0$ hold. Since the first equality is impossible, this investment profile is not part of a SPE. Fourth, $\delta^* \in (0,1)$ and $\omega^* \in (0,1)$ when the FOCs $\lambda = \frac{c}{(1-\gamma^*)\rho}\left(\frac{\delta^*}{\omega^*}\right)^{1-\rho}$ and $\lambda = \frac{c}{\gamma^*(1-\rho)}\left(\frac{\omega^*}{\delta^*}\right)^{\rho}$ hold. This investment profile is part of a SPE and entails a positive $\frac{(1-\rho)c}{\rho}\delta^*$ ($\frac{\rho c}{1-\rho}\delta^*$) ex post bargaining payoff for firm D (U) at $\gamma^* = \gamma^J = \rho$ since, then, the two right-hand sides are equal only for $\delta^* = \omega^*$ and $\lambda = \frac{c}{(1-\rho)\rho}$. Fifth, $\delta^* = 1$ and $\omega^* \in (0,1)$ when the FOCs $(1-\gamma^*)\lambda\rho(\omega^*)^{1-\rho} > c$ and $\lambda = \frac{c(\omega^*)^{\rho}}{\gamma^*(1-\rho)}$ hold. Since for $\gamma^* = \gamma^J$ the first inequality becomes $\omega^* > \frac{\gamma^J(1-\rho)}{(1-\gamma^J)\rho} = 1$, this investment profile is not part of a SPE. Sixth, $\delta^* \in (0,1)$ and $\omega^* = 1$ when the FOCs $\lambda = \frac{c}{(1-\gamma^*)\rho(\delta^*)^{\rho-1}}$ and $\gamma^*\lambda(1-\rho)(\delta^*)^{\rho} > c$ hold. Since for $\gamma^* = \gamma^J$ the second inequality becomes $\delta^* > \frac{(1-\gamma^J)\rho}{(1-\rho)\gamma^J} = 1$, this investment profile is not part of a SPE. Finally, $\delta^* = 1$ and $\omega^* = 1$ when the FOCs $\lambda > \frac{c}{(1-\gamma^*)\rho}$ and $\lambda > \frac{c}{\gamma^*(1-\rho)}$ hold. Both inequalities identify thresholds more stringent than those implied by the IR constraints if binding and, thus, the legislator picks the $\gamma^* = \gamma^J$ such that their right-hand sides are equalized, i.e., $\gamma^J = \rho$. The full-investment profile is part of a SPE and entails positive π_i^o. Regarding the choice of o, the latter is irrelevant for $\omega^* < 1$ and $\delta^* < 1$. When $\omega^* = \delta^* = 1$ and firm D makes the take-or-leave-it offer: 1. $o = J$ if $\frac{c}{(1-\rho)\rho} \leq \lambda < \frac{c}{(1-\rho)\rho} + \alpha$; 2. $o = D$ if $\lambda \geq \frac{c}{(1-\rho)\rho} + \alpha$. Hence, $V \propto \overline{\lambda} - \frac{c}{(1-\rho)\rho} - \alpha$. When $\omega^* = \delta^* = 1$ and firm U makes the take-or-leave-it offer: 1. $o = J$ if $\frac{c}{(1-\rho)\rho} \leq \lambda < \frac{c}{(1-\rho)\rho} + \beta$; 2. $o = U$ if $\lambda \geq \frac{c}{(1-\rho)\rho} + \beta$. Then, $V \propto \overline{\lambda} - \frac{c}{(1-\rho)\rho} - \beta$.

For $o = D$ and given γ^*, there are seven possible investment profiles. First, $\delta^* = 0$ and $\omega^* = 0$ when the FOCs $-c < 0$ and $-c < 0$ hold. This investment profile is part of a SPE and entails 0 ex post bargaining payoffs and production. Second, $\delta^* = 0$ and $\omega^* \in (0,1)$ when the FOCs $-c < 0$ and $-c = 0$ hold. Since the second equality is impossible, this is not part of a SPE. Third, $\delta^* \in (0,1)$ and $\omega^* = 0$ when the FOCs $-c = 0$ and $-c < 0$ hold. Since the first equality is impossible, this is not part of a SPE. Fourth, $\delta^* \in (0,1)$ and $\omega^* \in (0,1)$ when the FOCs $\lambda = \frac{c}{(1-\gamma^*)\rho\left(\frac{\omega^*}{\delta^*}\right)^{1-\rho}} - \frac{\gamma^*\alpha}{1-\gamma^*}$ and $\lambda = \frac{c}{\gamma^*(1-\rho)\left(\frac{\omega^*}{\delta^*}\right)^{-\rho}} + \alpha$ hold. This investment profile entails positive $\frac{(1-\rho)c}{\rho}\delta^*$ ($\frac{\rho c}{1-\rho}\delta^*$) ex post bargaining payoff for firm D (U) at $\gamma^* = \gamma^D$ since, then, the two right-hand sides are equal only for $\delta^* = \omega^*$ and $\lambda = \frac{c}{(1-\rho)\rho}$. Fifth, $\delta^* = 1$

and $\omega^* \in (0,1)$ when the FOCs $[\gamma^*\alpha + (1-\gamma^*)\lambda]\rho(\omega^*)^{1-\rho} > c$ and $\lambda = \frac{c}{\gamma^*(1-\rho)(\omega^*)^{-\rho}} + \alpha$ hold. Since for $\gamma^* = \gamma^D$ the first inequality becomes $\omega^* > \frac{c-\alpha\rho(\omega^*)^{1-\rho}}{c-\alpha\rho} > 1$, this is not part of a SPE. Sixth, $\delta^* \in (0,1)$ and $\omega^* = 1$ when the FOCs $\lambda = \frac{c}{(1-\gamma^*)\rho(\delta^*)^{\rho-1}} - \frac{\alpha\gamma^*}{1-\gamma^*}$ and $\gamma^*(\lambda-\alpha)(1-\rho)(\delta^*)^\rho > c$ hold. Since for $\gamma^* = \gamma^D$ the second inequality becomes $\delta^* > \frac{c-\alpha\rho}{c-\alpha\rho(\delta^*)^{\rho-1}} > 1$, this is not part of a SPE. Finally, $\delta^* = 1$ and $\omega^* = 1$ when the FOCs $\lambda > \frac{c}{(1-\gamma^*)\rho} - \frac{\alpha\gamma^*}{1-\gamma^*}$ and $\lambda > \frac{c}{\gamma^*(1-\rho)} + \alpha$ hold. Both inequalities identify thresholds more stringent than those implied by the IR constraints if binding and, thus, the legislator picks the $\gamma^* = \gamma^D$ such that their right-hand sides are equalized, i.e., $\gamma^D = \frac{c\rho}{c-\alpha\rho(1-\rho)} > \rho$. The full-investment profile is part of a SPE and entails positive π_i^o. Turning to the choice of o, it is irrelevant for $\omega^* < 1$ and $\delta^* < 1$. When $\omega^* = \delta^* = 1$ and firm D makes the take-or-leave-it offer: $o = D$ for $\lambda \geq \frac{c}{(1-\rho)\rho}$ and $V \propto \overline{\lambda} - \frac{c}{(1-\rho)\rho}$. When $\omega^* = \delta^* = 1$ and firm U makes the take-or-leave-it offer: 1. $o = D$ if $\frac{c}{(1-\rho)\rho} \leq \lambda < \frac{c[c-\alpha\rho(1-\rho)]}{\rho(1-\rho)(c-\alpha\rho)}$; 2. $o = J$ if $\frac{c[c-\alpha\rho(1-\rho)]}{\rho(1-\rho)(c-\alpha\rho)} \leq \lambda < \frac{c[c-\alpha\rho(1-\rho)]}{\rho(1-\rho)[c-\alpha\rho]} + \beta$; 3. $o = U$ if $\lambda \geq \frac{c[c-\alpha\rho(1-\rho)]}{\rho(1-\rho)[c-\alpha\rho]} + \beta$. Hence, $V \propto \overline{\lambda} - \frac{c}{(1-\rho)\rho} - \beta$.

For $o = U$ and and given γ^*, there are seven possible investment profiles. First, $\delta^* = 0$ and $\omega^* = 0$ when the FOCs $-c < 0$ and $-c < 0$ hold. This investment profile is part of a SPE and entails 0 ex post bargaining payoffs and production. Second, $\delta^* = 0$ and $\omega^* \in (0,1)$ when the FOCs $-c < 0$ and $-c = 0$ hold. Since the second equality is impossible, this is not part of a SPE. Third, $\delta^* \in (0,1)$ and $\omega^* = 0$ when the FOCs $-c = 0$ and $-c < 0$ hold. Since the first equality is impossible, this investment profile is not part of a SPE. Fourth, $\delta^* \in (0,1)$ and $\omega^* \in (0,1)$ when the FOCs $\lambda = \frac{c}{(1-\gamma^*)\rho\left(\frac{\delta^*}{\omega^*}\right)^{\rho-1}} + \beta$ and $\lambda = \frac{c}{\gamma^*(1-\rho)\left(\frac{\delta^*}{\omega^*}\right)^{\rho}} - \frac{1-\gamma^*}{\gamma^*}\beta$ hold. This investment profile entails a positive $\frac{(1-\rho)c}{\rho}\delta^*$ ($\frac{\rho c}{1-\rho}\delta^*$) ex post bargaining payoff for firm D (U) at $\gamma^* = \gamma^U$ since, then, the two right-hand sides are equal only for $\delta^* = \omega^*$ and $\lambda = \frac{c}{(1-\rho)\rho}$. Fifth, $\delta^* = 1$ and $\omega^* \in (0,1)$ when the FOCs $\lambda > \frac{c}{(1-\gamma^*)\rho(\omega^*)^{1-\rho}} + \beta$ and $[(1-\gamma^*)\beta + \gamma^*\lambda](1-\rho)(\omega^*)^{-\rho} = c$ hold. Since for $\gamma^* = \gamma^U$ the first inequality becomes $\omega^* > \frac{c-\beta(1-\rho)}{c-\beta(1-\rho)(\omega^*)^{-\rho}} > 1$, this is not part of a SPE. Sixth, $\delta^* \in (0,1)$ and $\omega^* = 1$ when the FOCs $(1-\gamma^*)(\lambda-\beta)\rho(\delta^*)^{\rho-1} = c$ and $\lambda > \frac{c}{\gamma^*(1-\rho)(\delta^*)^\rho} - \frac{\beta(1-\gamma^*)}{\gamma^*}$ hold. Since for $\gamma^* = \gamma^U$ the second inequality becomes $\delta^* > \frac{c-\beta(1-\rho)(\delta^*)^\rho}{c-\beta(1-\rho)} > 1$, this is not part of a SPE. Finally, $\delta^* = 1$ and $\omega^* = 1$ when the FOCs $\lambda > \frac{c}{(1-\gamma^*)\rho} + \beta$ and $\lambda > \frac{c}{\gamma^*(1-\rho)} - \frac{\beta(1-\gamma^*)}{\gamma^*}$ hold. Both inequalities identify thresholds more stringent than those implied by the IR constraints if binding and, thus, the legislator picks the $\gamma^* = \gamma^U$ such that the two right-hand sides are

equalized, i.e., $\gamma^U = \frac{\rho[c-\beta(1-\rho)]}{c-\beta\rho(1-\rho)} < \rho$. The full-investment profile is part of a SPE and entails positive π_i^o. Regarding the choice of ownership structure, it is irrelevant for $\omega^* < 1$ and $\delta^* < 1$. When, instead, $\omega^* = \delta^* = 1$ and firm D makes the take-or-leave-it offer: 1. $o = U$ if $\frac{c}{(1-\rho)\rho} \leq \lambda < \frac{c[c-\beta\rho(1-\rho)]}{\rho(1-\rho)[c-\beta(1-\rho)]}$; 2. $o = J$ if $\frac{c[c-\beta\rho(1-\rho)]}{\rho(1-\rho)[c-\beta(1-\rho)]} \leq \lambda < \frac{c[c-\beta\rho(1-\rho)]}{\rho(1-\rho)[c-\beta(1-\rho)]} + \alpha$; 3. $o = D$ if $\lambda \geq \frac{c[c-\beta\rho(1-\rho)]}{\rho(1-\rho)[c-\beta(1-\rho)]} + \alpha$. Hence, $V \propto \overline{\lambda} - \frac{c}{(1-\rho)\rho} - \alpha$. When, finally, $\omega^* = \delta^* = 1$ and firm U makes the take-or-leave-it offer: $o = U$ for $\lambda \geq \frac{c}{(1-\rho)\rho}$ and $V \propto \overline{\lambda} - \frac{c}{(1-\rho)\rho}$. □

Imperfect Complementarity

The necessary FOCs for δ^* and ω^* are $\gamma^* d_D^o + (1-\gamma^*)\lambda\omega^* - c + \mu_1 - \mu_2 = 0$ and $(1-\gamma^*) d_U^o + \gamma^*\lambda\delta^* - c + \mu_3 - \mu_4 = 0$, respectively. For $o = J$ and given γ^*, there are seven possible investment profiles. First, $\delta^* = 0$ and $\omega^* = 0$ when the FOCs $-c < 0$ and $-c < 0$ hold. This is part of a SPE and entails 0 ex post bargaining payoffs and production. Second, $\delta^* = 0$ and $\omega^* \in (0,1)$ when the FOCs $(1-\gamma^*)\lambda\omega^* < c$ and $-c = 0$ hold. Since the second equality is impossible, this investment profile is not part of a SPE. Third, $\delta^* \in (0,1)$ and $\omega^* = 0$ when the FOCs $-c = 0$ and $\gamma^*\lambda\delta^* < c$ hold. Since the first equality is impossible, this investment profile is not part of a SPE. Fourth, $\delta^* \in (0,1)$ and $\omega^* \in (0,1)$ when the FOCs $\lambda = \frac{c}{(1-\gamma^*)\omega^*}$ and $\lambda = \frac{c}{\gamma^*\delta^*}$ hold. This investment profile is part of a SPE and entails 0 ex post bargaining payoffs. Fifth, $\delta^* = 1$ and $\omega^* \in (0,1)$ when the FOCs $(1-\gamma^*)\lambda\omega^* > c$ and $\lambda = \frac{c}{\gamma^*}$ hold. Since the first inequality is impossible at $\gamma^* = \gamma^J$, this investment profile is not part of a SPE. Sixth, $\delta^* \in (0,1)$ and $\omega^* = 1$ when the FOCs $\lambda = \frac{c}{(1-\gamma^*)}$ and $\gamma^*\lambda\delta^* > c$ hold. Since the second inequality is impossible at $\gamma^* = \gamma^J$, this investment profile is not part of a SPE. Finally, $\delta^* = 1$ and $\omega^* = 1$ when the FOCs $\lambda > \frac{c}{(1-\gamma^*)}$ and $\lambda > \frac{c}{\gamma^*}$ hold. This is part of a SPE. $\delta^* \in (0,1)$ and $\omega^* \in (0,1)$ prevail for the set of matches $\lambda_U^J(\epsilon) - \lambda_D^J(1-\epsilon) = \frac{2c}{\epsilon} - \frac{2c}{1-\epsilon}$.

For $o = D$ and given γ^*, there are seven possible investment profiles. First, $\delta^* = 0$ and $\omega^* = 0$ when the FOCs $\gamma^*\alpha < c$ and $-c < 0$ hold. This investment profile is part of a SPE and entails 0 ex post bargaining payoffs and production. Second, $\delta^* = 0$ and $\omega^* \in (0,1)$ when the FOCs $\gamma^*\alpha + (1-\gamma^*)\lambda\omega^* < c$ and $-c = 0$ hold. Since the second equality is impossible, this is not part of a SPE. Third, $\delta^* \in (0,1)$ and $\omega^* = 0$ when the FOCs $\gamma^* = \frac{c}{\alpha}$ and $\gamma^*\lambda\delta^* < c$ hold. Since the first equality is impossible for $c > \alpha$—i.e., $\gamma^* > 1$, this investment profile is not part of a SPE. Fourth, $\delta^* \in (0,1)$ and $\omega^* \in (0,1)$ when the FOCs $\gamma^*\alpha + (1-\gamma^*)\lambda\omega^* = c \to \lambda = \frac{c-\gamma^*\alpha}{(1-\gamma^*)\omega^*}$ and $\gamma^*\lambda\delta^* = c \to \lambda = \frac{c}{\gamma^*\delta^*}$ hold. This investment

profile is part of a SPE and entails 0 ex post bargaining payoffs. Fifth, $\delta^* = 1$ and $\omega^* \in (0,1)$ when the FOCs $\gamma^*\alpha + (1-\gamma^*)\lambda\omega^* > c$ and $\lambda = \frac{c}{\gamma^*}$ hold. Since at γ^D the first inequality should be $2c - \alpha > \frac{2c}{\omega^*}$, this is not part of a SPE. Sixth, $\delta^* \in (0,1)$ and $\omega^* = 1$ when the FOCs $\lambda = \frac{c-\gamma^*\alpha}{1-\gamma^*}$ and $\gamma^*\lambda\delta^* > c \rightarrow \delta^* > \frac{2c-\alpha}{2c}$ hold. Then, $\pi_D^D = 0$ and $\pi_U^D \geq 0 \leftrightarrow \delta^* > 1$, which is impossible. Hence, this investment profile is not part of a SPE. Finally, $\delta^* = 1$ and $\omega^* = 1$ when the FOCs $\lambda > \frac{c-\gamma^*\alpha}{1-\gamma^*}$ and $\lambda > \frac{c}{\gamma^*}$ hold. This is part of a SPE. $\delta^* \in (0,1)$ and $\omega^* \in (0,1)$ prevail for the set of matches $\lambda_U^D(\epsilon) - \lambda_D^D(1-\epsilon) = \frac{2c}{\epsilon} - \frac{\alpha}{\epsilon} - \frac{2c}{1-\epsilon}$.

For $o = U$ and and given γ^*, there are seven possible investment profiles. First, $\delta^* = 0 = \omega^*$ when the FOCs $-c < 0$ and $(1-\gamma^*)\beta - c < 0$ hold. This investment profile is part of a SPE for $c > \beta$. Second, $\delta^* = 0$ and $\omega^* \in (0,1)$ when the FOCs $(1-\gamma^*)\lambda\omega^* < c$ and $1 - \gamma^* = \frac{c}{\beta}$ hold. Since the second inequality is impossible for $c > \beta$—i.e., $\gamma^* < 0$, this investment profile is not part of a SPE. Third, $\delta^* \in (0,1)$ and $\omega^* = 0$ when the FOCs $-c = 0$ and $(1-\gamma^*)\beta < c$ hold. Since the first equality is impossible, this investment profile is not part of a SPE. Fourth, $\delta^* \in (0,1)$ and $\omega^* \in (0,1)$ when the FOCs $\lambda = \frac{c}{(1-\gamma^*)\omega^*}$ and $\lambda = \frac{c-(1-\gamma^*)\beta}{\gamma^*\delta^*}$ hold. This investment profile is part of a SPE and entails zero ex post bargaining payoffs. Fifth, $\delta^* = 1$ and $\omega^* \in (0,1)$ when the FOCs $(1-\gamma^*)\lambda\omega^* > c$ and $\lambda = \frac{c-(1-\gamma^*)\beta}{\gamma^*} \rightarrow \omega^* > \frac{2c-\beta}{2c}$ hold. Then, $\pi_U^U = 0$ and $\pi_D^U \geq 0 \leftrightarrow \omega^* > 1$, which is impossible. Hence, this investment profile is not part of a SPE. Sixth, $\delta^* \in (0,1)$ and $\omega^* = 1$ when the FOCs $\lambda = \frac{c}{1-\gamma^*}$ and $\gamma^*\lambda\delta^* + (1-\gamma^*)\beta > c$ hold. Since at γ^U the second inequality should be $2c - \beta > \frac{2c}{\delta^*}$, this investment profile is not part of a SPE. Finally, $\delta^* = 1$ and $\omega^* = 1$ when the FOCs $\lambda > \frac{c}{1-\gamma^*}$ and $\lambda > \frac{c-(1-\gamma^*)\beta}{\gamma^*}$ hold. This investment profile is part of a SPE. $\delta^* \in (0,1)$ and $\omega^* \in (0,1)$ arise for the set of matches $\lambda_D^U(\epsilon) - \lambda_U^U(1-\epsilon) = \frac{2c}{\epsilon} - \frac{\beta}{\epsilon} - \frac{2c}{1-\epsilon}$. □

Bargaining Over the Ownership Structure

If $\lambda \geq 2c$, $\delta^* = \omega^* = 1$ and firm D makes the take-or-leave-it offer, the comparison between what firm D would pay and what firm U would require for a reform is as follows. A switch from $o = U$ to $o = D$ would require $\pi_U^U - \pi_U^D - \nu > \pi_D^D - \pi_D^U \leftrightarrow \lambda - 2c = \pi_U^U + \pi_D^U > \pi_U^D + \pi_D^D + \nu = \lambda - 2c + \nu$, which is impossible for $\nu > 0$. Similarly, a switch from $o = J$ to $o = D$ would require $\pi_U^J - \pi_U^D - \nu > \pi_D^D - \pi_D^J \leftrightarrow \lambda - 2c = \pi_U^J + \pi_D^J > \pi_U^D + \pi_D^D + \nu = \lambda - 2c + \nu$, which is again impossible for $\nu > 0$. Finally, a switch from $o = U$ to $o = J$ would require $\pi_U^U - \pi_U^J - \nu > \pi_D^J - \pi_D^U \leftrightarrow \lambda - 2c = \pi_U^U + \pi_D^U > \pi_U^J + \pi_D^J + \nu = \lambda - 2c + \nu$, which

cannot be the case for $\nu > 0$. Similarly, no agreement can be struck when either $\lambda \geq 2c$, $\delta^* = \omega^* = 1$ and firm U make the take-or-leave-it offer. The same conclusion arises if $\lambda < 2c$ or $\lambda \geq 2c$ and either $\delta^* = \omega^* = 0$ or δ^* and ω^* are interior since each firm gains zero. □

References

Acemoglu, Daron, and James A. Robinson. 2000. "Why Did the West Extend the Franchise? Democracy, Inequality and Growth in Historical Perspective." *Quarterly Journal of Economics*, 115: 1167-1199.

Angrist, Joshua D., and Jörn-Steffen Pischke. 2009. *Mostly Harmless Econometrics*. Princeton, NJ: Princeton University Press.

Antràs, Pol. 2015. *Global Production: Firms, Contracts, and Trade Structure*. Princeton, NH: Princeton University Press.

Arruñada, Benito, Giorgio Zanarone, and Nuno Garoupa. 2019. "Property Rights in Sequential Exchange." *Journal of Law, Economics and Organization*, 35: 127-153.

Baudry, Bernard, and Virgile Chassagnon. 2018. "The Analysis of Employment Relationship in Contract Economic Theories: a Critical Review Based on the Nature of American and French Labor Laws." *Économie et institutions*, 27.

Bellows, John, and Edward Miguel. 2009. "War and Local Collective Action in Sierra Leone." *Journal of Public Economics*, 93: 1144-1157.

Besley, Timothy, and Torsten Persson. 2009. "The Origins of State Capacity: Property Rights, Taxation and Politics." *American Economic Review*, 99: 1218-1244.

Burk, Dan L., and Brett McDonnel. 2007. "The Goldilocks Hypothesis: Balancing Intellectual Property Rights at the Boundary of the Firm." *University of Illinois Law Review*, 2: 575-636.

Coase, Ronald H. 1937. "The Problem of Social Cost." *Journal of Law and Economics*, 3: 1-44.

Coase, Ronald H. 1960. "The Nature of the Firm." *Economica*, 4: 386-405.

Dari-Mattiacci, Giuseppe, and Carmine Guerriero. 2015. "Law and Culture: A Theory of Comparative Variation in Bona Fide Purchase Rules." *Oxford Journal of Legal Studies*, 35: 543-574.

Eppinger, Peter, and Bohdan Kukharskyy. 2019. "Contracting Institutions and Firm Integration." Unpublished.

Felli, Leonardo, and Antonio Merlo. 2006. "Endogenous Lobbying." *Journal of the European Economic Association*, 4: 180-215.

Gennaioli, Nicola. 2013. "Optimal Contracts with Enforcement Risk." *Journal of the European Economic Association*, 11: 59-82.

Gibbons, Robert. 2005. "Four formal(izable) theories of the firm?" *Journal of Economic Behavior & Organization*, 58: 200-245.

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

Guerriero, Carmine. 2016. "Endogenous Property Rights." *Journal of Law and Economics*, 59: 313-358.

Guerriero, Carmine. 2020. "Property Rights, Transaction Costs, and the Limits of the Market." Unpublished.

Hart, Oliver. 1995. *Firms, Contracts and Financial Structure*. Oxford, UK: Clarendon Press.

Hart, Oliver, and John Moore. 1990. "Property Rights and the Nature of the Firm." *Journal of Political Economy*, 98: 1119-1158.

Inglehart, Ronald, and Christian Welzel. 2005. *Modernization, Cultural Change, and Democracy: The Human Development Sequence*. Cambridge, UK: Cambridge University Press.

Kukharskyy, Bohdan. 2020. "A Tale of Two Property Rights: Knowledge, Physical Assets, and Multinational Firm Boundaries." *Journal of International Economics*, 122: 1-29.

Lafontaine, Francine, and Margaret Slade. 2007. "Vertical Integration and Firm Boundaries: The Evidence." *Journal of Economic Literature*, 55: 629-685

Müller, Daniel, and Patrick W. Schmitz. 2016. "Transaction Costs and the Property Rights Approach to the Theory of the Firm." *European Economic Review*, 87: 92-107.

Myerson, Roger B. 1978. "Refinements of the Nash Equilibrium Concept." *International Journal of Game Theory*, 15: 133-154.

Rose, Francis. 2019. *Blackstone's Statutes on Commercial & Consumer Law 2019-2020*. Oxford, UK: Oxford University Press.

Roth, Alvin E. 1985. "A Note on Risk Aversion in a Perfect Equilibrium Model of Bargaining." *Econometrica*, 53: 207-211.

Rubinstein, Ariel. 1982. "Perfect Equilibrium in a Bargaining Model." *Econometrica*, 50: 97-109.

Saxenian, AnnaLee. 1996. *Culture and Competition in Silicon Valley and Route 128*. Cambridge, MA: Harvard University Press.

Segal, Ilya, and Michael Whinston. 2016. "Property Rights and the Efficiency of Bargaining." *Journal of the European Economic Association*, 14: 1287-1328.

Whinston, Michael D. 2003. "On the Transaction Cost Determinants of Vertical Integration." *The Journal of Law, Economics, & Organization*, 19: 1-23.

Williamson, Oliver E. 2010. "Transaction Cost Economics: The Natural Progression." *American Economic Review*, 100: 673-690.

Figures

Figure 1: Property Rights as a Function of c

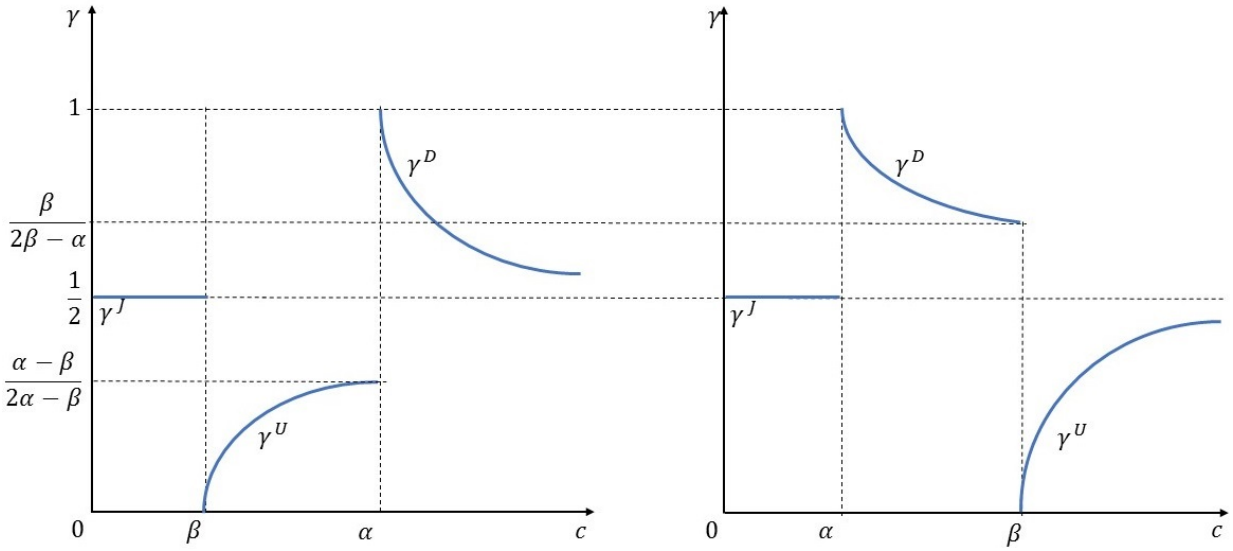


Figure 2: Property Rights as a Function of α

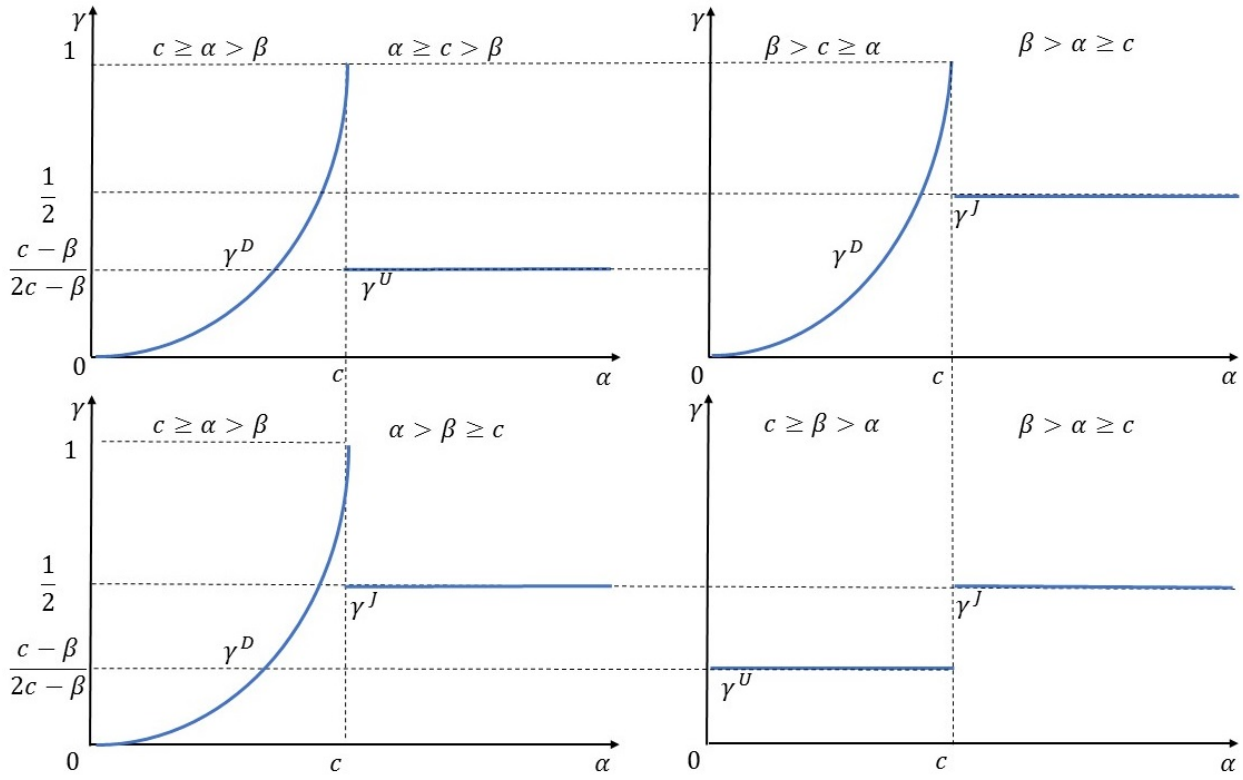


Figure 3: Property Rights as a Function of β

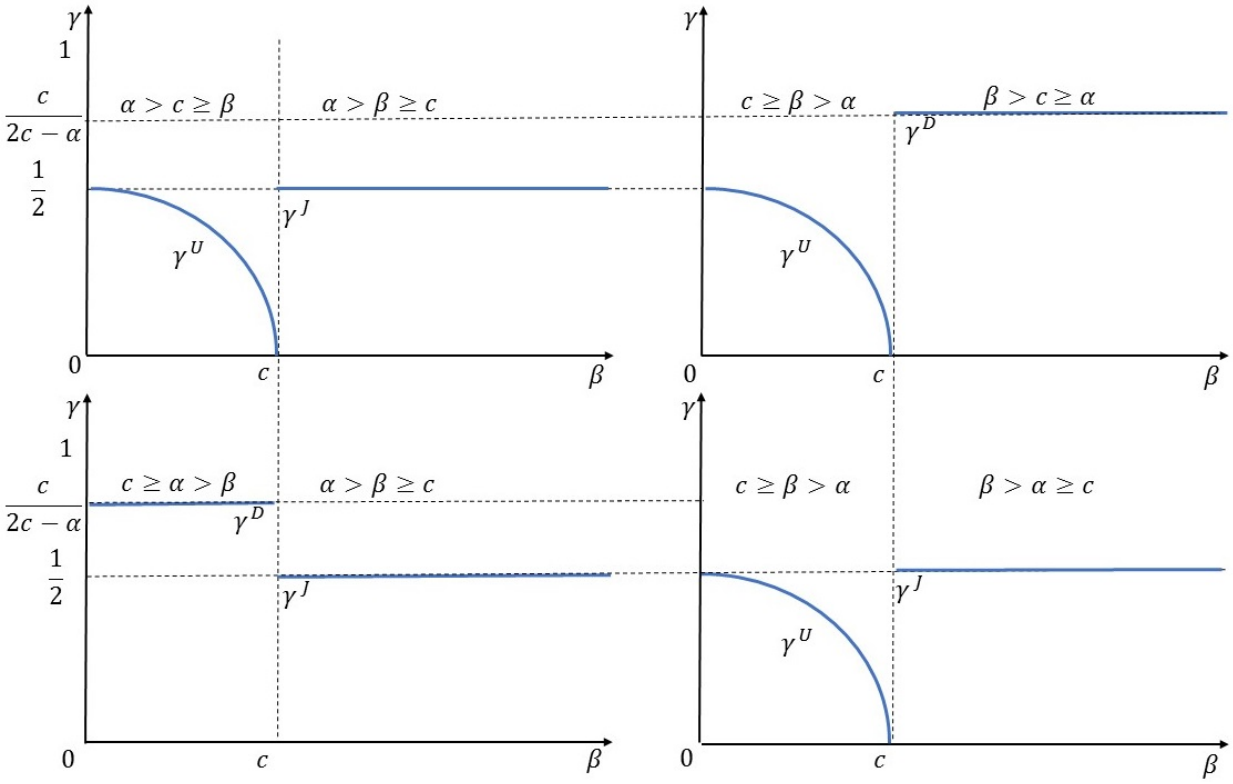


Figure 4: Vertical Integration as a Function of c

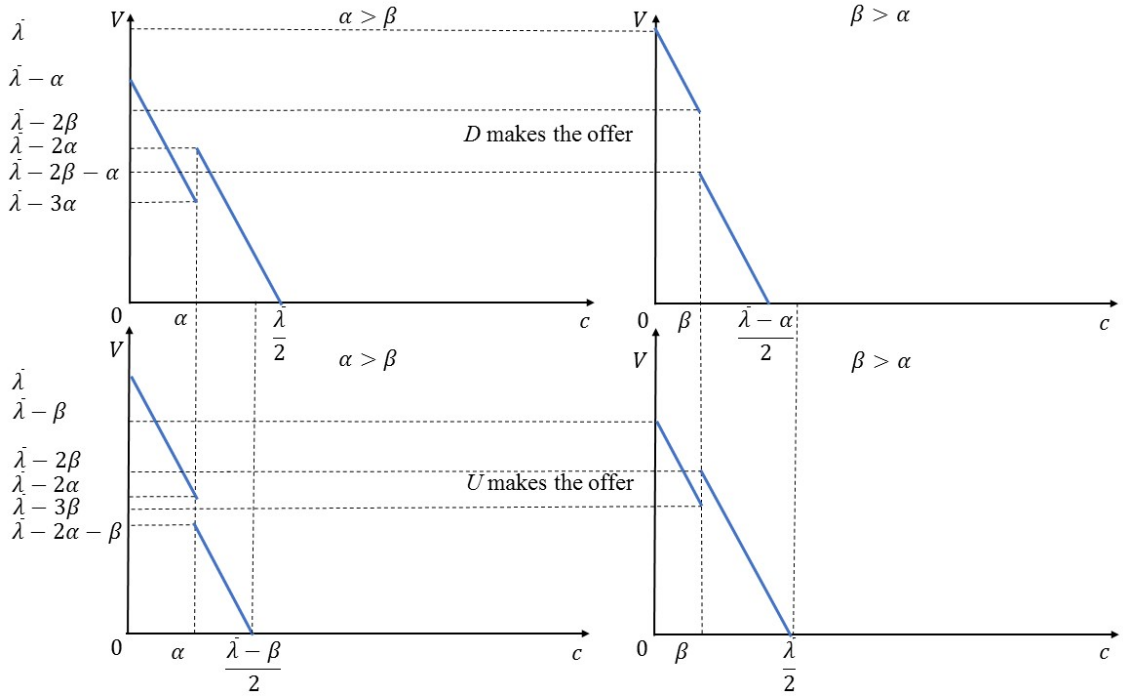


Figure 5: Vertical Integration as a Function of α

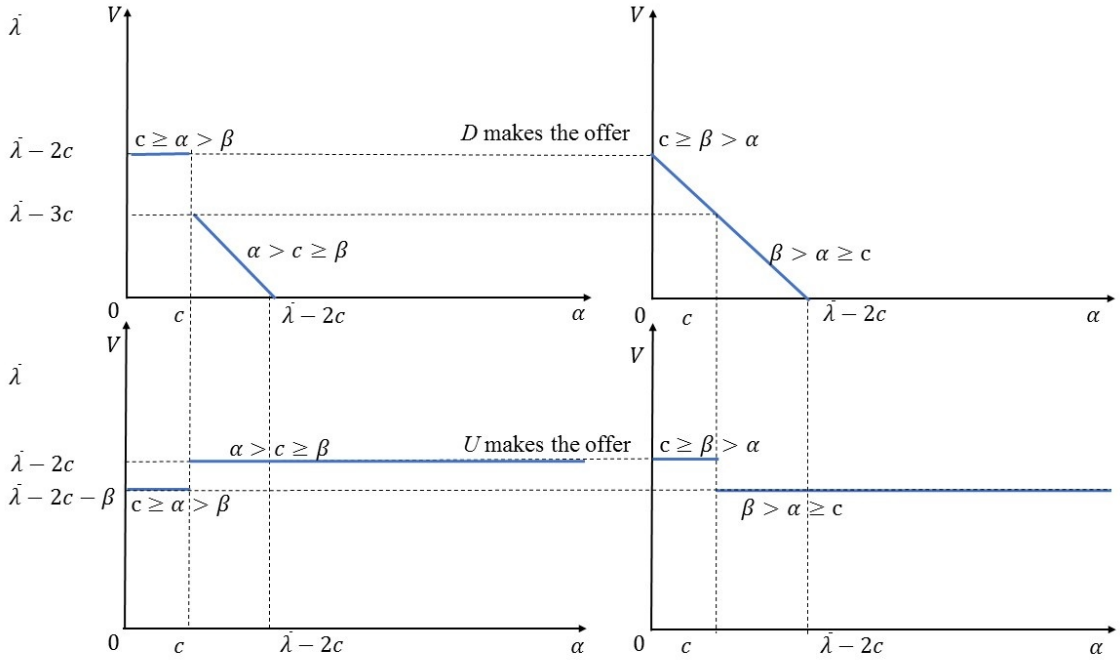


Figure 6: Vertical Integration as a Function of α (Continued)

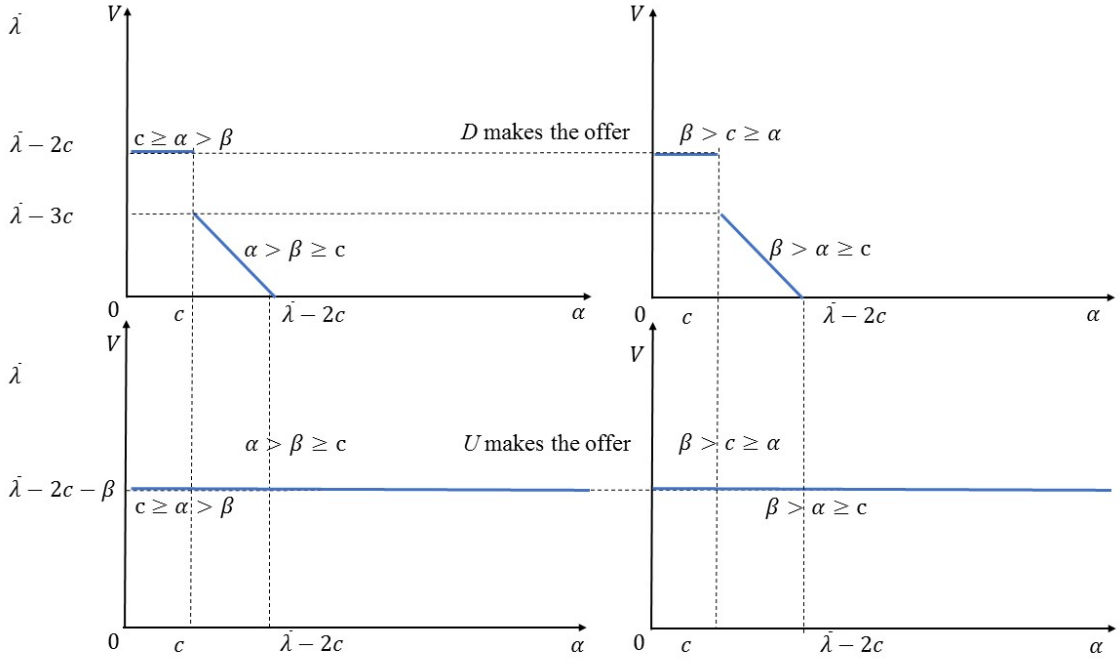


Figure 7: Vertical Integration as a Function of β

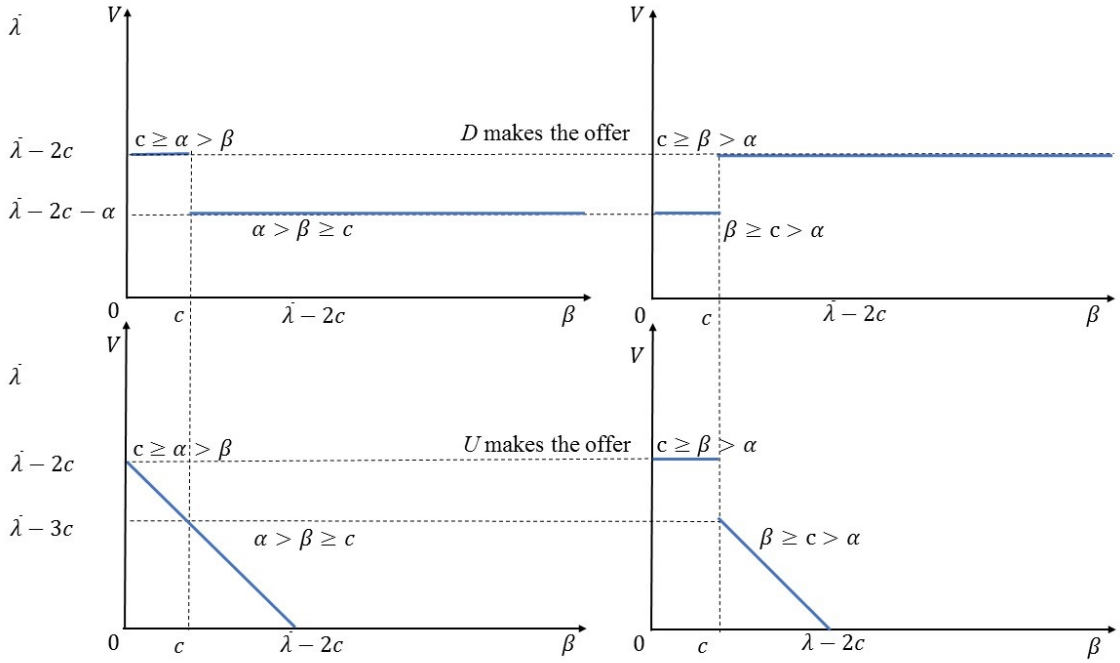


Figure 8: Vertical Integration as a Function of β (Continued)

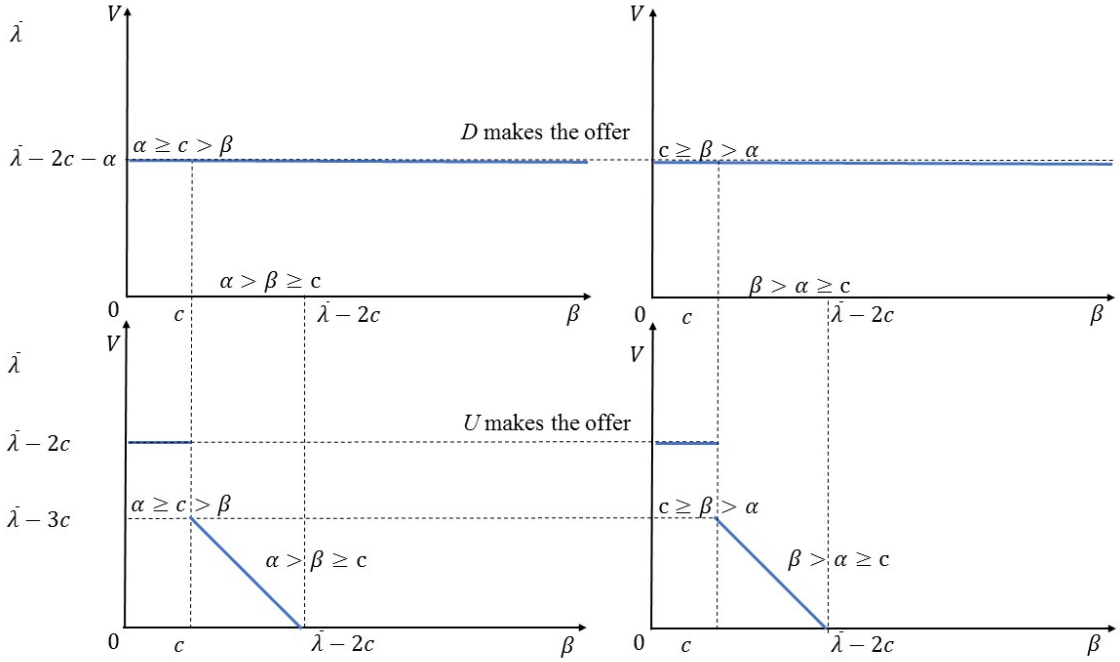
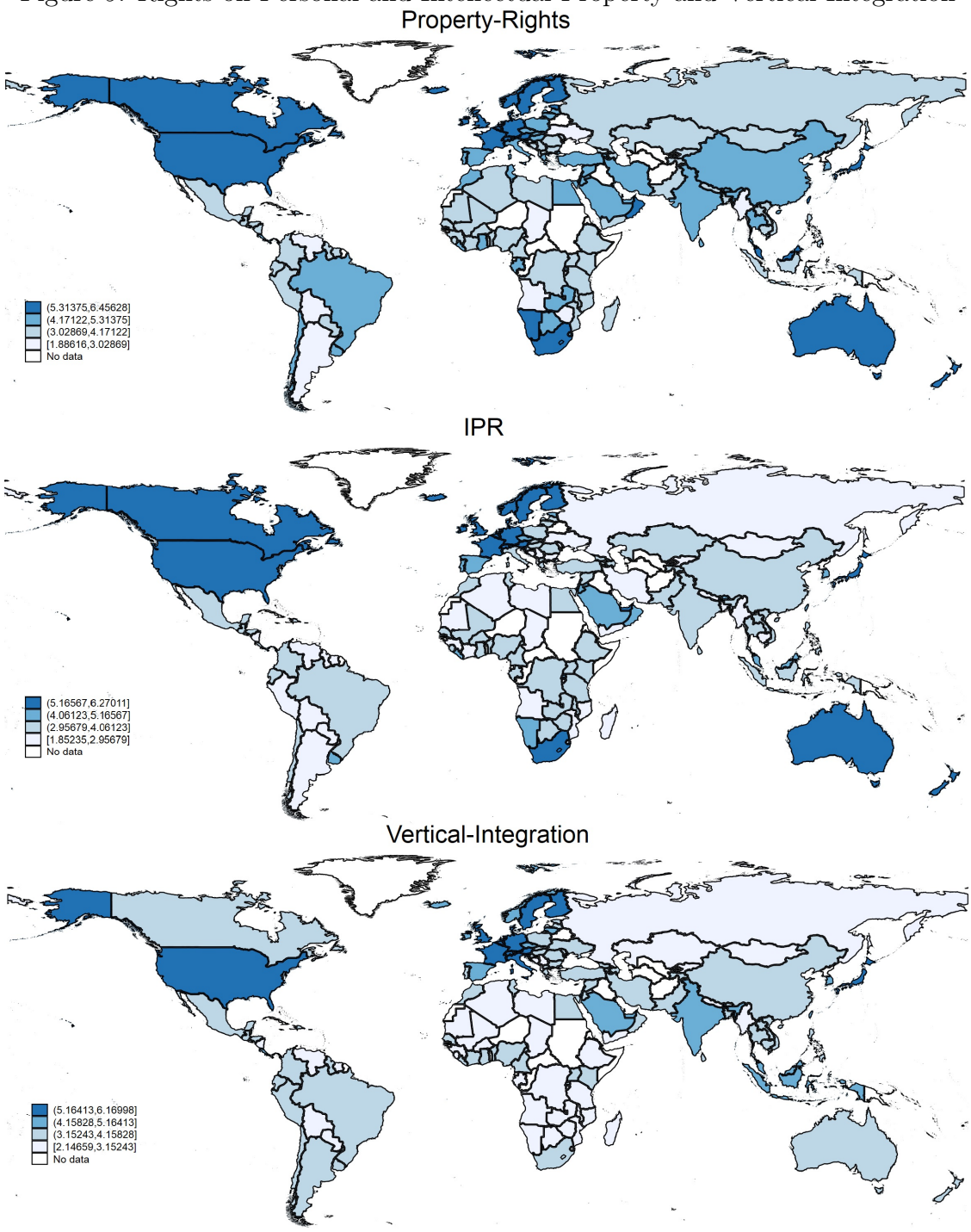


Figure 9: Rights on Personal and Intellectual Property and Vertical Integration



Note: 1. The range of each of the three variables, whose definitions and sources are listed in table 2, is divided into four equal intervals.

Table 1: The Sample

Albania; Algeria; Angola; Argentina; Armenia; Australia; Austria; Azerbaijan; Bahrain; Bangladesh; Belgium; Bolivia; Botswana; Brazil; Bulgaria; Burkina Faso; Burundi; Cambodia; Canada; Chad; Cape Verde; Chile; China; Colombia; Congo Democratic Republic; Costa Rica; Croatia; Cyprus; Czech Republic; Denmark; Dominican Republic; Ecuador; Egypt; El Salvador; Estonia; Ethiopia; Finland; France; Gabon; Gambia; Georgia; Germany; Ghana; Greece; Guatemala; Hungary; India; Indonesia; Iran; Ireland; Israel; Italy; Jamaica; Japan; Jordan; Kazakhstan; Kenya; Kuwait; Kyrgyz Republic; Latvia; Lesotho; Lithuania; Luxembourg; Macedonia; Madagascar; Malawi; Malaysia; Mali; Mauritius; Mexico; Moldova; Mongolia; Montenegro; Morocco; Mozambique; Namibia; Nepal; Netherlands; New Zealand; Nicaragua; Nigeria; Norway; Oman; Pakistan; Panama; Paraguay; Peru; Philippines; Poland; Portugal; Qatar; Romania; Russia; Saudi Arabia; Senegal; Serbia; Singapore; Slovak Republic; Slovenia; South Africa; South Korea; Spain; Sri Lanka; Sweden; Switzerland; Taiwan; Tajikistan; Tanzania; Thailand; Trinidad and Tobago; Tunisia; Turkey; Uganda; Ukraine; United Arab Emirates; UK; USA; Uruguay; Vietnam; Yemen; Zambia.

Table 2: Summary of Variables

	Variable	Definition and Sources	Statistics
Property rights:	*Property-Rights*:	Index ranging between one and seven and gaging the strength of generic property rights. Source: 2006-2015 EOS, see https://www.weforum.org/	4.509 (0.969)
	IPR:	Index ranging between one and seven and gaging the strength of intellectual property rights. Source: 2006-2015 EOS.	3.933 (1.112)
Vertical integration:	*Vertical-Integration*:	Index ranging between one and seven and gauging whether firms have a narrow or broad presence in the value chain. Source: 2006-2015 EOS.	3.868 (0.917)
Asset specificity:	*Process-Specificity*:	Index ranging between one and seven and gauging how sophisticated are production processes. Source: 2006-2015 EOS.	3.964 (1.071)
	Competitive-Advantage:	Index ranging between one and seven and identifying the competitive advantage of companies in international markets. Source: 2006-2015 EOS.	3.717 (1.063)
	Site-Specificity:	Index ranging between one and seven and gauging the extent of site specificity. Source: 2006-2015 EOS.	2.833 (1.180)
	Financial-Frictions:	See text. Source: 2006-2015 EOS.	0.560 (0.177)
Investment intensity:	*R&D-Intensity*:	Research and development expenditure as a percentage of GDP. Source: World Bank, see https://data.worldbank.org/indicator/	0.856 (0.945)
	Patent-Intensity:	PCT patent applications over the population in million. Source: 2006-2015 EOS.	35.180 (72.187)
Other controls:	*Income*:	Natural logarithm of the output-side real GDP at chained PPPs in 2011 US dollar per capita. Source: Penn World Table, see https://pwt.sas.upenn.edu/	12.026 (1.745)
	Democracy:	Polity IV constraints on the executive authority score ranging between one and seven. Source: POLITY IV dataset, see http://www.systemicpeace.org	5.606 (1.767)
	Reserves:	Crude oil proved reserves in barrels per capita. Source: Energy Information Administration, see http://www.eia.gov/	1387.014 (8017.142)
	Conflict-External:	Share of previous half-century in which the country partook in external military conflicts. Source: COW project, see http://www.correlatesofwar.org/	0.016 (0.054)
	Conflict-Internal:	Share of previous half-century in which the country partook in internal military conflicts. Source: COW project.	0.056 (0.110)

Note: 1. The last column reports the mean value and, in parentheses, the standard deviation of each variable. Both are computed for the sample employed in tables 3 to 6.

Table 3: Endogenous Property Rights and the Nature of the Firm

	(1)	(2)	(3)	(4)	(5)	(6)
	The dependent variable is:					
	Property-Rights	*IPR*	*Vertical-Integration*	*Property-Rights*	*IPR*	*Vertical-Integration*
Property-Rights			0.033			0.024
			(0.058)			(0.059)
IPR			0.184			0.170
			(0.058)***			(0.057)***
Process-Specificity	0.295	0.397	0.536	0.266	0.367	0.525
	(0.076)***	(0.065)***	(0.060)***	(0.076)***	(0.069)***	(0.059)***
Site-Specificity	- 0.211	- 0.286	- 0.027	- 0.180	- 0.264	- 0.013
	(0.042)***	(0.040)***	(0.046)	(0.043)***	(0.043)***	(0.044)
R&D-Intensity	- 0.185	- 0.249	- 0.117	- 0.164	- 0.225	- 0.116
	(0.101)*	(0.099)**	(0.131)	(0.098)*	(0.104)**	(0.128)
$R\&D\text{-}Intensity^2$			- 0.047			- 0.043
			(0.041)			(0.040)
Extra Controls	NO	NO	NO	YES	YES	YES
Estimation	OLS					
Within R^2	0.32	0.57	0.45	0.34	0.58	0.46
# of observations	1547	1547	1547	1547	1547	1547

Notes: 1. Robust standard errors allowing for clustering by country in parentheses. *** significant at the 1% confidence level; **, 5%; *, 10%.
2. All specifications include country and year fixed effects. Columns (4) to (6) also consider *Income*, *Democracy*, *Reserves*, *Conflict-External* and *Conflict-Internal*.

Table 4: Using Selection on Observables to Assess the Bias from Unobservables

	(1)	(2)	(3)
The dependent variable is	*Property-Rights*	*IPR*	*Vertical-Integration*
The regressor is:			
Process-Specificity	9.17	12.23	47.73
Site-Specificity	5.81	12	1
R&D-Intensity	7.81	9.38	116
R&D-Intensity^2			10.75

Note: 1. Each cell reports an index constructed as explained in section 5.4.1 and based on the coefficients on the variables listed in the leftmost column and get from either columns (1) to (3) or columns (4) to (6) of table 3. The number of observations is 1547.

Table 5: Alternative Measures of Asset Specificity and Investment Intensity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	The dependent variable is:								
	Property-Rights	*IPR*	*Vertical-Integration*	*Property-Rights*	*IPR*	*Vertical-Integration*	*Property-Rights*	*IPR*	*Vertical-Integration*
Property-Rights			0.049			0.002			0.031
			(0.073)			(0.059)			(0.061)
IPR			0.216			0.158			0.172
			(0.055)***			(0.055)***			(0.061)***
Process-Specificity				0.229	0.380	0.493	0.273	0.368	0.523
				(0.073)***	(0.071)***	(0.061)***	(0.080)***	(0.069)***	(0.069)***
Competitive-Advantage	0.122	0.201	0.370						
	(0.054)**	(0.060)***	(0.062)***						
Site-Specificity	- 0.227	- 0.324	- 0.067				- 0.188	- 0.272	- 0.016
	(0.038)***	(0.045)***	(0.044)				(0.043)***	(0.045)***	(0.045)
Financial-Frictions				- 1.415	- 1.313	- 0.599			
				(0.250)***	(0.237)***	(0.245)**			
R&D-Intensity	- 0.156	- 0.215	- 0.013	- 0.140	- 0.203	- 0.123			
	(0.102)	(0.103)**	(0.139)	(0.092)	(0.119)*	(0.128)			
R&D-Intensity^2			- 0.068			- 0.039			
			(0.041)			(0.040)			
Patent-Intensity							0.0004	- 0.002	- 0.0001
							(0.0012)	(0.001)	(0.0027)
Patent-Intensity^2									- 4.1E^{-6}
									(7.4E^{-6})
Estimation	OLS								
Within R^2	0.32	0.55	0.43	0.36	0.56	0.47	0.35	0.57	0.45
Number of observations	1547	1547	1547	1547	1547	1547	1469	1469	1469

Notes: 1. Robust standard errors allowing for clustering by country in parentheses. *** significant at the 1% confidence level; **, 5%; *, 10%.
2. All specifications include country and year fixed effects, *Income*, *Democracy*, *Reserves*, *Conflict-External* and *Conflict-Internal*.

Table 6: Testing for Reverse Causality

	(1)	(2)	(3)
	The dependent variable is:		
	Property-Rights	*IPR*	*Vertical-Integration*
Property-Rights			- 0.058
			(0.079)
Property-Rights-F			0.109
			(0.090)
IPR			0.265
			(0.091)***
IPR-F			- 0.123
			(0.088)
Process-Specificity	0.315	0.426	0.543
	(0.084)***	(0.074)***	(0.059)***
Process-Specificity-F	- 0.057	- 0.071	- 0.022
	(0.084)	(0.081)	(0.064)
Site-Specificity	- 0.307	- 0.353	0.044
	(0.071)***	(0.066)***	(0.060)
Site-Specificity-F	0.147	0.103	- 0.065
	(0.074)*	(0.067)	(0.062)
R&D-Intensity	- 0.129	- 0.197	- 0.004
	(0.096)	(0.102)**	(0.103)
R&D-Intensity^2			- 0.141
			(0.157)
R&D-Intensity-F	- 0.049	- 0.037	- 0.087
	(0.112)	(0.124)	(0.031)***
R&D-Intensity-F^2			0.054
			(0.050)
Estimation	OLS		
Within R^2	0.35	0.58	0.47
Number of observations	1547	1547	1547

Notes: 1. Robust standard errors allowing for clustering by country in parentheses. *** significant at the 1% confidence level; **, 5%; *, 10%.
2. *Property-Rights-F*, *IPR-F*, *Process-Specificity-F*, *Site-Specificity-F* and *R&D-Intensity-F* correspond, respectively, to *Property-Rights*, *IPR*, *Process-Specificity*, *Site-Specificity* and *R&D-Intensity* lead one year.
3. All specifications include country and year fixed effects, *Income*, *Democracy*, *Reserves*, *Conflict-External* and *Conflict-Internal*.