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Endogenous property rights and the nature of the firm

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Abstract

While focusing on residual control rights, the property rights theory of the firm overlooks that the legal protection of each party's input shapes its *ex post* bargaining power. To evaluate this issue, we assume that the property rights on the inputs are selected by a legislator to maximize full investment and, conditional on this goal being reached, minimize inefficient deviations to intermediate investment profiles. Our model delivers three key novel implications. First, the strength of a party's property rights is related negatively to the strength of its residual control rights and determines entirely its *ex ante* incentives to invest. Second, the legislator tends to protect a firm less when its default payoff under its preferred ownership structure is larger and when its contribution to the relationship is the greatest. Finally, the extent of integration falls weakly with the default payoffs and displays an inverted U-shaped link with the intensity of the downstream firm's investment activity. Crucially, these predictions are consistent with the relationships between proxies for the strength of the downstream firms' property rights and firms' presence in the value chain, and measures of asset specificity and R&D intensity for 119 countries observed over the 2006–18 period.

1 | INTRODUCTION

The property rights theory (PRT) of the firm, developed by Grossman and Hart (1986), Hart and Moore (1990) and Hart (1995), has emerged as the most tractable and insightful model of 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 incentives of the acquiring party to undertake *ex ante* non-contractible specific investments, while weakening the corresponding incentives of the acquired party. As a result, allocative efficiency can be improved by selecting the appropriate ownership structure.

This paper is part of the Economica 100 Series. Economica, the LSE "house journal" is now 100 years old. To commemorate this achievement, we are publishing 100 papers by former students, as well as current and former faculty. Carmine Guerriero completed his MSc at the LSE.

While focusing on residual control rights, however, the PRT treats each party's *ex post* bargaining power as exogenous, obscuring the role of the legal environment. Regardless of the arranged ownership structure, indeed, each party's renegotiation power is deeply shaped by the legal protection of its input. As detailed in the Online Appendix, commercial law strengthens the *ex post* bargaining power of the party whose contribution to the relationship is the most limited and/or that enjoys a smaller default payoff by expanding the actions and remedies at its disposal and/or limiting the clauses available to its partner. By doing so, the renegotiation power of the other party gets weaker (Dari-Mattiacci and Guerriero 2015).

The following legal cases are enlightening. First, employers and downstream firms enjoy strong and easily obtainable unregistered intellectual property rights when they provide specific processes in sectors in which the upstream parties' capital inputs are intensive (Burk and McDonnel 2007). Moreover, this unregistered protection of the downstream parties' intellectual property is strengthened via non-disclosure, work for hire and non-competition agreements only when these clauses do not discourage employees and upstream firms from supplying specific inputs (Saxenian 1996). Second, the compulsory licensing of the upstream parties' registered intellectual property rights is more often granted when the terms for voluntary licensing are unreasonable and thus the downstream parties' default payoffs are tiny (Burk and McDonnel 2007). Finally, to curb the exploitation of proprietary information, commercial law trades the reliance of employers/downstream firms on fiduciary duties and shop right provisions for the use of unfair contract terms and abuse of right doctrines by employees/upstream firms (Baudry and Chassagnon 2018).

To shed light on these issues, we study heterogeneous projects, each involving an upstream and a downstream firm—for example, production of an electronic device of heterogeneous quality by a component producer and an electronics contract manufacturer (Antràs 2015). While the two parties bargain over residual control rights—that is, downstream, upstream or joint ownership—the strength of the upstream firm's property rights on his input, which, in turn, determines the *ex post* bargaining powers, is selected by a legislator.[1] A micro-foundation to this view is to assume that parties also contract over the *ex post* bargaining power but can obtain in court that the legislator's choice is enforced. Then one party must prefer to file suit *ex post*, and both firms agree on the legislative choice *ex ante*, that is, in the 'shadow of the law'.

There are a mass one of projects, each worth the product of the project-specific productivity and each firm's effort to raise the odds of its success. This effort lies between zero and one, and entails a linear cost. Given this technology, firms might select the 'zero,' 'intermediate' and 'full' investment profiles, with the first two delivering zero *ex post* bargaining payoffs. Accordingly, we assume that the legislator selects the strength of upstream firm's property rights to maximize the possible adoption of full investment and, conditional on this goal being reached, minimize deviations to the inefficient intermediate investment profiles. This assumption incorporates into the subgame perfect equilibrium (SPE) the idea that costly deviations are unlikely and assures its uniqueness. Moreover, it implies that the legislator designs property rights as if she were maximizing the expected social welfare with respect to the distribution of the parties' deviations from full investment. Once property rights are selected, and within each project, a party makes a take-it-or-leave-it offer to its partner on the ownership structure—for example, the manufacturer acquires residual control rights over the physical assets of the component producer, or the latter integrates the manufacturer's production processes, or the two parties remain unaffiliated. If the offer is refused, then both firms receive a zero outside option. If it is accepted, then they select an investment level simultaneously and non-cooperatively. Finally, after having invested, the parties bargain over trade. Operationally, they decide whether to divide the surplus produced through joint production on the bases of each firm's property rights or accept the default payoffs, that is, return on the next-best alternative use of their investments outside the project.

Different from the PRT, the strength of each party's residual control right depends on the identity of the party making the take-it-or-leave-it offer, thus it is not generally unique. Moreover, it is inversely related to the strength of its property rights, which in turn entirely drives investment incentives and is solely shaped by the size of the default payoffs. When the latter are small relative to the innovation cost, thus the gains from trade—that is, project value net of default payoffs—are large, full investment is assured by any of the three market structures: (a) strong upstream firm's property rights generally combined with downstream ownership; (b) weak upstream firm's property rights generally accompanied by upstream ownership; (c) Nash bargaining generally combined with joint ownership. Under these scenarios, the legislator designs property rights to discourage costly deviations to intermediate investment by unbalancing the most the parties' *ex ante* incentives. To do so, she protects more the firm with the smallest default payoff to assure that its partner obtains more often its preferred ownership structure. As a result, each firm's property rights are weaker, the larger its default payoff under its preferred ownership structure, and they are stronger, the greater its partner's default payoff under this party's preferred ownership structure.[2] Moreover, the adoption of either downstream or upstream ownership, which we consider a situation of lateral or vertical integration, is more limited, the larger the innovation cost and the greater the default payoff of the party making the take-it-or-leave-it offer. While the former curbs any investment incentive, the latter reduces the incentives to invest of the party operating under its least preferred ownership structure. Opposite patterns arise when one of the two parties gains little from trade, thus fostering the full-investment profile is pivotal. Since, then, integration cannot maximize the adoption of full investment, the legislator prefers to implement the Nash bargaining solution.

In the most likely case of large gains from trade (see Section 3 and Antràs 2015), there are three most innovative implications of the model. First, the strength of property rights is unique, the strength of residual control rights depends on the identity of the party making the take-or-leave-it offer, and property and residual control rights tend to be strategic substitutes. Second, the strength of the upstream firm's property rights falls weakly with his default payoff and rises weakly with the downstream firm's default payoff. Finally, the extent of integration decreases with the default payoffs. These implications are similar if only self-investment is allowed, investment is either discrete or unilateral, either upstream or downstream firms have more influence on institutional design, the firm receiving the take-it-or-leave-it offer can pay the other party to get a particular offer, and/or the production function is Cobb–Douglas with constant returns to scale, thus the impact of each party's investment is asymmetric. In this last case, intermediate-investment profiles have measure zero and the legislator cares only about maximizing the adoption of full investment. For large gains from trade, then, the upstream firm is more legally protected if the intensity of his contribution to the relationship is limited, thus his investment incentives are weaker, and the extent of integration has an inverted U-shaped link with the intensity of the downstream firm's investment.

To assess whether the correlations in the available data are consistent with main implications of the model, we analyse a panel of 119 countries spanning the 2006–18 period. For this sample, the Executive Opinion Survey run by the World Economic Forum reports proxies, 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 inversely related to, respectively, downstream firm's and upstream firm's default payoff, and R&D intensity, which we employ as a measure of the intensity of the downstream firm's investment activity. Conditional on country and year fixed effects, OLS estimates suggest that the strength of the downstream firms' property rights is significantly and positively related to our proxy for process specificity, and significantly and negatively linked to our measures of both site specificity and R&D intensity. Instead, the extent of vertical integration is significantly—and positively—connected to the proxy for process specificity, and displays an inverted U-shaped link with R&D intensity.

The paper proceeds as follows. We review in Section II the literature most related to our analysis. Next, we discuss in Section III the basic correlations in the available data. This analysis motivates the baseline model that we illustrate in Section IV. Next, we evaluate in Section V how robust the model predictions are to alternative assumptions. Finally, we conclude in Section VI, and we gather proofs in an Appendix, plus figures and tables in an Online Appendix.

2 | RELATED LITERATURE

Our analysis is strictly connected with five well-known strands of literature.

First, it is linked with the other theories of the firm, notably the PRT (Gibbons 2005). Different from the latter, we do not assume that the legal protection of each party's input is irrelevant for its *ex post* bargaining payoff—as 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; Kukharskyy 2020; Biancini and Bombarda 2021). Instead, we distinguish between the property rights on the firms' inputs, which determine their *ex post* bargaining power and are selected by the legislator, and residual control rights, which define the default payoffs and are decided by the parties. By endogenizing both choices, our setup shows that the ownership structure is driven completely by the legal protection of each firm's input and its determinants. This is not a subtle difference. To begin with, the PRT approach concludes that there is a unique optimal ownership structure (Hart 1995), whereas we show that residual control rights are, generally, multiple. Being a private choice, they depend on the identity of the party formulating the take-or-leave-it offer. Second, the PRT suggests that as one party's default payoff under its preferred ownership structure decreases, 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, a rise in the default payoff of the firm making the take-it-or-leave-it offer always discourages integration. Finally, Antràs and Helpman (2004) claim that the distribution of renegotiation power should favour the party whose relative contribution to the relationship value is disproportionate. We reach the opposite conclusion when we consider asymmetric investment activities under the most likely scenario of large gains from trade.

Second, our analysis relates to the literature on non-cooperative bargaining. This stream of research suggests that parties guiding the exchange, with larger outside options and whose contribution to the relationship value is the largest, should have a stronger renegotiation power (Rubinstein 1982; Roth 1985; Antràs 2015). These implications do not arise in our framework for two key reasons. First, since the ownership structure does not autonomously shape investment incentives, the identity of the party making the take-or-leave-it offer is irrelevant for the design of property rights. Second, each party's default payoff and contribution to the relationship are not generally positively correlated with the strength of its *ex post* bargaining power since the legislator must always assure that both firms face the maximum *ex ante* incentives to coordinate on full investment (Guerriero 2011, 2013, 2020).

Third, our paper is linked with a recent and growing literature on endogenous property rights (Guerriero 2016a; Segal and Whinston 2016; Arruñada *et al.* 2019; Benati *et al.* 2022) and, above all, to Guerriero (2023). Different from us, this contribution focuses on destructive *ex post* haggling and studies the downstream firm's choice of whether to produce in house rather than under joint ownership. Accordingly, Guerriero (2023) concludes that the strength of the upstream firm's property rights should depend—and in a negative manner—only on the degree of specificity of the downstream firm's asset.

Fourth, the tie-breaking rule that we embrace to characterize the legislator's design of property rights is logically consonant with the literature on trembling hand perfection (Selten 1975). We extend this strand of research by envisioning that the institutional designer considers the costs and odds of unintended strategies by each of the two parties.

Finally, we contribute to a burgeoning empirical literature on the impact of the intensity of each party's investment decision, asset specificity and contractibility on vertical integration.[3] On the one hand, we clarify that future research should consider both the direct and indirect—going through property rights—effects of the partnership details. On the other hand, we propose to overcome the challenge of the measurement of these fundamental objects by relying on a single dataset on both institutions and aggregated firm characteristics.

3 | PROPERTY RIGHTS OUTSIDE AND INSIDE THE FIRM

To evaluate the relationships between either property or residual control rights and their determinants, we analyse data from 119 countries surveyed by the Executive Opinion Survey (EOS) between 2006 and 2018, for which we can observe all controls (see Table 1).[4] The EOS is the longest-running survey of the opinions of business leaders, and provides information on the strength of the downstream firms' property rights, intensity of their investment activity, asset specificity and firms' presence in the value chain, which are unavailable at either the national or multinational firm level (World Economic Forum (WEF) 2015; Antràs 2015).

3.1 | Measurement

Starting with the strength of property rights, we consider two continuous indexes ranging between 1 and 7, and increasing with the intensity of the protection of generic property, including financial assets (i.e. *Property-Rights*), and the defence of intellectual property rights, including anti-counterfeiting measures (i.e. *IPR*); see Table 2 for the definitions and sources of all the variables that we employ. Since these rights are typically defined on the final goods produced by downstream firms (Burk and McDonnel 2007, pp. 591–4), these indexes constitute direct metrics of the strength of the downstream parties' property rights and inverse proxies for the intensity of the legal protection of upstream firms. Intuitively, because of limited liability, the legal system must balance the protection of the property rights of the original owners of an input (i.e. upstream firms) with the reliance on contract of their partners (i.e. downstream firms) and a strengthening of the latter must be accompanied by a weakening of the former (Dari-Mattiacci and Guerriero 2015).

TABLE 1 The sample.

Albania, Algeria, Angola, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahrain, Bangladesh, Belgium, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cambodia, Canada, Cape Verde, Chad, 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, UK, Ukraine, United Arab Emirates, Uruguay, USA, Vietnam, Yemen, Zambia.

TABLE 2 Summary of variables.

	Variable	Definition and sources	Statistics
Downstream firms' property rights	*Property-Rights*	1–7 index capturing strength of downstream parties' generic property rights	4.509
		Source: 2006–19 EOS; see https://www.weforum.org	(0.969)
	IPR	1–7 index picking strength of downstream parties' intellectual property rights	3.933
		Source: 2006–19 EOS	(1.112)
Vertical integration	*Vertical-Integration*	1–7 index rising when firms have broader presence in value chain	3.868
		Source: 2006–19 EOS	(0.917)
Asset specificity	*Process-Specificity*	1–7 index increasing with sophistication of production processes	3.964
		Source: 2006–19 EOS	(1.071)
	Site-Specificity	1–7 index gauging extent of site specificity	2.833
		Source: 2006–19 EOS	(1.180)
Downstream firms' investment activity	*R&D-Intensity*	R&D expenditures as percentage of GDP	0.856
		Source: World Bank; see https://data.worldbank.org/indicator	(0.945)

Notes: The last column reports the mean value and, in parentheses, the standard deviation of each variable. Both are computed for the sample employed in Table 3.

Turning to the ownership structure, we focus on the 1–7 continuous indicator *Vertical-Integration*. This index captures whether firms have a narrow or a broad presence in the value chain. A value 1 indicates a narrow presence, primarily involved in individual steps (e.g. production), whereas a value 7 indicates a broad presence across the value chain (e.g. production, marketing, distribution, design, and so on).

Regarding the downstream and upstream firms' default payoffs, we follow the extant literature (Whinston 2003; Williamson 2010), and we assume that they are inversely related to, respectively, process and capital specificity. To elaborate, we consider two continuous indicators ranging between 1 and 7. First, *Process-Specificity* picks the sophistication of the production method. A value 1 suggests that it uses labour-intensive processes and/or an old technology, whereas a value 7 implies that it uses sophisticated and knowledge-intensive processes. Hence *Process-Specificity* increases with the degree of specificity of the intangible assets and production processes typically brought about by downstream parties. Second, *Site-Specificity* measures the state of infrastructures. A value 7 indicates extremely underdeveloped infrastructures, whereas a value 1 points towards an extensive and efficient system. Thus *Site-Specificity* rises as the economy becomes more unable to ease the provision by the upstream firms of facilities and/or physical assets.

Finally, we proxy the intensity of downstream firms' investment activity with an estimate of the research and development expenditures 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 larger relative relevance for the production activities of a country of the intangible assets/processes provided by the downstream parties.

3.2 | Estimating equation

Ultimately, we run panel OLS regressions of the form

$$Y_{c,t} = \alpha_c + \beta_t + \gamma' \mathbf{X}_{c,t} + \delta' \mathbf{Z}_{c,t} + \varepsilon_{c,t}, \tag{1}$$

where $Y_{c,t}$ is *Property-Rights*, *IPR* or *Vertical-Integration* in country c at time t. Here, α_c represents country fixed effects controlling for time-independent determinants of $Y_{c,t}$ such as those discussed by the literature on endogenous property rights, that is, strength of a culture of morality and quality of legal enforcement (Dari-Mattiacci and Guerriero 2015, 2019), degree of preference heterogeneity (Guerriero 2016a), and size of transaction costs (Guerriero 2023). Parameter β_t labels year dummies gauging macro-shocks like financial crises and macroeconomic imbalances; $\mathbf{X}_{c,t}$ gathers *Process-Specificity*, *Site-Specificity* and *R&D-Intensity*; finally, $\mathbf{Z}_{c,t}$ might include extra controls. First, we consider possibly *R&D-Intensity*^{2} and *R&D-Intensity*^{3} to account for the highly non-linear impact of the intensity of the downstream firm's investment activity on integration. Second, we evaluate possibly the impact on the main coefficients of omitted variables (see the Online Appendix).

3.3 | Basic empirical results

Two key patterns are uncovered by the estimates listed in Table 3. First, the downstream firms' property rights are the strongest whenever process specificity is the most severe, site specificity is most limited and R&D intensity is the smallest (see columns (1) and (2)). All these links are significant at 10% or more. Second, the extent of vertical integration is positively and significantly related (at 1%) to process specificity, has a significant inverted U-shaped relationship with *R&D-Intensity*, and is negatively and significantly (at 10%) linked to *Site-Specificity* (see column (5)).[5] This last coefficient is the only one inconsistent with the main predictions of our

TABLE 3 Endogenous property rights and the nature of the firm.

Dependent variable	*Property-Rights* (1)	*IPR* (2)	*Vertical-Integration* (3)	*Vertical-Integration* (4)	*Vertical-Integration* (5)
Process-Specificity	0.295	0.397	0.627	0.617	0.605
	(0.076)***	(0.065)***	(0.058)***	(0.058)***	(0.057)***
Site-Specificity	−0.211	−0.286	−0.088	−0.086	−0.087
	(0.042)***	(0.040)***	(0.046)*	(0.046)*	(0.046)*
R&D-Intensity	−0.185	−0.249	−0.324	−0.150	0.406
	(0.101)*	(0.099)**	(0.113)***	(0.140)	(0.205)**
R&D-Intensity^2				−0.052	−0.498
				(0.044)	(0.161)***
R&D-Intensity^3					0.075
					(0.029)***
Estimation	OLS				
Within R^2	0.32	0.57	0.42	0.42	0.44
Number of observations	1547	1547	1547	1547	1547

Notes: Robust standard errors allowing for clustering by country in brackets. All specifications include country and year fixed effects. ***, **, * indicate significant at the 1%, 5%, 10% confidence level, respectively.

model, and it becomes insignificant when we consider the impact of unobserved heterogeneity (see the Online Appendix).

3.4 | Robustness checks

To evaluate causality, without the presumption to prove it, we discuss in the Online Appendix the following robustness checks. First, we document that our conclusions are similar when we capture process and capital specificity with a proxy for whether unique processes are a country's competitive advantage, and a measure of the severity of financial frictions, respectively, and when we substitute patent applications over the population in million for R&D intensity. These patterns suggest that measurement errors are not a major issue in our analysis. Second, we consider the other determinants of property rights identified by the extant literature. These are income, inclusiveness of political institutions, non-produced output, and both external and internal conflicts (Guerriero 2023). Including these observable factors together leaves the results almost intact, as it does considering the main determinants of either property rights or vertical integration lead one, two or three years. The fact that these lead values are also insignificant excludes that the estimates are driven by reverse causation. Finally, we calculate that the influence of unobservable factors would need to be on average more than ten times stronger than the influence of all main observables to explain away the OLS estimates.

3.5 | Discussion

Our empirical exercise highlights two stylized facts.

First, the strength of the downstream firm's property rights falls weakly with both her default payoff and the intensity of her investment activity, and rises weakly with the upstream firm's default payoff. Second, the extent of integration falls weakly with the default payoffs and has an inverted U-shaped link with the intensity of the downstream firm's investment activity.

Next, we illustrate a model of endogenous market design that is both tractable and sufficiently general to produce implications consistent with the two aforementioned stylized facts, and to encompass the ideas that each party's renegotiation power is shaped by its property rights on input and that the gains from trade are large. While the first of these two assumptions is further supported by the institutional analysis reported in the Online Appendix, the second is backed up by the fact that only 0.4% and 22.7% of, respectively, the *Process*-*Specificity* and *Site*-*Specificity* observations are below 2. As clarified by our theoretical analysis, sizeable asset specificity entails that the two parties should be protected asymmetrically. A glance at Figure 1 confirms that this is the case in our data, whereby only 26.8% of the *Property*-*Rights* observations lie within the intermediate values 3 and 4.

4 | THEORY

4.1 | Technology

Consider a mass one of projects, each worth $\Pi = \lambda\delta\omega$, and each involving an upstream firm U and a downstream firm D. Here, λ is the 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 $\lambda_m \equiv \left(\overline{\lambda} + \underline{\lambda}\right)/2$. Also, $\delta \in [0, 1]$ and $\omega \in [0, 1]$ are the non-contractible investment activities of firms D and U, respectively, and entail costs $c\delta$ and $c\omega$.

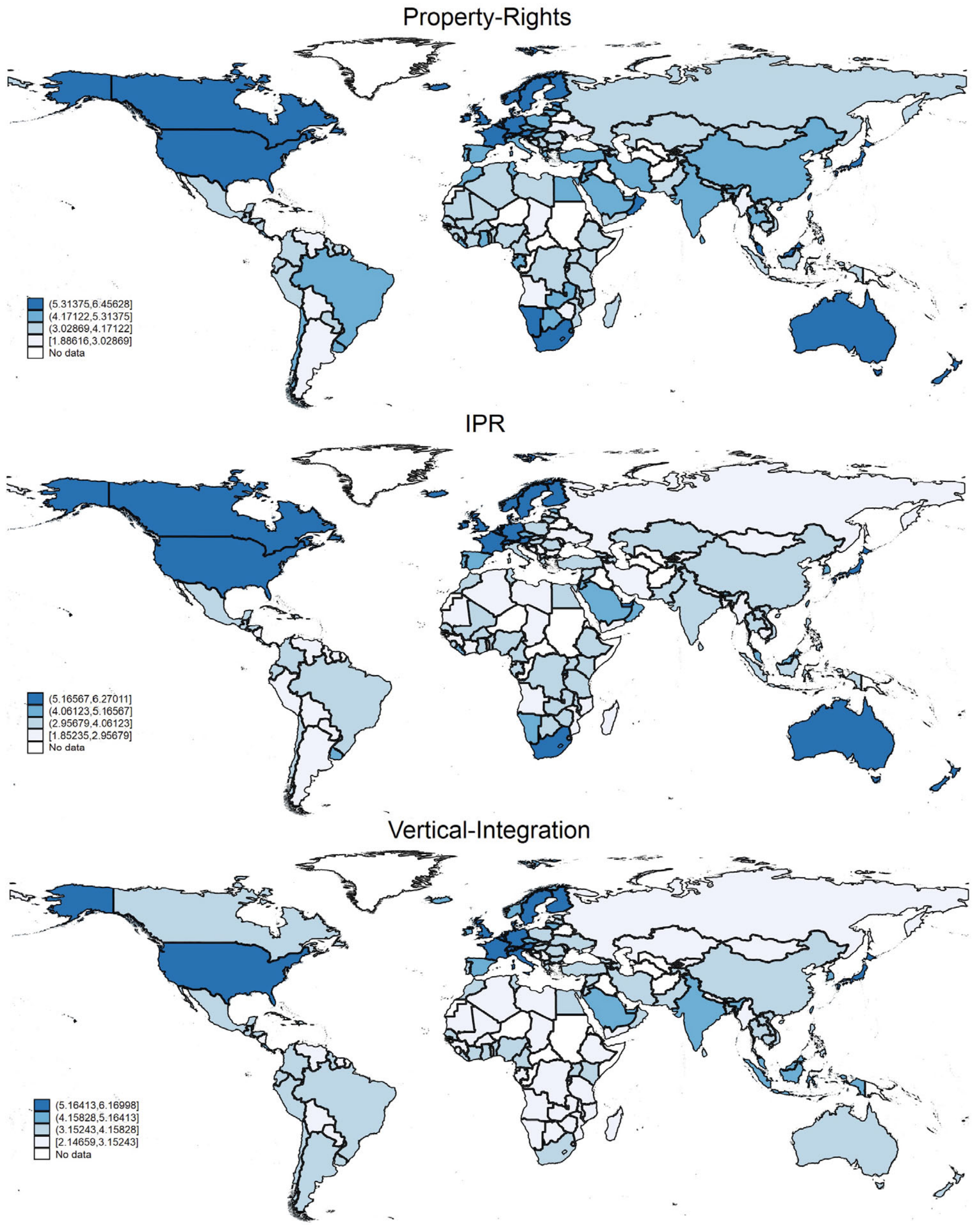

FIGURE 1 Rights on personal and intellectual property and vertical integration. *Notes*: The range of each of the three variables, whose definitions and sources are listed in Table 2, is divided into four equal intervals.

Accordingly, in our basic setup, the two parties' investment activities increase symmetrically the probability that the joint project is successful.

4.2 | Payoffs

A project starts with the parties bargaining over the ownership structure $o \in \{D, U, J\}$, with D, U and J labelling, respectively, downstream, upstream and joint ownership. If no agreement is reached, then firm D (U) produces in house by means of her (his) input, and obtains an outside option normalized to zero. When an agreement on o is reached, and after the parties have invested, they bargain over trade, that is, they decide whether to use their assets for joint production and divide the gains from trade or accept the default payoff $d_i^o \delta\omega$. This denotes the utility to firm $i \in \{D, U\}$ from its next-best alternative to trading, given the previously selected investments and under ownership o. Hence we allow for a party's investment to affect both its own and its partner's default payoff, that is, 'self-investment' and 'cross-investment' (Whinston 2003). Following Whinston (2003), the next-best alternative to trading is such that only a sole owner can improve over its outside option, since two parties jointly owning the assets have veto power on each other. To illustrate, $d_U^D = d_D^U = d_i^J = 0$, $d_D^D = \alpha > 0$ and $d_U^U = \beta > 0$. To exclude trivial cases, we impose the following.

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

There are two key observations. First, the condition $\overline{\lambda} > 2c > \underline{\lambda}$ allows for both projects supporting only the zero-investment profile, and 'productive' projects sustaining also positive investment levels. Second, the inequality $2c > \max\{\alpha, \beta\}$ implies that selecting the default payoff is not a dominant strategy, and that equilibrium property rights are positive.

When the two parties decide to divide the gains from trade under ownership structure o, firm U receives $d_U^o \delta\omega$ plus a share γ of the gains from trade—that is, project value net of default payoffs—and firm D pockets the rest. The *ex post* bargaining payoffs of firms D and U are

$$\pi_D^o(\gamma) \equiv d_D^o \delta\omega + (1-\gamma)\left(\lambda - d_D^o - d_U^o\right)\delta\omega - c\delta,$$
$$\pi_U^o(\gamma) \equiv d_U^o \delta\omega + \gamma(\lambda - d_D^o - d_U^o)\delta\omega - c\omega,$$

respectively. As a result, $\pi_D^D(\gamma) > \pi_D^J(\gamma) > \pi_D^U(\gamma)$ and $\pi_U^U(\gamma) > \pi_U^J(\gamma) > \pi_U^D(\gamma)$.

4.3 | Interpretation

The parameter γ captures the strength of the upstream firm's property rights on his facility/physical asset relative to the strength of the downstream firm's property rights on her intangible asset/process and, in turn, on the final good. To elaborate, γ is larger, the stronger the remedies (i.e. unfair contract terms and abuse of right doctrines) in the upstream party's hands, the more efficient their enforcement and the longer their prescription period. Symmetrically, γ is smaller, the more intense the legal protection of the downstream party's input, that is, the easier it is to impose non-disclosure, work for hire and non-competition agreements, and both fiduciary duties and shop right provisions.[6] Similarly, $1-\gamma$ might pick the odds with which the infringement by firm D of the patent of firm U is condoned because of compulsory licensing. In this regard, Kukharskyy (2020) and Biancini and Bombarda (2021) observe that by weakening protection from imitation, stronger firm U's intellectual property rights might improve his default payoff and worsen that of firm D. In our setup, a court enforcing intellectual property rights by redistributing the default payoffs between parties induces the three residual control rights regimes to collapse into joint ownership.[7] In general, the investment interaction that we study can be envisioned as any endeavour requiring cooperation between two parties D and U (e.g. individuals, firms and organizations) and such that the renegotiation power of U is fixed by the socially devised γ.

4.4 | Timing of events

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

In t_0, the legislator selects the protection of the upstream firms' property rights γ.

In t_1, and within each project, a party makes to its partner a take-it-or-leave-it offer on the ownership structure o. If the offer is refused, then everybody gains the outside option 0.

In t_2, and within projects for which the take-it-or-leave-it offer has been accepted, firms select simultaneously and non-cooperatively an investment level, that is, δ and ω.

In t_3, and after having invested, firms bargain over trade, that is, they pick either $d_i^o \delta\omega$ or π_i^o.

4.5 | Discussion

In evaluating the soundness of our setup, several remarks should be considered.

First, our results will be similar should the impact of each firm's investment on the project success be asymmetric (see Subsection 5.1). Second, should we either focus on self-investment, as in Grossman and Hart (1986), or switch to a discrete investment technology, as in Müller and Schmitz (2016), we will obtain similar testable predictions (see Subsections 5.2 and 5.3). Third, the message of our analysis will be unchanged should we consider a unilateral investment decision (see Subsection 5.4). Fourth, since modulating property rights has only the marginal effect of determining the measure of productive projects, our analysis is the same for any other continuous probability density function of λ. Similarly, our conclusions will be the same should the legislator be partisan (see Subsection 5.5).[8] Fifth, the randomness of the project value can also be interpreted as an unforeseen shock to already matched pairs.[9] Sixth, we characterize the equilibrium in the two cases in which either firm U or firm D makes the take-it-or-leave-it offer. Crucially, our analysis will be the same should we study a more general form of bargaining over the ownership structure (see Subsection 5.6). Finally, the division of the gains from trade will still be determined by γ should we envision that the parties can contract on a possibly different *ex post* bargaining parameter ζ at time t_1, but can also obtain at time t_3 that γ is enforced by filing suit. Then one party will always prefer *ex post* γ over $\zeta \neq \gamma$, thus ζ will be picked in the shadow of the law to equal γ.[10]

4.6 | Equilibrium

4.6.1 | Regularities

We focus on SPE in pure strategies. Any such equilibrium prescribes a property rights level γ^* and, for each productive project, an ownership structure o^* and investment levels δ^* and ω^*, which might be multiple. Two characteristics of an SPE follow immediately from our assumptions. First, the parties never strictly prefer to accept the default payoffs since at least one of them will then select the zero-investment level, thus $\Pi = 0$. Second, the two firms weakly prefer the *ex post* bargaining payoff to the outside option—that is, their individual rationality (IR) constraints hold—if $\pi_D^o \geq 0$ and $\pi_U^o \geq 0$, which together imply $\pi_D^o + \pi_U^o = \lambda\delta^*\omega^* - c(\delta^* + \omega^*) \geq 0$. As a consequence, the IR constraints can hold under three scenarios. First, they are met for the zero-investment profile $\delta^* = \omega^* = 0$, which delivers zero *ex post* bargaining payoffs. Second, as detailed in the Appendix, the IR constraints are also satisfied for the intermediate-investment profile $0 < \delta^* < 1$ and $0 < \omega^* < 1$ for values of λ larger than $2c$. Again, this investment profile delivers zero *ex post* bargaining payoffs for every γ^*. Finally, the IR constraints hold for the full-investment profile $\delta^* = \omega^* = 1$ whenever $\lambda \geq 2c$. This investment profile assures weakly positive *ex post* bargaining payoffs. Since the social value of each project is given by $\pi_D^o + \pi_U^o$, full investment for $\lambda \geq 2c$ is also the first best investment choice taken by an unconstrained planner.

These two remarks imply three regularities of the SPE. First, the smallest productive project has $\lambda = 2c$. Second, since the zero- and intermediate-investment profiles always entail zero *ex* *post* bargaining payoffs for any strength of property rights protection, and all investment pairs encompassing an intermediate- and full-investment choice have mass zero, the legislator selects the functional form of γ^* focusing only on the full-investment profiles (see the Appendix). Finally, since for productive projects any take-it-or-leave-it offer must continue to support full investment to be accepted, and full investment in turn implies the maximization of the *ex post* bargaining payoffs, the legislator does not care about residual control rights. As a consequence, any firm involved in a $\lambda = 2c$ project offers to its partner the only ownership structure assuring that both IR constraints are satisfied given γ^*, whereas the identity of the party making the take-it-or-leave-it offer within $\lambda > 2c$ projects matters for which ownership structure prevails, but it does not affect the investment choices.

4.6.2 | Tie-breaking rule

We exploit the inefficiency of the intermediate-investment profile to impose a rule breaking the legislator's indifference among property rights levels.

> **Assumption 2.** The legislator picks the property rights level maximizing the possible adoption of the full-investment profile and, if still indifferent among different solutions, minimizing inefficient deviations to the intermediate-investment profile.

Assumption 2 can be justified by referring to the logic of trembling hand perfection (Selten 1975), which, in turn, builds on the idea that through unlikely trembles, agents may play dominated strategies. In the present model, these plays are the zero- and intermediate-investment profiles. Since both strategies deliver a zero social value, and the full-investment profile can be played whenever also zero investment is a possibility, the expected social welfare with respect to the distribution of the parties' trembles reduces to the expected social value from full investment should the intermediate-investment profiles be unavailable minus the expected social loss from deviations to these inefficient plays (see the Appendix). To maximize this difference, the legislator should then pick, among levels of property rights protection assuring the same adoption of full investment, the one that minimizes deviations to the intermediate-investment profiles. When, instead, fostering full investment conflicts with discouraging intermediate investment, the legislator should focus on the first task being full investment as a dominating and more likely strategy. This routine is exactly what the criterion described by Assumption 2 prescribes (see also note 21 and the Appendix). As a consequence, effectively the legislator will maximize the expected social welfare with respect to the distribution of the parties' deviations from full investment by selecting γ^* maximizing the measure of $\lambda \geq 2c$ projects supporting also the full-investment profile, and whenever indifferent among different choices, by picking the one that minimizes the measure of $\lambda > 2c$ projects supporting also the intermediate-investment profile.

4.6.3 | Selecting investment

Given λ, γ^* and o^*, firms D and U select $\delta \in [0, 1]$ and $\omega \in [0, 1]$ maximizing, respectively,

$$d_D^{o^*}\delta\omega + (1-\gamma^*)\left(\lambda - d_D^{o^*} - d_U^{o^*}\right)\delta\omega - c\delta + \mu_1\delta - \mu_2(\delta - 1), \tag{2}$$

$$d_U^{o^*}\delta\omega + \gamma^*\left(\lambda - d_D^{o^*} - d_U^{o^*}\right)\delta\omega - c\omega + \mu_3\omega - \mu_4(\omega - 1), \tag{3}$$

subject to the canonical dual feasibility and complementary slackness conditions.[11] While μ_1 and μ_3 are the Karush–Kuhn–Tucker multipliers of the constraints $-\delta \leq 0$ and $-\omega \leq 0$, μ_2 and μ_4

refer to the constraints $\delta \leq 1$ and $\omega \leq 1$. As clarified in the Appendix, the mix of the complementarity in the firms' investment choices and the opposite impacts of γ^* on the two firms' *ex post* bargaining payoffs entails that only three among the nine possible investment profiles can be part of an SPE. First, the zero-investment profile $\delta^* = 0 = \omega^*$ is always part of an SPE and delivers zero *ex post* bargaining payoffs. Second, the intermediate-investment profiles

$$\left\{\delta^* = \frac{(1-\gamma^*)\omega^*}{\gamma^*}, \omega^*\right\}, \quad \left\{\delta^* = \frac{(1-\gamma^*)c\omega^*}{\gamma^*(c-\alpha\omega^*)}, \omega^*\right\}, \quad \left\{\omega^* = \frac{\gamma^* c\delta^*}{(1-\gamma^*)(c-\beta\delta^*)}, \delta^*\right\}$$

are part of an SPE when the ownership structure $\hat{o}$ embraced by the $\lambda = 2c$ project is, respectively, joint, downstream and upstream, and the maximum value of the project is sufficiently larger than $2c$ (see the Appendix).[12] In this case, δ^* (ω^*) is obtained by equalizing to zero the derivative with respect to δ (ω) of the objective function in equation (2) (equation (3)) evaluated at $\mu_1 = \mu_2 = 0$ ($\mu_3 = \mu_4 = 0$), and delivers a zero *ex post* bargaining payoff for every γ^*. Finally, the full-investment profile $\delta^* = 1 = \omega^*$ is part of an SPE if: (i) o^* is joint ownership and both $\lambda > c/(1-\gamma^*) \equiv \hat{\lambda}_D^J$ and $\lambda > c/\gamma^* \equiv \hat{\lambda}_U^J$; (ii) o^* is downstream ownership and both $\lambda > (c-\alpha\gamma^*)/(1-\gamma^*) \equiv \hat{\lambda}_D^D$ and $\lambda > c/\gamma^* + \alpha \equiv \hat{\lambda}_U^D$; (iii) o^* is upstream ownership and both $\lambda > c/(1-\gamma^*) + \beta \equiv \hat{\lambda}_D^U$ and $\lambda > (c - \beta(1-\gamma^*))/\gamma^* \equiv \hat{\lambda}_U^U$. As we show in the following, all these $\hat{\lambda}_i^o$ equal $2c$.

4.6.4 | Selecting property rights and the ownership structure

To maximize the measure of $\lambda \geq 2c$ projects possibly adopting full investment and induce the $\lambda = 2c$ project to embrace joint ownership, the legislator selects the $\gamma \in [0, 1]$ maximizing

$$\int_{\hat{\lambda}_D^J}^{\bar{\lambda}} \frac{\lambda - 2c}{l}\, \mathrm{d}\lambda \quad \text{for } \hat{\lambda}_D^J \geq \hat{\lambda}_U^J \leftrightarrow \gamma \geq \gamma^J \equiv \frac{1}{2}, \tag{4}$$

and

$$\int_{\hat{\lambda}_U^J}^{\bar{\lambda}} \frac{\lambda - 2c}{l}\, \mathrm{d}\lambda \quad \text{otherwise.}$$

The first-order conditions (FOCs) are

$$-\frac{c\left[c - 2c(1-\gamma^J)\right]}{l(1-\gamma^J)^3} = 0 \quad \text{and} \quad \frac{c(c - 2c\gamma^J)}{l(\gamma^J)^3} = 0,$$

respectively. In both instances, the unique solution is $\gamma^* = \gamma^J$.[13] Intuitively, the legislator realizes that a rise in γ encourages firm U and disincentivizes firm D, thus she calibrates the property rights level to convince both parties to possibly pick the full-investment profile within a $\hat{\lambda}_D^J(\gamma^J) = \hat{\lambda}_U^J(\gamma^J) = 2c$ project and, *a fortiori*, for all the more profitable ones. This requires us to protect both sides equally since the default payoffs are the same. Then all the firms involved in projects whose λ is strictly smaller than $2c$ pick the zero-investment profile, and those parts of projects whose λ is equal to or just above $2c$ can adopt either the zero- or full-investment profile. Finally, those for which $\lambda = 2c/\omega^* = 2c/\delta^* > 2c$ can also turn to the intermediate-investment profile.

Regarding the ownership structure, it is irrelevant when only the zero-investment profile is possible since $\pi_D^o = \pi_U^o = 0$. When also full investment is an option, the downstream party offers to her partner an ownership structure increasingly appealing to herself whenever she knows that such an offer is accepted. To elaborate, she offers joint ownership if $2c \leq \lambda < \widehat{\lambda}_U^D(\gamma^J) = 2c + \alpha$, and downstream ownership when $\lambda \geq 2c + \alpha$. As any of the other thresholds inducing a change in ownership structure, $\widehat{\lambda}_U^D(\gamma^J)$ supports the adoption of full investment by both firms involved in weakly more profitable projects. Considering joint ownership as an instance of non-integration, and both downstream and upstream ownership otherwise, the extent of integration, which we label with V, equals $[\overline{\lambda} - \widehat{\lambda}_U^D(\gamma^J)]/l$, which is proportional to $\overline{\lambda} - 2c - \alpha$. Intuitively, it falls with the innovation cost c and the firm D's default payoff α since the former reduces all *ex post* bargaining payoffs, whereas the latter decreases the firm U's gains from trade under his least preferred ownership structure, which is downstream ownership. Similarly, the upstream firm U offers to his partner an ownership structure increasingly appealing to himself when he knows that such an offer is accepted. To illustrate, he proposes joint ownership if $2c \leq \lambda < \widehat{\lambda}_D^U(\gamma^J) = 2c + \beta$, and upstream ownership when $\lambda \geq 2c + \beta$. These patterns produce an extent of integration proportional to $\overline{\lambda} - 2c - \beta$, thus falling with c and β. Provided that $\overline{\lambda}$ is not too large when compared to the innovation costs c and the default payoffs α and β, joint ownership is the residual control rights arrangement most likely to arise whenever the optimal strength of the upstream firm's property rights is γ^J.

The analysis is similar in the instances in which the legislator wishes to maximize the measure of projects $\lambda \geq 2c$ possibly adopting full investment and induce the $\lambda = 2c$ project to embrace either downstream or upstream ownership. In the former case, she selects $\gamma \in [0, 1]$ maximizing

$$\int_{\widehat{\lambda}_D^D}^{\overline{\lambda}} \frac{\lambda - 2c}{l}\, d\lambda \quad \text{for } \widehat{\lambda}_D^D \geq \widehat{\lambda}_U^D \leftrightarrow \gamma \geq \gamma^D \equiv \frac{c}{2c - \alpha} > \frac{1}{2},$$

and

$$\int_{\widehat{\lambda}_U^D}^{\overline{\lambda}} \frac{\lambda - 2c}{l}\, d\lambda \quad \text{otherwise.}$$

This time, the unique solution is $\gamma^* = \gamma^D$,[14] which falls with the innovation cost c, and rises with the downstream firm's default payoff α.[15] Intuitively, a rise in α decreases the firm U's *ex post* bargaining payoff under downstream ownership. Hence a higher γ^* is needed to convince the upstream party to possibly embrace full investment. Assumption 1 implies that $\gamma^D \geq 0$. When $c < \alpha$, however, $1 - \gamma^D < 0$, $\pi_U^D < 0$ at $\lambda = 2c$, and the legislator does not consider the solution γ^D since, as seen before, she can obtain with γ^J the maximum measure of projects possibly embracing full investment. Turning to the intermediate-investment profiles

$$0 < \delta^* = \frac{(c - \alpha)\omega^*}{c - \alpha\omega^*} < \omega^* < 1,$$

they might arise for

$$\lambda = \frac{2c - \alpha(1 - \delta^*)}{\delta^*} = \frac{c[2c - \alpha(1 + \omega^*)]}{(c - \alpha)\omega^*} > 2c.$$

Regarding the ownership structure, it is again irrelevant when only zero investment is possible. When also full investment is an option (i.e. $\lambda \geq 2c$), the downstream firm always offers D ownership and her proposal is accepted. The extent of integration V is maximum, is proportional to $\overline{\lambda} - 2c$, and falls with the innovation cost c. The upstream firm, instead, offers for $\lambda \geq 2c$ an ownership structure increasingly appealing to himself and accepted by his partner. V is proportional to $\overline{\lambda} - 2c - \beta$, thus falls with c and the upstream firm default payoff β.[16] Ultimately, downstream ownership is the residual control rights arrangement most likely to arise when the legislator selects $\gamma^* = \gamma^D$.

When, finally, the legislator wishes to maximize the measure of $\lambda \geq 2c$ projects possibly adopting full investment and induce the $\lambda = 2c$ project to embrace upstream ownership, she selects $\gamma \in [0, 1]$ maximizing

$$\int_{\hat{\lambda}_D^U}^{\bar{\lambda}} \frac{\lambda - 2c}{l}\, \mathrm{d}\lambda \quad \text{for } \hat{\lambda}_D^U \geq \hat{\lambda}_U^U \leftrightarrow \gamma \geq \gamma^U \equiv \frac{c-\beta}{2c-\beta} < \frac{1}{2},$$

and

$$\int_{\hat{\lambda}_U^U}^{\bar{\lambda}} \frac{\lambda - 2c}{l}\, \mathrm{d}\lambda \quad \text{otherwise.}$$

This time, the unique solution is $\gamma^* = \gamma^U$,[17] which rises with the innovation cost c, and falls with the upstream party's default payoff β.[18] Intuitively, a rise in β decreases the firm D's *ex post* bargaining payoff under upstream ownership. Hence a smaller γ^* is needed to convince party D to embrace full investment. Assumption 1 implies that $\gamma^U \geq 0$ if $c \geq \beta$. When $c < \beta$ instead, $\gamma^U < 0$, $\pi_D^U < 0$ at $\lambda = 2c$, and the legislator does not consider the solution γ^U since she can obtain with γ^J the maximum measure of projects possibly embracing full investment. Turning to the intermediate-investment profiles

$$\omega^* = \frac{(c-\beta)\delta^*}{c - \beta\delta^*} < \delta^*,$$

they might arise for

$$\lambda = \frac{2c - \beta(1-\omega^*)}{\omega^*} = \frac{c[2c - \beta(1+\delta^*)]}{(c-\beta)\delta^*} > 2c.$$

Regarding the ownership structure, it is again irrelevant when only zero investment is possible. When also full investment is an option (i.e. $\lambda \geq 2c$), the downstream firm offers residual control rights increasingly appealing to herself and accepted by her partner. Then V is proportional to $\bar{\lambda} - 2c - \alpha$ and thus falls with both the innovation cost c and the downstream firm's default payoff α.[19] The upstream firm, instead, always offers for $\lambda \geq 2c$ upstream ownership, and this proposal is accepted. This time, the extent of integration is proportional to $\bar{\lambda} - 2c$, thus falls with the innovation cost c. Ultimately, upstream ownership is the residual control rights arrangement most likely to arise when the legislator selects $\gamma^* = \gamma^U$.

The three market structures induced by the selection of γ^J, γ^D or γ^U always support the zero-investment profile, and for $\lambda \geq 2c$, also the full-investment profile. The intermediate-investment profiles are, instead, most likely for $\gamma^* = \gamma^J$, and more likely for $\gamma^* = \gamma^U$ than for $\gamma^* = \gamma^D$ when the downstream party's default payoff is the largest, that is, $\alpha > \beta$. Intuitively, for $\gamma^* = \gamma^U$ and $\alpha > \beta$, the party operating under its least preferred ownership structure—that is, downstream firm under upstream ownership—faces larger gains from trade (see the Appendix). A symmetrical analysis holds for $\gamma^* = \gamma^D$ and $\alpha < \beta$. Hence $\gamma^* = \gamma^J$ is selected only when either $\gamma^* = \gamma^D$ or $\gamma^* = \gamma^U$ cannot assure the maximum adoption of full investment, and the legislator prefers γ^D to γ^U if $\alpha > \beta$ (otherwise), and both γ^D and γ^U maximize the measure of projects possibly embracing full investment. Ultimately, the strength of the upstream firm's property rights γ^* is independent of the identity of the party making the take-it-or-leave-it offer, and under Assumptions 1 and 2, it is unique.

TABLE 4 Main model predictions under sizeable gains from trade.

Parametric restrictions	Upstream party's property rights	Vertical integration if D offers o	Vertical integration if U offers o
Basic setup: multiplicative investments			
$c \geq \alpha \geq \beta$	$\gamma^* = \gamma^D \equiv \dfrac{c}{2c-\alpha}$	$V \propto \overline{\lambda} - 2c$	$V \propto \overline{\lambda} - 2c - \beta$
$c \geq \beta > \alpha$	$\gamma^* = \gamma^U \equiv \dfrac{c-\beta}{2c-\beta}$	$V \propto \overline{\lambda} - 2c - \alpha$	$V \propto \overline{\lambda} - 2c$
$\alpha > c \geq \beta$	$\gamma^* = \gamma^U \equiv \dfrac{c-\beta}{2c-\beta}$	$V \propto \overline{\lambda} - 2c - \alpha$	$V \propto \overline{\lambda} - 2c$
$\beta > c \geq \alpha$	$\gamma^* = \gamma^D \equiv \dfrac{c}{2c-\alpha}$	$V \propto \overline{\lambda} - 2c$	$V \propto \overline{\lambda} - 2c - \beta$
Robustness: Cobb–Douglas production function			
	$\gamma^J = \rho$	$V \propto \overline{\lambda} - \dfrac{c}{(1-\rho)\rho} - \alpha$	$V \propto \overline{\lambda} - \dfrac{c}{(1-\rho)\rho} - \beta$
	$\gamma^D = \dfrac{c\rho}{c-\alpha\rho(1-\rho)}$	$V \propto \overline{\lambda} - \dfrac{c}{(1-\rho)\rho}$	$V \propto \overline{\lambda} - \dfrac{c}{(1-\rho)\rho} - \beta$
	$\gamma^U = \dfrac{\rho[c-\beta(1-\rho)]}{c-\beta\rho(1-\rho)}$	$V \propto \overline{\lambda} - \dfrac{c}{(1-\rho)\rho} - \alpha$	$V \propto \overline{\lambda} - \dfrac{c}{(1-\rho)\rho}$

To summarize, the legislator organizes the market in one of the following three ways. First, she selects a relatively strong protection of the upstream firm's property rights γ^D to induce more often downstream ownership when either (i) the upstream firms' default payoff is larger and the gains from trade are small (i.e. $\beta > c \geq \alpha$), or (ii) the downstream firms' default payoff is larger and the gains from trade are large (i.e. $c \geq \alpha \geq \beta$). This choice is useful to maximize the possible adoption of full investment and, possibly, minimize deviations to the inefficient intermediate-investment profile. To elaborate, under scenario (i), $\alpha < \beta$ but γ^U is not an option, and under scenario (ii), all three market structures maximize full investment but $\alpha \geq \beta$. Second, and 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 when either the downstream firms' default payoff is larger and the gains from trade are small (i.e. $\alpha > c \geq \beta$) or the upstream firms' default payoff is larger and the gains from trade are large (i.e. $c \geq \beta > \alpha$).[20] Finally, an equal protection of both parties, usually combined with joint ownership, constitutes the only market structure that maximizes the possible adoption of full-investment for $\max\{\alpha, \beta\} \geq \min\{\alpha, \beta\} > c$. While Lemma 1 in the Appendix formally states the results of our analysis detailing the unique SPE of the game,[21] Proposition 1 illustrates the three main implications of the basic setup for the most likely case of large gains from trade (see also Table 4), that is, $c > \min\{\alpha, \beta\}$.

Proposition 1. *Under Assumptions 1 and 2, and for sizeable gains from trade:*

(a) the strength of property rights is unique, the strength of residual control rights o^* is generally multiple and depends on who makes the take-or-leave-it offer, and property and residual control rights tend to be strategic substitutes;
(b) the strength of the upstream firm's property rights γ^* falls weakly with his default payoff β under upstream ownership, and rises weakly with the downstream firm's default payoff α under downstream ownership;
(c) the extent of integration V shrinks with the default payoff of the party making the take-or-leave-it offer.

4.6.5 | Discussion

The intuitions for the results discussed in Proposition 1 are as follows.

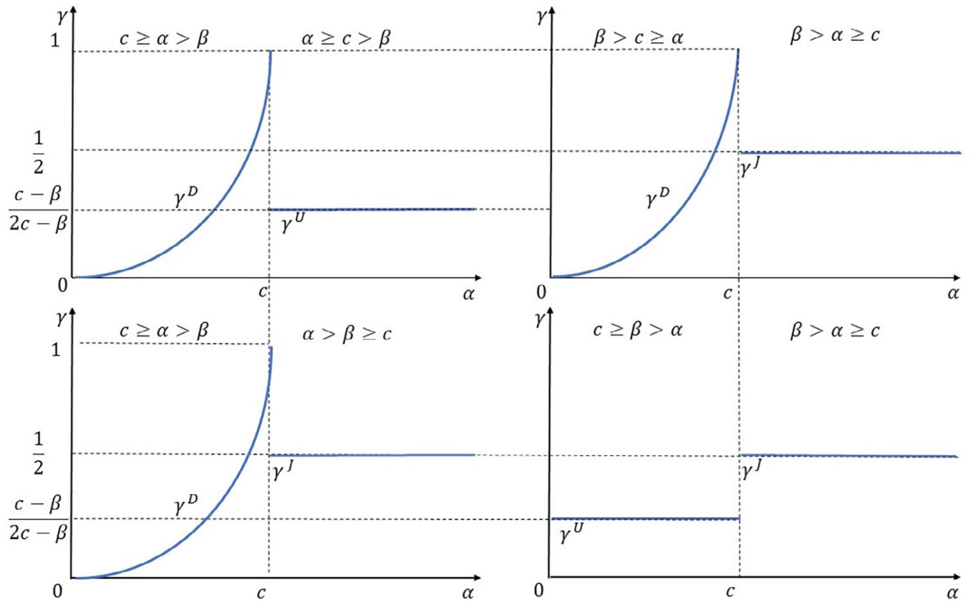

FIGURE 2 Property rights as a function of α.

First, implication (a) summarizes the fact that the strategic substitutability of the two institutions induces the legislator to compare different combinations of property and residual control rights to support the maximum adoption of full investment.

Second, implication (b) captures the idea that 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 the firm D default payoff. Symmetrically, it must be weaker when his own default payoff increases under upstream ownership. Opposite patterns hold true for the legal protection of the downstream firm's input (see Figures 2 and 3). These conclusions differ from those by Guerriero (2023), who focuses on hold-up failures and thus documents that the strength of the upstream firm's property rights depends only—and in a positive way—on the downstream firm's default payoff. In addition, combined with implication (a), they contrast with the deductions of a vast literature on bargaining (Rubinstein 1982; Roth 1985), which claims that the party endowed with the largest outside option and/or moving first should receive a stronger renegotiation power. This is not the case here because of two key features of the setup. On the one hand, the legislator must assure that both parties face the maximum *ex ante* incentives to coordinate on the full-investment profile. On the other hand, the ownership structure does not shape *ex ante* investment incentives autonomously.

Finally, implication (c) synthesizes the fact that a larger default payoff of the party offering the ownership structure leads its partner to consider the outside option more appealing (see Figures 4 and 5). This implication is at odds with the conclusions of the other major theories of the firm. On the one hand, the PRT claims that, if one party's default payoff under its preferred ownership structure falls, then its willingness to integrate might either fall or rise depending on whether the default payoffs shape the marginal returns on investment or the *ex post* bargaining power (Whinston 2003; Antràs 2015). On the other hand, the transaction costs theory suggests that integration maximizes *ex ante* incentives when markets do not (Coase 1937; Williamson 2010).[22] This is not our case since zero- and intermediate-investment profiles cannot be eliminated.

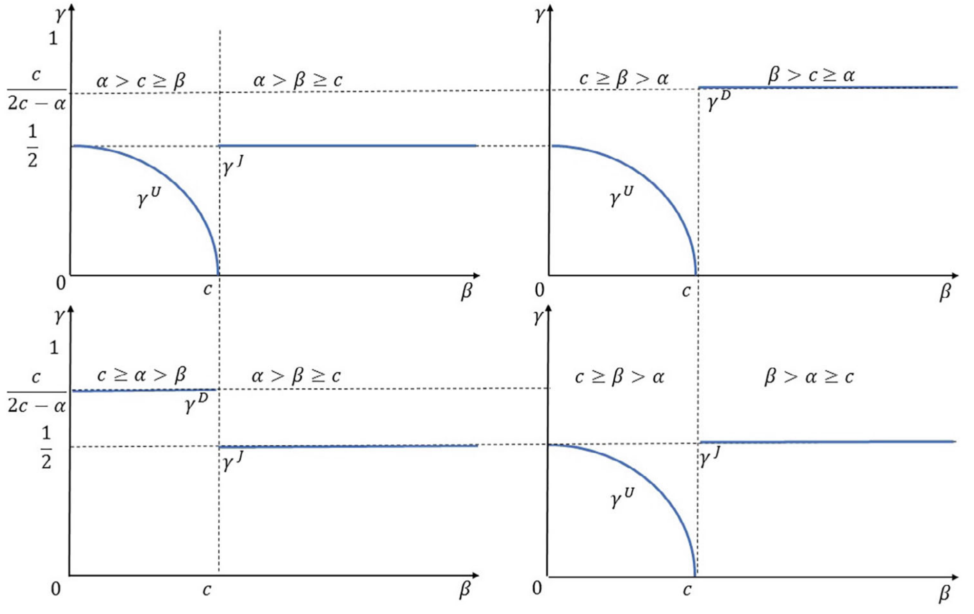

FIGURE 3 Property rights as a function of β.

5 | ROBUSTNESS TO ALTERNATIVE ASSUMPTIONS

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

5.1 | Asymmetric investment

A crucial difference between our study and those in the PRT spirit is that the latter conclude consistently that the ownership structure should favour 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 $A > 1$ measures either the major contribution to the project success of a party's effort or the degree of complementarity between the firms' investment activities. Except for the fact that the lowest productive project has a maximum value equal to $2c/A$, the analysis is unaffected, since all the $\hat{\lambda}_i^o$ equal those of the basic setup multiplied by a factor $1/A$. As a consequence, γ^* and the set of projects for which the intermediate-investment profile might arise are the same as in the basic setup.

An obvious objection to these conclusions is that they might be driven by the Hicks-neutral nature of A. To elucidate why our argument is, indeed, more general, in the Appendix we also solve the model for a Cobb–Douglas production function with constant return to scale and intensity of the firm D's investment activity equal to ρ. Under such a scenario, the two firms' *ex post* bargaining payoffs are

$$\pi_D^o(\gamma) \equiv d_D^o \delta^\rho \omega^{1-\rho} + (1-\gamma)\left(\lambda - d_D^o - d_U^o\right)\delta^\rho\omega^{1-\rho} - c\delta,$$
$$\pi_U^o(\gamma) \equiv d_U^o \delta^\rho \omega^{1-\rho} + \gamma\left(\lambda - d_D^o - d_U^o\right)\delta^\rho\omega^{1-\rho} - c\omega,$$

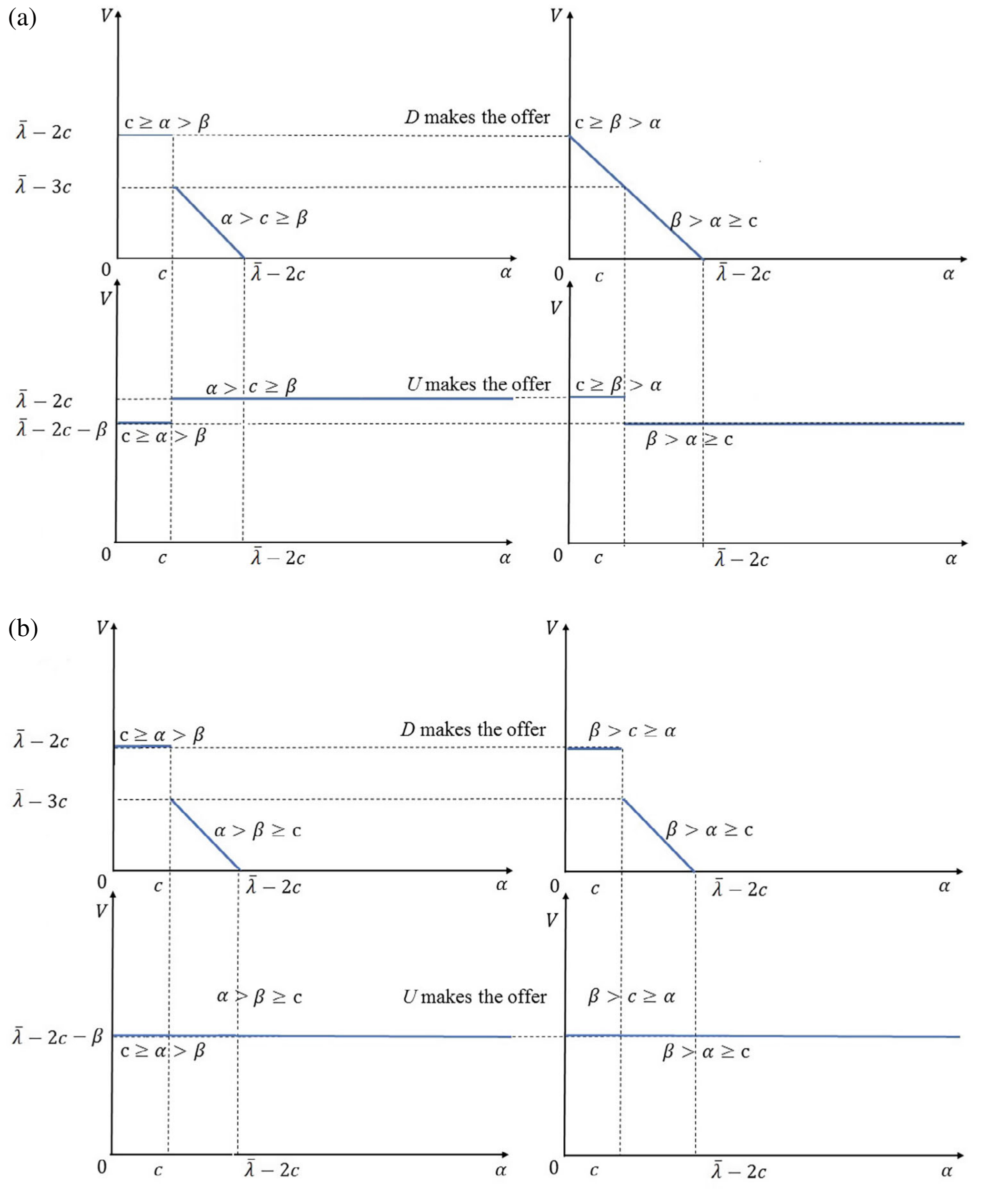

FIGURE 4 Extent of integration as a function of α.

and incentive compatibility is more stringent than individual rationality. Therefore the intermediate-investment profiles have measure zero, and the legislator is always indifferent among the three possible market structures when available. To elaborate, all the $\lambda \geq c/((1-\rho)\rho)$ projects select the full-investment profile and thus gain a positive *ex post* bargaining payoff. Then the strength of property rights is

$$\gamma^J = \rho, \quad \gamma^D = \frac{c\rho}{c - \alpha\rho(1-\rho)} > \rho \quad \text{or} \quad \gamma^U = \frac{\rho[c - \beta(1-\rho)]}{c - \beta\rho(1-\rho)} < \rho.$$

As in the basic setup, property rights determine the *ex ante* parties' incentives completely. Moreover, in the most likely case of large gains from trade (i.e. $c > \min\{\alpha\rho^2, \beta(1-\rho)^2\}$), γ^* always rises

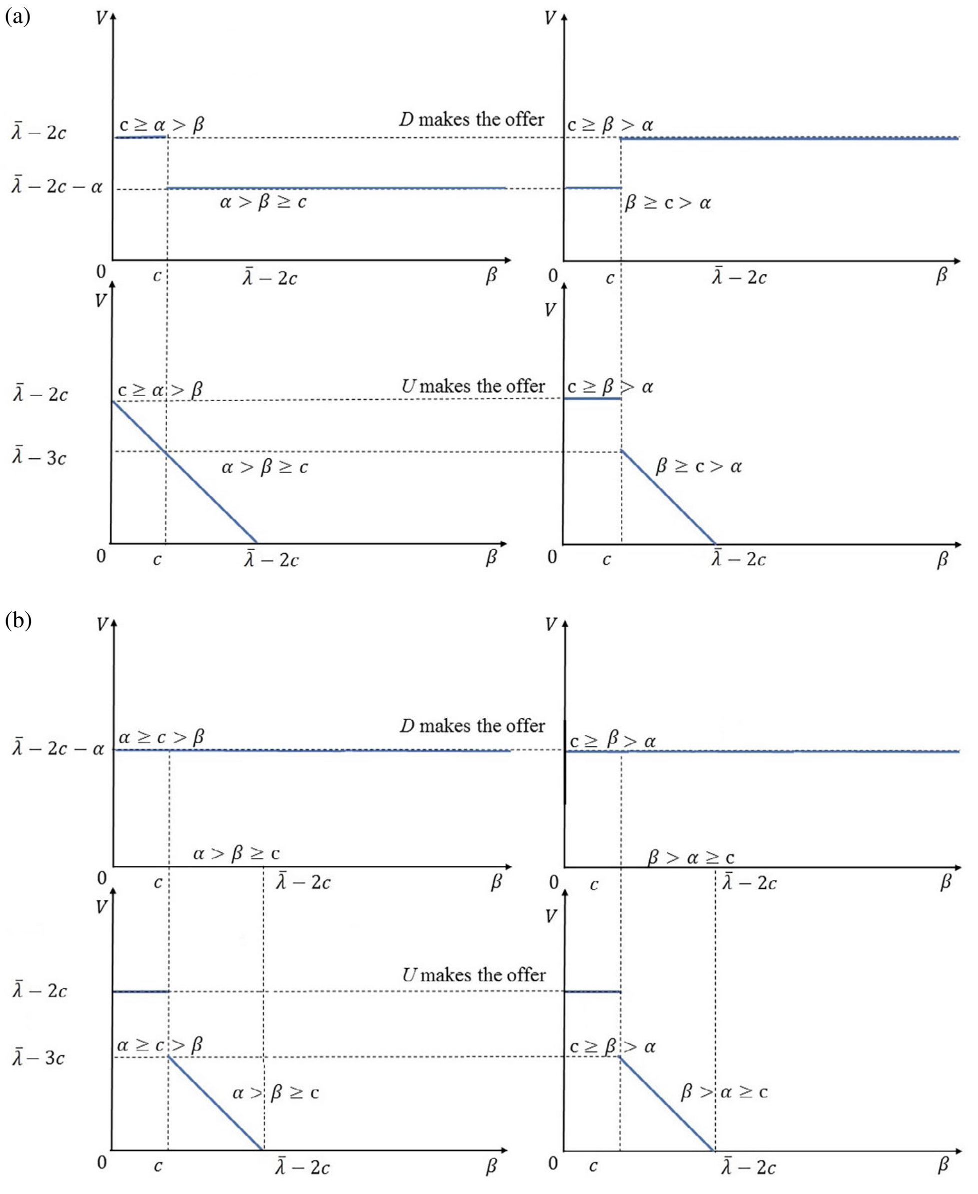

FIGURE 5 Extent of integration as a function of β.

with the intensity of the downstream firm's investment activity ρ. This result is different from the conclusions of those applications of the PRT endogenizing the choice of *ex post* bargaining power (Antràs and Helpman 2004).[23] These authors suggest that this decision and the ownership structure should both favour the party whose relative contribution to the relationship value is larger. In our setup, instead, a rise in the intensity of a party's investment activity induces a fall in its partner's investment return. Hence the partner must enjoy a stronger legal protection to assure that both firms face maximum *ex ante* incentives to embrace full investment. Regarding the impact of the default payoffs on γ, a glance at γ^* suggests that it continues to rise weakly with α and fall weakly with β. Finally, the extent of integration still decreases with the default payoffs and the innovation cost, and it is proportional to $-c/((1-\rho)\rho)$. Then, different from the basic setup, the relationship between integration and the intensity of the firm D's investment activity is inverted U-shaped since, intuitively, $\rho = 1/2$ maximizes both parties' *ex ante* incentives to invest optimally under integration. Proposition 2 summarizes this subsection (see also Table 4).

Proposition 2. *Under Assumptions 1 and 2, and for sizeable gains from trade (i.e.* $c > \min\{\alpha\rho^2, \beta(1-\rho)^2\}$*):*

(a) the protection of the upstream firm's property rights γ^* *reinforces with the intensity of the downstream firm's investment activity* ρ*;*
(b) the extent of integration has an inverted U-shaped link with the intensity of the downstream firm's investment activity.

5.2 | Self-investment

Following Grossman and Hart (1986), one might alternatively allow only for self-investment activities by assuming that the firm D's (U's) default payoff is shaped only by δ (ω). Then the firm D's *ex post* bargaining payoff is $d_D^o\delta + (1-\gamma)(\lambda\delta\omega - d_D^o\delta - d_U^o\omega) - c\delta$, whereas that for firm U is $d_U^o\omega + \gamma(\lambda\delta\omega - d_D^o\delta - d_U^o\omega) - c\omega$. As a result, the thresholds over which the two IR constraints are satisfied are weakly larger than those over which full-investment profiles prevail, but determine the same $\widehat{\widehat{\lambda}}{}_i^o$, γ^* and measures of intermediate-investment profiles discussed in the basic setup (see the Appendix). Hence our analysis remains exactly the same.

5.3 | Discrete investment

Following Müller and Schmitz (2016), we also consider the alternative setup in which the project value is λ only when the two firms simultaneously and non-cooperatively bear the upfront cost c at time t_2, and the default payoffs equal d_i^o. Then firm D invests only if $d_D^o + (1-\gamma)(\lambda - d_D^o - d_U^o) > c$, whereas firm U incurs the upfront cost only if $d_U^o + \gamma(\lambda - d_D^o - d_U^o) > c$. Thus either zero- or full-investment profiles prevail, and the same $\widehat{\widehat{\lambda}}{}_i^o$ and γ^* of the basic setup arise for $\lambda \geq 2c$. However, the absence of intermediate-investment profiles entails that the legislator cannot break the indifference among the three possible market structures—that is, those for which the two firms pay c for $\lambda \geq 2c$ under joint, downstream or upstream ownership—exploiting the criterion stated in Assumption 2.

5.4 | Unilateral investment

An alternative tradition on the impact of the ownership structure on allocative efficiency has focused on unilateral investment (Gibbons 2005). Our setup can be modified to analyse 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 $\widehat{\widehat{\lambda}}{}_i^o$ and γ^* are as in the basic setup, but we lose the refinement mechanism described in Assumption 2 and assured by the existence of two investment decisions, that is, δ and ω.

5.5 | The political economy of market design

Thus far, we have examined the choice of the design of the property rights of downstream and upstream firms with equal political power. Reality, however, might be quite different. To evaluate this issue, we follow Guerriero (2016a, 2023), and we consider a situation in which a partisan legislator can exclude from the social welfare maximization the payoffs of either the upstream or downstream parties partaking in a subgroup of projects. It seems natural to think of these 'outsiders' as those participating in least valuable projects. This assumption incorporates into the model the idea put forward by the literature on endogenous lobbying that the groups dominating the institutional design are those most affected by it (Felli and Merlo 2006; Guerriero 2016b; Boranbay and Guerriero 2019), and the intuition of a well-known literature on the relationships between politicians and firms that the interests of the latter might heavily shape public policy (Shleifer and Vishny 1994). Moreover, given the opposite impact of the strength of the upstream firm's property rights on the two firms' *ex post* bargaining payoffs, this scenario is similar to the case in which the legislator attaches a larger weight to the utility of one of the two parties (Aghion *et al.* 2004).

Since modulating the strength of the upstream firm's property rights has only a marginal effect on the legislator's objective function, excluding a sufficiently small share of either upstream or downstream firms participating in low-value projects does not affect the selection of γ, the distribution of ownership structures and the extent of integration. To further elaborate, the legislator's programme is exactly as in the basic setup as long as the projects in which the group of excluded firms participates display a λ lower than the largest $\hat{\lambda}_i^o$, since then their contribution to social welfare is zero.[24]

5.6 | Bargaining over the ownership structure

In the basic setup, we maintain that trade is only possible—and costless—*ex post*, that is, at time t_3. This assumption forbids the firm receiving the take-it-or-leave-it offer o to contract with the other party at time t_1 to get a different residual control rights arrangement. As discussed in the Appendix, allowing for this possibility keeps our analysis intact provided that the *ex ante* costs of bargaining (e.g. borrowing expenses; Guerriero 2023) are positive, that is, $\nu > 0$. Then 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 a loss by the other side. The main criticism of these conclusions is, obviously, that *ex ante* and *ex post* contracting costs should be equal. Nevertheless, should we envision an *ex post* trade cost ν, the only difference with the basic setup will be that projects whose maximum value is between $2c$ and $2c + \nu$ prefer the zero-investment profile, and therefore γ^* depends on ν as it does on c.

6 | CONCLUSIONS

We have developed and tested a theory of endogenous market design in which the legal protection of the firms' assets shapes their *ex post* bargaining power, and it is chosen by the legislator, whereas residual control rights define the default payoffs and are selected by the parties. Considering the endogeneity of property rights produces relationships between both asset specificity and the intensity of investment activities on the one hand, and both the *ex post* bargaining power and the extent of integration on the other hand, which are different from those suggested by the PRT. We close by highlighting three avenues for future research.

First, our model can be extended fruitfully to the analysis of the boundaries of the multinational firms, which, differently from the study of the ownership structure of national firms, became in the last few decades also the object of a massive empirical literature (Antràs, 2015; Kukharskyy 2020; Biancini and Bombarda 2021).

Second, the tendency of property rights towards optimality does not imply that the existing legal variation is irrelevant, thus it does not warrant reforms. Not only an imperfect political process, but also an incompletely informed legislator can distort institutional design. Evaluating this possibility is a key extension to the basic setup.

Finally, more empirical research at the national and multinational firm level is needed to understand the interplay among asset specificity, each party's contribution to the relationship value, property rights and the extent of integration.

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ENDNOTES

1 We refer to the downstream firm as 'she', to the upstream party as 'he', and to a generic firm as 'it'. Furthermore, we refer to the legislator as 'she' since this choice does not cause confusion.

2 Furthermore, the strength of the upstream firms' property rights has an inverted U-shaped (U-shaped) link with the innovation cost when the largest (smallest) default payoff is the downstream firm's one.

3 One strand of literature has examined the integration decisions of a handful of firms in quite specific industries (for a review, see Lafontaine and Slade 2007), whereas another strand has analysed the international internalization decisions of huge cross-sections of multinational firms (for a review, see Antràs 2015).

4 The 2019 edition of the EOS gathers the views of 16,936 business executives in 139 countries (WEF 2019). We substitute the closest data points for missing observations. This choice is immaterial to the gist of the analysis.

5 While a comparison among columns (3), (4) and (5) of Table 3 suggests how the fit of these specifications increases as non-linearities are considered, the statistical but not economic relevance of the coefficient on *R&D-Intensity*^{3} entails that the relationship between *Vertical-Integration* and R&D intensity is almost perfectly inverted U-shaped. Figure 1 of the Online Appendix depicts this link for the two cases in which we condition or not on observable factors.

6 In Section III, we focused on yearly data exactly because the legislator can reform any of these dimensions at each point in time. Notably, the within variation in our property rights proxies is roughly 10% of the total.

7 Then π_D^o and π_U^o would equal $(1-\gamma)(d_D^o+d_U^o)\delta\omega+(1-\gamma)\left[\lambda-(1-\gamma)(d_D^o+d_U^o)-\gamma(d_D^o+d_U^o)\right]\delta\omega-c\delta=\pi_D^J$ and $\gamma(d_D^o+d_U^o)\delta\omega+\gamma\left[\lambda-(1-\gamma)(d_D^o+d_U^o)-\gamma(d_D^o+d_U^o)\right]\delta\omega-c\omega=\pi_U^J$, respectively.

8 This is a less likely instance since firms usually cover the roles of upstream and downstream parties at different points in time, thus might not be interested in lobbying (Dari-Mattiacci and Guerriero 2015).

9 A case in point is the asymmetric economic impact of Covid-19. Demand for services that require face-to-face interaction, such as hotels, restaurants and retail trade, has shrunk substantially, whereas demand for services that can be performed remotely or provide solutions to reduced personal interactions, such as information and communication technology, has expanded significantly (Abay *et al.* 2020).

10 We can also see γ as the share of courts favouring firm U and defined by the strength of property rights (Guerriero 2016b). This view squares with the idea that courts arbitrarily evaluate the evidence when the state of the world is hard to verify, and can thus be manipulated at adjudication (Gennaioli 2013). More generally, our setup entails that the legal order can enforce property rights without, however, allowing contract completeness, that is, the removal of intermediate and zero investment (see section 4).

11 The necessary—and sufficient—first-order conditions are respectively $[\gamma^* d_D^{o^*}+(1-\gamma^*)(\lambda-d_U^{o^*})]\omega^*-c+\mu_1-\mu_2=0$ and $[(1-\gamma^*)d_U^{o^*}+\gamma^*(\lambda-d_D^{o^*})]\delta^*-c+\mu_3-\mu_4=0$ (see the Appendix).

12 This holds if, respectively, λ equals

$$\frac{c}{(1-\gamma^*)\omega^*}=\frac{c}{\delta^*\gamma^*}>2c,\quad \frac{c-\alpha\gamma^*\omega^*}{(1-\gamma^*)\omega^*}=\frac{c}{\gamma^*\delta^*}+\alpha>2c,\quad \frac{c}{(1-\gamma^*)\omega^*}+\beta=\frac{c-\beta(1-\gamma^*)\delta^*}{\delta^*\gamma^*}>2c.$$

13 Albeit the legislator's objective function is not concave, the left-hand sides of the FOCs are strictly positive if $\gamma\leq\gamma^J$, and strictly negative otherwise. Hence γ^J is the unique and global equilibrium property rights level.

[14] The FOCs are

$$-\frac{c-\alpha}{l(1-\gamma^D)^3}\left[c-\alpha\gamma^D-2c(1-\gamma^D)\right]=0 \quad \text{and} \quad \frac{c}{l(\gamma^D)^3}\left[c+\gamma^D(\alpha-2c)\right]=0,$$

respectively. Albeit the legislator's objective function is not concave, the left-hand sides of the FOCs are strictly positive if $\gamma \le \gamma^D$, and strictly negative otherwise. Hence γ^D is the unique and global equilibrium property rights level.

[15] A rise in the innovation cost c has both the marginal effect of reducing the measure of productive projects $(\overline{\lambda}-2c)$ and the inframarginal effect of decreasing the social value of the finalized projects. As both effects are negative, the legislator discourages investment by disincentivizing the firm operating under its least preferred ownership structure, thus obtaining the lowest payoff for $\lambda = 2c$, i.e. U party.

[16] $o^* = D$ if $2c \le \lambda < \widehat{\lambda}_D^J(\gamma^D) = c(2c-\alpha)/(c-\alpha)$, $o^* = J$ if $\widehat{\lambda}_D^J(\gamma^D) \le \lambda < \widehat{\lambda}_D^U(\gamma^D) = c(2c-\alpha)/(c-\alpha)+\beta$, and $o^* = U$ if $\lambda \ge \widehat{\lambda}_D^U(\gamma^D)$.

[17] The FOCs are

$$-\frac{c}{l(1-\gamma^U)^3}\left[c+(\beta-2c)(1-\gamma^U)\right]=0 \quad \text{and} \quad \frac{c-\beta}{l(\gamma^U)^3}\left[c-\beta(1-\gamma^U)-2c\gamma^U\right]=0,$$

respectively. Albeit the legislator's objective function is not concave, the left-hand sides of the FOCs are strictly positive if $\gamma \le \gamma^U$, and strictly negative otherwise. Thus γ^U is the unique and global equilibrium property rights level.

[18] A rise in c has both a negative marginal effect and a negative inframarginal impact on the objective function of the legislator, who then discourages investment by disincentivizing the firm operating under its least preferred ownership structure, thus obtaining the lowest payoff for $\lambda = 2c$, i.e. D party.

[19] $o^* = U$ if $2c \le \lambda < \widehat{\lambda}_U^J(\gamma^U) = c(2c-\beta)/(c-\beta)$, $o^* = J$ if $\widehat{\lambda}_U^J(\gamma^U) \le \lambda < \widehat{\lambda}_U^D(\gamma^U) = c(2c-\beta)/(c-\beta)+\alpha$, and $o^* = D$ if $\lambda \ge \widehat{\lambda}_U^D(\gamma^U)$.

[20] This last case is quite important since it prescribes that the gains from trade are large and upstream firms display a larger default payoff. This second regularity is consistent with recent empirical evidence implying that product markets are more competitive than input markets (Morlacco 2020), thus upstream firms should find it easier to locate alternative partners. We thank an anonymous reader for pointing this out.

[21] If firms play zero- and intermediate-investment profiles each with probability σ, and full investment otherwise, then it follows immediately that full investment is the only trembling hand perfect equilibrium. Intuitively, the relative *ex post* bargaining payoffs are strictly greater than those assured by the other two options.

[22] More generally, if one interprets the parameter c as an *ex post* transaction cost (see Müller and Schmitz 2016), then our conclusions also contradict the dual spirit of the Coase theorem (Coase 1960). Regardless of the size of transaction costs, property rights always shape the efficiency of the final allocation.

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

[24] We will reach similar conclusions should we follow Felli and Merlo (2006) and allow the two groups of firms to lobby the legislator, since no group will promise any transfer to obtain a different *ex post* renegotiation power because social welfare maximization also implies the maximization of the *ex post* bargaining payoffs.

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APPENDIX A.

Lemma 1. *Under Assumptions 1 and 2, the unique SPE of the game is such that we have the following.*

(a) For $c \geq \alpha \geq \beta$, $\gamma^* = \gamma^D \equiv c/(2c-\alpha)$. We have: $\omega^* = \delta^* = 0$ for $\lambda < 2c$; $\omega^* = \delta^* = 0$, $\omega^* = \delta^* = 1$ or $\delta^* = (c-\alpha)\omega^*/(c-\alpha\omega^*) < \omega^* < 1$ for $\hat{\lambda}_U^D(\epsilon) \leq \lambda \leq \hat{\lambda}_D^D(1-\epsilon)$; and either $\omega^* = \delta^* = 0$ or $\omega^* = \delta^* = 1$ otherwise. Also, $V \propto \overline{\lambda} - 2c$ when firm D offers o, and $V \propto \overline{\lambda} - 2c - \beta$ otherwise.

(b) For $c \geq \beta > \alpha$, $\gamma^* = \gamma^U \equiv \frac{c-\beta}{2c-\beta}$. We have: $\omega^* = \delta^* = 0$ for $\lambda < 2c$; $\omega^* = \delta^* = 0$, $\omega^* = \delta^* = 1$ or $\omega^* = (c-\beta)\delta^*/(c-\beta\delta^*) < \delta^* < 1$ for $\hat{\lambda}_D^U(\epsilon) \leq \lambda \leq \hat{\lambda}_U^U(1-\epsilon)$; and either $\omega^* = \delta^* = 0$ or $\omega^* = \delta^* = 1$ otherwise. Also, $V \propto \overline{\lambda} - 2c - \alpha$ when firm D offers o, and $V \propto \overline{\lambda} - 2c$ otherwise.

(c) For $\alpha > c \geq \beta$, $\gamma^* = \gamma^U$. We have: $\omega^* = \delta^* = 0$ for $\lambda < 2c$; $\omega^* = \delta^* = 0$, $\omega^* = \delta^* = 1$ or $\omega^* = (c-\beta)\delta^*/(c-\beta\delta^*) < \delta^* < 1$ for $\hat{\lambda}_D^U(\epsilon) \leq \lambda \leq \hat{\lambda}_U^U(1-\epsilon)$; and either $\omega^* = \delta^* = 0$ or $\omega^* = \delta^* = 1$ otherwise. Also, $V \propto \overline{\lambda} - 2c - \alpha$ when firm D offers o, and $V \propto \overline{\lambda} - 2c$ otherwise.

(d) For $\beta > c \geq \alpha$, $\gamma^* = \gamma^D$. We have: $\omega^* = \delta^* = 0$ for $\lambda < 2c$; $\omega^* = \delta^* = 0$, $\omega^* = \delta^* = 1$ or $\delta^* = (c-\alpha)\omega^*/(c-\alpha\omega^*) < \omega^* < 1$ for $\hat{\lambda}_U^D(\epsilon) \leq \lambda \leq \hat{\lambda}_D^D(1-\epsilon)$; and either $\omega^* = \delta^* = 0$ or $\omega^* = \delta^* = 1$ otherwise. Also, $V \propto \overline{\lambda} - 2c$ when firm D offers o, and $V \propto \overline{\lambda} - 2c - \beta$ otherwise.

(e) For $\max\{\alpha,\beta\} \geq \min\{\alpha,\beta\} > c$, $\gamma^* = \gamma^J \equiv \frac{1}{2}$. We have: $\omega^* = \delta^* = 0$ for $\lambda < 2c$; $\omega^* = \delta^* = 0$, $\omega^* = \delta^* = 1$ or $\delta^* = \omega^* < 1$ for $\hat{\lambda}_D^J(\epsilon) \leq \lambda \leq \hat{\lambda}_U^J(1-\epsilon)$; and either $\omega^* = \delta^* = 0$ or $\omega^* = \delta^* = 1$ otherwise. Also, $V \propto \overline{\lambda} - 2c - \alpha$ when firm D offers o, and $V \propto \overline{\lambda} - 2c - \beta$ otherwise.

Proof. Given γ^* and $o^* = J$, parties D and U solve the linear programmes $(1-\gamma^*)\lambda\delta\omega - c\delta + \mu_1\delta - \mu_2(\delta - 1)$ and $\gamma^*\lambda\delta\omega - c\omega + \mu_3\omega - \mu_4(\omega - 1)$, respectively. Then there are nine possible investment profiles. First, $\delta^* = 0$ and $\omega^* = 0$ when the FOCs $-c + \mu_1 = 0 \to -c < 0$ and $-c + \mu_3 = 0 \to -c < 0$ hold. This investment profile is part of an SPE and entails zero *ex post* bargaining payoffs. Second, $\delta^* = 0$ and $\omega^* \in (0,1)$ when the FOCs $(1-\gamma^*)\lambda\omega^* < c$ and $-c = 0$ hold. Since the equality is impossible, this investment profile is not part of an SPE. Third, $\delta^* \in (0,1)$ and $\omega^* = 0$ when the FOCs $-c = 0$ and $\gamma^*\lambda\delta^* < c$ hold. Since the equality is impossible, this investment profile is not part of an SPE. Fourth, $\delta^* = 0$ and $\omega^* = 1$ 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 an SPE. Fifth, $\delta^* = 1$ 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 an SPE. Sixth, $\delta^* \in (0,1)$ and $\omega^* \in (0,1)$ when the FOCs $\tilde{\lambda}_D^J(\omega) = c/((1-\gamma^*)\omega^*)$ and $\tilde{\lambda}_U^J(\delta) = c/(\gamma^*\delta^*)$ hold. This investment profile is part of an SPE for $\delta^* = (1-\gamma^*)\omega^*/\gamma^*$, entails $\pi_D^J = (1-\gamma^*)\delta^*\omega^* c/((1-\gamma^*)\omega^*) - c\delta^* = 0 = \gamma^*\delta^*\omega^* c/(\gamma^*\delta^*) - c\omega^* = \pi_U^J$ for every γ^*, and arises for $\tilde{\lambda}_D^J(\epsilon) - \tilde{\lambda}_D^J(1-\epsilon) = 2c/\epsilon - 2c/(1-\epsilon)$ projects with $\epsilon \to 0$. Seventh, $\delta^* = 1$ and $\omega^* \in (0,1)$ when the FOCs $(1-\gamma^*)\lambda\omega^* > c$ and $\lambda = c/\gamma^* \to (1-\gamma^*)\omega^*/\gamma^* > 1$ hold. Since the second inequality is impossible at $\gamma^* = \gamma^J$, this investment profile is not part of an SPE. Eighth, $\delta^* \in (0,1)$ and $\omega^* = 1$ when the FOCs $\lambda = c/(1-\gamma^*)$ and $\gamma^*\lambda\delta^* > c \to \gamma^*\delta^*/(1-\gamma^*) > 1$

hold. Since the second inequality is impossible at $\gamma^* = \gamma^J$, this investment profile is not part of an SPE. When picking γ^*, the legislator does not consider the zero- and intermediate-investment profiles, which deliver zero *ex post* bargaining payoffs, and those for which one party selects full investment and the other intermediate investment since they have measure 0. Finally, $\delta^* = 1$ and $\omega^* = 1$ when the FOCs $\lambda > c/(1-\gamma^*)$ and $\lambda > c/\gamma^*$ hold. This investment profile is part of an SPE.

Given γ^* and $o^* = D$, firms D and U solve the programmes $\alpha\delta\omega + (1-\gamma^*)(\lambda-\alpha)\delta\omega - c\delta + \mu_1\delta - \mu_2(\delta-1)$ and $\gamma^*(\lambda-\alpha)\delta\omega - c\omega + \mu_3\omega - \mu_4(\omega-1)$, respectively. Then there are seven relevant cases. First, $\delta^* = 0$ and $\omega^* = 0$ when the FOCs $-c < 0$ and $-c < 0$ hold. This investment profile is part of an SPE and entails zero *ex post* bargaining payoffs. Second, $\delta^* = 0$ and $\omega^* \in (0,1]$ when the FOCs $[(1-\gamma^*)\lambda + \gamma^*\alpha]\omega^* < c$ and $-c \geq 0$ hold. Since the second inequality is impossible, this investment profile is not part of an SPE. Third, $\delta^* \in (0,1]$ and $\omega^* = 0$ when the FOCs $-c \geq 0$ and $\gamma^*(\lambda-\alpha)\delta^* < c$ hold. Since the first inequality is impossible, this investment profile is not part of an SPE. Fourth, $\delta^* \in (0,1)$ and $\omega^* \in (0,1)$ when the FOCs $[(1-\gamma^*)\lambda + \gamma^*\alpha]\omega^* = c \rightarrow \widetilde{\lambda}_D^D(\omega) = (c - \gamma^*\alpha\omega^*)/((1-\gamma^*)\omega^*)$ and $\gamma^*(\lambda-\alpha)\delta^* = c \rightarrow \widetilde{\lambda}_U^D(\delta) = c/(\gamma^*\delta^*) + \alpha$ hold. This investment profile is part of an SPE if $\delta^* = (1-\gamma^*)c\omega^*/(\gamma^*(c-\alpha\omega^*))$, entails $\pi_D^D = \alpha\delta^*\omega^* + (1-\gamma^*)\delta^*\omega^*(c-\gamma^*\alpha\omega^*)/((1-\gamma^*)\omega^*) - (1-\gamma^*)\alpha\delta^*\omega^* - c\delta^* = 0 = \gamma^*\delta^*\omega^* c/(\delta^*\gamma^*) - c\omega^* = \pi_U^D$ for every γ^*, and arises for $\widetilde{\lambda}_D^D(\epsilon) - \widetilde{\lambda}_D^D(1-\epsilon) = 2c/\epsilon - \alpha(1-\epsilon)/\epsilon - 2c/(1-\epsilon) - \epsilon\alpha/(1-\epsilon)$ projects with $\epsilon \rightarrow 0$. Fifth, $\delta^* = 1$ and $\omega^* \in (0,1)$ when the FOCs $[(1-\gamma^*)\lambda + \gamma^*\alpha]\omega^* > c$ and $\lambda = c/\gamma^* + \alpha \rightarrow [(1-\gamma^*)c/\gamma^* + \alpha]\omega^* > c$ hold. Since the second inequality is impossible at $\gamma^* = \gamma^D$, this investment profile is not part of an SPE. Sixth, $\delta^* \in (0,1)$ and $\omega^* = 1$ when the FOCs $\lambda = (c - \gamma^*\alpha)/(1-\gamma^*)$ and $\gamma^*(\lambda-\alpha)\delta^* > c \rightarrow \gamma^*(c-\alpha)\delta^*/(1-\gamma^*) > c$ hold. Since the second inequality is impossible at $\gamma^* = \gamma^D$, this investment profile is not part of an SPE. Finally, $\delta^* = 1 = \omega^*$ when the FOCs $\lambda > (c-\gamma^*\alpha)/(1-\gamma^*)$ and $\lambda > c/\gamma^* + \alpha$ hold. This investment profile is part of an SPE.

Given γ^* and $o^* = U$, firms D and U solve the linear programmes $(1-\gamma^*)(\lambda-\beta)\delta\omega - c\delta + \mu_1\delta - \mu_2(\delta-1)$ and $\beta\delta\omega + \gamma^*(\lambda-\beta)\delta\omega - c\omega + \mu_3\omega - \mu_4(\omega-1)$, respectively. Then there are seven relevant cases. First, $\delta^* = 0 = \omega^*$ when the FOCs $-c < 0$ and $-c < 0$ hold. This investment profile is part of an SPE and entails zero *ex post* bargaining payoffs. Second, $\delta^* = 0$ and $\omega^* \in (0,1]$ when the FOCs $(1-\gamma^*)(\lambda-\beta)\omega^* < c$ and $-c \geq 0$ hold. Since the second inequality is impossible, this investment profile is not part of an SPE. Third, $\delta^* \in (0,1]$ and $\omega^* = 0$ when the FOCs $-c \geq 0$ and $[\gamma^*\lambda + (1-\gamma^*)\beta]\delta^* < c$ hold. Since the first inequality is impossible, this investment profile is not part of an SPE. Fourth, $\delta^* \in (0,1)$ and $\omega^* \in (0,1)$ when the FOCs $\widetilde{\lambda}_D^U(\omega) = c/((1-\gamma^*)\omega^*) + \beta$ and $\widetilde{\lambda}_U^U(\delta^*) = (c - (1-\gamma^*)\beta\delta^*)/(\gamma^*\delta^*)$ hold. This investment profile is part of an SPE if $\omega^* = \gamma^* c\delta^*/((1-\gamma^*)(c-\beta\delta^*))$, entails $\pi_U^U = \beta\delta^*\omega^* + \gamma^*\delta^*\omega^*(c-(1-\gamma^*)\beta\delta^*)/(\delta^*\gamma^*) - \gamma^*\beta\delta^*\omega^* - c\omega^* = 0 = (1-\gamma^*)c\delta^*\omega^*/((1-\gamma^*)\omega^*) - c\delta^* = \pi_U^D$ for every γ^*, and arises for $\widetilde{\lambda}_D^U(\epsilon) - \widetilde{\lambda}_D^U(1-\epsilon) = 2c/\epsilon - \beta(1-\epsilon)/\epsilon - 2c/(1-\epsilon) - \epsilon\beta/(1-\epsilon)$ projects with $\epsilon \rightarrow 0$. Fifth, $\delta^* = 1$ and $\omega^* \in (0,1)$ when the FOCs $(1-\gamma^*)(\lambda-\beta)\omega^* > c$ and $\lambda = (c-(1-\gamma^*)\beta)/\gamma^* \rightarrow (1-\gamma^*)(c-\beta)\omega^*/\gamma^* > c$ hold. Since the second inequality is impossible at $\gamma^* = \gamma^U$, this investment profile is not part of an SPE. Sixth, $\delta^* \in (0,1)$ and $\omega^* = 1$ if the FOCs $\lambda = c/(1-\gamma^*) + \beta$ and $[\gamma^*\lambda + (1-\gamma^*)\beta]\delta^* > c \rightarrow (\gamma^* c/(1-\gamma^*) + \beta)\delta^* > c$ hold. Since the second inequality is impossible at $\gamma^* = \gamma^U$, this investment pair is not part of an SPE. Finally, $\delta^* = 1 = \omega^*$ when the FOCs $\lambda > c/(1-\gamma^*) + \beta$ and $\lambda > (c-(1-\gamma^*)\beta)/\gamma^*$ hold. This investment profile is part of an SPE.

■

A.1 Assumption 2 entails expected social welfare maximization

Assume that the two parties select either the intermediate- or zero-investment profile with—a small—probability σ, and full investment otherwise. Then the full-investment profile arises with probability $1-2\sigma$ if intermediate investment is possible (for $\widetilde{\lambda}_i^o(\epsilon) < \lambda < \widetilde{\lambda}_i^o(1-\epsilon)$) and with probability $1-\sigma$ otherwise. As a result, the expected social welfare with respect to the distribution of the parties' trembles can be written as

$$(1-\sigma)\int_{\widehat{\lambda}_i^o}^{\bar{\lambda}} \frac{\lambda-2c}{l} d\lambda - \sigma \int_{\widetilde{\lambda}_i^o(1-\varepsilon)}^{\widetilde{\lambda}_i^o(\varepsilon)} \frac{\lambda-2c}{l} d\lambda + \sigma \int_{\widetilde{\lambda}_i^o(1-\varepsilon)}^{\widetilde{\lambda}_i^o(\varepsilon)} \frac{\lambda\delta^*\omega^* - c(\delta^*+\omega^*)}{l} d\lambda + \sigma \int_{\widehat{\lambda}_i^o}^{-\lambda} \frac{0}{l} d\lambda \quad \text{(A1)}$$

if $\widehat{\lambda}_i^o \geq \widehat{\lambda}_{-i}^o$ and

$$(1-\sigma)\int_{\widehat{\lambda}_{-i}^o}^{\bar{\lambda}} \frac{\lambda-2c}{l} d\lambda - \sigma \int_{\widetilde{\lambda}_{-i}^o(1-\varepsilon)}^{\widetilde{\lambda}_{-i}^o(\varepsilon)} \frac{\lambda-2c}{l} d\lambda + \sigma \int_{\widetilde{\lambda}_{-i}^o(1-\varepsilon)}^{\widetilde{\lambda}_{-i}^o(\varepsilon)} \frac{\lambda\delta^*\omega^* - c(\delta^*+\omega^*)}{l} d\lambda + \sigma \int_{\widehat{\lambda}_{-i}^o}^{-\lambda} \frac{0}{l} d\lambda \quad \text{(A2)}$$

otherwise, with $\widetilde{\lambda}_i^o$ and $\widetilde{\lambda}_{-i}^o$ defined in the previous proof. Since the last two terms of equation (A1) are zero because the intermediate- and zero-investment profiles deliver zero *ex post* bargaining payoffs, expected social welfare maximization boils down to maximizing the first two terms, which in turn requires abiding by the tie-breaking rule described in Assumption 2. To elaborate, when multiple property rights levels induce the same value of the first term of equation (A1), expected social welfare maximization amounts to minimizing the second term, that is, expected deviations to intermediate investment. When, instead, the maximization of the first term of equation (A1)—that is, expected adoption of full-investment—conflicts with the minimization of the second term, the first task must be favoured as σ is small.

A.2 Asymmetric investment

The FOCs for δ^* and ω^* are

$$\left[\gamma^* d_D^o + (1-\gamma^*)(\lambda - d_U^o)\right]\rho(\delta^*)^{\rho-1}(\omega^*)^{1-\rho} - c + \mu_1 - \mu_2 = 0,$$
$$\left[(1-\gamma^*) d_U^o + \gamma^*(\lambda - d_D^o)\right](1-\rho)(\delta^*)^{\rho}(\omega^*)^{-\rho} - c + \mu_3 - \mu_4 = 0,$$

respectively.

Given γ^* and $o^* = J$, there are seven relevant cases. First, $\delta^* = 0$ and $\omega^* = 0$ when the FOCs $-c < 0$ and $-c < 0$ hold. This investment profile is part of an SPE and entails zero *ex post* bargaining payoffs. Second, $\delta^* = 0$ and $\omega^* \in (0,1]$ when the FOCs $-c < 0$ and $-c \geq 0$ hold. Since the second inequality is impossible, this investment profile is not part of an SPE. Third, $\delta^* \in (0,1]$ and $\omega^* = 0$ when the FOCs $-c \geq 0$ and $-c < 0$ hold. Since the first inequality is impossible, this investment profile is not part of an SPE. Fourth, $\delta^* \in (0,1)$ and $\omega^* \in (0,1)$ when the FOCs

$$\lambda = \frac{c}{(1-\gamma^*)\rho}\left(\frac{\delta^*}{\omega^*}\right)^{1-\rho} \quad \text{and} \quad \lambda = \frac{c}{\gamma^*(1-\rho)}\left(\frac{\omega^*}{\delta^*}\right)^{\rho}$$

hold. This investment profile is part of an SPE and entails a positive $(1-\rho)c\delta^*/\rho$ $(\rho c\delta^*/(1-\rho))$ *ex post* bargaining payoff for firm D (U) at $\gamma^* = \gamma^J = \rho$. Then the two right-hand sides are equal only for $\delta^* = \omega^*$ and $\lambda = c/((1-\rho)\rho)$. Fifth, $\delta^* = 1$ and $\omega^* \in (0,1)$ when the FOCs $(1-\gamma^*)\lambda\rho(\omega^*)^{1-\rho} > c$ and $\lambda = c(\omega^*)^{\rho}/(\gamma^*(1-\rho))$ hold. Since for $\gamma^* = \gamma^J$ the first inequality becomes $\omega^* > \gamma^J(1-\rho)/\left((1-\gamma^J)\rho\right) = 1$, this investment profile is not part of an SPE. Sixth, $\delta^* \in (0,1)$ and $\omega^* = 1$ when the FOCs $\lambda = c/\left((1-\gamma^*)\rho(\delta^*)^{\rho-1}\right)$ and $\gamma^*\lambda(1-\rho)(\delta^*)^{\rho} > c$ hold. Since for $\gamma^* = \gamma^J$ the second inequality becomes $\delta^* > (1-\gamma^J)\rho/\left((1-\rho)\gamma^J\right) = 1$, this investment profile is not part of an SPE. Finally, $\delta^* = 1$ and $\omega^* = 1$ when the FOCs $\lambda > c/((1-\gamma^*)\rho)$ and $\lambda > c/(\gamma^*(1-\rho))$ hold. Both inequalities identify thresholds more stringent than those implied by the binding IR constraints, thus γ^* must equalize their right-hand sides, that is, $\gamma^* = \gamma^J = \rho$. The full-investment profile is part of an SPE and entails positive π_i^o. The choice of o is irrelevant when $\omega^* = \delta^* = 0$ is the only investment profile. Within productive projects, firm D makes the following offers that are accepted: (i) $o^* = J$ if $c/((1-\rho)\rho) \leq \lambda < c/((1-\rho)\rho) + \alpha$; (ii) $o^* = D$ if $\lambda \geq c/((1-\rho)\rho) + \alpha$. Hence $V \propto \overline{\lambda} - c/((1-\rho)\rho) - \alpha$. Firm U, instead, makes the following offers that are accepted: (i) $o^* = J$ if $c/((1-\rho)\rho) \leq \lambda < c/((1-\rho)\rho) + \beta$; (ii) $o^* = U$ if $\lambda \geq c/((1-\rho)\rho) + \beta$. Hence $V \propto \overline{\lambda} - c/((1-\rho)\rho) - \beta$.

Given γ^* and $o^* = D$, there are seven relevant cases. First, $\delta^* = 0$ and $\omega^* = 0$ when the FOCs $-c < 0$ and $-c < 0$ hold. This investment profile is part of an SPE and entails zero *ex post* bargaining payoffs. Second, $\delta^* = 0$ and $\omega^* \in (0, 1]$ when the FOCs $-c < 0$ and $-c \geq 0$ hold. Since the second inequality is impossible, this is not part of an SPE. Third, $\delta^* \in (0, 1]$ and $\omega^* = 0$ when the FOCs $-c \geq 0$ and $-c < 0$ hold. Since the first inequality is impossible, this is not part of an SPE. Fourth, $\delta^* \in (0, 1)$ and $\omega^* \in (0, 1)$ when the FOCs

$$\lambda = \frac{c}{(1-\gamma^*)\rho(\omega^*/\delta^*)^{1-\rho}} - \frac{\gamma^*\alpha}{1-\gamma^*} \quad \text{and} \quad \lambda = \frac{c}{\gamma^*(1-\rho)(\omega^*/\delta^*)^{-\rho}} + \alpha$$

hold. This investment profile entails positive $(1-\rho)c\delta^*/\rho$ $(\rho c\delta^*/(1-\rho))$ *ex post* bargaining payoff for firm D (U) at $\gamma^* = \gamma^D$. Then the two right-hand sides are equal only for $\delta^* = \omega^*$ and $\lambda = c/((1-\rho)\rho)$. Fifth, $\delta^* = 1$ and $\omega^* \in (0, 1)$ when the FOCs $[\gamma^*\alpha + (1-\gamma^*)\lambda]\rho(\omega^*)^{1-\rho} > c$ and $\lambda = c/(\gamma^*(1-\rho)(\omega^*)^{-\rho}) + \alpha$ hold. Since for $\gamma^* = \gamma^D$ the first inequality becomes $\omega^* > \left(c - \alpha\rho(\omega^*)^{1-\rho}\right)/(c - \alpha\rho) > 1$, this is not part of an SPE. Sixth, $\delta^* \in (0, 1)$ and $\omega^* = 1$ when the FOCs $\lambda = c/\left((1-\gamma^*)\rho(\delta^*)^{\rho-1}\right) - \alpha\gamma^*/(1-\gamma^*)$ and $\gamma^*(\lambda - \alpha)(1-\rho)(\delta^*)^\rho > c$ hold. Since for $\gamma^* = \gamma^D$ the second inequality becomes $\delta^* > (c - \alpha\rho)/\left(c - \alpha\rho(\delta^*)^{\rho-1}\right) > 1$, this is not part of an SPE. Finally, $\delta^* = 1$ and $\omega^* = 1$ when the FOCs $\lambda > c/((1-\gamma^*)\rho) - \alpha\gamma^*/(1-\gamma^*)$ and $\lambda > c/(\gamma^*(1-\rho)) + \alpha$ hold. Both inequalities identify thresholds more stringent than those implied by the binding IR constraints, thus γ^* must equalize their right-hand sides, that is, $\gamma^* = \gamma^D = c\rho/(c - \alpha\rho(1-\rho)) > \rho$. The full-investment profile is part of an SPE and entails positive π_i^o. The choice of o is irrelevant when $\omega^* = \delta^* = 0$ is the only investment profile. Within productive projects, firm D always offers $o = D$ for $\lambda \geq c/((1-\rho)\rho)$, firm U accepts, and $V \propto \overline{\lambda} - c/((1-\rho)\rho)$. Firm U, instead, makes the following take-or-leave-it offers that are accepted:

(i) $o = D$ if $\dfrac{c}{(1-\rho)\rho} \leq \lambda < \dfrac{c[c - \alpha\rho(1-\rho)]}{\rho(1-\rho)(c - \alpha\rho)}$;

(ii) $o = J$ if $\dfrac{c[c - \alpha\rho(1-\rho)]}{\rho(1-\rho)(c - \alpha\rho)} \leq \lambda < \dfrac{c[c - \alpha\rho(1-\rho)]}{\rho(1-\rho)[c - \alpha\rho]} + \beta$;

(iii) $o = U$ if $\lambda \geq \dfrac{c[c - \alpha\rho(1-\rho)]}{\rho(1-\rho)[c - \alpha\rho]} + \beta$.

The extent of integration is such that $V \propto \overline{\lambda} - c/((1-\rho)\rho) - \beta$.

Given γ^* and $o^* = U$, there are seven relevant cases. First, $\delta^* = 0$ and $\omega^* = 0$ when the FOCs $-c < 0$ and $-c < 0$ hold. This investment profile is part of an SPE and entails zero *ex post* bargaining payoffs. Second, $\delta^* = 0$ and $\omega^* \in (0, 1]$ when the FOCs $-c < 0$ and $-c \geq 0$ hold. Since the second inequality is impossible, this is not part of an SPE. Third, $\delta^* \in (0, 1]$ and $\omega^* = 0$ when the FOCs $-c \geq 0$ and $-c < 0$ hold. Since the first inequality is impossible, this investment profile is not part of an SPE. Fourth, $\delta^* \in (0, 1)$ and $\omega^* \in (0, 1)$ when the FOCs

$$\lambda = \frac{c}{(1-\gamma^*)\rho(\delta^*/\omega^*)^{\rho-1}} + \beta \quad \text{and} \quad \lambda = \frac{c}{\gamma^*(1-\rho)(\delta^*/\omega^*)^{\rho}} - \frac{1-\gamma^*}{\gamma^*}\beta$$

hold. This investment profile entails a positive $(1-\rho)c\delta^*/\rho$ $(\rho c\delta^*/(1-\rho))$ *ex post* bargaining payoff for firm D (U) at $\gamma^* = \gamma^U$. Then the two right-hand sides are equal only for $\delta^* = \omega^*$ and $\lambda = c/((1-\rho)\rho)$. Fifth, $\delta^* = 1$ and $\omega^* \in (0,1)$ when the FOCs $\lambda > c/\left((1-\gamma^*)\rho(\omega^*)^{1-\rho}\right) + \beta$ and $[(1-\gamma^*)\beta + \gamma^*\lambda](1-\rho)(\omega^*)^{-\rho} = c$ hold. Since for $\gamma^* = \gamma^U$ the first inequality becomes $\omega^* > (c - \beta(1-\rho))/(c - \beta(1-\rho)(\omega^*)^{-\rho}) > 1$, this is not part of an SPE. Sixth, $\delta^* \in (0,1)$ and $\omega^* = 1$ when the FOCs $(1-\gamma^*)(\lambda-\beta)\rho(\delta^*)^{\rho-1} = c$ and $\lambda > c/(\gamma^*(1-\rho)(\delta^*)^{\rho}) - \beta(1-\gamma^*)/\gamma^*$ hold. Since for $\gamma^* = \gamma^U$ the second inequality becomes $\delta^* > (c - \beta(1-\rho)(\delta^*)^{\rho})/(c - \beta(1-\rho)) > 1$, this is not part of an SPE. Finally, $\delta^* = 1$ and $\omega^* = 1$ when the FOCs $\lambda > c/((1-\gamma^*)\rho) + \beta$ and $\lambda > c/(\gamma^*(1-\rho)) - \beta(1-\gamma^*)/\gamma^*$ hold. Both inequalities identify thresholds more stringent than those implied by the binding IR constraints, thus γ^* must equalize their right-hand sides, that is, $\gamma^* = \gamma^U = \rho[c - \beta(1-\rho)]/(c - \beta\rho(1-\rho)) < \rho$. The full-investment profile is part of an SPE and entails positive π_i^o. The choice of o is irrelevant when $\omega^* = \delta^* = 0$ is the only possible investment profile. Within productive projects, firm D makes the following take-or-leave-it offers that are accepted:

(i) $o = U$ if $\dfrac{c}{(1-\rho)\rho} \le \lambda < \dfrac{c[c - \beta\rho(1-\rho)]}{\rho(1-\rho)[c - \beta(1-\rho)]}$;

(ii) $o = J$ if $\dfrac{c[c - \beta\rho(1-\rho)]}{\rho(1-\rho)[c - \beta(1-\rho)]} \le \lambda < \dfrac{c[c - \beta\rho(1-\rho)]}{\rho(1-\rho)[c - \beta(1-\rho)]} + \alpha$;

(iii) $o = D$ if $\lambda \ge \dfrac{c[c - \beta\rho(1-\rho)]}{\rho(1-\rho)[c - \beta(1-\rho)]} + \alpha$.

Hence $V \propto \overline{\lambda} - c/((1-\rho)\rho) - \alpha$. For $\lambda \ge c/((1-\rho)\rho)$, firm U always offers $o = U$, which is accepted by firm D. Therefore the extent of integration is such that $V \propto \overline{\lambda} - c/((1-\rho)\rho)$.

A.3 Self-investment

The necessary FOCs for the investment level 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.

Given γ^* and $o^* = J$, there are seven relevant cases. First, $\delta^* = 0$ and $\omega^* = 0$ when the FOCs $-c < 0$ and $-c < 0$ hold. This pair is part of an SPE and entails zero *ex post* bargaining payoffs. Second, $\delta^* = 0$ and $\omega^* \in (0,1]$ when the FOCs $(1-\gamma^*)\lambda\omega^* < c$ and $-c \ge 0$ hold. Since the second inequality is impossible, this investment profile is not part of an SPE. Third, $\delta^* \in (0,1]$ and $\omega^* = 0$ when the FOCs $-c \ge 0$ and $\gamma^*\lambda\delta^* < c$ hold. Since the first inequality is impossible, this investment profile is not part of an SPE. Fourth, $\delta^* \in (0,1)$ and $\omega^* \in (0,1)$ when the FOCs $\lambda = c/((1-\gamma^*)\omega^*)$ and $\lambda = c/(\gamma^*\delta^*)$ hold. This pair is part of an SPE, entails zero *ex post* bargaining payoffs, and arises for $\lambda_U^J(\epsilon) - \lambda_D^J(1-\epsilon) = 2c/\epsilon - 2c/(1-\epsilon)$ matches. Fifth, $\delta^* = 1$ and $\omega^* \in (0,1)$ when the FOCs $(1-\gamma^*)\lambda\omega^* > c$ and $\lambda = c/\gamma^*$ hold. Since the first inequality is impossible at $\gamma^* = \gamma^J$, this investment profile is not part of an SPE. Sixth, $\delta^* \in (0,1)$ and $\omega^* = 1$ when the FOCs $\lambda = c/(1-\gamma^*)$ and $\gamma^*\lambda\delta^* > c$ hold. Since the second inequality is impossible at $\gamma^* = \gamma^J$, this investment profile is not part of an SPE. Finally, $\delta^* = 1$ and $\omega^* = 1$ when the FOCs $\lambda > c/(1-\gamma^*)$ and $\lambda > c/\gamma^*$ hold. This pair is part of an SPE.

Given γ^* and $o^* = D$, there are seven relevant cases. First, $\delta^* = 0$ and $\omega^* = 0$ when the FOCs $\gamma^*\alpha < c$ and $-c < 0$ hold. This investment profile is part of an SPE and entails zero *ex post* bargaining payoffs. Second, $\delta^* = 0$ and $\omega^* \in (0,1]$ when the FOCs $\gamma^*\alpha + (1-\gamma^*)\lambda\omega^* < c$ and $-c \ge 0$ hold. Since the second inequality is impossible, this is not part of an SPE. Third, $\delta^* \in (0,1]$ and $\omega^* = 0$ when the FOCs $\gamma^* \ge c/\alpha$ and $\gamma^*\lambda\delta^* < c$ hold. Since the first inequality is impossible for $c > \alpha$ (i.e. $\gamma^* > 1$), this investment profile is not part of an SPE. Fourth, $\delta^* \in (0,1)$ and $\omega^* \in (0,1)$ when the FOCs $\gamma^*\alpha + (1-\gamma^*)\lambda\omega^* = c \to \lambda = (c - \gamma^*\alpha)/((1-\gamma^*)\omega^*)$ and $\gamma^*\lambda\delta^* = c \to \lambda = c/(\gamma^*\delta^*)$ hold. This investment profile is part of an SPE, entails zero *ex post* bargaining payoffs, and arises for $\lambda_U^D(\epsilon) - \lambda_D^D(1-\epsilon) = 2c/\epsilon - \alpha/\epsilon - 2c/(1-\epsilon)$ matches. Fifth,

$\delta^* = 1$ and $\omega^* \in (0,1)$ if the FOCs $\gamma^*\alpha + (1-\gamma^*)\lambda\omega^* > c$ and $\lambda = c/\gamma^*$ hold. Since at γ^D the first inequality should be $2c - \alpha > 2c/\omega^*$, this is not part of an SPE. Sixth, $\delta^* \in (0,1)$ and $\omega^* = 1$ when the FOCs $\lambda = (c - \gamma^*\alpha)/(1-\gamma^*)$ and $\gamma^*\lambda\delta^* > c \rightarrow \delta^* > (2c-\alpha)/(2c)$ 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 an SPE. Finally, $\delta^* = 1$ and $\omega^* = 1$ when the FOCs $\lambda > (c - \gamma^*\alpha)/(1-\gamma^*)$ and $\lambda > c/\gamma^*$ hold. This investment profile is part of an SPE.

Given γ^* and $o^* = U$, there are seven relevant cases. First, $\delta^* = 0 = \omega^*$ when the FOCs $-c < 0$ and $(1-\gamma^*)\beta - c < 0$ hold. This investment profile is part of an SPE for $c > \beta$. Second, $\delta^* = 0$ and $\omega^* \in (0,1]$ when the FOCs $(1-\gamma^*)\lambda\omega^* < c$ and $1 - \gamma^* \geq c/\beta$ hold. Since the second inequality is impossible for $c > \beta$ (i.e. $\gamma^* < 0$), this investment profile is not part of an SPE. Third, $\delta^* \in (0,1]$ and $\omega^* = 0$ when the FOCs $-c \geq 0$ and $(1-\gamma^*)\beta < c$ hold. Since the first inequality is impossible, this investment profile is not part of an SPE. Fourth, $\delta^* \in (0,1)$ and $\omega^* \in (0,1)$ when the FOCs $\lambda = c/\left((1-\gamma^*)\omega^*\right)$ and $\lambda = \left(c - (1-\gamma^*)\beta\right)/(\gamma^*\delta^*)$ hold. This investment profile is part of an SPE, entails zero *ex post* bargaining payoffs, and arises for $\lambda_D^U(\epsilon) - \lambda_U^U(1-\epsilon) = 2c/\epsilon - \beta/\epsilon - 2c/(1-\epsilon)$ matches. Fifth, $\delta^* = 1$ and $\omega^* \in (0,1)$ when the FOCs $(1-\gamma^*)\lambda\omega^* > c$ and $\lambda = \left(c - (1-\gamma^*)\beta\right)/\gamma^* \rightarrow \omega^* > (2c-\beta)/(2c)$ hold. Then $\pi_U^U = 0$ and $\pi_D^U \geq 0 \leftrightarrow \omega^* > 1$, which is impossible. Hence this pair is not part of an SPE. Sixth, $\delta^* \in (0,1)$ and $\omega^* = 1$ when the FOCs $\lambda = c/(1-\gamma^*)$ and $\gamma^*\lambda\delta^* + (1-\gamma^*)\beta > c$ hold. Since at γ^U the second inequality should be $2c - \beta > 2c/\delta^*$, this pair is not part of an SPE. Finally, $\delta^* = 1$ and $\omega^* = 1$ when the FOCs $\lambda > c/(1-\gamma^*)$ and $\lambda > \left(c - (1-\gamma^*)\beta\right)/\gamma^*$ hold. This investment profile is part of an SPE.

A.4 Bargaining over the ownership structure

When $\lambda \geq 2c$ and firm D makes the take-or-leave-it offer, the comparison between what firm U would pay and what firm D would require for a reform is as follows. A switch from $o = D$ to $o = U$ 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 $o = D$ to $o = J$ 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 $o = J$ to $o = U$ 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 $\lambda \geq 2c$ and firm U makes the take-or-leave-it offer. Obviously, the same conclusion arises for $\lambda < 2c$.