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ORIGINAL PAPER

Property rights, transaction costs, and the limits of the market

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Abstract

To clarify the determinants and interaction of property rights and transaction costs, I study the design of the property rights on either a good whose consensual transfer entails a transaction inefficiency or an upstream firm's input whose random cost is nonverifiable and ex ante non-contractible. More disperse traders' valuations and larger odds that the upstream party can appropriate the quasi-rent induced by contract incompleteness produce more severe transaction inefficiencies and larger incomplete contracting costs, respectively. Larger transaction costs, in turn, induce weaker property rights because of the trade-off between inefficient exclusion from trade/innovation and expropriation. These implications survive when some transactors have more political influence on institutional design, or I consider the disincentive effect of weak property rights. Furthermore, they are consistent with the interplay among proxies for the availability of technological progress, severity of transaction costs and strength of property rights for 139 countries observed between 2006 and 2018.

Keywords Property rights · Transaction costs · Preference dispersion · Innovation

JEL Classification D23 · D40 · K11 · O12

> "Whenever transactions […] are very expensive, […] coercion is inherent [and] society will pick the entitlement it deems favorable to the general welfare" (Calabresi and Melamed 1972, p. 1101).

> "As soon as the land [has] all become private property, the landlords [...] love to reap where they never sowed, and demand a rent even for its natural produce" (Smith 2017, p. 67).

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1 Introduction

Albeit vast evidence suggests that strong property rights and limited transaction costs foster trade and innovation, their determinants and interaction are still poorly understood. To help tackle this issue, I provide a theory of the formation of transaction costs and the consequent selection of property rights incorporating into economics the key Calabresi and Melamed's (1972) insight that incomplete property rights can be efficient when transaction costs impede valuable exchange/innovation and, thus, deliver large ex post misallocations. Consistent with this view, despite all legal systems punish theft and embezzlement and provide remedies for dispossessed owners, parties are allowed, whenever the obstacles to transactions are sizable, to take private property without the original owners' consent and by possibly paying a predetermined compensation (Bouckaert and De Geest 1995). This is the case of a good faith buyer acquiring from an intermediary a good either stolen or embezzled from its original owner, a nonpaying tenant successfully avoiding eviction,[1] a state expropriating a citizen for private for-profit use, an agent lawfully breaching a contract, majority shareholders successfully extracting from a firm creditors' and minority shareholders' resources, a principal lawfully segmenting a market and a downstream firm exploiting an upstream party's intellectual property through fiduciary duties and shop right provisions.

To analyze these and other cases of legalized direct and indirect—i.e., mediated by the state—private takings, I study the design of the property rights on either a good whose consensual transfer entails a transaction inefficiency or an upstream firm's input whose random cost is nonverifiable and ex ante non-contractible. Following the "property rights" literature (Allen 2000),[2] I define the strength of the original owner's property rights as the odds with which he receives back a good expropriated by the potential buyer and the legal protection of the upstream firm as his ex post bargaining power.[3] Both definitions are consistent with Alchian's (1965) view that economic property rights are those of "individuals to the use of resources." Departing from the property rights literature, I define transaction costs as "any impediments or costs of negotiating" (Calabresi and Melamed 1972), and I distinguish between trade barriers that are outside the control of transactors—e.g., financial frictions—and trade/innovation hurdles driven by either the market power, superior information or contractual advantage of some of them (see the Internet Appendix). I label the former as "exogenous" transaction costs and the latter as "endogenous" transaction costs.

Starting with the interplay among property rights, transaction costs and exchange, I build on Guerriero (2016a), and I evaluate a society equally split into homogeneous original owners and potential buyers having different valuations for the single

[1] Policies easing this outcome are right-to-counsel and eviction moratoria (Abramson 2022). Let me thank an anonymous reader for drawing my attention to this particular example.

[2] Different from Barzel (1994), who identifies property rights with the agent's expected stream of net utility, I avoid lumping together the probability of usage with its value.

[3] I refer to an original owner/upstream firm as "he" and to a potential buyer/downstream party as "she."

good in the economy. The two groups are randomly matched by an intermediation technology allowing the potential buyers to obtain the good via either a consensual transfer entailing a transaction inefficiency or by expropriating it at a cost that, without loss of generality, I assume negligible. When transaction costs are exogenous, consensual transfers require that the potential buyers pay to the original owners their valuation plus a socially wasteful fee. Then, full protection of the original owners' property implies that an expropriated good is always returned and some potential buyers with valuations higher than that of the original owners are inefficiently excluded from trade due to the transaction fee. Weaker property rights, instead, alleviate this misallocation by probabilistically allowing middle-valuation potential buyers to consume, but, contemporaneously, push low-valuation potential buyers to inefficiently expropriate their match. This trade-off between inefficient exclusion from trade and expropriation implies that property rights are optimally weakened when transaction costs are sizable and more so the larger are the impediments to negotiation. Intuitively, a rise in transaction costs has both the marginal effect of pushing some high-valuation potential buyers to expropriate the good and the infra-marginal effect of decreasing the social gains from consensual transfers. Being both effects welfare-decreasing, larger negotiation costs must also weaken the protection of property and, in turn, shrink the market, i.e., decrease the measure of consensual transfers.

Similar patterns prevail when transaction costs are endogenously determined by either the original owners' market power or their privileged information. In the former case, the markup selected by the original owners is socially valuable as a transfer but entails an equal distortion in the potential buyers' demand. Since a rise in the dispersion in the traders' valuation increases the measure of matches on which a markup is commanded relative to the number of matches supporting expropriation, it also augments the markup itself and the demand distortion to the point of making incomplete property rights optimal. When it is the degree of asymmetry in information to inefficiently exclude middle-valuation potential buyers, a rise in the difference between their payoff and the original owners' valuation endogenously worsens the lemons-type distortions and calls for a weaker protection of property.

Turning to the interplay among property rights, transaction costs and innovation, I build on Grossman and Hart (1986) and Guerriero and Pignataro (2021), and I consider heterogeneous projects each involving an upstream and a downstream firm. The former can either produce in-house via an "old" technology or adopt a "new"—more efficient—technology necessitating both parties' investments. While both input costs and payoffs are nonverifiable and ex ante non-contractible, only the former are ex post contractible and only the upstream firms' input cost is random and realized after he has committed his investment. The mix of contract incompleteness and the upstream firm's uncertainty on his cost assures him an "appropriable quasi-rent" (Barzel 1994), which rises with the likelihood of a low cost realization, equals the specificity of the downstream firms' input and distorts the extent of innovation if too large. As a consequence, a strong protection of the upstream party's input excessively increases the expected appropriable quasi-rent, discouraging high-productivity downstream firms from innovating. When, instead, property rights are weak, low-productivity downstream parties inefficiently select the new technology.

This trade-off between inefficient exclusion from innovation and expropriation entails that larger odds of a low innovation cost and, thus, a more severe contract incompleteness must undermine the upstream firms' property rights and reduce the extent of in-house production.

Two obvious objections to the model reasoning are that some transactors have more political influence on institutional design and that weak property rights entail a disincentive effect. Crucially, the model testable predictions survive when I consider these possibilities, but two novel implications arise. First, property is protected too much in the most likely case in which those guiding institutional design are also initially holding economic value since these transactors prefer a too strong protection of their property. Second, property rights are optimally strengthened to incentivize original owners to either produce or invest.

To assess whether the correlations in the available data are consistent with the most innovative model implications, I analyze a panel of 139 countries spanning the 2006–2018 period. For this sample, the Executive Opinion Survey—EOS, hereafter—reports measures for the protection of the original owners' and downstream firms' personal, intellectual, and financial property as well as proxies for the severity of financial frictions, market power, lemons-type distortions and the specificity of the downstream parties' input, which, as aforementioned, picks the severity of contract incompleteness. By combining information collected from the EOS and the Doing Business Project, moreover, I obtain a measure of the availability for firms of technological innovations, which I employ as proxy for less disperse traders' valuations and larger odds of a low innovation cost. While the second interpretation is straightforward, the first one is consonant with recent firm-level evidence suggesting that a limited technological availability, and not more severe transaction costs, induces less-developed countries to organize themselves around economies marked by a larger dispersion in the firms' productivity and, in turn, in the consumers' valuation for final goods (Porzio 2018). Conditional on country and year fixed effects, OLS estimates reveal two key results coherent with the model. First, the protection of the original owners' and downstream parties' property is weaker where financial frictions, market power and lemons-type distortions are more severe and where the downstream firms' input is less specific. Second, the availability of technological progress is negatively related to financial inefficiencies, market power and lemons-type distortions and positively linked to the specificity of the downstream parties' input.

To gain more insights about causality without the presumption to prove it, I discuss in the Internet Appendix three extra results. First, my conclusions are similar when I either switch to an objective measure of property rights or consider different proxies for both exogenous and endogenous transaction costs. This pattern suggests that measurement error does not seem to be a major issue. Second, I also consider the other main determinants of property rights and transaction costs such as income, inclusiveness of political institutions, non-produced output, both external and internal conflicts and a culture of innovation. Including these observable factors together leaves the results almost intact as it does also considering the main determinants of either legal protection or transaction costs lead one year. The fact that these lead values are insignificant, moreover, excludes that the estimates are driven by reverse

causation. Finally, I calculate that the influence of unobservables would need to be on average more than seven times stronger than the influence of all the observables that I consider to completely explain away the OLS estimates. Accordingly, it seems difficult to envision that unobserved heterogeneity is driving the empirical results.

This study provides and tests a first theory of endogenous market design clarifying how fundamental factors, such as the dispersion in the traders' valuation and the odds of a lower innovation cost, shape the severity of the impediments to negotiation and, in turn, the protection of property. The strength of property rights determines, in turn, the limits between market and non-market activities. Hence, my paper is related to four strands of the literature on transaction costs and property rights. First, it is linked to several contributions showing that weak property rights can be optimal in an endowment economy (Kaplow and Shavell 1996; Jordan 2006; Bar-Gill and Persico 2016; Segal and Whinston 2016; Arruñada et al. 2019). As Guerriero (2016a), not only do I extend this result to production economies, but I also clarify how weak property rights can partially neutralize market frictions and failures [see also Boldrin and Levine (2013)]. Different from the present paper however, Guerriero (2016a) focuses on the link between the diversity in the potential buyers' valuation and the legal protection of original owners, without characterizing theoretically the determinants and impact of contract incompleteness and empirically the determinants of transaction costs and their impact on property rights. Second, my study is also related to that of Guerriero and Pignataro (2021), who analyze the interplay among the intensity and specificity of the firms' inputs, their property rights, and the ownership structure. Because of their focus on ex ante incentives, these Authors conclude that the strength of the upstream firms' property rights not only falls with the specificity of the downstream parties' input but also rises with the specificity of their own investment. Third, my analysis of negotiating costs is part of a body of research—still in its infancy—on endogenous transaction costs (Williamson 2010; Barry et al. 2014). None of these papers, however, has emphasized the roles of the dispersion in the traders' valuation and/or the odds of innovation. Finally, Acemoglu and Johnson (2005) compare property rights protection with contract enforcement. Different from these Authors, I examine the determinants of the trade-off between these two institutional strategies created by the possibility of non-consensual transfers, and I emphasize that weak property rights are society's response to sizable transaction costs (see also Aghion et al. (2010)).

The paper proceeds as follows. In Sect. 2, I show that the basic correlations in the available data are consistent with the main model implications. Next, I illustrate the main model in Sect. 3, and I evaluate its robustness to alternative assumptions in Sect. 4. Finally, I conclude in Sect. 5, and I gather proofs, tables, and figures in the Appendix.

2 Property rights and transaction costs: evidence

Data The sample comprehends data on 139 countries observed yearly between 2006 and 2018 for a total of 1807 observations. For this panel, I also observe all the main control variables discussed in the Internet Appendix. While Table 1 lists the

countries part of the sample, Table 2 reports the definitions and sources of all the variables I employ in Table 3. The key data source is the EOS, which is devised by the World Economic Forum. This is the longest-running and most extensive survey of business leaders and provides their yearly evaluation of critical economic aspects for which statistical data is missing because extremely difficult to measure (WEF 2019).[4] To account for unrepresented clusters in the global population and tackle heterogeneity in institutional design, I always allow for clustering by country and control for both country and year fixed effects (Abadie et al. 2017).

Starting with property rights, I rely on three indicators picking the protection of generic property including financial assets—i.e., *Property-Rights*, the defense of intellectual property including anti-counterfeiting measures—i.e., *Intellectual-Property*, and the safeguard of the interests of minority investors and shareholders, i.e., *Investors-Protection*. While the first two indexes range between one and seven and are directly collected from the EOS, the last one is the normalized—to range between zero and one—first principal component extracted from a 1–10 index of the protection of minority investors compiled by the Doing Business project and a 1–7 index of the protection of minority shareholders produced by the EOS. Since private rights are typically defined on final goods (Burk and McDonnel 2007, pp. 591–594), the three indicators constitute inverse metrics of the legal protection of the upstream firms and direct ones of the safeguard of the downstream parties' property. The maps in Fig. 1 visualize the three variables averaged over time. I divide the range of each variable into four equal intervals to draw these maps, whereas I use the continuous data in the empirical test. Three are the key observations. First, the three indexes are strongly—nowhere lower than 0.73—correlated and point at the general incompleteness of property rights protection. Second, there is sizable variation across countries. Finally, this between variation is accompanied by a comparable within variation with the latter representing roughly half of the former,[5] Accordingly, the message of the empirical exercise is unaltered when I either aggregate the data at the cross-sectional level or I do not control for year fixed effects (see the Internet Appendix). More important, the three indexes are strongly and significantly correlated with an cross-sectional objective measure of property rights defined as the length of adverse possession of personal property in years, i.e., *Adverse-Possession*.[6] This proxy captures the extent to which a legal system protects the original owner relative to the bona fide purchaser, and it is based on both the prevailing law

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

[5] It is the 28, 31 and 31 percent of the total for *Property-Rights Intellectual-Property* and *Investors-Protection*.

[6] Adverse possession is a form of derivative acquisition such that ownership of a good is obtained by virtue of a sufficiently long, open, continuous, and notorious possession and without the original owner's consent. Conditional on income, the partial correlations between *Adverse-Possession* and, respectively, *Property-Rights*, *Intellectual-Property* and *Investors-Protection* equal 0.21, 0.24 and 0.33 and are significant at 1%.

Table 1 Full sample

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

and judicial decisions (Dari-Mattiacci and Guerriero 2015, 2019). Crucially, the gist of my analysis remains the same when I proxy the strength of property rights with *Adverse-Possession* (see the Internet Appendix).

Turning to exogenous and endogenous transaction costs, I employ several EOS indexes. Starting with market frictions, I focus on the financial sector for its crucial relevance, and I evaluate an 1–7 index measuring its difficulties in providing products and services to businesses, i.e., *Unavailability-Financing*. A value of one suggests that the financial sector offers a wide variety of product and services, whereas a value of seven implies that it does not provide them at all. Turning to endogenous transaction costs, I construct proxies for market power, lemons-type distortions, and the severity of contract incompleteness. For what concerns market power, I employ a 1–7 indicator capturing the lack of competitiveness of corporate activity, i.e., *Market-Dominance*. A value of one suggests that corporate activity is spread among many firms, whereas a value of seven implies that it is dominated by few business groups. Regarding lemons-type distortions, I rely on a 1–7 index falling with the information used by buyers, i.e., *Asymmetric-Information*. A value of one suggests that purchases are based on a sophisticated analysis of attributes, whereas a value of seven implies that they are driven solely by the lowest price. Finally, I capture the severity of contract incompleteness with a 1–7 indicator rising with the specificity of the intangible assets/processes usually brought about by the downstream parties (Williamson 1983), i.e., *Process-Specificity*. A value of one suggests that production uses labor-intensive processes and a value of seven implies that it embraces sophisticated and knowledge-intensive processes. Crucially, my conclusions are similar when I capture market frictions with indexes for either the firms' difficulty to access equity financing, burden of administrative requirements on firms or their necessity to bribe and when I measure market power with either an indicator for the lack of competitiveness of national markets or an index of the impact of non-tariff barriers on the ability of imports to compete with domestic goods (see the Internet Appendix).

For what, finally, concerns both the dispersion in the traders' valuation and the likelihood of a lower innovation cost, I rely on the normalized—to range

Table 2 Summary of variables

	Variable	Definition and Sources	Statistics
Property rights	*Property-Rights*	Index ranging between one and seven and picking the strength of generic property rights. Source: 2006–2019 EOS, available at https://www.weforum.org/reports	4.381 (1.007)
	Intellectual-Property	Index ranging between one and seven and capturing how strong intellectual property rights are. Source: 2006–2019 EOS	3.819 (1.106)
	Investors-Protection	Variable ranging between zero and one and picking the strength of the rights of minority investors and shareholders. Sources: 2006–2019 Doing Business Project, available at http://www.doingbusiness.org, and 2006–2019 EOS	0.471 (0.162)
Transaction costs	*Unavailability-Financing*	Index ranging between one and seven and capturing the financial sector difficulties in providing products and services to businesses. Source: 2006–2019 EOS	2.568 (0.927)
	Market-Dominance	Index ranging between one and seven and falling with the competitiveness of the corporate activity. Source: 2006–2019 EOS	3.203 (0.811)
	Asymmetric-Information	Index ranging between one and seven and decreasing with the extent of information used by buyers to make purchasing decisions. Source: 2006–2019 EOS	3.490 (0.819)
	Process-Specificity	Index ranging between one and seven and picking the specificity of production process. Source: 2006–2019 EOS	3.820 (1.065)
Determinants of transaction costs	*Technology-Availability*	Variable ranging between zero and one and capturing the availability for firms of technological innovations. Source: 2006–2019 EOS	0.474 (0.207)

The last column reports the mean value and, in parentheses, the standard deviation of each variable. Both are computed for the 1807 observations used in Table 3

Table 3 Property rights, transaction costs and their determinants

	Panel A. The dependent variable is:							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Property-Rights	*Property-Rights*	*Property-Rights*	*Property-Rights*	*Intellectual-Property*	*Intellectual-Property*	*Intellectual-Property*	*Intellectual-Property*
Unavailability-Financing	− 0.260				− 0.194			
	(0.070)***				(0.061)***			
Market-Dominance		− 0.395				− 0.481		
		(0.057)***				(0.054)***		
Asymmetric-Information			− 0.329				− 0.393	
			(0.038)***				(0.047)***	
Process-Specificity				0.391				0.556
				(0.060)***				(0.068)***
Estimation	OLS							
Within R^2	0.23	0.29	0.26	0.25	0.38	0.50	0.46	0.48
Number of observations	1807	1807	1807	1807	1807	1807	1807	1807
	Panel B: The dependent variable is:							
	Investors-protection	*Investors-protection*	*Investors-protection*	*Investors-protection*	*Unavailability-financing*	*Market-dominance*	*Asymmetric-information*	*Process-specificity*
Unavailability-Financing	− 0.035							
	(0.012)***							
Market-Dominance		− 0.056						
		(0.010)***						
Asymmetric-Information			− 0.050					
			(0.010)***					

Table 3 (continued)

	Panel B: The dependent variable is:							
	Investors-protection	*Investors-protection*	*Investors-protection*	*Investors-protection*	*Unavailability-financing*	*Market-dominance*	*Asymmetric-information*	*Process-specificity*
Process-Specificity				0.038				
				(0.016)**				
Technology-Availability					− 1.010	− 2.305	− 1.762	2.134
					(0.336)***	(0.225)***	(0.293)***	(0.231)***
Estimation	OLS							
Within R^2	0.05	0.10	0.09	0.04	0.15	0.21	0.30	0.41
Number of observations	1807	1807	1807	1807	1807	1807	1807	1807

(1) Robust standard errors allowing for clustering by country in parentheses. *** significant at the 1% confidence level; **, 5%; *, 10%

(2) All specifications include country and year fixed effects

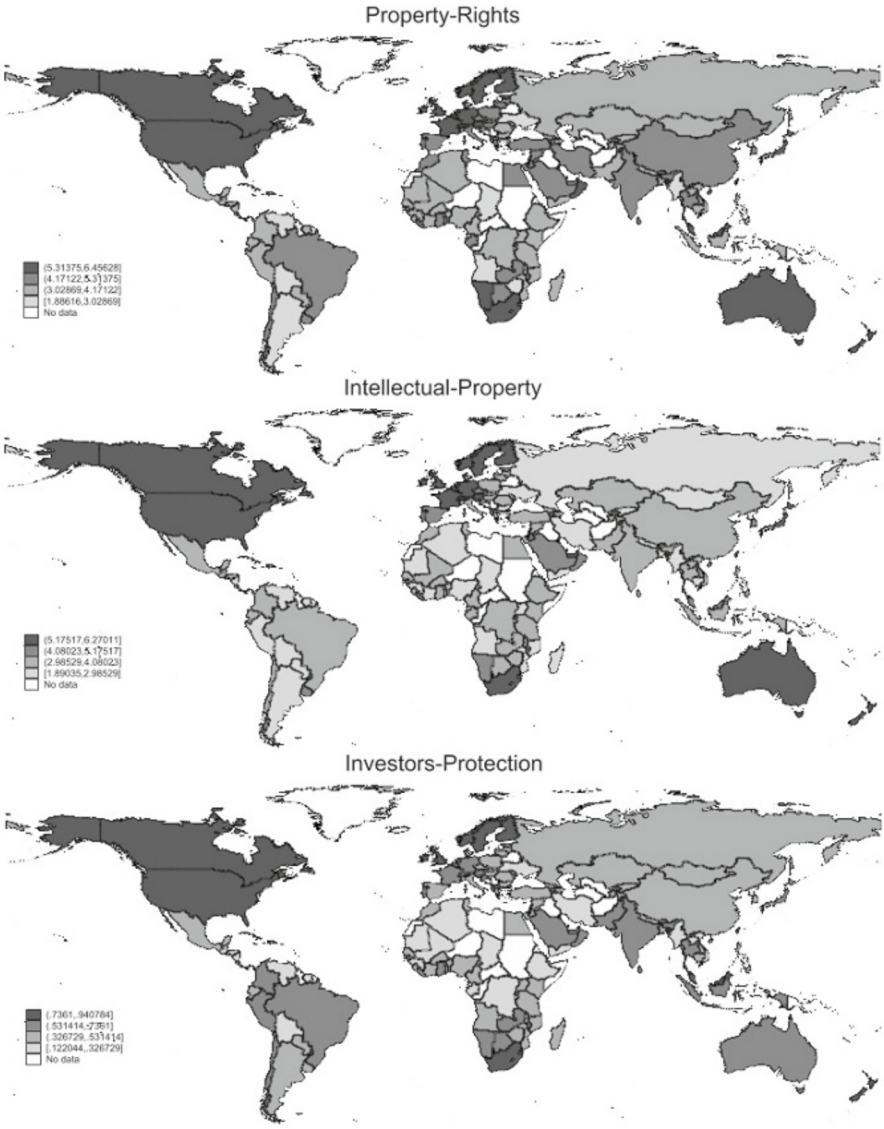

Fig. 1 Strength of property rights protection. *Note* 1: The range of each of the three variables, whose definitions and sources are listed in Table 2, is divided into four equal intervals

between zero and one—first principal component extracted from two 1–7 EOS indexes for the availability for firms of scientists and engineers and for the availability for firms of the latest technologies, i.e., *Technology-Availability*.[7] This choice is consistent with recent firm-level evidence on the fact that the larger

[7] A value of one suggests that they are unavailable and a seven that they are readily available (WEF 2015).

productivity dispersion displayed by jurisdictions further away from the technology frontier can be accounted for by two investment incentives of their high-skilled individuals (Porzio 2018). First, they find easier than low-skilled individuals to imitate technologies discovered elsewhere. Second, they cluster in innovative teams segregated from the rest of the population, segmenting in this way the production sector. Four are the key implications of these remarks for my measurement strategy. First, since productivity dispersion induces more heterogeneous traders' valuations, a limited technology availability produces more severe market power and lemons-type distortions (see sections 3.1.2 and 3.1.3 and Porzio (2018)). Second, economies nearer to the technology frontier exhibit a lower innovation cost (Acemoglu et al. 2006), which entails more severe asset specificity (see Sect. 3.2). Third, it is reasonable to think that the same determinants of market failures also drive market frictions. For instance, Acemoglu et al. (2006) claim that market over-regulation, an example of exogenous transaction cost, is a strategy typical of countries more distant to the technological frontier since it avoids a premature switch from imitation to a costlier investment approach based on innovative activities.

Basic results The OLS estimates reported in Table 3 reveal that the protection of the original owners' property is strongly and negatively related to financial frictions, market power and lemons-type distortions and that the strength of the downstream firms' property rights is strongly and positively linked to the specificity of their inputs. Moreover, financial frictions, market power and lemons-type distortions are more severe in countries more distant to the technological frontier. Finally, the degree of specificity of the downstream firms' inputs is the fiercest where the odds of a low innovation cost are larger because of the easier access to technological innovations. All these coefficients are significant at 5% or better, and Figs. 2, 3, 4 and 5 suggest that they are not driven by a handful of abnormal observations. To confirm this idea, I document in the Internet Appendix that the estimates are similar when I exclude the outliers identified through the Cook's distance (Cook 1977).

3 Theory

Next, I present a model of the formation of transaction costs and the consequent selection of property rights rationalizing the evidence just discussed as well as several key legal cases. First, I analyze the case of exogenous transaction costs and, then, I turn to characterize the scenario in which the costs of negotiating are endogenously determined by either the market power, superior information or contractual advantage of a group of transactors.

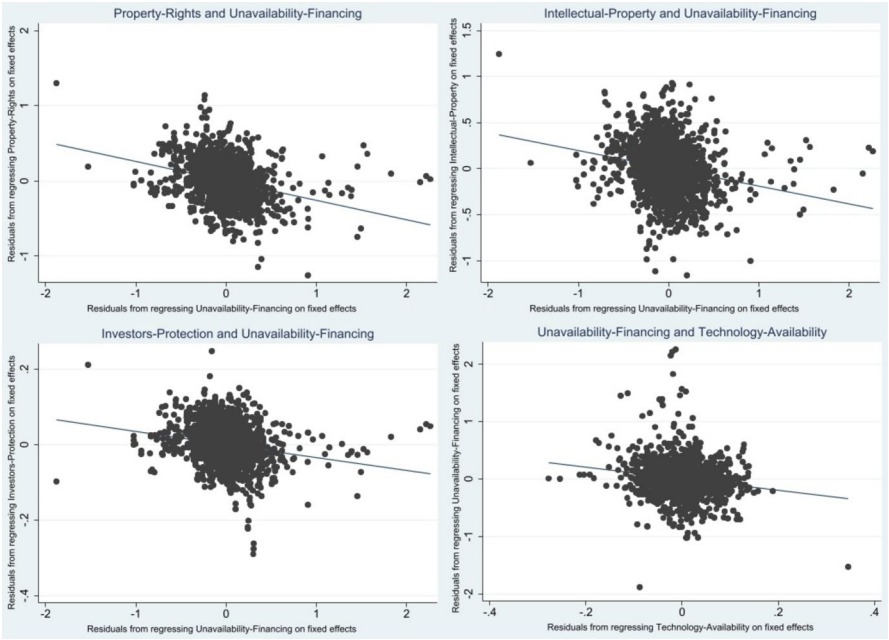

Fig. 2 Property rights, financial frictions and their determinants. *Note 1* Residuals and fitted values lines are obtained from the sample employed in Table 3

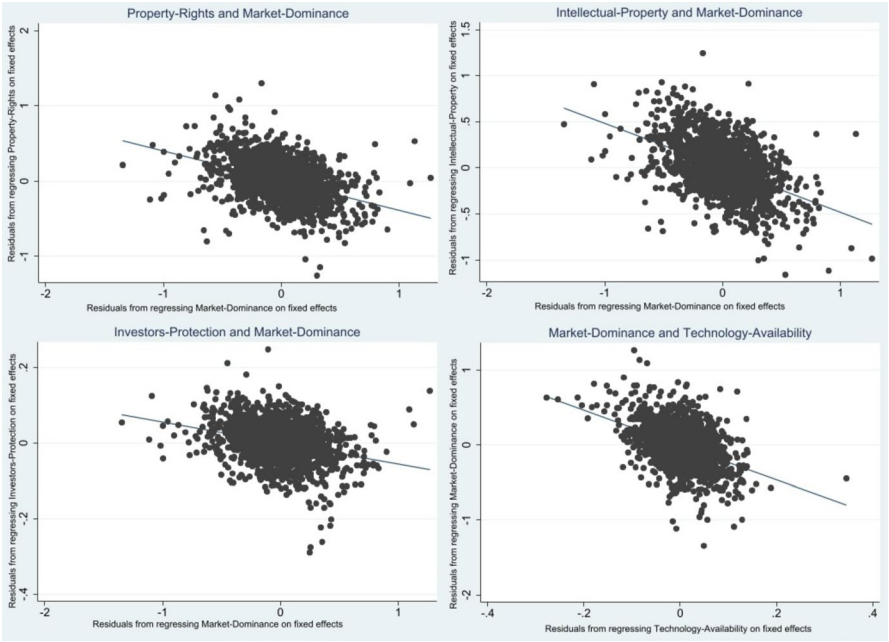

Fig. 3 Property rights, market power and its determinants. *Note 1* Residuals and fitted values lines are obtained from the sample employed in Table 3

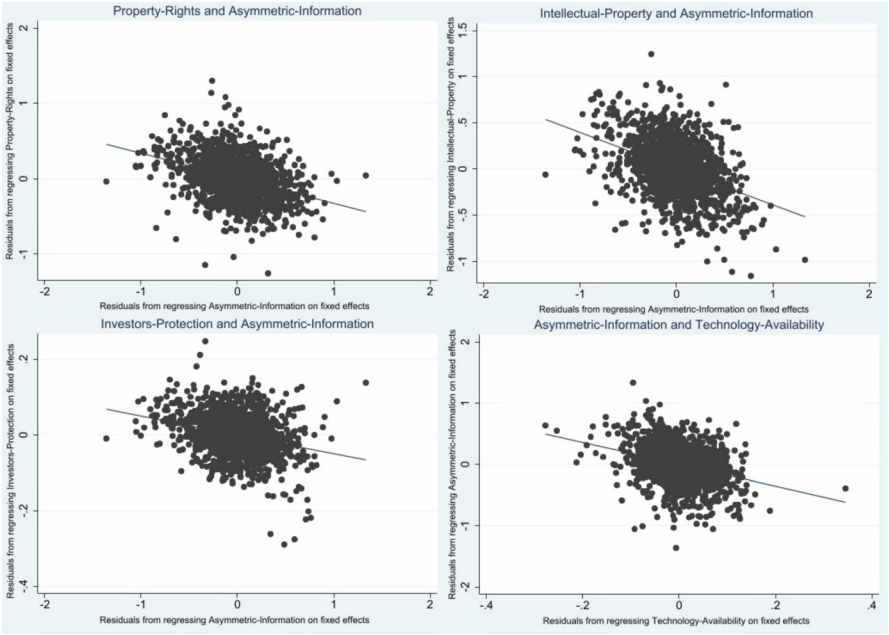

Fig. 4 Property rights, lemons-type distortions and their determinants. *Note 1* Residuals and fitted values lines are obtained from the sample employed in Table 3

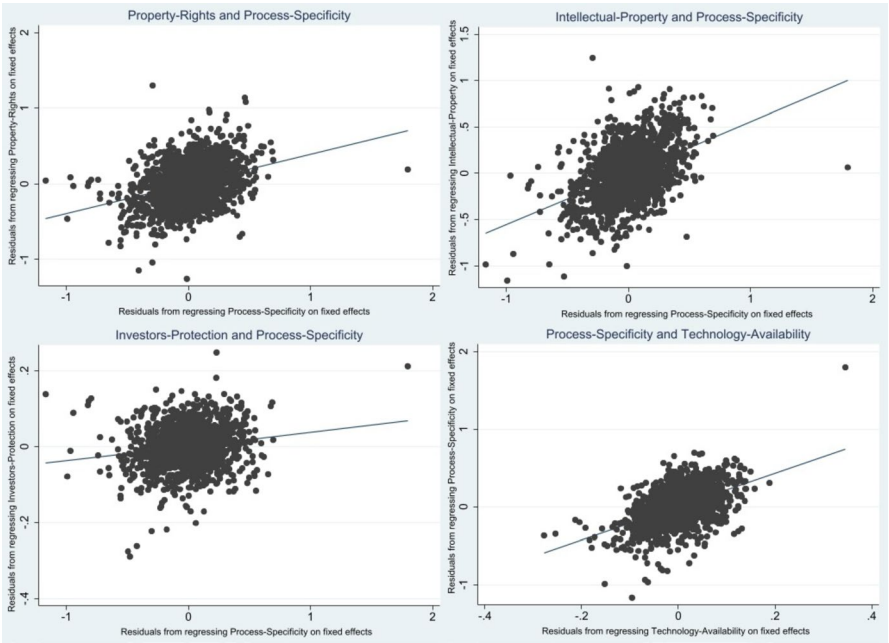

Fig. 5 Property rights, severity of contract incompleteness and its determinants. *Note 1*. Residuals and fitted values lines are obtained from the sample employed in Table 3

3.1 Property rights, transaction costs and exchange

3.1.1 Exogenous transaction costs

Payoffs I consider a society composed by a mass one of original owners and a mass one of potential buyers, all having linear utility over a good x. While the original owners value x at v, the potential buyers have a valuation λ uniformly distributed over $\left[\underline{\lambda}, \overline{\lambda}\right]$ with $l \equiv \overline{\lambda} - \underline{\lambda}$, $\overline{\lambda} > v > \underline{\lambda}$, and $\lambda_m \equiv \left(\overline{\lambda} + \underline{\lambda}\right)/2$. Original owners are randomly matched to potential buyers by an intermediation technology allowing the latter to either obtain the good via consensual transfer by paying the former v and bearing positive transaction costs $\alpha < \min\left\{v, \overline{\lambda} - v\right\}$ or expropriate it at no cost. α has no social value and measures market inefficiencies like financial frictions related to the borrowing of v, those necessary to legalize the transfer, those due to bribery, bargaining costs, over-regulation costs or the markup imposed by a foreign intermediary. An expropriated x is returned back with odds γ, which, thus, summarizes the legal protection of the original owners' property, i.e., the odds with which the original owner is protected by a property rule as opposed to $1 - \gamma$, which is the chance with which the potential buyer is shielded by a liability rule (Calabresi and Melamed 1972).

Timing The sequence of institutional and economic decisions is as follows:

t_0 : the strength of the original owners' property rights γ is chosen to maximize the social welfare, which is the sum of the original owners' and potential buyers' utilities.
t_1 : the traders learn who they are and, notably, their valuation.
t_2 : the traders are matched by the intermediation technology.
t_3 : any expropriated x is given back to its original owner with probability γ.

Discussion In evaluating the generality of the setup, several remarks should be borne in mind. First, I employ the uniform distribution to obtain closed form solutions, but in the appendix I show that the results hold under more general probability density functions of λ. Second, the predictions of the theoretical framework are the same when the traders are risk-averse (see footnote 16). Third, the model implications are unaffected when the original owners have heterogeneous valuations (Guerriero 2016a). Fourth, the random matching assumption can also be interpreted as a shock to already matched pairs making the potential buyer's valuation random. Fifth, the main model results hold when the traders can bargain over the price and if potential buyers must pay damages when the liability rule is enforced with probability $1 - \gamma$.[8] Similarly, the message of the analysis survives when expropriation entails either an effort or a punishment cost. While the analysis remains unchanged

[8] Provided that damages are optimally set at v, both scenarios entail that $\hat{\lambda}$ equals $v + \frac{\alpha}{\gamma}$, society's objective function is convex and property protection becomes complete for α sufficiently small (Guerriero 2016a).

when these expenses are limited, sizable expropriation costs eliminate the social loss from the takings of low-valuation potential buyers and induce full protection of property (Guerriero 2016a). Sixth, not only do the main model results prevail for the limited severity of transaction costs considered in this section, but also for larger negotiating costs (see footnote 13). Finally, an alternative instrument in the hands of society is to eliminate α. This policy reduces market distortions leading to complete property rights (see footnotes 14 and 15), but it is very costly if not impossible to implement because of either technological constraints or the political opposition of those transactors who gain from larger transaction costs. Starting from the former, important forms of negotiating costs originate from the superior information of a group of transactors and, therefore, are inherent in the prevailing technology (see Sects. 3.1.3 and 3.2). Turning to transaction costs created by powerful interest groups, some transactors might either design market institutions to command a markup (Guerriero 2020) or create negotiating costs to keep certain parties—including themselves—away from the bargaining in order to strike a better deal (Barry et al. 2014). Crucially, a less inclusive political process is not a necessary condition for these inefficiencies to arise.[9]

Interpretation One glaring example of the type of expropriation captured by the basic model setup is that of either an intermediary selling at a low price a good stolen from an original owner to a buyer in good faith or an agent selling out personal property that she embezzled.[10] As I assume, the good is possibly given back to its original owner and the strength of property rights reduces the probability that the buyer consumes. To elaborate, γ is larger the longer the buyer needs to wait before acquiring ownership by adverse possession, the stronger the original owner's remedies are, and the more effective their enforcement is (Dari-Mattiacci and Guerriero 2015, 2019). The basic setup applies, however, to a large array of legal instances. First, γ can capture the probability of eviction of either a nonpaying tenant or a squatter and the chances that a court judges a public taking groundless,[11] whereas $1-\gamma$ represents the odds with which an agent can legally breach a contract (Ganglmair 2017), a majority shareholder can lawfully "tunnel" resources out of the firm (Johnson et al. 2000), and a principal can legally segment a labor/housing market.[12]

[9] Accordingly, the inclusiveness of political institutions is never statistically significant when included in the regressions studying the determinants of transaction costs (see the Internet Appendix).

[10] An objection to this interpretation is that a low price could signal a defective title and impair good faith. Yet, out of the 126 jurisdictions analyzed by Dari-Mattiacci and Guerriero (2015), only four condition good faith on prices, while the other subject it to more stable characteristics, such as the competitiveness of the market environment (Dari-Mattiacci et al. 2016). Accordingly, Dari-Mattiacci et al. (2016) conclude that, under good faith buyer protection, the most likely equilibrium of a setup endogenizing prices and theft is separating, i.e., such that legitimate (stolen) goods are sold to good faith buyers at a high (low) prices.

[11] Then, x has a fixed value for the original owners and an uncertain one for the state. One interesting case is that of "partial taking" law, when the state pays severance damages $(1-\gamma)v$ to an original owner to compensate a partial expropriation by a potential buyer (Bouckaert and De Geest 1995).

[12] Financial costs explain 14% of the first-secondary housing markets price gap (Piazzesi et al. 2020).

Equilibrium A potential buyer buys if her valuation λ net of the purchasing costs $v+\alpha$ is greater than her expected payoff from expropriation $(1-\gamma)\lambda$, i.e., $\lambda \geq \hat{\lambda} \equiv \frac{v+\alpha}{\gamma}$. When selecting the optimal γ^*, society, then, maximizes the strictly concave function

$$\int_{\hat{\lambda}}^{\overline{\lambda}} \frac{\lambda-\alpha}{l} d\lambda + \int_{\underline{\lambda}}^{\hat{\lambda}} \frac{(1-\gamma)\lambda+\gamma v}{l} d\lambda \tag{1}$$

for $\hat{\lambda} < \overline{\lambda} \leftrightarrow \gamma^* \in \left(\frac{v+\alpha}{\overline{\lambda}}, 1\right]$ and the full expropriation social welfare $(1-\gamma)\lambda_m + \gamma v \equiv W^{FE}$ whenever $\hat{\lambda} \geq \overline{\lambda}$. Under this last scenario, all potential buyers prefer to expropriate.[13]

Switching from complete to incomplete property rights—i.e., from $\gamma^* = 1$ to $\gamma^* < 1$—has three effects: 1. for $v+\alpha \leq \lambda < \hat{\lambda}$ matches, it saves α at the cost of misallocating x with probability γ^*; 2. for $v \leq \lambda < v+\alpha$ matches, it avoids misallocation with probability $1-\gamma^*$ by expanding the consumption set of the potential buyers; 3. for $\lambda < v$ matches, it misallocates x with probability $1-\gamma^*$. While the last effect is negative, the sum of the first two is positive for α not too small.[14] To gain more insights, it is key to notice that, for $\hat{\lambda} < \overline{\lambda}$, an interior γ^* is uniquely defined by the necessary and sufficient first-order condition

$$-2\frac{d\hat{\lambda}}{d\gamma}\left(\gamma^*\hat{\lambda} - \gamma^* v - \alpha\right) - \left(\hat{\lambda}^2 - \underline{\lambda}^2\right) + 2v\left(\hat{\lambda} - \underline{\lambda}\right) = 0 \leftrightarrow (\gamma^*)^2 = \frac{v^2-\alpha^2}{\underline{\lambda}\left(2v-\underline{\lambda}\right)}. \tag{2}$$

Equation (2) implies that a rise in γ has a marginal effect, which is positive, and an infra-marginal effect $\int_{\underline{\lambda}}^{\hat{\lambda}} \frac{v-\lambda}{l} d\lambda = -\frac{(\hat{\lambda}-\underline{\lambda})(\hat{\lambda}+\underline{\lambda}-2v)}{2l}$, which can be negative only if $v < \lambda_m$. For $v \geq \lambda_m$ then, optimal property rights are complete since also W^{FE} rises with γ. For $v < \lambda_m$ instead, W^{FE} falls with γ and a $\gamma^* \leq 1$ is possible. It equals either the level defined by Eq. (2) or 0 depending on which of the two maximizes the social welfare. The latter is more likely the case the larger α is.[15] Moreover, an interior γ^* falls with α (see Fig. 6).

Intuitively, a rise in α has the marginal effect of raising $\hat{\lambda}$ and, thus, misallocating with probability γ^* goods otherwise always earmarked to high-valuation potential buyers and the infra-marginal effect of decreasing the social gain from consensual

[13] The objective function in Eq. (1) is strictly concave for $\alpha < v$. When this inequality fails and $v < \lambda_m$, γ^* equals 1 (0) when the social welfare is larger at 1 (0) than it is at 0 (1), i.e., if $(v+\alpha)^2 - 2\left(\alpha\overline{\lambda} + v\underline{\lambda}\right) + \underline{\lambda}^2 > (\leq) 0$. This last inequality is more difficult to satisfy the larger α is because of the hypothesis $v+\alpha < \overline{\lambda}$.

[14] Precisely, if $\alpha^2 > (1-\gamma)v^2$. Moreover, $\gamma^* < 1$ whenever $\alpha > v - \underline{\lambda}$, which can be given my assumptions.

[15] The exact condition is $\gamma^*\left(\overline{\lambda} - v\right) > \alpha$, which is true for the lowest interior $\gamma^* = (v+\alpha)/\overline{\lambda}$ if $\alpha < \overline{\lambda} - v$.

transfers, i.e., for which $\lambda \geq \hat{\lambda}$. Both effects call for a smaller γ^*. Proposition 1 rephrases this idea[16]:

Proposition 1 *Optimal property rights γ^* weakly fall with the transaction costs α.*

Not only is Proposition 1 consistent with some of the estimates discussed in Sect. 2 and the Internet Appendix, but it also sheds light on several cases of incomplete protection of both personal and real property and their relationship with exogenous transaction costs.

Anecdotal evidence Starting with personal property, the analysis of this section clarifies why most Indian states, just after having received from the 1948 Electricity Act the authority to set prices, have granted free power supply to agricultural consumers. Despite being more expensive than health spending and linked to both utilities' financial distress and groundwater overuse, this policy has been strenuously defended by local politicians on the grounds that collecting the electricity invoices, which are mainly constituted by wasteful metering costs, would destroy subsistence farming (Charnoz and Swain 2012). Turning to real property, inefficiently stringent regulatory requirements for both the provision of low-cost housing and eviction are the most recurring justifications to the tolerance towards the almost one billion squatters estimated around the world and the 40% share of the private lands of developing countries that is invaded (Brueckner and Selod 2009).[17]

3.1.2 Endogenous transaction costs: market power

Setup Following Guerriero (2016a), I consider the case in which the original owners control the intermediation technology and α is the markup on their valuation v. Original owners select the markup between t_1 and t_2 by maximizing the sum of the expected profits and the expected payoff from consuming x when handed back, i.e., $\frac{(v+\alpha)\left(\overline{\lambda}-\hat{\lambda}\right)}{l} + \gamma^* v \frac{\left(\hat{\lambda}-\underline{\lambda}\right)}{l}$ for $\frac{v+\alpha}{\gamma^*} = \hat{\lambda} < \overline{\lambda}$ and $\gamma^* v$ otherwise. Then, α^* can be positive only for $\hat{\lambda} < \overline{\lambda}$ when it equals $\alpha^* = \frac{\gamma^*\left(\overline{\lambda}+v\right)}{2} - v$ and rises with the strength of property rights. The latter increases the original owners' payoff regardless of whether transfers are consensual. A rise in γ^* reduces, instead, the potential buyers' payoff from expropriating and, through its positive impact on α^*, their utility from buying

[16] If risk-averse, the traders who gain an expected utility lower than that prevailing under the certain scenario of full property rights also incur a loss u. Since all original owners (potential buyers) weakly prefer complete (incomplete) property rights, a rise in risk aversion is isomorphic to a fall in v and, thus, induces a weakly lower γ^*. Indeed, an increase in v has the infra-marginal effect of boosting the original owners' payoff when property rights are protected and the marginal effect of raising $\hat{\lambda}$. Both patterns imply a higher γ^*.

[17] Benati et al. (2022) build on data on a panel of 44 major Mesopotamian polities spanning each half-century between 3050 and 1750 BCE to document that the elites optimally strengthened the nonelites' use rights to land—and contemporaneously weakened their own—to curb the ex post misallocation due to the mix of their lack of commitment and adverse production conditions (see also Benati and Guerriero (2021)).

x. Because of the linearity of preferences, the two effects cancel out and $\frac{d\hat{\lambda}}{d\gamma^*} = 0$ (see the Appendix). Then, $\gamma^* < 1$ if the distortion in the potential buyers' demand becomes more socially relevant than the value of the markup as transfer. Formally, $\hat{\lambda} = \frac{\overline{\lambda}+v}{2} < \overline{\lambda}$ and society maximizes the following linear objective function

$$\int_{\hat{\lambda}}^{\overline{\lambda}} \frac{\lambda}{l} d\lambda + \int_{\underline{\lambda}}^{\hat{\lambda}} \frac{(1-\gamma)\lambda + \gamma v}{l} d\lambda, \tag{3}$$

whose derivative with respect to γ is always positive for $v \geq \lambda_m$ and, for $v < \lambda_m$, it is negative when $\alpha^* > \left(2v - \underline{\lambda}\right)\gamma^* - v \leftrightarrow \frac{\overline{\lambda}-v}{2} > v - \underline{\lambda}$. Then, γ^* must equal 1 if $v \geq \lambda_m$. For $v < \lambda_m$ instead, γ^* jumps from 0 to 1 as α^* becomes sufficiently small. Then, the markup is positive and equals the distortion in the potential buyers' demand $\frac{\overline{\lambda}-v}{2} = \hat{\lambda} - v$. To elaborate, a rise in the dispersion in the traders' valuation $\overline{\lambda} - v$ increases the measure of matches on which a markup is commanded by the original owners relative to the measure of matches in which the good is expropriated by the potential buyers and, thus, enlarges the markup itself. When the dispersion in the traders' valuation becomes sufficiently large and, thus, the distortion in demand is sufficiently severe—i.e., $\frac{\overline{\lambda}-v}{2} > v - \underline{\lambda}$, full expropriation becomes socially preferable to any protection of property. Ultimately, α constitutes a socially valuable transfer but entails an equal distortion in the potential buyers' demand, which captures here the severity of endogenous transaction costs. Proposition 2 takes stock of the above analysis:

Proposition 2 *Optimal property rights γ^* weakly decrease with the markup α^*, which, in turn, is larger the greater the dispersion in the traders' valuation $\overline{\lambda} - v$ is.*

Not only does Proposition 2 rationalize some of the empirical results discussed in Sect. 2 and the Internet Appendix, but it also helps make sense of growing evidence on the weakness of property rights on both movable and immovable property in the presence of market power.

Anecdotal evidence Starting from the former, Croutzet and Lasserre (2017) document that common access to the fishing harvest and individual transferable quotas are more often observed in Nova Scotia and New Zealand where the fishermen have more market power. Turning to immovable property, over and above regulatory costs, the other main explanation for the tolerance towards widespread condoning of land invasion and house squatting is the lack of competitiveness of the land and housing markets (World Bank 1993).

3.1.3 Endogenous transaction costs: lemons-type distortions

Setup As noticed by Hasen and McAdams (1997), "theft may avoid the "lemons" problem." To evaluate this remark, I follow Guerriero (2016a) and I maintain that the original owners have private information on v, which is correlated with the potential buyers' valuations and drawn from an uniform distribution with support

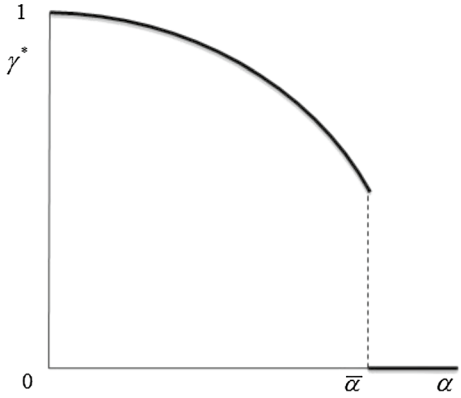

Fig. 6 Property rights and transaction costs

$\left[0, \overline{\lambda}\right]$. To illustrate, $\Delta/2 > 0$ potential buyers value x at θv, $1 - \Delta$ of them have valuation αv, and the remainder gain from consuming x a payoff v/θ with $\Delta > 0$ and $\theta > 2 > \alpha > 1$. These assumptions have two key consequences. First and as in the basic setup, the distribution of the potential buyers' preferences is more heterogeneous than that of the original owners' valuations. Second, a rise in α increases the difference between the payoff of the middle-valuation potential buyers and the valuation of the original owners enlarging the loss of social welfare due to lemons-type distortions. Accordingly, α measures the extent to which the degree of asymmetry in information between transactors endogenously entails a cost of negotiating under regime L.

Formally, since the original owners sell only if $v \leq p_L$, the expected value of x is $p_L/2$ at the price p_L.[18] Then, the middle- and low-valuation potential buyers expropriate if property rights are incompletely protected and do not consume otherwise. For $\gamma^* = 1$ indeed, their expected payoffs from consensual trade are $\frac{\alpha p_L}{2} - p_L < 0$ and $\frac{p_L}{2\theta} - p_L < 0$, respectively. Turning to high-valuation potential buyers, their expected payoff from purchasing the good—i.e., $\theta\frac{p_L}{2} - p_L$—is weakly greater than their expected utility from expropriating it—i.e., $(1-\gamma)\theta\frac{p_L}{2}$—for γ^* higher than $\frac{2}{\theta} < 1$. Ultimately, society maximizes the linear function

$$\theta\lambda_m\frac{\Delta}{2} + (1-\Delta)\left[(1-\gamma)\alpha\lambda_m + \gamma\lambda_m\right] + \left[(1-\gamma)\frac{\lambda_m}{\theta} + \gamma\lambda_m\right]\frac{\Delta}{2} \tag{4}$$

for $\gamma^* \geq \frac{2}{\theta}$ and $(1-\gamma)\left[(1-\Delta)\alpha + \frac{\theta^2+1}{\theta}\frac{\Delta}{2}\right]\lambda_m + \gamma\lambda_m$ otherwise. Hence, the derivative of society's problem with respect to γ is negative for $\gamma^* < \frac{2}{\theta}$ and, for $\gamma^* \geq \frac{2}{\theta}$, it is positive when both $1 - \Delta$ and α are sufficiently small (see the Appendix). Intuitively, as the heterogeneity in the potential buyers' valuations rises, the measure of matches

[18] Whenever endogenous, p_L equals, under full property rights, the value $\theta\lambda_m = \frac{\theta\overline{\lambda}}{2} > \overline{\lambda}$ making the only potential buyers interested in consensual trade—i.e., the high-valuation ones—indifferent between purchasing or not consuming and the original owners better off when selling instead of consuming x.

involving middle-valuation potential buyers and for which, then, x is misallocated under complete property rights becomes less important. Then, γ^* may jump from 0 to 1 when lemons-type distortions α are sufficiently small. Proposition 3 recaps the key conclusions of the analysis of this section:

Proposition 3 *The strength of the original owners' property rights γ^* falls with the extent of lemons-type distortions α, which rises with the dispersion in the traders' valuation.*

Not only does Proposition 3 clear up some of the estimates illustrated in Sect. 2 and the Internet Appendix, but it also helps explain recent stylized facts about incomplete property rights on both personal and real property and the severity of lemons-type distortions.

Anecdotal evidence Starting with personal property, Lee (2018) builds on 2008 data on BitTorrent private-network file sharing activity and album sales to conclude that the former has no impact on top-tier artists' sales for which the asymmetry in information on perceived talent is less hazardous and a positive effect on mid-tier artists' sales for which lemons-type distortions are the fiercest. Turning to real property, Chau and Choy (2011) document that, in the Hong Kong's housing market, a 32.3% larger overpricing premium—and, thus, more exchanges because of less severe lemons-type distortions—are observed together with a switch from the caveat venditor to the caveat emptor rule, i.e., a rise in γ^*.

3.2 Property rights, transaction costs and innovation

Technology Consider a mass one of projects, each involving a risk-neutral upstream firm and a risk-neutral downstream party and whose random value is a function of the technology embraced by the downstream firm. Two are the possible alternatives. The old technology does not necessitate any input from the upstream firm and delivers an output x of value $\delta\lambda$ to the downstream party and zero to the upstream firm. These payoffs also constitute the downstream firm's and upstream party's outside options and default payoffs. I maintain that $\delta < 1$, λ is uniformly distributed over $\left[\underline{\lambda}, \overline{\lambda}\right]$, $l \equiv \overline{\lambda} - \underline{\lambda}$, $\overline{\lambda} > v > \underline{\lambda}$ and $\lambda_m \equiv \left(\overline{\lambda} + \underline{\lambda}\right)/2$. The new technology, instead, delivers an output x of value λ and requires both firms' inputs. While the downstream firm's input—e.g., intangible asset/process—costs v, the upstream party's input—e.g., facility/physical asset—costs either 0 with probability $0 < \alpha < 1$ or $(1 - \delta)\lambda$ otherwise. This last cost is realized after the upstream party commits his investment and before ex post contracting. To elaborate, input costs and payoffs are nonverifiable and ex ante non-contractible, while the investment costs are ex post contractible.

Payoffs Without investment, each firm obtains its outside option. If the firms invest, they bargain over trade. To illustrate, they decide whether to use their inputs

for joint production and divide the gains from trade or to accept the default payoffs, i.e., their utilities from the next-best alternative to trading that, given the existence of only two technologies, I equate to the outside options. While the upstream party's ex post bargaining payoff is his outside option plus a share γ of the gains from trade—i.e., the output value λ net of the sum of the default payoffs, the downstream firm pockets the rest. Hence, the downstream and upstream parties' ex post bargaining payoffs equal $\delta\lambda + (1-\gamma)(\lambda - \delta\lambda) - v = \gamma\delta\lambda + (1-\gamma)\lambda - v$ and $\gamma(\lambda - \delta\lambda) - (1-\alpha)(1-\delta)\lambda = \gamma\alpha(1-\delta)\lambda - (1-\gamma)(1-\alpha)(1-\delta)\lambda$.

Timing The sequence of institutional and economic decisions is as follows:

t_0 : society selects the protection of the upstream firms' property rights by maximizing social welfare, which is the sum of the downstream and upstream parties' payoffs.

t_1 : within each project, the downstream party selects either the old technology assuring to everybody its outside option or the new technology.

t_2 : under the new technology, firms decide simultaneously and noncooperatively whether to invest or accept the default payoffs. Next, the upstream party's input cost is realized.

t_3 : within each project and under the new technology, the two parties bargain over trade.

Discussion In evaluating the generality of the setup, three remarks should be borne in mind. First, the conclusions of the analysis survive under a more general probability density functions of λ (see the Internet Appendix). Second, the mix of contractual incompleteness and the upstream firm's uncertainty over his cost links the setup to the formalizable theories of the firm (Gibbons 2005), and it captures all those situations "in which it is extremely difficult to think about and describe in advance how the production allocation should depend on the "state of the world" but in which it is relatively easy to specify production decisions ex post once the state of the world is realized" (Grossman and Hart 1986, p. 698). Crucially, these assumptions produce a closed-form expression for the appropriable quasi-rent. Third, γ captures the strength of the upstream party's property rights on his input relative to that of the downstream firms' property rights on both her input and the output x. A microfoundation to this view is that firms contract over their ex post bargaining power in the "shadow of the law." To elaborate, the division of the gains from trade will still be determined by γ should I 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 always prefers ex post γ over ζ and, thus, ζ is picked in the shadow of the law to equal γ. Building on the same intuition, γ can also be seen as the share of courts favoring the upstream firms and determined

by the strength of property rights.[19] This last 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). Finally, to focus on the design of property rights, I don't consider the role of residual rights. Guerriero and Pignataro (2021) study also the choice of the ownership structure, proving that it is completely determined by the legal protection of each party's input.

Interpretation γ is larger the stronger the remedies in the upstream party's hands—e.g., "unfair contract terms," "abuse of right" and "compulsory licensing" doctrines applied to the downstream firm's intangible asset—are,[20] the longer their prescription period is and the more efficient their enforcement is. Symmetrically, it is smaller the more intense the legal protection granted to the downstream party—e.g., "non-disclosure," "work for hire" and "non-competition" agreements as well as "fiduciary duties" and "shop right" provisions—is.[21] More generally, the setup applies to any endeavor requiring inter-party cooperation and such that the upstream party's renegotiation power is fixed by the socially devised γ.

Pareto-superior Equilibrium With odds γ, the mix of contract incompleteness and the cost uncertainty assures to the upstream parties an appropriable quasi-rent $\alpha(1-\delta)\lambda$, which rises with the likelihood of a low cost realization and is bound to distort innovation when its expected value is strictly larger than the upstream firm's expected cost $(1-\gamma)(1-\alpha)(1-\delta)\lambda$. Then, the extent of innovation is lower than the under the ex ante efficient equilibrium prescribing it for $\lambda \geq \tilde{\lambda} \equiv \frac{v}{\alpha(1-\delta)}$ and downstream and upstream firms' expected payoffs of $\alpha\lambda + (1-\alpha)\delta\lambda - v$ and 0, respectively. Hence, α picks the extent to which a rise in the appropriable quasi-rent endogenously entails larger incomplete contracting costs.

Both parties always prefer to divide the gains from trade to the default payoffs. When her partner invests, the downstream firm prefers to trade to the old technology for $\lambda \geq \hat{\lambda} \equiv \frac{v}{(1-\delta)(1-\gamma)}$, and the upstream party prefers to invest to the outside option only if property rights are sufficiently strong, i.e., $\frac{\gamma^*}{(1-\gamma^*)} \geq \frac{1-\alpha}{\alpha} \leftrightarrow \gamma^* \geq 1-\alpha$. Assuming, as standard in contract theory (Müller and Schmitz 2016), that firms

[19] Cohen et al. (2019) embrace this view showing that an excessive protection of the upstream parties' invention pushes them to bring nuisance lawsuits, which, in turn, crowd out downstream partners' innovation.

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

[21] Non-disclosure(competition) agreements identify processes whose access should be restricted to third parties (that should not be replicated by employees in competitive enterprises), whereas a work made for hire leaves authorship of a particular innovation in the hands of the employers (Burk and McDonnel 2007). Moreover, fiduciary duties should ensure that agents act in their principals' interests. Finally, a shop right license allows principals to use a patented invention that agents devised (Burk and McDonnel 2007).

coordinate on the Pareto-superior equilibrium,[22] society maximizes, for $\gamma^* \geq 1-\alpha$ and $\hat{\lambda} < \overline{\lambda}$, the strictly concave function

$$\alpha \int_{\hat{\lambda}}^{\overline{\lambda}} \frac{\lambda - v}{l} d\lambda + (1-\alpha) \int_{\hat{\lambda}}^{\overline{\lambda}} \frac{\delta\lambda - v}{l} d\lambda + \int_{\underline{\lambda}}^{\hat{\lambda}} \frac{\delta\lambda}{l} d\lambda, \tag{5}$$

which falls with γ for $-\frac{d\hat{\lambda}}{d\gamma}\left[\alpha\hat{\lambda} + (1-\alpha)\delta\hat{\lambda} - v - \delta\hat{\lambda}\right] = -\frac{v^2(\alpha-1+\gamma)}{(1-\delta)(1-\gamma)^3} \leq 0$, i.e., if $\gamma \geq 1-\alpha$. A rise in $\gamma \geq 1-\alpha$ has the welfare-decreasing marginal effect of discouraging high-productivity downstream firms from innovating. Yet, a γ^* weakly larger than $1-\alpha$ is necessary to push the upstream parties to invest. Hence, $\gamma^* = 1-\alpha$ and the Pareto-superior equilibrium is socially efficient. To gain a deeper intuition of this result, it is useful to observe that the severity of the specificity of the downstream firm's input, which is the gap between the net value of the downstream party's investment within the relationship—$\alpha(1-\delta)\lambda + \delta\lambda - v$—and its net value as a disagreement payoff—i.e., $\delta\lambda - v$,[23] equals the appropriable quasi-rent. Then, the larger the odds α of a positive appropriable quasi-rent are and, thus, the more severe the specificity of the downstream firm's input is, the lower γ^* needs to be to convince the upstream party to provide his input and the downstream firm to adopt the new technology. For α sufficiently large, the welfare under incomplete property rights and innovation is larger than that under $\gamma^* = 1$ and the old technology, which is also the Pareto-superior equilibrium for $\hat{\lambda} \geq \overline{\lambda} \leftrightarrow v \geq \alpha(1-\delta)\overline{\lambda}$. Proposition 4 summarizes the conclusions of this section:

Proposition 4 *The strength of the upstream firms' property rights γ^* falls with the severity of contract incompleteness α, which is the likelihood of a low innovation cost.*

Not only is Proposition 4 coherent with part of the empirical evidence discussed in Sect. 2 and the Internet Appendix, but it also clarifies why commercial law weakens the ex post position of upstream firms when downstream parties provide very specific inputs.

Anecdotal evidence First, employers and downstream firms enjoy stronger and easier to obtain unregistered intellectual property rights, such as trade secrets,[24] and these rights are strengthened by non-disclosure, work for hire and non-competition agreements, when providing specific inputs in sectors such as the software and entertainment industries (Burk and McDonnel 2007, p. 605). Intuitively, "trade secrets are [...] likely to be among the most firm-specific of intellectual inputs—specialized processes, customer lists, business plans, and other information integral to the firm" (Burk and McDonnel 2007, p. 608). Second, Article 31 of the TRIPS allows upstream parties to obtain the compulsory licensing of the downstream

[22] If they do not, also an equilibrium in which none of the firms invests would always exist and the analysis would be slightly more cumbersome but substantially similar (Guerriero and Pignataro 2021).

[23] Such a gap turns out to be zero for the upstream firms.

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

parties' registered intellectual property rights—i.e., patents—when the commercial terms for voluntary license are "unreasonable" given the limited specificity of intangible assets/processes (Bond and Saggi 2018; Rose 2019). Third, employers and downstream firms can rely on fiduciary duties and shop right provisions to curb the exploitation of information intimately related to their inputs (Baudry and Chassagnon 2018). These provisions prescribe that "information whose usefulness is specific to the firm belongs to the firm, while employees can use for themselves more general information" (Burk and McDonnel 2007, p. 597). Finally, three recent U.S. Supreme Court's decisions made more difficult for nonpracticing entities to behave as opportunistic "patent trolls",[25] Designed to amass patents not for the sake of production, these upstream parties have increasingly sued cash-rich downstream firms that hold specific patents in business segments such as software, semiconductors and electronics and, thus, have led to a real decrease in innovation (Cohen et al. 2019).

4 Robustness to alternative assumptions

In this section, I document the robustness of the main model implications to two key alternative assumptions, i.e., the possibility that some transactors are excluded from institutional design and the possibility for the original owners to decide whether to produce the good or to invest on its quality before trading (see the Appendix for the relative proofs).

4.1 The political economy of property rights protection

Thus far, I have examined the design of property rights under a veil of ignorance. Reality is, however, much less ideal than that. To evaluate the positive side of property rights protection, I consider a situation in which the transactors selecting γ know their future role in the economy and can exclude the rest of the population from the social welfare maximization (Aghion et al. 2004). It seems natural to think about these "insiders" as either all the original owners and the potential buyers with intermediate valuations or all upstream firms and the downstream parties with intermediate productivity. This view is consonant with the idea that the groups actively participating in institutional design are those most affected by it (Felli and Merlo 2006; Guerriero 2016b).

When transaction costs are exogenous and the excluded potential buyers have valuations lower than $\underline{\lambda}+\epsilon$ with ϵ not too large, γ^* maximizes $\int_{\hat{\lambda}}^{\overline{\lambda}} \frac{\lambda-\alpha}{l} d\lambda + \int_{\underline{\lambda}+\epsilon}^{\hat{\lambda}} \frac{(1-\gamma)\lambda+\gamma v}{l} d\lambda + \frac{\gamma v \epsilon}{l}$ for $\hat{\lambda} < \overline{\lambda}$ and $W^{FE} - (1-\gamma)\frac{\epsilon^2+2\epsilon\underline{\lambda}}{2l}$ otherwise, with $\frac{\epsilon}{l}$ being the share of potential buyers left out of the welfare maximization. Comparing this objective function with that in Eq. (1) suggests that γ^* still falls with α for

[25] First, it imposed a standard reasonableness test to determine which patent infringement injunction is warranted in *eBay Inc. v. MercExchange, LLC* 547 U.S. 388 (2006). Second, it eased the award of frivolous patent lawsuits costs in *Octane Fitness, LLC v. ICON Health & Fitness, Inc.*, 572 U.S. 545 (2014). Finally, it forbade forum shopping in *TC Heartland LLC v. Kraft Foods Group Brands LLC*, 581 U.S. (2017).

ϵ not too large, but it is set inefficiently high,[26] e.g., Zamindari system of taxation allowing Indian landowners to evict evading tenants who were often more productive (Besley and Ghatak 2010). If, instead, the excluded potential buyers have valuations higher than $\overline{\lambda} - \epsilon$, γ^* decreases with α for ϵ small, equals the γ^* found in the basic setup if interior and is inefficiently high otherwise. When, instead, transaction costs are driven by market power, α^* continues to be determined as in Sect. 3.1.2 and, thus, a rise in γ still has only an infra-marginal effect on society's objective function. As a result, Eq. (3) implies that the analysis is unchanged when high-valuation potential buyers are excluded from the institutional design and that γ^* is set too high and falls with α^* for ϵ small when, instead, low-valuation potential buyers are kept out. Similarly, in the scenario of lemons-type distortions, a gaze at Eq. (4) suggests that equilibrium property rights are again inefficiently strong and decrease with α, provided that ϵ is not too large. Finally, a glance at Eq. (5) clarifies that excluding a sufficiently small group of either high- or low-productivity downstream firms from the institutional design does not affect at all the Pareto-superior equilibrium in the case of contract incompleteness.

The following proposition lumps together the new results of this section:

Proposition 5 *In a political economy, property tends to be too protected.*

4.2 The disincentive to effort effect of weak property rights

Production In the following, I prove that the main model mechanisms survive when the original owners decide between t_1 and t_2 whether to produce x at the cost $\kappa < v$. For $\gamma^* = 0$ and $\hat{\lambda} \geq \overline{\lambda}$, there is no production. Yet, there can be for $\gamma^* > 0$ and $\hat{\lambda} < \overline{\lambda}$. To elaborate, the original owners' expected utility increases with γ^* and, thus, for κ not too large, there is a $\tilde{\gamma}$ such that x is produced only if $\gamma^* \geq \tilde{\gamma}$. Then, society always selects the maximum $\hat{\gamma}$ between $\tilde{\gamma}$ and γ^* since production creates value also for the potential buyers. In the most interesting case of endogenous transaction costs, $\tilde{\gamma}$ weakly decreases with α for $\overline{\lambda}$ sufficiently large and v not too small compared to the transaction costs α.

Investment The standard "security" argument for strong property rights claims that expropriation induces a disincentive to invest (Besley and Ghatak 2010). To understand how this pattern affects the basic results, I analyze a regime I in which the original owners possibly implement between t_1 and t_2 an investment raising, at the cost $\zeta < v$,[27] their valuation v and those of the potential buyers λ to, respectively,

[26] In a political economy, γ^* is always too high since some potential buyers, which always prefer $\gamma^* = 0$, are excluded from the social welfare maximization and the original owners, who, instead, favor $\gamma^* = 1$, are not.

[27] When investment is continuous, the algebra becomes so tangled to be uninformative about the model robustness except in the $\overline{\lambda}$ large and v small case. Then, the basic analysis stands being $\frac{d\rho}{d\gamma^*}$ small. The core results will also survive, should potential buyers decide whether to invest. Then, γ_I^* is optimally weakened as in the case of "tracing" by an original owner asking a court either proprietary remedies, an asset substituted for the original property acquired by a good faith buyer or its proceeds (Smith 1997).

$v(1+\rho)$ and $\lambda(1+\rho)$ with $\rho > 0$. Accordingly, this setup is similar to the instance of a production economy.

When transaction costs are exogenous, original owners invest only if $\gamma_I^* > 0$ and their expected utility $v(1+\rho)\frac{\overline{\lambda}-\hat{\lambda}_I}{l} + \gamma_I^* v(1+\rho)\frac{\hat{\lambda}_I-\underline{\lambda}}{l} - \zeta$ is weakly positive. Both γ_I^* and $\hat{\lambda}_I$ are as in Sect. 3.1.1 with $\alpha/(1+\rho)$ in place of α and, thus, $\gamma_I^* > \gamma^*$, $\frac{d\gamma_I^*}{d\alpha} \leq 0$, and $\hat{\lambda}_I < \hat{\lambda}$. Hence, investment inducement weakly strengthens property rights protection. Since the original owners' expected payoff rises with γ_I^*, there is a $\tilde{\gamma}_I$ such that investment goes through only if optimal property rights are larger than $\tilde{\gamma}_I$. For $\gamma_I^* > \tilde{\gamma}_I$, society picks γ_I^*, instead of γ^*, if the social welfare is larger at γ_I^* with investment than it is at γ^* without. For $\gamma_I^* \leq \tilde{\gamma}_I$, $\tilde{\gamma}_I$ is preferred to γ^* if the social welfare is larger at $\tilde{\gamma}_I$ with investment than it is at γ^* without. To elaborate, investment always goes through for α sufficiently small compared to v, ρ not too small and ζ not too large. For $v \geq \lambda_m$, $\gamma_I^* = 1$ and investment materializes.

When transaction costs are determined by market power, also the markup is multiplied by $1+\rho$ and, thus, $\gamma_I^* = \gamma^*$ and $\hat{\lambda}_I = \hat{\lambda}$. Since the original owners' expected payoff rises with γ_I^*, investment realizes only if γ_I^* is larger than $\tilde{\gamma}_I$. As in the production case, $\tilde{\gamma}_I$ falls with α when the markup is sufficiently small compared to v. Under the same condition and for ρ not too small and ζ not too large, society picks the maximum $\hat{\gamma}_I$ between γ_I^* and $\tilde{\gamma}_I$ since investment is socially beneficial. For $v \geq \lambda_m$, $\gamma_I^* = 1$ and investment is successful.

Finally, in the case of lemons-type distortions, a glance at Eq. (4) suggests that society's objective function is now multiplied by $1+\rho$ and the analysis of the basic setup is unchanged, provided that $\alpha < \frac{2}{1+\rho}$. High-valuation potential buyers buy for $\gamma^* \geq \frac{2}{\theta(1+\rho)}$ and expropriate otherwise. Once again, the original owners' expected utility rises with γ_I^* and, therefore, investment prevails only if optimal property rights are larger than a threshold $\tilde{\gamma}_I$. Society selects $\hat{\gamma}_I$ if investment is welfare-enhancing, i.e., ρ not too small and ζ not too large.

The following proposition gathers the novel patterns uncovered by this section:

Proposition 6 *The extent of protection of the original owners' property is strengthened to favor either production or investment, and the level of property safeguard over which either production or investment arises tends to fall with the severity of endogenous transaction costs.*

5 Conclusions

I have developed and tested a theory of the endogenous market design. Because of the trade-off between inefficient exclusion from trade/innovation and expropriation, property rights are weakened in the face of sizable market frictions and failures, which, in turn, are more severe if either the dispersion in the traders' valuation or the odds of a lower innovation cost are larger. Not only do all these implications survive when some transactors have more political influence on institutional design

or the disincentive effect of weak property rights is considered, but they are also consonant with the interplay among proxies for the availability of technological progress, severity of transaction costs and strength of property rights for 139 countries observed between 2006 and 2018. I close by highlighting two key avenues for future research. First, the tendency of property rights towards optimality does not imply that the existing legal variation is irrelevant and, thus, it does not warrant reforms. On the contrary, the model reveals that special interests can distort the design of property rights away from optimality when the political process is not fully inclusive. Second, weak property rights are society's response to the existence of sizable transaction costs and, thus, their negative correlations with economic outcomes might be partly spurious (Coase 1960). Hence, further research on property rights, transaction costs, and economic outcomes is needed.

Appendix

Property rights and market power

The first-order condition of society's problem is $-\frac{\hat{\lambda}-\underline{\lambda}}{2l}\left(\hat{\lambda}+\underline{\lambda}-2v\right)=0$, whose left-hand side is the infra-marginal effect of a rise in γ. This can be negative only for $v<\lambda_m$. □

Property rights and lemons-type distortions

For $\gamma^*\leq\frac{2}{\theta}$, the derivative of society's objective function with respect to the strength of property rights is $-\left[(1-\Delta)(\alpha-1)+\frac{(\theta-1)^2}{\theta}\frac{\Delta}{2}\right]\lambda_m$, which is negative. For $\gamma^*>\frac{2}{\theta}$, it equals $-\left[(1-\Delta)(\alpha-1)-\frac{\theta-1}{\theta}\frac{\Delta}{2}\right]\lambda_m$, which falls with α, rises with Δ, is negative for $\Delta\to 0$, and positive for $\Delta\to 1$. γ^* possibly jumps from 0 to 1 for α small and Δ large. □

Generic probability density function of the potential buyers' valuations

In the case of exogenous transaction costs, consider a $\lambda\in\left[\underline{\lambda},\overline{\lambda}\right]$ distributed according to the log-concave probability density function f with cumulative distribution function F. Then, γ^* maximizes $\int_{\hat{\lambda}}^{\overline{\lambda}}(\lambda-\alpha)dF(\lambda)+\int_{\underline{\lambda}}^{\hat{\lambda}}[(1-\gamma)\lambda+\gamma v]dF(\lambda)$ for $\hat{\lambda}<\overline{\lambda}$ and W^{FE} otherwise. For $\hat{\lambda}<\overline{\lambda}$, $\gamma^*>0$ is defined by $\frac{1-\gamma^*}{\gamma^*}v\hat{\lambda}f\left(\hat{\lambda}\right)-\left(\hat{\lambda}-v\right)F\left(\hat{\lambda}\right)+\int_{\underline{\lambda}}^{\hat{\lambda}}F(\lambda)d\lambda=0$ and society's objective function is submodular in γ and α when $\frac{f'(\hat{\lambda})}{f(\hat{\lambda})}<\frac{\alpha}{v(v+\alpha)}\frac{\gamma^*}{1-\gamma^*}$. While the right-hand side of this inequality is greater than $\frac{\alpha}{v\left(\overline{\lambda}-v-\alpha\right)}$, its left-hand side is lower than $\frac{f'}{f}(v+\alpha)$ since log-

concavity of f implies a decreasing $\frac{f'}{f}$ (Dharmadhikari and Joag-Dev 1988). Hence, the inequality must be true and $\frac{d\gamma^*}{d\alpha} \leq 0$ if $\frac{f'}{f}(v+\alpha) < \frac{\alpha}{v\left(\overline{\lambda}-v-\alpha\right)}$, i.e., if v is sufficiently large (see Sect. 3.1.1 for the corresponding restriction in the basic setup). To understand this last remark, notice that the right-hand side of the sufficient condition increases with v for $2v > \overline{\lambda} - \alpha$, whereas its left-hand side is negative for $v + \alpha$ larger than the mode of λ, being every log-concave density function defined on a real support also unimodal (Dharmadhikari and Joag-Dev 1988; Piazzesi et al. 2020). For $\hat{\lambda} < \overline{\lambda}$, the infra-marginal effect of a rise in γ is $\left[v - E\left(\lambda | \lambda \leq \hat{\lambda}\right)\right] F\left(\hat{\lambda}\right)$, which can be negative only if $v < E\left(\lambda | \lambda \leq \hat{\lambda}\right) \leq \lambda_m = E(\lambda)$. For $\hat{\lambda} < \overline{\lambda}$ and $v \geq \lambda_m$, therefore, $\gamma^* = 1$. For $\hat{\lambda} < \overline{\lambda}$ and $v < \lambda_m$ instead, γ^* can jump from 0 to the interior solution whenever $\int_{\hat{\lambda}}^{\overline{\lambda}} (\lambda - \alpha) dF(\lambda) + \int_{\underline{\lambda}}^{\hat{\lambda}} [(1-\gamma^*)\lambda + \gamma^* v] dF(\lambda) > \lambda_m$. This last condition is more difficult to satisfy the larger the transaction costs are since the derivative of its left-hand side with respect to α equals $-\frac{1-\gamma^*}{\gamma^*} v f\left(\hat{\lambda}\right) - F\left(\overline{\lambda}\right) + F\left(\hat{\lambda}\right) < 0$.

The results produced by the other setups survive to considering any f. When, indeed, original owners have market power, two observations are key. First, the markup α^* maximizes now the original owners' expected payoff $\int_{\hat{\lambda}}^{\overline{\lambda}} (v+\alpha) dF(\lambda) + \int_{\underline{\lambda}}^{\hat{\lambda}} \gamma^* v dF(\lambda)$, whose derivative with respect to α is $1 - F\left(\hat{\lambda}\right) - \left(\hat{\lambda} - v\right) f\left(\hat{\lambda}\right)$. Hence, $\frac{d\alpha^*}{d\gamma} = \hat{\lambda}$ and, thus, $\frac{d\hat{\lambda}}{d\gamma} = \left(\frac{d\alpha^*}{d\gamma}\gamma - v - \alpha^*\right)\frac{1}{\gamma^2} = 0$. Again, the effect of a rise in the strength of optimal property rights on society's objective function $\int_{\hat{\lambda}}^{\overline{\lambda}} \lambda dF(\lambda) + \int_{\underline{\lambda}}^{\hat{\lambda}} [(1-\gamma)\lambda + \gamma v] dF(\lambda)$ equals $-\frac{\hat{\lambda}-\underline{\lambda}}{2}\left(\hat{\lambda} + \underline{\lambda} - 2v\right) f\left(\hat{\lambda}\right)$, which is negative for $\frac{v+\alpha^*}{\gamma^*} + \underline{\lambda} - 2v > 0$ and positive otherwise. As in the basic setup, γ^* jumps from 0 to 1 as α^* becomes sufficiently small. Turning to the case of lemons-type distortions, only the mean λ_m of the distribution of the potential buyers' valuations matters, and the analysis of the basic setup turns out to be completely general. For what concerns the case of contract incompleteness, society maximizes $\alpha \int_{\hat{\lambda}}^{\overline{\lambda}} (\lambda - v) dF(\lambda) + (1-\alpha) \int_{\hat{\lambda}}^{\overline{\lambda}} (\delta\lambda - v) dF(\lambda) + \int_{\underline{\lambda}}^{\hat{\lambda}} \delta\lambda dF(\lambda)$, which increases with γ if $-\frac{d\hat{\lambda}}{d\gamma}\left[\alpha\hat{\lambda} + (1-\alpha)\delta\hat{\lambda} - v - \delta\hat{\lambda}\right] f\left(\hat{\lambda}\right) = -\frac{v^2(\alpha-1+\gamma)}{(1-\delta)(1-\gamma)^3} f\left(\hat{\lambda}\right) > 0 \leftrightarrow \gamma < 1 - \alpha$ and falls otherwise. As in the basic setup, the unique and global solution is $\gamma^* = 1 - \alpha$. □

The political economy of property rights protection

In the case of exogenous transaction costs and excluded low-valuation potential buyers, the derivative of the objective function with respect to γ equals $\frac{v^2-\alpha^2}{(\gamma^*)^2} + \left(\underline{\lambda} + \epsilon\right)^2 - 2v\underline{\lambda}$ for $\hat{\lambda} < \overline{\lambda}$ and $v - \lambda_m + \frac{2\epsilon\underline{\lambda}+\epsilon^2}{2l}$ otherwise, the infra-marginal effect of a rise in γ is $-\frac{\left(\hat{\lambda}-\underline{\lambda}-\epsilon\right)\left(\hat{\lambda}+\underline{\lambda}+\epsilon-2v\right)}{2l} + \frac{2v\epsilon}{2l}$ for $\hat{\lambda} < \overline{\lambda}$, and the second-order conditions are as in the basic setup. Thus, γ^* is set inefficiently high, falls with α if

$\left(\underline{\lambda}+\epsilon\right)^2 - 2v\underline{\lambda} < 0$—i.e., ϵ not too large, and possibly jumps from 0 to the interior solution for α sufficiently small under the same condition on the severity of transaction costs discussed in the basic setup. When the potential buyers excluded have high valuations, society maximizes $\int_{\hat{\lambda}}^{\overline{\lambda}-\epsilon} \frac{\lambda-\alpha}{l} d\lambda + \int_{\underline{\lambda}}^{\hat{\lambda}} \frac{(1-\gamma)\lambda+\gamma v}{l} d\lambda$ for $\hat{\lambda} < \overline{\lambda}$ and $W^{FE} - (1-\gamma)\frac{2\epsilon\overline{\lambda}-\epsilon^2}{2l}$ otherwise. Both the infra-marginal effect of a rise in γ for $\hat{\lambda} < \overline{\lambda}$ and the first- and second-order conditions for a positive solution are as in the baseline case. For $\hat{\lambda} \geq \overline{\lambda}$, the first-order condition is $v - \lambda_m + \frac{2\epsilon\overline{\lambda}-\epsilon^2}{2l}$. Again, γ^* is set inefficiently large. The condition such that γ^* possibly jumps from 0 to the interior solution is easier to satisfy the smaller α is for $\alpha < \gamma^*\left(\overline{\lambda} - v - \epsilon\right)$, i.e., under the usual restrictions on α and for ϵ small.

When original owners have market power, the only relevant case is $\lambda < \hat{\lambda}$ and society maximizes $\int_{\hat{\lambda}}^{\overline{\lambda}} \frac{\lambda}{l} d\lambda + \int_{\underline{\lambda}+\epsilon}^{\hat{\lambda}} \frac{(1-\gamma)\lambda+\gamma v}{l} d\lambda$, whose derivative with respect to γ is $-\frac{(\hat{\lambda}-\underline{\lambda}-\epsilon)(\hat{\lambda}+\underline{\lambda}+\epsilon-2v)}{2l} + \frac{2v\epsilon}{2l}$. Hence, equilibrium property rights jump from 0 to 1 for α^* and ϵ sufficiently small. Regarding the case of lemons-type distortions and low-valuation potential buyers excluded form institutional design, society's objective function is as in the basic setup with $(1-\gamma)\frac{\lambda_m}{\theta}\left(\frac{\Delta}{2} - \epsilon\right)$ in place of $(1-\gamma)\frac{\lambda_m}{\theta}\frac{\Delta}{2}$. While for $\gamma^* \leq \frac{2}{\theta}$ the first-order condition of society's problem equals $-\left[(1-\Delta)(\alpha-1) + \frac{(\theta-1)^2}{\theta}\frac{\Delta}{2} - \frac{\epsilon}{\theta}\right]\lambda_m$ and, thus, it is negative for ϵ not too large, for $\gamma^* > \frac{2}{\theta}$ it equals $-\left[(1-\Delta)(\alpha-1) - \frac{\theta-1}{\theta}\frac{\Delta}{2} - \frac{\epsilon}{\theta}\right]\lambda_m$ and, thus, is negative for Δ and ϵ small and α large. When the potential buyers excluded have high valuations, society's objective function is as in the basic setup with $(1-\gamma)\theta\lambda_m\left(\frac{\Delta}{2} - \epsilon\right)$ in place of $(1-\gamma)\theta\lambda_m\frac{\Delta}{2}$ for $\gamma^* \leq \frac{2}{\theta}$ and $\theta\lambda_m\left(\frac{\Delta}{2} - \epsilon\right)$ in place of $\theta\lambda_m\frac{\Delta}{2}$ otherwise. While for $\gamma^* \leq \frac{2}{\theta}$ the first-order condition of society's problem equals $-\left[(1-\Delta)(\alpha-1) + \frac{(\theta-1)^2}{\theta}\frac{\Delta}{2} - \epsilon\theta\right]\lambda_m$ and, thus, it is negative for ϵ not too large, for $\gamma^* > \frac{2}{\theta}$ the baseline case analysis applies. For what concerns the case of contract incompleteness, the Pareto-superior equilibrium is the same whether or not a sufficiently small group of either high- or low-productivity downstream firms is kept out of the institutional design. My conclusions continue to hold when I consider a generic distribution of valuation/productivity and/or production and investment activities. □

Production

In the case of exogenous transaction costs, the original owners' expected utility equals $\frac{v\left(\overline{\lambda}-\hat{\lambda}\right)}{l} + \frac{\gamma^* v\left(\hat{\lambda}-\underline{\lambda}\right)}{l} - \kappa$ and, thus, $\tilde{\gamma}$ is defined by

$\frac{v\left[\overline{\lambda}-(v+\alpha)\tilde{\gamma}^{-1}\right]}{l}+\frac{\tilde{\gamma}v\left[(v+\alpha)\tilde{\gamma}^{-1}-\underline{\lambda}\right]}{l}=\kappa$. The left-hand side of this equality rises with $\tilde{\gamma}$ because $-\frac{d\hat{\lambda}}{d\tilde{\gamma}}\frac{v}{l}(1-\tilde{\gamma})+\frac{v\left(\hat{\lambda}-\underline{\lambda}\right)}{l}=\frac{v\hat{\lambda}}{\tilde{\gamma}l}(1-\tilde{\gamma})+\frac{v\left(\hat{\lambda}-\underline{\lambda}\right)}{l}\geq 0$. As a result, production realizes for $\gamma^*\geq\tilde{\gamma}$. When original owners have market power, their expected utility is $\frac{(v+\alpha^*)\left(\overline{\lambda}-\hat{\lambda}\right)}{l}+\frac{\gamma^*v\left(\hat{\lambda}-\underline{\lambda}\right)}{l}-\kappa$, and $\tilde{\gamma}$ is defined by $\frac{(v+\alpha^*)\left[\overline{\lambda}-(v+\alpha^*)\tilde{\gamma}^{-1}\right]}{l}+\frac{\tilde{\gamma}v\left[(v+\alpha^*)\tilde{\gamma}^{-1}-\underline{\lambda}\right]}{l}=\kappa$. The left-hand side of this equality rises with $\tilde{\gamma}$ because $-\frac{d\hat{\lambda}}{d\tilde{\gamma}}\frac{v(1-\tilde{\gamma})+\alpha^*}{l}+\frac{v\left(\hat{\lambda}-\underline{\lambda}\right)}{l}=\frac{\hat{\lambda}}{\tilde{\gamma}l}[v(1-\tilde{\gamma})+\alpha^*]+\frac{v\left(\hat{\lambda}-\underline{\lambda}\right)}{l}\geq 0$ and with α if $-\frac{d\hat{\lambda}}{d\alpha}\frac{v(1-\tilde{\gamma})+\alpha^*}{l}+\frac{\overline{\lambda}-\hat{\lambda}}{l}=-\frac{v(1-\tilde{\gamma})+\alpha^*}{\tilde{\gamma}l}+\frac{\overline{\lambda}-\hat{\lambda}}{l}\geq 0$, i.e., for $\overline{\lambda}$ large and v not too small compared to α^* and, thus, $\gamma^*\to 1$. Hence, production realizes for $\gamma^*\geq\tilde{\gamma}$, and $\frac{d\tilde{\gamma}}{d\alpha}\leq 0$. Turning to the scenario of lemons-type distortions, the original owners' expected payoff is $\frac{\Delta}{2}p_L+\left(1-\frac{\Delta}{2}\right)\gamma^*\lambda_m-\kappa$ and $\tilde{\gamma}$ is independent of α being equal to $\frac{2\kappa-\Delta p_L}{(2-\Delta)\lambda_m}$. Once again, x is produced if $\gamma^*\geq\tilde{\gamma}$. □

Investment

With exogenous transaction costs, potential buyers buy if $\lambda(1+\rho)-v(1+\rho)-\alpha\geq\left(1-\gamma_I\right)\lambda\leftrightarrow\lambda\geq\hat{\lambda}_I\equiv\frac{v+\alpha(1+\rho)^{-1}}{\gamma_I}$. Hence, society's objective function is $\int_{\hat{\lambda}_I}^{\overline{\lambda}}\frac{\lambda(1+\rho)-\alpha}{l}d\lambda+(1+\rho)\int_{\underline{\lambda}}^{\hat{\lambda}_I}\frac{(1-\gamma)\lambda+\gamma v}{l}d\lambda$, $\gamma_I^*=\frac{v^2-\left(\frac{\alpha}{1+\rho}\right)^2}{\underline{\lambda}\left(2v-\underline{\lambda}\right)}$, and the original owners' expected payoff from investment equals $v(1+\rho)\frac{\left(\overline{\lambda}-\hat{\lambda}_I\right)}{l}+\gamma_I^*v(1+\rho)\frac{\hat{\lambda}_I-\underline{\lambda}}{l}-\zeta$, whose derivative with respect to γ_I^* is $-\frac{d\hat{\lambda}_I}{d\gamma_I^*}v(1+\rho)\frac{\left(1-\gamma_I^*\right)}{l}+v(1+\rho)\frac{\hat{\lambda}_I-\underline{\lambda}}{l}\geq 0$. For $\gamma_I^*>\tilde{\gamma}_I$, society picks γ_I^* if the social welfare is larger at γ_I^* with investment than it is at γ^* without, i.e., whenever the inequality $\int_{\hat{\lambda}_I}^{\overline{\lambda}}\frac{\lambda(1+\rho)-\alpha}{l}d\lambda-\int_{\hat{\lambda}}^{\overline{\lambda}}\frac{\lambda-\alpha}{l}d\lambda+(1+\rho)\int_{\underline{\lambda}}^{\hat{\lambda}_I}\frac{\left(1-\gamma_I^*\right)\lambda+\gamma_I^*v}{l}d\lambda-\int_{\underline{\lambda}}^{\hat{\lambda}}\frac{(1-\gamma^*)\lambda+\gamma^*v}{l}d\lambda-\zeta\geq 0$ holds. The left hand side of this condition is larger than $(1+\rho)\left(\gamma^*\hat{\lambda}^2-\gamma_I^*\hat{\lambda}_I^2\right)+\left(\gamma_I^*-\gamma^*\right)\underline{\lambda}^2(1+\rho)+2v\left[(1+\rho)\gamma_I^*\left(\hat{\lambda}_I-\underline{\lambda}\right)-\gamma^*\left(\hat{\lambda}-\underline{\lambda}\right)\right]$ $-2\alpha\left(\hat{\lambda}-\hat{\lambda}_I\right)-\zeta l$, which is positive for α small relative to v and, thus, $\gamma_I^*\to\gamma^*$, ρ not too small and ζ not too large. A similar analysis applies to the $\gamma_I^*\leq\tilde{\gamma}_I$ scenario when society chooses $\tilde{\gamma}_I$ and not γ^* if the social welfare is larger at $\tilde{\gamma}_I$ with investment than it is at γ^* without investment. In the former case, $\hat{\lambda}_I$ is evaluated at $\tilde{\gamma}_I$. Finally, whenever $v\geq\lambda_m$, then $\gamma^*=1$ and investment is certain.

When original owners have market power, their expected utility rises with $\tilde{\gamma}_I$, which falls with α if $-\frac{d\hat{\lambda}}{d\alpha}\frac{v(1-\tilde{\gamma}_I)(1+\rho)+\alpha^*}{l}+\frac{\overline{\lambda}-\hat{\lambda}}{l}=-\frac{v(1-\tilde{\gamma}_I)+\alpha^*}{\tilde{\gamma}_I(1+\rho)l}+\frac{\overline{\lambda}-\hat{\lambda}}{l}\geq 0$, i.e., if v is not too small compared to α^* since, then, $\gamma^*\to 1$. In addition, $\hat{\gamma}_I$ prevails if investment is welfare-enhancing. For $\gamma^*>\tilde{\gamma}_I$, this happens if $\rho\int_{\hat{\lambda}}^{\overline{\lambda}}\frac{\lambda}{l}d\lambda+\rho\int_{\underline{\lambda}}^{\hat{\lambda}}\frac{(1-\gamma^*)\lambda+\gamma^* v}{l}d\lambda-\zeta\geq 0$, i.e., for ρ not too small and ζ not too large. For $\gamma^*\leq\tilde{\gamma}_I$, the analysis is as with exogenous transaction costs, and $\tilde{\gamma}_I$ prevails for α small compared to v, ρ not too small and ζ not too large. Regarding the scenario of lemons-type distortions, the original owners' expected utility is $\frac{\Delta}{2}p_L(1+\rho)+\left(1-\frac{\Delta}{2}\right)\gamma^*\lambda_m(1+\rho)-\kappa$, $\tilde{\gamma}_I=\frac{2\kappa-\Delta p_L(1+\rho)}{(2-\Delta)\lambda_m(1+\rho)}$, and γ_I^* is as in the basic setup. Investment prevails only if optimal property rights are larger than $\tilde{\gamma}_I$, and society, then, selects $\hat{\gamma}_I$ if investment is welfare-enhancing. For $\gamma^*>\tilde{\gamma}_I$, this is the case if $\theta\lambda_m\frac{\Delta}{2}+(1-\Delta)\left[(1-\gamma^*)\alpha\lambda_m+\gamma^*\lambda_m\right]+\left[(1-\gamma^*)\frac{\lambda_m}{\theta}+\gamma^*\lambda_m\right]\frac{\Delta}{2}\geq\zeta\rho^{-1}$ and, thus, for ρ not too small and ζ not too large. For $\gamma^*\leq\tilde{\gamma}_I$ instead, society selects $\tilde{\gamma}_I$ if $\rho\theta\lambda_m\frac{\Delta}{2}+\left[(1+\rho)\left(1-\tilde{\gamma}_I\right)-(1-\gamma^*)\right]\left[(1-\Delta)\alpha\lambda_m+\frac{\lambda_m}{\theta}\frac{\Delta}{2}\right]+\left(1-\frac{\Delta}{2}\right)\left(\tilde{\gamma}_I-\gamma^*\right)\lambda_m-\zeta\geq 0$. This last conditions is true for α small relative to v, ρ not too small and ζ not too large. □

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