

Incomplete property rights and overinvestment

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Abstract I consider a model in which an asset owner must decide how much to invest in his asset mindful of the fact that an encroacher's valuation of the asset is increasing in the asset owner's investment. Due to incomplete property rights, the encroacher and asset owner engage in a contest over the control of the asset after investment has taken place. A standard result is that the asset owner will underinvest in the asset relative to the first-best level of investment when property rights are complete. Contrary to this standard result, I find that when the interaction between the asset owner and the encroacher is infinitely repeated and the encroacher has some bargaining power over the size of the transfer from the asset owner to him, then there is a cooperative equilibrium in which the asset owner finds it optimal to overinvest in the asset when property rights are incomplete relative to the first-best level of investment when property rights are complete. Overinvestment is used to induce cooperation. However, this result depends on the encroacher's bargaining power or, *more generally*, whether the transfer is an increasing function of investment.

1 Introduction

It is widely accepted that the level of investment and creation of surplus in a country or by individuals in their assets depends on the security of property rights. Property rights affect economic performance. In recent years, this view has been forcefully expoused in [De Soto \(2000, 2001\)](#). [De Soto \(2001\)](#) argues that “[W]hat the poor lack is the easy access to the property mechanisms that could legally fix the economic potential of

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their assets, so that they could be used to produce, secure, or guarantee greater value in the expanded market ... assets need a formal property system to produce significant surplus value.”

To be sure, [De Soto \(2000, 2001\)](#) focuses on formal, legal, and *direct* protection of property rights of the kind provided by the state. However, since the protection of property rights is costly, it is unlikely that the state can provide complete property rights. In a world of such incomplete property rights, individuals and private agents also invest in property rights protection. And the state cannot fully protect property rights through direct enforcement. Therefore, even if private agents or the state take actions to protect their property rights, these actions need not be only direct investments in fighting those who challenge their property rights. For example, [Allen \(2002\)](#), drawing on the insights of [Demsetz \(1967\)](#), shows that an asset owner might have the incentive to reduce the value of his asset in order to make the asset less attractive to encroachers. In particular, the asset owner might destroy attributes of the asset which are valued by the encroacher but not valued by owner or are valued less highly by him (i.e., the owner). [Allen \(2002\)](#) presents many interesting examples to illustrate his point. For example, he argues that Rhinoceros in Africa and elsewhere are dehorned to reduce their value to poachers. Also, he argues that Monsanto, the American seed company, purchased the “terminator gene” to make its plants sterile (unable to germinate) in order to reduce the value of its seed to seed pirates. He also applies this simple idea to penal colonies, the quality of office furniture in public buildings, toilet paper and soap dispensers in public washrooms, the quality of children’s skis, snowboards, bikes, and other interesting phenomena.

[Konrad \(2002\)](#) also finds that incomplete property rights lead to underinvestment or cannot lead to overinvestment. He applies his analysis to investments by managers within firms and by autocrats within countries.¹ In a similar but more elaborate model, [Gonzalez \(2005\)](#) also finds that when property rights are incomplete, it may be optimal to adopt inferior technologies even if a superior technology is costless.² Finally, there is an empirical literature that shows that weaker protection of property rights lead to lower investment (e.g., see [Besley 1995](#); [Goldstein and Udry 2008](#), and the references therein).

Clearly, in [Allen \(2002\)](#), [Konrad \(2002\)](#), [Gonzalez \(2005\)](#) and [Goldstein and Udry \(2008\)](#), a lower investment is used as a deterrent to encroachers. Therefore, overinvestment is not possible in any of these papers.

While property rights affect investment in assets, investments in an asset can also affect property rights. [Besley \(1995\)](#) discusses this endogeneity issue in his econometric analysis. The use of investments to enhance property rights is evident in [Razzaz \(1993\)](#) work on squatters in Jordan. [Razzaz \(1993, p. 351\)](#) notes that the settlers

¹ More importantly, [Konrad \(2002\)](#) examines how the advantages of incumbency affect the investment incentives of the incumbent.

² In a growth model with incomplete property rights, [Gonzalez \(2007\)](#) and [Gonzalez and Neary \(2008\)](#) show that it may be optimal to reduce the rate of economic growth. This result is in the spirit of [Allen \(2002\)](#); [Konrad \(2002\)](#) and [Gonzalez \(2005\)](#) although the analysis is undertaken in a much richer dynamic environment.

“... know that a makeshift shelter stands little chance and that the more they invest in permanent material the more their claim to the land is legitimized.” This suggests that if the settlers had complete property rights over the land, they would have invested less which is an indication of overinvestment when property rights incomplete.

The asset owner may increase the value of the asset for strategic reasons. A higher value of the asset could be seen as a commitment device by the owner to credibly communicate to the encroacher that he (i.e., the owner) is willing to spend enough resources to protect it. This may cause the encroacher to reduce his effort. Even if the higher value causes the encroacher to increase his effort, the owner might still find it optimal to increase the value of the asset if the increase in his effort is sufficiently greater than the increase in the encroacher's effort such that his probability of keeping the asset or the proportion of it that he appropriates is sufficiently high and the increase in the cost of effort required to achieve this outcome is sufficiently low.

Although the preceding argument is intuitive and may be a potential reason for overinvestment, I find that it is unable to generate overinvestment. I therefore extend a complete-information model to an infinitely-repeated game setting and find that overinvestment may be undertaken because it facilitates cooperation between the asset owner and encroacher. In this case, the asset owner makes a transfer to the encroacher in each period and in return the encroacher promises not to challenge the property rights of the asset owner. However, I show that whether this results in overinvestment depends on whether the transfer is an increasing function of investment. It turns out that when the encroacher has some bargaining power over the size of the transfers, then the transfer is indeed an increasing function of the investment in the asset. The idea that transfers or redistribution can be used to induce cooperation, when property rights are incomplete, is not new.³ The new result here is that the encroacher's bargaining power or, more generally, the relationship between the transfer and investment can lead to overinvestment.

The intuition for the overinvestment result is as follows: given that the transfer is increasing in the level of investment, cooperation is easier to sustain when there is overinvestment because it is costlier for the encroacher to renege on the agreement and suffer the consequence of losing this sufficiently high transfer forever.⁴ This is what gives the crucial condition in the model that the critical discount factor must be decreasing in the level of investment. Yet, overinvestment will not always sustain cooperation because while it imposes the threat of a relatively high punishment on the encroacher, it also makes the one-time gain from deviation relatively high, since the value of the asset is higher when there is overinvestment compared to when there

³ For example, see [Amegashie \(2008\)](#) and the references therein.

⁴ In [Skaperdas \(1992\)](#) static model in which there is no investment, cooperation is possible to sustain if the conflict success technology is sufficiently ineffective. This condition does not hold in my model.

is no overinvestment.⁵ Therefore, if this latter effect dominates, then overinvestment will not hold.

When the transfer is lump-sum (i.e., independent of investment), overinvestment is never optimal because it does not affect the magnitude of the punishment but increases the gain from deviation.

The motivation behind the preceding argument is related to an argument in [Halonen \(2002\)](#). In an infinitely repeated prisoner's dilemma-type game within a Grossman–Hart–Moore framework⁶ where take-it-or-leave-it transfers are made from one party to another in order to sustain cooperation, [Halonen \(2002\)](#) shows that relative to single-ownership, joint-ownership of an asset has the desirable feature of imposing the threat of a higher punishment but has the undesirable feature of yielding a higher one-time gain from deviation. If the latter effect is sufficiently strong, then joint ownership is the optimal ownership structure. However, [Halonen \(2002\)](#) does not obtain the result of overinvestment in this article.

My paper is also related to but different from a recent contribution by [Robinson and Torvik \(2005\)](#). In their paper, they opine that in the political economy of development, the issue of investments with negative social surplus is more important than underinvestment. In the case of Ghana under its first president, Kwame Nkrumah, [Killick \(1978, p. 207\)](#) notes that “[T]he larger volume of ‘investment’ ... could not compensate for the low-productivity uses to which it was put.” Indeed, as [Robinson and Torvik \(2005, note 2\)](#) argue “[T]he problem under Nkrumah was not underinvestment ... the consensus view is that the capital stock increased by 80% between 1960 and 1965 ... The problem was in the way this investment was allocated.” Using a model of political competition, [Robinson and Torvik \(2005\)](#) argue that such investments with negative social surplus (i.e., white elephants) could be seen as a credible promise to redistribute income to a segment of the electorate in order to influence the outcomes of elections in a world where politicians do not have complete property rights over power. However, my model and analysis differ from [Robinson and Torvik \(2005\)](#) in the following respects. First, I use a model of contest where efforts in the contest are not pure transfers. Second, overinvestment in my model does not lead to negative surplus. While overinvestment need not lead to a negative surplus, a negative surplus is an indication of overinvestment. My model cannot explain why an agent will invest in a white elephant while [Robinson and Torvik \(2005\)](#) cannot explain overinvestment that does not lead to a negative surplus. Indeed, while [Robinson and Torvik \(2005\)](#) present a very plausible theory to explain white elephants, their theory cannot explain the construction of projects like Ghana's recent multi-million dollar

⁵ Subsidies for activities like R&D financed by taxes can also lead to overinvestment. However, in this case there could be overinvestment even if the subsidy was financed by a lump-sum tax. To be sure, the idea that subsidies can lead to overinvestment is obvious and such arguments are different from the argument being made here. It is not obvious that a distortionary tax can lead to overinvestment. In the present model, it is the combination of incomplete property rights and transfers that are similar to distortionary taxes which account for overinvestment.

⁶ This is the property-rights theory of the firm pioneered by [Grossman and Hart \(1986\)](#) and [Hart and Moore \(1990\)](#).

and controversial presidential palace⁷ which was constructed in the capital, Accra, an ethnically diverse and metropolitan city in the Greater Accra region of the country. It is hard to believe that the NPP government's goal was to use the project to transfer resources to its political supporters given that its strongholds are in the Ashanti and Eastern regions of the country. Third, I show that even if investment is used as a transfer to induce cooperation, whether there is overinvestment depends on the nature of transfers.

The seminal models of entry deterrence by Dixit (1980) and Spence (1977) also predict overinvestment. To the extent that an incumbent firm has to overinvest because it has incomplete property rights over market power, such models are related to the idea in this article. A difference is that, unlike this article, the investment undertaken by the incumbent firm does not have any positive value to the entrant. Therefore, investment is not used to make transfers to the entrant and so does not facilitate cooperation in the sense of this article.

The remainder of this article is organized as follows: the next section considers a single-period two-stage model of investment and contest over property rights with complete information. Section 3 considers an infinitely-repeated version of the model in Sect. 2 and discusses the results. Section 4 concludes this article.

2 Investment and incomplete property rights

Consider a variant of the model of investment in the absence of complete property rights in Konrad (2002). There are two risk-neutral agents, 1 and 2. Agent 1 owns an asset (e.g., a piece of land). Agent 2 is an encroacher who derives utility from using the asset. Let $V = V(x)$ be the value of an asset to the owner when he invests x dollars in the asset. Assume that $x \geq 0$, $V(0) = 0$, $V'(x) > 0$ and $V''(x) < 0$. Without loss of generality, let $V(x)$ also be the value of the asset to the encroacher.

First, consider the benchmark case of complete property rights. In this case, the owner's first-best level of x is

$$x^* = \arg \max V(x) - x,$$

where x^* satisfies $V'(x^*) = 1$.

Now consider the case of incomplete property rights. Suppose the owner invests e_1 dollars in protecting his property and the encroacher invests e_2 dollars to challenge the property rights of the owner.

Assume that the probability that the owner will successfully protect his asset is $p_1 = \frac{e_1}{e_1 + e_2}$. Accordingly, the probability that the encroacher will be successful is $p_2 = 1 - p_1$. This is an all-or-nothing, winner-takes-all contest. However, we can also interpret these probabilities as the proportions of the asset that each person can control or use.

I model the game as a two-stage game. In the first stage, the owner chooses x and in the second stage, the encroacher and owner choose e_1 and e_2 simultaneously in a

⁷ See a report by BBC on Ghana's presidential palace at <http://news.bbc.co.uk/2/hi/africa/7720653.stm>

complete-information contest. I look for a subgame perfect equilibrium by backward induction.

Working backwards, consider stage 2. In this stage, noting that x is sunk, the players' payoffs are

$$U_1 = p_1 V(x) - e_1 \tag{1}$$

and

$$U_2 = p_2 V(x) - e_2. \tag{2}$$

The unique pure-strategy Nash equilibrium values, after some algebra, are $\hat{e}_1 = \frac{V(x)}{4}$ and $\hat{e}_2 = \frac{V(x)}{4}$ (see, for example, Nti 1999; Konrad 2009). The equilibrium probability for the owner is $\hat{p}_1 = \frac{1}{2}$. The owner's payoff is $U_1^N(x) = \frac{V(x)}{4} > 0$ and the encroacher's payoff is also $U_2^N(x) = \frac{V(x)}{4} > 0$.

In stage 1, the owner chooses x to maximize

$$S_1(x) = \frac{V(x)}{4} - x. \tag{3}$$

Taking the derivative of (3) with respect to x and setting it equal to zero gives

$$V'(\hat{x}) = 4, \tag{4}$$

where $\hat{x} = \arg \max S_1(x)$. Then given $V'(x^*) = 1$ and Eq. 4, the strict concavity of $V(x)$ implies that $\hat{x} < x^*$. Hence, there is underinvestment when property rights are incomplete.

The analysis gives the following proposition:

Proposition 1 *In the subgame perfect equilibrium of the two-stage investment-contest game, the owner's level of investment in the asset when property rights are incomplete will be smaller than his level of investment when property rights are complete.*

Proposition 1 is robust to (a) changing the timing of moves in the contest, (b) different valuations for the asset owner and encroacher, and (c) the using the generalized Tullock contest success function (e.g., see Konrad (2009) for a discussion of this function). It is consistent with the results of Allen (2002), Konrad (2002), Gonzalez (2005) and the other papers cited in Sect. 1.

3 Infinitely-repeated interaction and incomplete property rights

Consider an infinitely repeated version of the model in Sect. 2. In *each* period, the asset owner makes an investment choice and then possibly engages in a contest with the encroacher. I shall show that there can be overinvestment in this environment.

Suppose the encroacher and the asset owner decide to negotiate a self-enforcing peaceful agreement. In each period, the asset owner will give the encroacher an upfront transfer. In return, the encroacher will not challenge the property rights of the asset owner. Since in the benchmark game in Sect. 2, the asset owner chooses his investment before the contest over property rights, I maintain consistency in the timing of moves by assuming that the asset owner chooses his investment before the parties bargain over the size of the transfer.

Suppose that the asset owner can commit to an agreement but the encroacher cannot. Commitment by the asset owner is plausible because he has to honor his side of the agreement first (i.e., make an upfront transfer to the encroacher) before the encroacher honors his side of the agreement. In other words, the asset owner cannot betray the encroacher in any period. This is also the case in Greif (1993, 1994) where merchants cannot cheat but their agents can. Hence, in Greif (1993, 1994), only the merchants have a punishment strategy and in Greif (1994) he refers to this as a one-sided prisoner's dilemma game. In my case, only the asset owner has a punishment strategy.

The asset owner uses a Nash reversion strategy (trigger strategy) where he punishes the encroacher by reverting to the Nash equilibrium play forever if the encroacher reneges on the agreement.⁸ Let $\delta \in [0, 1)$ be the encroacher's discount factor.

The timing of actions is as follows. In each period:

- Stage (i): The asset owner chooses the level of investment, x ,
- Stage (ii): The asset owner and the encroacher bargain over the size of a transfer from the asset owner to the encroacher.
- Stage (iii): If they agree on the transfer, the asset owner gives the transfer to the encroacher and the encroacher agrees not to challenge the property rights of the asset owner. And if the encroacher does not renege, the sequence of actions is repeated in the next period.⁹ If the encroacher reneges, the equilibrium of the stage game is played forever in subsequent periods.
- Stage (iv): If there is no agreement in stage (iii), there is a contest over control of the asset. Thereafter, we are back to stage (i) and the sequence of actions is repeated in the next period.

⁸ For a recent and interesting analysis using a Nash reversion strategy, see Conconi and Sahuguet (2009). It is well known that the strategies in Abreu (1986, 1988) can sustain cooperation in cases where a Nash reversion strategy fails to do so. However, using a Nash reversion strategy is sufficient to prove that there could be overinvestment. As will be shown below, what matters is not the value of the critical discount factor but whether it is decreasing in the level of investment.

⁹ Of course, after several periods of successful bargaining agreements, a norm will develop under which there is no further need to bargain and the parties simply use the transfer rule used in previous periods. However, since bargaining is costless in my model, it really does not matter whether they bargain in every period.

3.1 Equilibrium analysis

I want to construct a cooperative (no-conflict) subgame perfect equilibrium, so I solve the game backwards beginning in stage (iii) in the above sequence of actions such that the parties agree on a transfer and the encroacher does not renege.

Let the transfer from the asset owner to the encroacher be $S_2^C = \Omega$ in each period. Then the asset owner gets $S_1^C = V(x) - \Omega - x$. For each party to participate in a cooperative arrangement we require the following necessary conditions:

$$S_2^C \geq U_2^N(\hat{x}) \tag{5}$$

and

$$S_1^C \geq S_1^N \equiv U_1^N(\hat{x}) - \hat{x}, \tag{6}$$

where S_1^N and U_2^N are the players' equilibrium payoffs in the stage game.

If the encroacher reneges on the agreement, he will expend a positive but small effort, ε , in the contest and, given the contests success function, appropriate the entire asset with certainty (i.e., $p_2 = 1$ if $e_2 > 0$ and $e_1 = 0$). So the encroacher's payoff, if he deviates, is $S_2^D = V(x) - \varepsilon + \Omega$ in the current period.¹⁰ In all subsequent periods, both players revert to the Nash equilibrium of the stage game, where in each period, the asset owner gets $S_1^N(\hat{x}) = 0.25V(\hat{x}) - \hat{x}$ and the encroacher gets $U_2^N = 0.25V(\hat{x})$. Noting that the game is stationary and comparing the encroacher's discounted continuation payoffs from cooperation and non-cooperation, it can easily be shown that, given the asset owner's Nash reversion strategy, the encroacher will cooperate in every period if

$$\hat{\delta} \geq \frac{S_2^D - S_2^C}{S_2^D - U_2^N} = \frac{V(x)}{V(x) + \Omega - 0.25V(\hat{x})} \equiv \hat{\delta}(x), \tag{7}$$

where the expression on the RHS is the limiting case as $\varepsilon \rightarrow 0$.

Case (a): Encroacher has no bargaining power

Now consider stage (ii). In this case, the asset owner can make a take-it-or-leave-it offer to the encroacher. Consider an equilibrium with cooperation. Since we require $\hat{\delta} < 1$ for (7) to hold, it follows that (5) must hold with strict inequality. Therefore, a necessary condition for cooperation is $\Omega > 0.25V(\hat{x})$. Next, note that if $\Omega > 0.25V(\hat{x})$, then $\hat{\delta}$ is increasing in x . Therefore, if (7) holds for some $x > x^*$, then it will necessarily hold for any $x \leq x^*$.

¹⁰ I assume that the encroacher does not invest in the asset because he does not have the power to take investment decisions. This is consistent with the subsequent example of political patronage discussed below. Therefore, if the encroacher deviates and fully acquires the asset and uses it, the asset owner thereafter has to decide how much to invest in it in the next period. Given his Nash reversion strategy, he will choose the non-cooperative level of investment forever.

Finally, consider stage (i). In this stage, $x^* = \arg \max[S_1^C = V(x) - \Omega - x]$. Hence, if there is cooperation the asset owner will choose $x \leq x^*$ and if there is no cooperation, he will choose $\hat{x} < x^*$. Therefore, overinvestment is not possible.¹¹

Case (b): Encroacher has some bargaining power

Consider stage (ii). Suppose instead that the encroacher and asset owner bargain over the size of the transfer. The bargaining game can be captured by the maximization of the generalized Nash bargaining product,

$$M = [V(x) - \Omega - U_1^N(x)]^\theta [\Omega - U_2^N(x)]^{1-\theta},$$

where $0 < \theta < 1$, x has already been chosen to determine $V(x)$, and M is strictly concave in Ω .¹²

Then the optimal transfer solves $\partial M / \partial \Omega = 0$ and is given by $\Omega^* = \eta V(x)$, where $\eta \equiv 0.75 - 0.5\theta \in (0.25, 0.75)$ given $0 < \theta < 1$.¹³ In this case, the transfer is a fixed proportion, η , of the value of the asset. Therefore, if the encroacher has some bargaining power, the transfer will be an increasing function of the investment in the asset.¹⁴

¹¹ Another way of proving this result is by contradiction. Consider a cooperative equilibrium with overinvestment. The asset owner can *maintain* the size of the lump-sum transfer at the same level and maximize his surplus at x^* . This will still ensure cooperation because $V(x^*)$ is smaller than $V(x)$ for $x > x^*$. Given that the size of the transfer is still the same, if the encroacher reneges he will get $V(x^*) + \Omega$ which is smaller than $V(x) + \Omega$ if $x > x^*$, so given that the encroacher does not deviate at $x > x^*$, he would also not deviate from cooperation if he is given the same transfer and x^* is the level of investment.

¹² Note that since x is sunk, the asset owner's threat point in the bargaining game does not include the cost of investment. It is simply his payoff in the contest. Therefore bargaining, as in Anbarci et al. (2002), takes place in the shadow of conflict. However, notice that the asset owner's individual rationality constraint in (6) is his payoff in the contest less the cost of investment. This is because to construct an equilibrium in which he cooperates in every period, he has to be guaranteed his payoff in the non-cooperative equilibrium. The same argument applies to the encroacher.

¹³ Note that the Nash bargaining solution can be derived from a Rubinstein-style *non-cooperative* alternating-offers bargaining game (Binmore et al. 1986; Sutton 1986). More simply, following Posanti and Sakovics (1998), consider a variant of the Rubinstein game where the players have different discount factors; the asset owner makes the first offer; the players take turns in making offers; when an offer is accepted the game ends and the players get agreed-upon offers; and the asset owner and encroacher have the outside options, u_a and u_e , respectively, where $u_a + u_b \leq V(x)$. Without loss of generality, I do not normalize the size of the surplus and the outside options by dividing $u_a + u_b \leq V(x)$ by $V(x)$. If an offer is rejected, either of the two parties may take their outside option. If an offer is rejected but neither player opts out, then bargaining goes on to the following round where an offer is made and so on. Suppose $u_e = \eta V(x) > 0$ and $0 \leq u_a \leq V(x) - u_e \leq V(x)$. Suppose a proposer in each round always plays the strategy of offering the responder his (i.e., responder's) outside option. Then according to Lemma 1 in Posanti and Sakovics (1998), there exists a subgame perfect equilibrium with immediate agreement in which the encroacher gets $\eta V(x)$ and the asset owner gets $(1 - \eta)V(x)$. Hence, the Nash solution above can be obtained from an alternating-offers non-cooperative bargaining game. And according to the Theorem in Posanti and Sakovics (1998), this equilibrium is unique if $u_a > (\delta_e)^2(1 - \eta/\delta_a)V(x)$, where δ_a and δ_e are the discount factors of the asset owner and encroacher respectively.

¹⁴ Suppose δ_a and δ_e are the discount factors of the asset owner and encroacher respectively, where $0 < \delta_a < 1$ and $0 < \delta_e < 1$. Then if the asset owner makes the first offer in the standard Rubinstein (1982) bargaining game where the players are (potentially) locked into bargaining forever, $\eta = \delta_e(1 - \delta_a)/(1 - \delta_a\delta_e)$ and if the encroacher makes the first offer, then $\eta = (1 - \delta_a)/(1 - \delta_a\delta_e)$. Our main result does not change if the asset owner and encroacher get the disagreement payoffs v_a and v_b and are the payoffs in the Nash

Before, we proceed to stage (i), note that given $\Omega^* = \eta V(x)$ implies that $S_1^C = V(x) - \eta V(x) - x$ and so the inequality in (7) becomes

$$\delta \geq \frac{V(x)}{(1 + \eta)V(x) - 0.25V(\hat{x})} \equiv \underline{\delta}(x) \tag{8}$$

In this case, $\underline{\delta}$ is decreasing in x .¹⁵

Now consider stage (i). Let \tilde{x} be the asset owner’s optimal level of x in a cooperative equilibrium. Define $x^{**} = \arg \max[S_1^C = V(x) - \eta V(x) - x]$. Note that $x^{**} < x^*$ given $V'(x) > 0$. Suppose \bar{x} satisfies (8) with strict equality. Then $\bar{x} = \underline{\delta}^{-1}(\delta)$ and any $x < \bar{x}$ violates (8) while any $x \geq \bar{x}$ satisfies (8). Therefore, a necessary condition for overinvestment is $\bar{x} > x^*$. Given that S_1^C is maximized at x^{**} , the asset owner will like to choose x as close as possible to x^{**} while satisfying (5), (6), and (8). Therefore, if $\bar{x} > x^* > x^{**}$ and (5) and (6) are also satisfied at \bar{x} , then the optimal investment is $\tilde{x} = \bar{x} = \underline{\delta}^{-1}(\delta) > x^*$. Indeed, since (8) is satisfied at \bar{x} , this implies that $\underline{\delta}(\bar{x}) < 1$ and therefore $\eta V(\bar{x}) > 0.25V(\hat{x})$ and, for that matter, (5) is also satisfied.¹⁶

As an example, consider $\eta = 0.3$, $\delta = 0.8006$, and $V(x) = 2x^{0.5}$.¹⁷ Then $x^* = 1$, $\hat{x} = 0.0625$, $S_1^N = 0.0625$, and $U_2^N = 0.125$. Let the asset owner choose $\bar{x} = 1.5 > x^*$. Then $S_1^C = 0.2146$, $S_2^C = 0.7348$, and $\underline{\delta}(\bar{x}) = 0.8006$. Clearly, $S_1^C > S_1^N$ and $S_2^C > U_2^N$. Note that $\underline{\delta}(x) > 0.8006$ for $x \in (0, \bar{x})$. It is easy to verify that any $x > \bar{x} = 1.5$ gives a lower value of $S_1^C = V(x) - \eta V(x) - x$ than at $x = \bar{x}$. Therefore, given

$\delta = \underline{\delta}(\bar{x}) = 0.8006$, there is a subgame perfect equilibrium with overinvestment where the optimal investment is $\tilde{x} = 1.5 > x^* = 1$.

Note that while overinvestment can be used to induce cooperation, it is not necessarily the case that cooperation requires overinvestment. It is possible to construct a cooperative equilibrium with underinvestment, even if the transfer depends on invest-

equilibrium of some game that is played in the event of a disagreement and the players are (potentially) locked into bargaining forever. If $\delta_a = \delta_e = \delta$, Busch and Wen (1995) show that the equilibrium of this game when (in our case) the asset owner makes the first offer is $\eta = (\delta + v_a - \delta v_b)/(1 + \delta)$. Again, the transfer is an increasing function of the investment in the asset. A difference between the game in Busch and Wen (1995) and game in Posanti and Sakovics (1998) is that in the former game, neither party can opt out after an offer is rejected. The players get their disagreement payoffs after a rejection in a given period but *must* return to the bargaining table thereafter.

¹⁵ When $x = 0$, the critical discount factor in (8) is equal to zero which suggests that cooperation can be sustained. But this cannot be possible because given $V(0) = 0$, the constraint in (6) is violated. Hence, (8) and, for that matter, (7) are defined for $x > 0$.

¹⁶ Under these assumptions, we $\partial \tilde{x} / \partial \delta < 0$. Therefore, the more patient the encroacher is, the less is the asset owner’s level of investment in the cooperative equilibrium. Note that we can write $\underline{\delta}(\bar{x}, \eta) = \delta$, where the LHS is decreasing in η using (8). Then given that $\underline{\delta}$ is also decreasing in x , it follows that when cooperation is sustained, an increase in η leads to a fall in \bar{x} .

¹⁷ In the standard Rubinstein (1982) bargaining game, the players’ discount factors determine η . Therefore, we cannot choose η and the discount factors independently. However, this does not affect the overinvestment result. For example, following the definitions in footnote 14, suppose $\delta_e = 0.8006$, $\delta_a \approx 0.8933$, and the asset owner makes the first offer in the Rubinstein bargaining game. Then $\eta = \delta_e(1 - \delta_a)/(1 - \delta_a \delta_e) = 0.3$ which is consistent with the parameter values in the above example. Therefore, our result remains unchanged and, of course, based on corollary 1 in Posanti and Sakovics (1998) and as shown in a previous footnote, we can choose the players’ outside options appropriately to replicate the Nash solution.

ment. However, overinvestment can only occur in a cooperative equilibrium while underinvestment can occur in either a cooperative or a non-cooperative equilibrium. Therefore, in the model, a cooperative equilibrium is necessary for overinvestment while it is not for underinvestment.

An important remark is in order. Notice that the asset owner could have chosen x^* and given the encroacher a lump-sum transfer of $\tilde{\Omega} = \eta V(\tilde{x})$. This would give

$\delta = \underline{\delta}(\tilde{x}) > \hat{\delta}(x^*)$, make the asset owner better off, and make the encroacher no worse off, where using (7) and (8)

$$\hat{\delta}(x^*) = \frac{V(x^*)}{V(x^*) + \eta V(\tilde{x}) - 0.25V(\hat{x})}, \tag{7a}$$

$$\underline{\delta}(\tilde{x}) = \frac{V(\tilde{x})}{V(\tilde{x}) + \eta V(\tilde{x}) - 0.25V(\hat{x})}, \tag{8a}$$

and

$$\eta V(\tilde{x}) \equiv \tilde{\Omega} > 0.25V(\hat{x}).$$

By breaking the link between the transfer to the encroacher and investment, it is clear that overinvestment is not possible. Therefore, to restore the overinvestment result we need to argue that breaking the link between the transfer and investment is not possible. Notice that by arguing that the asset owner could have given the encroacher a lump-sum transfer of $\tilde{\Omega} = \eta V(\tilde{x})$, we were making the implicit assumption that we were back to the case where the asset owner could make a take-it-or-leave-it offer. Yet, if the asset owner had this power, he will not choose $\tilde{\Omega} = \eta V(\tilde{x})$. To see this, note that given $\delta = \underline{\delta}(\tilde{x}) > \hat{\delta}(x^*)$, the asset owner can sustain cooperation at x^* and increase his payoff by choosing a transfer $\Omega^{**} < \tilde{\Omega} = \eta V(\tilde{x})$ and still satisfy $\delta = \underline{\delta}(\tilde{x}) \geq \hat{\delta}(x^*)$ and $\Omega^{**} > 0.25V(\hat{x})$. This means that the encroacher will be worse off. This means that the encroacher will prefer that the $\eta V(x)$ transfer rule is followed or will use his bargaining power. Therefore, the overinvestment result still holds.

It is important to note that I am not arguing that $\{x^*, \tilde{\Omega}\}$ is not feasible or will not satisfy the parties' individual rationality constraints. My argument is that given $\delta = \underline{\delta}(\tilde{x}) > \hat{\delta}(x^*)$, if the asset owner can make a take-it-or-leave-it offer, then there exists a pair $\{x^*, \Omega^{**}\}$ that strictly dominates $\{x^*, \tilde{\Omega}\}$ for the asset owner and satisfies the encroacher's individual rationality constraints, where $\Omega^{**} < \tilde{\Omega}$.

Even if one were to argue that the encroacher can simply ask the asset owner to give him $\tilde{\Omega} = \eta V(\tilde{x})$, nothing prevents the asset owner from making a counter offer which is less than $\tilde{\Omega}$. Once we appreciate the incentive to make these offers and counter offers, we are back to the process of bargaining.¹⁸ Therefore, if we accept that bargaining is what determines the size of the transfer then we have to stick to the $\eta V(x)$

¹⁸ Note again that the Nash bargaining solution can be derived from a Rubinstein-style non-cooperative alternating offers bargaining game.

transfer rule. To argue otherwise is to argue that somehow the asset owner can make a take-it-or-leave-it offer.

It should be obvious that what is generally required for the overinvestment result is that the transfer must be an increasing function of investment. Bargaining is only a mechanism that produces this result and so it is not a necessary mechanism. Another mechanism that can make the transfer an increasing function of investment is a requirement that the transfer must be an in-kind transfer. For example, if the asset-owner can only compensate the encroacher by transferring a proportion of the asset to him after investment has taken place, then the transfer will be an increasing function of investment.

To sum up, if the encroacher has some bargaining power over how the returns from the asset should be shared or, *more generally*, if the transfer is increasing in the level of investment, then overinvestment is possible. This gives the following proposition:

Proposition 2 *If the encroacher has some bargaining power over the size of the transfer from the asset owner to him or, more generally, if the transfer is increasing in the level of investment, then in the infinite-period investment-cum-contest game, it is possible to construct subgame perfect equilibria with cooperation in which the owner's level of investment in the asset when property rights are incomplete is greater than his level of investment when property rights are complete.*

In Sect. 1, I elaborated on the intuition for the overinvestment result in proposition 2. I will not rehash it here. The reader may refer to the argument in Sect. 1.

3.2 Further remarks

By allowing commitment and the use of credible punishment by the asset owner, it is obvious that the underinvestment problem can be solved. However, to explain overinvestment, I introduce a new imperfection into the environment (i.e., imperfect transfers) which creates a new efficiency problem (i.e., overinvestment). Therefore, I removed some distortions and introduced a new one with the goal of demonstrating how that might give rise to a different kind of inefficiency (i.e., overinvestment).

A requirement that the transfer must be linked to the proceeds of a public project could make the transfer an increasing function of investment. Such transfers may be desirable when there are institutional constraints on the nature of transfers from the asset owner to the encroacher. For example, consider a politician who can only make transfers to those who challenge his authority by investing in pork-barrel and then bargain with them over the proceeds of the project in each period.¹⁹ This will be

¹⁹ It is important to note that the politician considers the investment in the pork-barrel project as a cost although he is financing it from public coffers. When Konrad (2002) applies his model to the behavior of autocrats he implicitly assumes that the politician takes the cost of investment into account. A reason why the politician may take the cost into account may be due to the moral and expected material cost of wrongdoing. For example, this makes sense if his punishment should he be out of power (e.g., by people other than his cronies) and convicted of corruption is increasing in x . Or as in Robinson and Torvik (2005), he may take this cost into account simply because every dollar spent has an opportunity cost. An example may be the distortionary cost of taxes used to finance the project.

consistent with the logic of political survival and patronage that is documented and discussed in [De Mesquita et al. \(2003\)](#). Indeed, as [Coate and Morris \(1995\)](#) show, it may be optimal for politicians to choose inefficient forms of transfers like in-kind transfers via public projects in order to disguise transfers to special interests

In some cases, the politician's main motivation may not be to make transfers to special interests. Again, suppose institutional constraints compel the politician to have surrogates who run public projects and give him his agreed-upon *share* of the proceeds of the public project. Therefore, the politician's investment decision in the project is driven by his own pecuniary motives. For example, if this is a democracy with term limits and the politician is in his last term, then the nature of his transfer and investment decision are not driven by the fear of losing power. These decisions are instead driven by the fear of being prosecuted after his tenure in office.²⁰ This is what induces him to choose less transparent forms of transfers like public projects. Then reneging on the agreement means that his surrogates take all the proceeds from the project in a given period. The politician who has the exclusive right on how much should be invested in each period will then revert to the non-cooperative level of investment which, in this case, could be the minimal level of level of investment in the project. The politician and his surrogates will get nothing or a very small payoff relative to the payoff in the cooperative equilibrium.²¹ As in the previous case, the politician has incomplete economic rights over the project.

In the above example, one may argue that when the politician's challengers deviate, they get $S_2^D = \eta V(x) + (1 - \eta)V(x) = V(x)$ not $S_2^D = (1 + \eta)V(x)$. Then the critical discount factor is $\bar{\delta}(x) = (1 - \eta)V(x)/[V(x) - S_2^N]$. However, it is still possible to construct equilibria with overinvestment. This is because the crucial condition that the critical discount factor, $\bar{\delta}(x)$, is decreasing in x still holds.

4 Conclusion

Contrary to the standard results in the recent literature on investment and property rights, I have shown it is possible for an asset-owner to overinvest in the asset when property rights are incomplete. As noted in the introduction, the idea that transfers or redistribution can be used to induce cooperation, when property rights are incomplete, is not new. The new result here is that the nature of transfers can lead to overinvestment.

The result of this article does not necessarily mean that incomplete property rights are desirable because they boost investment. Like underinvestment, overinvestment

²⁰ Technically, though, the term limit makes the interaction between the politician and his surrogates a finitely-repeated game. However, in a democracy without term limits or in an autocracy (as in the previous example), cooperation could still be sustained if the politician is re-elected or stays in power with an exogenous probability (see [Conconi and Sahuguet 2009](#); [Dal Bo 2005](#)). This means that the last period is not known with certainty. And in my model, the critical discount factor will still be decreasing in x with such an exogenous probability of staying in power. This is what is required to get the overinvestment result.

²¹ Generally, what matters for the analysis is that the one-period payoff from deviating from the cooperative equilibrium outweighs the payoff in the cooperative equilibrium which, in turn, outweighs the payoff in the Nash equilibrium.

also leads to a welfare loss relative to the first-best case of complete property rights. The goal of social policy ought to be the enhancement of property rights taking into account the cost of establishing such enhanced property rights. Of course, I do not mean the enhancement of the property rights of corrupt politicians.

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References

- Abreu D (1986) Extremal equilibria of oligopolistic supergames. *J Econ Theory* 39:191–225
- Abreu D (1988) On the theory of infinitely repeated games with discounting. *Econometrica* 56:383–396
- Allen DW (2002) The Rhino's horn: incomplete property rights and the optimal value of an asset. *J Legal Stud XXXI:S339–S358*
- Amegashie JA (2008) Incomplete property rights, redistribution, and welfare. *Soc Choice Welf* 30:685–699
- Anbarci N, Skaperdas S, Syropoulos C (2002) Comparing bargaining solutions in the shadow of conflict: how norms against threats can have real effects. *J Econ Theory* 106:1–16
- Besley T (1995) Property rights and investment incentives: theory and evidence from Ghana. *J Political Econ* 103:903–937
- Binmore K, Rubinstein A, Wolinsky A (1986) The Nash bargaining solution in economic modeling. *Rand J Econ* 17:176–188
- Busch L-A, Wen Q (1995) Perfect equilibria in a negotiation model. *Econometrica* 63:545–565
- Coate S, Morris S (1995) On the form of transfers to special interests. *J Political Econ* 105:1210–1235
- Conconi P, Sahuguet N (2009) Policymakers' horizon and the sustainability of international cooperation. *J Public Econ* 93:549–558
- Dal Bo P (2005) Cooperation under the shadow of the future: experimental evidence from infinitely repeated games. *Am Econ Rev* 95:1591–1604
- Demsetz H (1967) Toward a theory of property rights. *Am Econ Rev (papers and proceedings)* 57:347–359
- De Mesquita B, Morrow J, Siverson R, Smith A (2003) *The logic of political survival*. MIT Press, Cambridge, MA
- De Soto H (2000) *The mystery of capital: why capitalism triumphs in the west and fails everywhere else*. Basic Books, New York
- De Soto H (2001) The mystery of capital. Finance and development. IMF: <http://www.imf.org/external/pubs/ft/fandd/2001/03/desoto.htm>
- Dixit A (1980) The role of investment in entry decisions. *Econ J* 90:95–106
- Goldstein M, Udry C (2008) The profits of power: land rights and agricultural investment in Ghana. *J Political Econ* 116:981–1022
- Gonzalez F (2005) Insecure property rights and technological backwardness. *Econ J* 115:703–721
- Gonzalez F (2007) Effective property rights, conflict, and growth. *J Econ Theory* 137:127–139
- Gonzalez F, Neary H (2008) Prosperity without Conflict. *J Public Econ* 92:2170–2181
- Greif A (1993) Contract enforceability and economic institutions in early trade: the Maghribi traders' coalition. *Am Econ Rev* 83:525–548
- Greif A (1994) Cultural beliefs and the organization of society: a historical and theoretical reflection on collectivist and individual societies. *J Political Econ* 102:912–950
- Grossman S, Hart O (1986) The costs and benefits of ownership: a theory of vertical and lateral integration. *J Political Econ* 94:691–719
- Halonen M (2002) Reputation and the allocation of ownership. *Econ J* 112:539–558
- Hart O, Moore J (1990) Property rights and the nature of the firm. *J Political Econ* 98:1119–1158
- Killick T (1978) *Development economics in action: a study of economic policies in Ghana*. Heinemann, London
- Konrad KA (2002) Investment in the absence of property rights: the role of incumbency advantages. *Eur Econ Rev* 46:1521–1537
- Konrad KA (2009) *Strategy and dynamics in contests*. Oxford University Press, Oxford

- Nti KO (1999) Rent-seeking with asymmetric valuations. *Public Choice* 98:415–430
- Posanti C, Sakovics J (1998) Rubinstein bargaining with two-sided outside options. *Econ Theory* 11: 667–672
- Razzaz OM (1993) Examining property rights and investment in informal settlements: the case of Jordan. *Land Econ* 69:341–355
- Robinson JA, Torvik R (2005) White elephants. *J Public Econ* 89:197–210
- Rubinstein A (1982) Perfect equilibrium in a bargaining model. *Econometrica* 50:97–109
- Skaperdas S (1992) Cooperation, conflict, and power in the absence of property rights. *Am Econ Rev* 82:720–739
- Spence MA (1977) Entry, capacity, investment, and oligopolistic pricing. *Bell J Econ* 8:534–544
- Sutton J (1986) Non-cooperative bargaining: an introduction. *Rev Econ Stud* 53:709–724