When Will Efficient Ownership Arise? Trading over Property Rights

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The property rights theory of the firm considers environments where asset ownership matters for ex post bargaining and hence, drives the efficiency of ex ante non-contractible actions. This paper complements this analysis by considering what ownership structures would arise in market settings. Building on earlier results based on simple auction mechanisms for allocating asset ownership, this paper considers when asset re-sale and share trading might lead to an efficient ownership structure. It is demonstrated that if asset trades are restricted to be bilateral in nature, efficient ownership cannot be guaranteed and, in equilibrium, ownership may rest with inefficient outside parties. However, in settings where (i) multilateral payments can be made; (ii) there are sufficient opportunities for asset re-trading and (iii) outside parties themselves are active traders, efficient ownership will be the unique equilibrium outcome. *Journal of Economic Literature* Classification Numbers: D23, L22.

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The property rights theory of the firm pioneered by Grossman and Hart (1986) and Hart and Moore (1990) – hereafter GHM – is based on the notion that firms are defined by the set of assets controlled by the firm's owners. Moreover, the boundary of the firm – that is, who owns what – is presumed to be determined by the efficiency of ownership; in particular, the way in which asset ownership drives surplus generation and the ownership structure that maximises that surplus. In this paper, however, this presumption is not made. Instead, ownership is driven by asset trading and it is asked under what circumstances such asset trading will lead to efficient ownership?

In answering this question, this paper builds upon the work of Gans (2004). That paper, in direct contrast to GHM, supposes that assets are allocated by means of a simple auction. The initial owner of the asset – be it a productive agent (who contributes something to surplus generation) or an outside party (who does not) – solicits bids from other interested parties. In the case where the initial owner is an outside party, the highest bidder is awarded ownership. In the case where a productive agent is the initial owner, that agent considers the identity of the bidder as well as their bid. This is because different bidders will hold different implications for a productive agents own relationship with the firm. It is these types of externalities that drives bidding behaviour. Specifically, an outside party will be willing to pay up to the rents they expect to receive from ownership. A productive agent will be willing to pay this less the rents they will accrue as a non-owner. If productive agents are complementary to one another, non-ownership rents may be substantial. For this reason, outside parties will often have the highest willingness to pay for ownership.

Gans (2004) demonstrates that this tendency for outside parties to bid aggressively for ownership in competition with productive agents may lead to such ownership even though that ownership may be inefficient. Specifically, as GHM demonstrate, when an outside party owns an asset, they always claim a portion of the ex post surplus, diminishing incentives for all productive agents to engage in surplus-enhancing activities. So long as those diminished incentives are not too large, Gans shows that outside parties may still solicit the highest bids in auctions for ownership.

While this demonstrates that market forces in asset markets can play an important role in determining firm boundaries, the auction mechanism itself has specific properties that might be driving the outside ownership outcome. First, it is a 'once-off' process. The asset is exchanged a single time and resides with an outside owner in equilibrium. However, given the inefficiency of such ownership, one wonders whether that ownership would 'stick' if the outside party themselves was able to re-sell the asset. One reason, of course, could be that the asset seller may impose restrictions on such re-sale. Second, the auction itself is a high commitment mechanism. Even if a re-sale restraint might be desired, it may not be possible to commit to that restraint. Indeed, the entire property rights literature is founded on the notion that such commitments are difficult, if not impossible, to make. Finally, the auction mechanism presumes the asset is sold as a whole. Would a similar result arise if the asset were made divisible through share trades?

For these reasons, this paper explores the *robustness* of the simple result that market equilibrium can involve outside ownership and *distills the conditions under which efficiency will arise*; something not done in Gans (2004). The baseline model in Section 1 reviews the conditions provided in Gans (2004) whereby an outside party is the unique winner of an auction for the asset from another disinterested outside party, Section 2 considers a re-sale model based on the framework of Jehiel and Moldovanu (1999) and identifies the role of bilateral trading restrictions when there are many productive agents. In addition, it is demonstrated that an outside party can be the ultimate equilibrium owner of an asset even when agents can engage in multiple asset exchanges prior to production. That section also demonstrates, however, that when multilateral trades are possible – with all agents potentially party to a transaction – efficient ownership arises. Thus, it is the restrictions of payments in auctions to be bilateral (even thought the mechanism itself involves all parties) rather than its high commitment properties that drives the potential inefficiency of ownership structures. Section 3 then turns to demonstrate that equilibrium outside ownership can also arise when ownership shares can be allocated and traded. Again bilaterality plays an important role here. A final section concludes.

1. Model Set-Up and Baseline Result

This section provides a simple model of the efficiency of ownership based on the GHM approach and then reviews the auction result of Gans (2004) in the context of that model. This is done to provide a base of reference with the more general models that follow in Sections 2 and 3 below.

Model Set-Up

Suppose there are two productive agents (*A* and *B*) and many outside parties (of type *O*). Outside parties are perfectly substitutable for one another in a productive sense.

There is a single alienable asset that with an initial owner who is either an outside party or a productive agent.

A can make an asset-specific investment (or take other actions), a (≥ 0), that generates value so long as it works in association with the asset.[1] This investment is privately costly – incurring a cost of a – and gives rise to total value created of $V(a)$ (an increasing function) so long as both *A* and *B* work or utilise the asset. If, however, *A* is the only agent associated with the asset, total value created is $v(a)$ (also increasing with $v(0) = 0$) whereas *B* on its own generates value of $\underline{v} \equiv V(0)$. Agents not associated with the asset generate no additional value. In this sense, the asset itself is necessary for any value to be created and so is *essential* (according the Hart and Moore's (1990) definition) to all agents.

On the other hand, an *O*'s association with the asset has no influence on the value of production from any coalition controlling the asset. Thus, following the definition of Hart and Moore (1990), *O* is a *dispensable*, *outside party*.

It is assumed that – at least in the first best world – it is desirable for both *A* and *B* to work with the asset. That is, let $V^* = \max_a V(a) - a$ and $v^* = \max_a v(a) - a$, so that $V^* > \max\{v^*, \underline{v}\}$. Finally, as in much of the incomplete contracts literature, it is assumed that the marginal return to investment is higher when *B* is associated with the asset; that is, $V'(a) > v'(a)$ for all *a, so that A and B are complementary in creating value.*[2] Note this in turn implies that $V(a) > v(a) + \underline{v}$ for $a > 0$.[3]

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[1] The non-contractible investment is limited to a single productive agent here. Gans (2004) presents a more general set-up.

[2] These assumptions are equivalent to Hart and Moore's (1990) assumptions 5 and 6.

[3] That is, $V(a) - \underline{v} = V(a) - V(0) > v(a) - v(0) = v(a)$.

Model Timing

The timing of the model is as follows:

DATE 0: The allocation of the asset is determined.

DATE 1: A chooses its investment, a.

DATE 2: All agents engage in efficient bargaining over the division of $V(a)$ where the precise division is based on the Shapley value,[4] production takes place and payments are made.

This is the same model timing that arises in GHM where a is considered non-contractible. The only difference here is the form of the Date 0 allocation mechanism which may be market-based as specified below.

Ownership-Contingent Outcomes

The central insight of GHM is that as ownership changes, the ex post bargaining position of agents (in Date 2) changes. Table 1 summarises the payoffs to each agent under each ownership configuration for a given level of investment, a. For notational convenience, these payoffs will sometimes be denoted by π_j^i, which is the payoff to agent j under i-ownership.

Table 1: Date 2 Payoffs

Ownership Structure	**Payoffs**		
	A	***B***	***O***
A-Ownership	$\frac{1}{2}\left(V(a)+v(a)\right)-a$	$\frac{1}{2}\left(V(a)-v(a)\right)$	0
B-Ownership	$\frac{1}{2}\left(V(a)-\underline{v}\right)-a$	$\frac{1}{2}\left(V(a)+\underline{v}\right)$	0
O-Ownership	$\frac{1}{3}\left(V(a)-\underline{v}+\frac{1}{2}v(a)\right)-a$	$\frac{1}{3}\left(V(a)-v(a)+\frac{1}{2}\underline{v}\right)$	$\frac{1}{3}\left(V(a)+\frac{1}{2}(v(a)+\underline{v})\right)$

[4] In this case, because the asset is essential, the Shapley value can be derived from a non-cooperative bargaining game where date 1 prices are non-binding until production begins (see Stole and Zwiebel, 1996).

A determines the level of investment at Date 1 with respect to its own payoff. Let a_i denote the chosen investment level under ownership structure *i* (= *A*, *B* or *O*). It is easy to see that $a_A > a_B > a_O$.[5] Thus, investment is highest under *A*-ownership as this is the structure that gives *A* the most favourable ex post bargaining position. For this reason, *A*-ownership is also the GHM (constrained) optimal outcome as it leads to the highest level of value created among ownership structures (i.e., $\pi_A^A + \pi_B^A > \pi_A^B + \pi_B^B > \pi_A^O + \pi_B^O + \pi_O^O$). Note also that this illustrates the standard result in GHM that ownership should not be allocated to outside parties (such as agent *O* in this model) as this results in the lowest value created.

Once-Off Auction

As in Gans (2004), consider a simple auction as the ownership allocation mechanism in Date 0. The interactions amongst the potential bidders make calculations of willingnesses to pay for ownership somewhat complex. Of key importance is the fact that, while an *O*-type's willingness to pay depends only on the rents they earn as an owner, this is not the case for productive agents. Both *A* and *B* earn rents under any ownership structure and hence, the value each places on ownership depends upon their conjectures as to what structure might alternatively arise.

Despite this potential complexity, the following can be demonstrated:

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[5] That is, the marginal value of investment under *A*-ownership ($\frac{1}{2}\left(V'(a)+v'(a)\right)$) exceeds that under *B*-ownership ($\frac{1}{2}V'(a)$) and *O*-ownership ($\frac{1}{3}\left(V'(a)+\frac{1}{2}v'(a)\right)$) as $V'(a) > v'(a)$.

Proposition 1 (Gans, 2004). *Suppose that the initial owner is an outside party. Let*

$$(\alpha)\ \pi_O^O > \pi_A^A - \pi_A^O \text{ and}$$
$$(\beta)\ \pi_O^O > \pi_B^B - \pi_B^O .$$

(α) and (β) are necessary and sufficient conditions for O-ownership to be the unique Nash equilibrium outcome. If either $\pi_O^O < \pi_A^A - \pi_A^O$ *or* $\pi_O^O < \pi_B^B - \pi_B^O$*, then O-ownership is not a Nash equilibrium. B-ownership is the unique Nash equilibrium if (α) holds but* $\pi_O^O < \pi_B^B - \pi_B^O$*. A-ownership is the unique Nash equilibrium if (β) holds but* $\pi_O^O < \pi_A^A - \pi_A^O$*.*

The proof is a special case of the results in Gans (2004). Note that the externalities mean that the auction outcome may not be efficient but, in addition, that the least efficient outcome (ownership by *O*) can be the unique equilibrium when (α) and (β) both hold. (α) and (β) are equivalent to:

$$\tfrac{1}{3}\left(V(a_O) - v(a_O) - \underline{v}\right) > V(a_A) + v(a_A) - 2a_A - \left(V(a_O) + v(a_O) - 2a_O\right) \qquad (1)$$
$$\tfrac{1}{3}\left(V(a_O) - v(a_O) - \underline{v}\right) > V(a_B) - V(a_O) \qquad (2)$$

It is perhaps not surprising that, all other things being equal, as the impact of ownership on *A*'s investment incentives becomes greater, *O*-ownership is less likely to be an equilibrium outcome. This effect is captured by the right hand sides of (1) and (2) above. Note that, for each, as $a_A, a_B \to a_O$, these inequalities always hold as the incomplete contracting case approximates the complete contracting one.

The above result applies when an outside party is the initial owner so that the asset is allocated to the highest bidder. When either *A* or *B* is the initial owner, they will need to compare any bid received to their own value of owning the asset. In addition, *A* or *B* would also care about which agent actually received the asset. *B*, for example, would earn more rents ex post by selling to *A* and hence, would be willing to accept a lower bid from *A* as compared to *O*.

Given this, it is easy to see that if *B* owned the asset initially, it would always sell to *A*. That is, suppose that *B* received *O*'s maximal bid of π_O^O and that (β) held (so the *B* preferred to accept this bid than retain ownership). Then, the minimum amount *A* would have to pay *B* to make *B* indifferent between selling to *A* or *O* would be: $\pi_O^O + \pi_B^O - \pi_B^A$. If *A* paid this amount, then it would receive a payoff of $\pi_A^A + \pi_B^A - \pi_O^O - \pi_B^O$ (exceeding its payoff under *O*-ownership) and *B* would receive $\pi_O^O + \pi_B^O$ (exceeding its payoff from retaining ownership).[6] A similar calculation reveals that *A* would sell to *B* if it were the initial owner, so long as (α) held.

Thus, if initial ownership resides with a productive agent, it is no longer the case that a once-off auction would result in *O*-ownership; although as demonstrated in Gans (2004) this outcome is specific to the two productive agent case.[7] Note, however, that the outcome is not necessarily efficient, as the presence of outside parties allows *A* to potentially extract more rents by threatening to impose a negative externality on *B*. In this model, *B* can only prevent this by (inefficiently) owning the asset.[8,9]

2. Re-Sale

The above discussion demonstrates the incentives of *A* to sell to *B* and vice versa when each has an option of selling to an outside party. However, this incentive is, in part,

[6] If condition (β) did not hold, then *B* would still sell to *A* as the presence of outside parties would not impact on their gains from trade and so the asset would go to the efficient owner.

[7] When there are *N* productive agents, conditions slightly strong than (α) and (β) are required to generate outside ownership as an equilibrium.

[8] If *B* could pay *A* not to sell the asset to any party, then *A*-ownership would be retained. The difficulties of restricting future asset trading are considered in the next sub-section.

[9] This reflects the general result of Segal (1999) that when there are negative externalities between potential

driven by the assumption that when one agent sells to the other, no further trades are possible.[10] If they were, this would open up the possibility that that asset might be sold back to the initial asset owner; utilising the threat of selling to an outside party to extract more rents from them. To take into account such possibilities, Jehiel and Moldovanu (1999) have constructed an explicit, dynamic model of re-sale markets when externalities are present between agents. Their model is applied here to the case of ownership. In so doing, we can exploit the advantages of their framework for considering potential restrictions on trade as well as situations where the sale of assets is negotiated rather than openly sold.

As it turns out, their re-sale model reinforces and in some respects strengthens the prediction of the simple once-off auction model, that outside parties control the asset at Date 1, *regardless of who the initial asset owner is*. To see this, suppose that between Dates 0 and 1, there are T trading periods in which the asset can be sold and re-sold. At the beginning of each stage t, $1 \leq t < T$, the current owner of the asset chooses between selling or waiting for one period. If a trade occurs at t, this determines the owner at $t+1$ who faces a similar choice. In the final stage, T, no further sales are possible and the owner then is the owner at Date 1 and beyond. There is no discounting, so the only friction in this model is driven by the looming deadline. For example, an owner in the penultimate period $(T-1)$ who proposes a trade that is refused faces no other trading opportunities and remains the owner.

buyers of an indivisible object, more trade occurs than would be socially efficient.

[10] Indeed, it is also driven by the commitment inherent in the auction format; if a sale to the preferred bidder does not occur, then the asset is sold to the next preferred bidder. Jehiel and Moldovanu (1999) describe this as a mechanism with commitment. In contrast, the re-sale model considered here is a mechanism without commitment.

Jehiel and Moldovanu study how restrictions on the types of trades an owner at any stage can propose impact on the identity and efficiency of ultimate asset owners. These restrictions will be discussed in more detail below. For the moment, suppose that agents are restricted to 'bilateral trades without commitment.' Under this restriction, the owner at time *t* can only make a sale offer (take it or leave it) to one other agent and, in so doing, base it only credible threats. Jehiel and Moldovanu (Proposition 4.3) demonstrate that in this case that, so long as *T* is large enough, in any subgame perfect equilibrium, the final owner (at *T*) is the same regardless of who the initial owner is.

Here, however, a more complete characterisation can be provided:

Proposition 2. *Let (β)' be* $\pi_O^O + \pi_B^O - \pi_A^A > \pi_B^A - \pi_A^B$. *If (α) and (β)' hold,* $T \geq 2$ *and asset owners are restricted to trade offers that are bilateral and without commitment. Then, the owner at T is always O. Otherwise so long as* $T > 2$, *A-ownership is an equilibrium outcome.*

Thus, as for Proposition 1, we can predict the identity of the final owner based on the payoffs that might be realised by each agent at Date 2.[11] Nonetheless, in contrast to Proposition 1, *B*-ownership is never an equilibrium outcome in the re-sale game. In addition, (*β*)' is a stronger condition than (*β*) (it, in fact, implies it). However, if *A* and *B* are symmetric or indispensable, (*β*)' and (*β*) are equivalent.

The intuition behind Proposition 2 is simple. As trades cannot occur beyond the final period, if, in the penultimate period, all agents had an incentive to sell to *O* (and *O* no incentive to sell to others), then *O*-ownership would be the outcome. This is because, in the absence of commitment, the history of trades up until that time is irrelevant. So if, say, *A* owned the asset at $T-1$, the bilateral offer constraint means that *A* chooses

[11] This modifies Proposition 4.7 of Jehiel and Moldovanu (1999) that requires that the payoffs of all agents when they do not own that asset be equal (although in that case it holds for $T \geq 2$).

between trading with O, B or holding onto the asset. There would be no gains from trade with B (as B could credibly refuse any payment and retain its payoff under A-ownership). By (α), A and O have positive gains from trade and so that would occur.[12]

It is worth comparing Proposition 2 with the earlier observation that, say B, used a simple (but discriminatory) auction to sell the asset, then A would purchase the asset. The gains from trade between B and A in that case (that is, $\pi_A^A + \pi_B^A - (\pi_O^O + \pi_A^O + \pi_B^O)$), depended upon the conjecture that B would otherwise sell the asset to O. In contrast, if B owned the asset in period $T-1$ of the re-sale game, the gains from trade with A would be $\pi_A^A + \pi_B^A - (\pi_B^B + \pi_A^B)$ based on the fact that otherwise B would be the ultimate asset owner. This difference in conjectures drives the distinct results and arises because the auction despite the bilateral nature of payments is, in fact, a multilateral trading mechanism with commitment.[13]

Restoring Efficiency

What the re-sale model demonstrates is that predictions of outside ownership are robust to variations in initial ownership. However, it relies on the dual restrictions of bilateral trading and a lack of commitment. Jehiel and Moldovanu (1999) demonstrate that when owners can choose multilateral mechanisms (offers of contingent payments to

[12] When there are more than two productive agents, it can be easily demonstrated that O-ownership continues to be the unique equilibrium outcome. The relevant condition (assuming all productive agents are symmetric is that $\pi_O^O + \pi_i^O > \pi_i^i$ for all i). This is because the constraint to bilateral trades means that in the penultimate period, an owner is constrained to make an offer to one agent only. Hence, even with N productive agents, the outcome in this period is a comparison of the gains of trade between an agent and another productive agent or an outside party.

[13] There is also a difference in the bargaining power assumptions on the buyer and seller with the re-sale (auction) model giving all power to the seller (buyer). The re-sale model's results only depend on the gains from trade and hence, can be re-stated for any bargaining power assumption.

any number of agents) without commitment (relying on threats that are not credible), the owner at *T* is always the efficient owner (maximising the joint payoffs of all agents). These conditions can be relaxed while preserved the efficiency outcome. In particular, they demonstrate that, so long as either (i) unanimity is required so that all agents must agree to any proposed trade or (ii) side-payments from non-owners are possible *and* the number of agents is less than or equal to 3, the owner at *T* is efficient.

On unanimity, as Jehiel and Moldovanu (1999) observe, while some institutions do exist that give such rights, "they seem hardly compatible with the common sense of 'property rights.' Quite often such institutions are inefficient because there is a risk that trades are delayed by agents who are not actually harmed by the transaction." (p.983)

On the other hand, it is possible to imagine institutions that allow for side-payments from non-owners. The following proposition demonstrates that when such payments are possible, even if commitment is not, then efficiency is restored.

Proposition 3. *Suppose there are N productive agents, $T > 2$ and asset owners at time t < T can make trade contingent offers to any number of agents. Then, in any subgame perfect equilibrium, the owner at T is always efficient (i.e., A) regardless of initial ownership.*

Jehiel and Moldovanu (1999) only find efficiency for multilateral mechanisms without commitment when there are three or fewer agents. In the ownership context, however, because *O*-ownership is the worst outcome for any non-owner, so long as a sufficient number of trades are possible, efficient ownership will result. Thus, it holds when there are many productive agents.

The proof of this proposition (in the appendix) demonstrates that the reason for this outcome is that in the penultimate trading period, if *O* owns the asset, it has the incentive to extract payments from all agents for a sale to the efficient owner. Other agents may not be able to achieve this as they cannot credibly threaten a low payoff outcome for each agent. Therefore, if any agent owns the asset prior to the penultimate period, it has an incentive to sell to *O*; themselves extracting their maximal rents.

Proposition 3 demonstrates that so long as payments can be extracted from all productive agents, markets for ownership will generate the GHM efficient outcome.[14] Importantly, *the efficiency of multilateral trading in the absence of commitment here relies on the role of outside parties as active trading partners*. It is precisely their role in extracting rents from productive agents that gives outside parties that ability to make credible threats and thus, trade to an efficient outcome.[15] In their absence, with many productive agents, efficient ownership may not arise.

3. Markets for Ownership Shares

The analysis to date has focused on situations where agents can only trade ownership of an entire asset. While this accords with the environment subject to the greatest attention in the incomplete contracts literature, in reality, ownership trade often involves the exchange of more limited rights – namely, of shares of ownership. This makes the commodities being traded more divisible and opens up the possibility that the potential inefficiencies and role of outside parties analysed above may not be robust to share trading.

[14] It also relies critically in the existence of a final trading period beyond which no further trading is possible. In an earlier version of Gans (2004) – available at www.ssrn.com – a re-sale model where future trading opportunities were stochastically available was developed. That model highlighted the importance of being able to impose contractual restrictions on future trade as a means to generating an efficient outcome.

[15] Nonetheless, while it is easy to imagine circumstances when multilateral trading is possible with a small number of productive agents, as their numbers grow there are potential difficulties in generating

This section examines this issue by allowing productive agents and outside parties to own and trade ownership shares. It is demonstrated that, in a natural extension of the re-sale model, there are conditions under which outside parties own non-trivial shares in the asset and that this is not GHM-efficient. However, the analysis also highlights the important role of joint ownership between productive agents in markets for ownership.

Control Structure and Bargaining with Ownership Shares

Let σ_i denote the share of agent *i* in the asset. It is assumed that the control structure of the asset is such that majority rule applies. That is, the asset can be utilised by a coalition of agents, *S*, so long as $\sum_{i \in S} \sigma_i > 0.5$. For example, if *A* and *B* each had half of the shares in the asset, it could not be used unless both agreed (i.e., were part of the coalition). Alternatively, if *A* owned 50 percent of the asset, while the rest of the shares were divided among *B* and an *O*, then the asset could only be utilised if *A* agreed; although if *A* did not agree, the asset could not be used. For this reason, if any agent has $\sigma_i > \frac{1}{2}$, then it controls the asset with the same ex post bargaining position as it would have with $\sigma_i = 1$ (i.e., 100% share ownership).

Given this majority rule control structure, Table 2 depicts the payoffs each agent expects to receive (based on the Shapley value) for any particular share allocation. Note that these calculations assume that no more than one outside party owns shares in the asset. Alternatively, one could suppose that outside parties, when they own shares, vote and negotiate as a block. This is a reasonable assumption given the fact that an outside party may not earn any rents unless it has at least half of the shares and would always

multilateral agreements. The issues associated with this are discussed in Gans (2004).

gain by collusion (say, through common appointees to a board of directors). However, this is an assumption here and a complete exploration of it would require a more fully specified model of voting block formation. That task is left for future work.

Table 2: Negotiated Payoffs with Ownership Shares
($a_A > a_E > a_B > a_O > a_{BO}$)

Ownership Structure $(\sigma_A, \sigma_B, \sigma_O)$ 0, <, = or > ½	**Payoffs** *A*	*B*	*O*
A: >, <, <	$\frac{1}{2}(V(a_A)+v(a_A))-a_A$	$\frac{1}{2}(V(a_A)-v(a_A))$	0
A-50: =, <, <	$\frac{1}{6}(3V(a_E)+v(a_E))-a_E$	$\frac{1}{6}(3V(a_E)-2v(a_E))$	$\frac{1}{6}v(a_E)$
E: <, <, <	$\frac{1}{6}(3V(a_E)+v(a_E)-2\underline{v})-a_E$	$\frac{1}{6}(3V(a_E)-2v(a_E)+\underline{v})$	$\frac{1}{6}(v(a_E)+\underline{v})$
AB: =, =, 0	$\frac{1}{2}V(a_B)-a_B$	$\frac{1}{2}V(a_B)$	0
B-50: <, =, <	$\frac{1}{6}(3V(a_B)-2\underline{v})-a_B$	$\frac{1}{6}(3V(a_B)+\underline{v})$	$\frac{1}{6}\underline{v}$
B: <, >, <	$\frac{1}{2}(V(a_B)-\underline{v})-a_B$	$\frac{1}{2}(V(a_B)+\underline{v})$	0
AO: =, 0, =	$\frac{1}{6}(2V(a_O)+v(a_O))-a_O$	$\frac{1}{3}(V(a_O)-v(a_O))$	$\frac{1}{6}(2V(a_O)+v(a_O))$
O: <, <, ≥	$\frac{1}{3}\left(V(a_O)-\underline{v}+\frac{1}{2}v(a_O)\right)-a_O$	$\frac{1}{3}\left(V(a_O)-v(a_O)+\frac{1}{2}\underline{v}\right)$	$\frac{1}{3}\left(V(a_O)+\frac{1}{2}(v(a_O)+\underline{v})\right)$
BO: 0, =, =	$\frac{1}{3}(V(a_{BO})-\underline{v})-a_{BO}$	$\frac{1}{6}(2V(a_{BO})+\underline{v})$	$\frac{1}{6}(2V(a_{BO})+\underline{v})$

Some observations arising from Table 2 are worthy of emphasis. First, note that there are only nine classes of ownership in terms of distinct payoffs to all three agents.[16] This is because it is not so much the level of share ownership that controls an agent's payoff in ex post bargaining but its ability to use those share rights to form coalitions that can make productive use of the asset. When two agents each own half of the shares, this requires consent of both parties. For this reason, outside parties can exercise some control

[16] In models where equity shares give rise to a continuum of outcomes, it is assumed that such a share entitles the owner to fixed proportion of the returns in the asset. For example, Aghion and Tirole (1994) provide a model where an outside party (a venture capitalist) owns shares that dilute a research unit's incentive to undertake non-contractible research effort. In their model, the share ownership guarantees the outside party to a proportion of the research unit's rents in bargaining. In a full GHM property rights model, like that studied here, such a commitment cannot be made and the division of rents between the research unit, venture capitalist and others would be determined only by ex post bargaining.

in only six of the ownership classes even though they might be observed to own shares in all of them. Thus, in understanding outside party share ownership it is important to distinguish between *trivial* ownership (affording them no rents) and *non-trivial* ownership (where they have some bargaining power).

Second, note that *A* and *O* earn strictly more rents from an *AO* joint venture than from *O*-ownership. This means that *O*-ownership will be less likely when shares can be traded as there are always gains from trade between *A* and *O*. Finally, *A*-ownership remains the unique GHM-efficient ownership structure in this environment.

Bilateral Share Trading with Re-Sale

Given the nature of externalities involved, constructing a model of share trading is potentially complex. An auction format, such as that used in Gans (2004) while easy to analyse when the initial owner owns all of the shares, becomes difficult for other initial ownership configurations when there might be multiple owners. In that situation, the model would be sensitive to assumptions regarding the timing of sale offers of those owners.

For this reason, a natural extension of the re-sale model is considered. This allows us to capture the idea that share deals might be negotiated as well as explore the restriction of *bilaterality* in this context. Rather than share owners being able to make take-it-or-leave-it offers to other agents (which creates difficulty of two owners offer to sell shares to one another), it is assumed here that trade occurs in a period to maximise the expected bilateral gains from trade between any two parties (where an outside party is always analysed as a single agent engaging in trade; although a continuum of such agents may exist). So, if A and O were to trade, then they re-allocate their shares optimally amongst themselves to maximise their expected joint surplus. Finally, the trading pair in a period is the pair that would achieve the greatest bilateral gains from trade. Thus, it is assumed here that only a single exchange can occur each period.[17]

Under this set of trading rules, the following can be demonstrated:

Proposition 4. *Let (γ) be:*

$$\max\left\{\pi_B^{AO}+\pi_O^{AO}-\pi_B^{AB},\pi_A^{BO}+\pi_O^{BO}-\pi_A^{AB}\right\}>\pi_A^{A}+\pi_B^{A}-\pi_A^{AB}-\pi_B^{AB}.$$

Then so long as (α), (β)' and (γ) hold and $T \geq 2$, then, in any equilibrium, O has a non-trivial level of ownership at T.

This result states that neither A, B nor an AB joint venture will occur in equilibrium, regardless of the initial distribution of ownership shares. The intuition for this result is simple. In order for there to be A-ownership at time T, the owners at time $T-1$ must agree to a share trade that leads to A having more than half of the shares. The fact that this exchange must be bilateral rules out an exchange from BO joint ownership. Moreover, conditions (α) and (β)' rule out exchanges from ownership classes where either A or B have a large proportion (half or greater) of shares as there are greater gains from trade from trading with O.[18] This leaves AB as the only candidate at $T-1$ for achieving A-ownership. (γ) rules out such a trade between A and B by assuming that the gains from trade between A and O or B and O from an AB joint venture exceed the gains from trade between A and B (that would otherwise lead to A-ownership). (γ) also rules out trading from an AO or BO joint venture at $T-1$, that might lead to AB.

Turning to the interpretation of (γ), note that it is equivalent to:

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[17] This is admittedly an ad hoc simplification but it does eliminate a potential source of multiple equilibria. If outside owners are always acting as a block, however, there would be no opportunity for more than a single bilateral trade in any period.

[18] Similarly, for trading from E.

$$\tfrac{1}{6}(V(a_O)-v(a_O)) > \tfrac{1}{2}\big(V(a_B)-V(a_O)\big)-a_B \tag{3}$$

As in conditions (α) and (β), the right hand side reflects the relative inefficiency of an *AO* joint venture to an *AB* joint venture, while the left hand side measures the degree of complementarity between *A* and *B*. Thus, it can be easily demonstrated that as the incentive effects of ownership diminish and the complete contracting outcome emerges, then all of the relevant conditions justifying a non-trivial level of outside party ownership in Proposition 4 hold. As in Gans (2004), one must be cautious in interpreting this relationship as the inefficiency of ownership by outside parties is associated with the degree of complementarity between *A* and *B*. Hence, one could observe increasing efficiency associated with an increased likelihood of outside party ownership.

The restriction to bilateral trades plays an important role in Proposition 4. In fact, when one agent controls most of the shares in the penultimate period of the re-sale model, it is easy to imagine situations in which they might make sale offers to several productive agents. For instance, if *O* owned all shares at $T-1$, it could make offers to *A* and *B* to achieve *AB* at *T*. As all three parties are participating in that exchange, all externalities could be internalised. In contrast, achieving *A*-ownership would be more difficult as *A* would prefer *O*-ownership and so by (α) there are no gains from trade here unless *B* participates in the exchange. Thus, this outcome could be achieved if *A* owned exactly half of the shares with some shares being sold to *B*. Otherwise to achieve full efficiency would require a multilateral mechanism or, alternatively, commitment devices.

4. Conclusion

This paper has explored the ownership structures that will arise under alternative asset trading assumptions. In so doing, it has been demonstrated that while such trading need not be based on mechanisms that require commitment (in the sense that non-credible threats can be made) in order to generate efficient ownership, such outcomes do require multilateral payments from productive agents as well as sufficient opportunities for re-sale. Interestingly, achieving efficiency relies upon outside parties being active traders as they are the only agents that can facilitate the coordination amongst productive agents to an efficient outcome. In the absence of multilateral payments, efficient ownership cannot be guaranteed and outside ownership (the least efficient structure) remains a robust possibility.

This analysis here suggests that in understanding the role of outside parties as owners, economists should look beyond their static role as permanent owners and should consider their role as traders as well. It has been demonstrated here that outside parties can, at times, play an important facilitating role and may have incentives to internalise ownership externalities amongst productive agents. Thus, their observed presence as owners could possibly mask their efficient role in a broader dynamic environment.

Appendix

Proof of Proposition 2

First, note that if at $T-1$, each agent wishes to sell to the same agent (or hold on to ownership if they are that agent), then that will be the equilibrium outcome. Second, if *B* wants to sell to *A* at $T-1$, then all agents will sell to *B* at $T-2$. This is because *B* at $T-1$ can always internalise the full surplus under *A*-ownership and compare it to other alternatives. This internalisation also holds for those selling to *B* at $T-1$.

Now note that $\pi_O^O + \pi_B^O - \pi_A^A > \pi_B^A - \pi_A^B \Rightarrow \pi_O^O + \pi_B^O > \pi_B^B$ (condition (β)). This means that if *O* owns the asset at $T-1$, they will continue to own it at *T*. Note also, that if *A* owns that asset at $T-1$, they will prefer to hold it rather than sell it to *B*. If (α) holds, they will sell it to *O* at this stage. Finally, if *B* owns the asset at $T-1$, by holding on to it they earn π_B^B, by selling to *A* they earn $\pi_A^A + \pi_B^A - \pi_A^B$ and by selling to *O* they earn $\pi_O^O + \pi_B^O$. Therefore, *B* always prefers selling to *A* than holding. However, if (β)' holds, it prefers to sell to *O*. Thus, all agents prefer to sell to *O* at $T-1$, if (α) and (β)' hold, so it is the unique subgame perfect equilibrium outcome in that case.

If (β)' does not hold, *B* prefers to sell to *A* at $T-1$. Therefore, by the earlier observation, all agents prefer to sell to *B* prior to $T-1$ and *B* prefers to hold until $T-1$. Thus, *A*-ownership is a subgame perfect equilibrium outcome. If (α) does not hold, but (β)' does, then *A* will hold at $T-1$. Again, by the earlier observation, all agents will prefer to sell to *A* prior to $T-1$; making it a subgame perfect equilibrium outcome. If either (α) or (β)' do not hold strictly, then *A*-ownership is the unique subgame perfect equilibrium outcome.

Proof of Proposition 3

Suppose that *O* is the owner at $T-1$ and wishes to sell to agent *j*. It can make a take-it-or-leave-it offer to all agents for a payment of $\pi_i^j - \pi_i^O$ from each agent *i*. The trade occurs so long as each agent accepts the offer; as the alternative is *O*-ownership and by complementarity, π_i^O is each agent's minimum payoff, each will accept this offer. Thus, *O* receives $\sum_i (\pi_i^j - \pi_i^O)$ which always exceeds π_O^O. *O* maximises this payoff by choosing *j* so that $\sum_i \pi_i^j$ is maximised; i.e., the efficient owner (say *A*).

To complete the proof, we need to demonstrate that any other agent has an incentive to ensure that *O* is the owner at $T-1$. If another productive agent, *j*, is the owner at $T-1$, the maximum payoff they can receive is: $\max\left\{\pi_j^j, \max_e \pi_j^e + \sum_{i\neq j}(\pi_i^e - \pi_i^j)\right\}$; suppose this results in an owner, *n*. Thus, any owner at *T* – 2 (say *m*), would be able to earn $\sum_i \pi_i^A - \sum_{i\neq m}\pi_i^O$ by selling to *O*, and only, at most (net of a reduced payment to *j* as it expects to earn something if it does not accept *m*'s offer), $\sum_i \pi_i^n - \sum_{i\neq m}\pi_i^j$ by selling to *j*.

Proof of Proposition 4

At $T-1$, note that for a bilateral trade to occur it must either (i) increase value created; or (ii) decrease the share of value appropriated by the agent not part of the transaction. Note that *A*-ownership cannot be achieved by a bilateral trade from *BO* joint ownership.

A, if it owns the asset at $T-1$, will prefer to sell to *O* rather than hold on to it, by condition (α). For the same reason, *A*-ownership cannot be achieved from *O*-ownership, *E*, *A*-50, or *AO* joint ownership (as this creates the same value as *O*-ownership but gives *A* a greater share of value). *A* will never sell any shares to *B* as this does not satisfy either (i) or (ii) above.

B, if it owns the asset (or only 50% of it) at $T-1$, will prefer to sell to *O* by condition (β) than hold on to it. It will not sell fully to *A* by condition (β)' nor partly as this does not satisfy (i) and (ii) above.

From *AB*, the gains to trade between *A* and *B* to reach *A*-ownership are: $V(a_A)-a_A-(V(a_B)-a_B)$. If *A* traded with *O*, the maximal gains from trade are $\frac{1}{3}(2V(a_{BO})-\frac{1}{2}\underline{v})-a_{BO}-(\frac{1}{2}V(a_B)-a_B)$ (moving to *BO* joint ownership) and between *B* and *O* the gains are $\frac{1}{3}(2V(a_O)-\frac{1}{2}v(a_O))-\frac{1}{2}V(a_B)$ (moving to *AO* joint ownership). By (γ), at least one of these will dominate trade between *A* and *B*.

Turning now to consider the possibility of *AB* emerging at *T*, note that the only structures at $T-1$ that can lead to this are *A*, *B*, *A*-50, *B*-50, *AO* and *BO*. It was demonstrated above that *A* will prefer to trade with *O* rather than *B* from *A*. Similarly, by (β)', *B* will prefer to trade with *O* rather than *A* from *B*. From *A*-50, the gains from trade from *A* and *O* exceed those from *B* and *O* (by (β)) and similarly for trade from *B*-50, relying on (α). Finally, (γ) rules out positive gains from trade from *BO* or *AO* to *AB*.

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