The Property-Contract Balance

by

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Internet Appendix

A.1 Moral Buyers

For the sake of simplicity and symmetry with the basic setup we assume that $s \ge q + \mu(1-q)$: this implies that, for $V = \overline{V}$, an immoral intermediary weakly prefers stealing and then charging \overline{p}^l to stealing and then charging \overline{p}^h . Should the latter not be the case, the analysis will be similar but more cumbersome since there could be pooling equilibria around¹

$$\tilde{p} \equiv \Pr(\text{proper title}|\hat{s} = 0)\overline{V} + \Pr(\text{defective title}|\hat{s} = 0)(1-q)\overline{V} \\ = (1-q)\overline{V} + \frac{q\mu}{1-s(1-\mu)}\overline{V}.$$

which is the price making all buyers indifferent between buying or not when the signal is uninformative and both types of intermediaries are in the market. Let us start with the $V = \overline{V}$ case by checking whether there is a separating equilibrium under owner protection. To avoid the cost m, moral buyers will not pay \overline{p}^l since this price signals a good stolen for sure (see Table A1). Also, immoral intermediaries will not lower the price to $(1-q)\overline{V} - m < \Delta$ in order to sell for sure since this strategy is dominated by the one of buying the good and then charging \overline{p}^h (see Table A1).

Table A1 Immoral Intermediary's Payoffs when Buyers Can Be Moral, i = O, and $V = \overline{V}$

| | \overline{p}^h | \overline{p}^l |
|-------|---------------------|--------------------------------|
| Buy | $\overline{V} - U$ | $(1-\mu)(1-q)\overline{V} - U$ |
| Steal | $(1-s)\overline{V}$ | $(1-\mu)(1-q)\overline{V}$ |

Therefore, there is a value of θ – i.e.,

$$\overline{\theta}_O^M \equiv \frac{1 - [q + \mu(1 - q)]}{q + \mu(1 - q)} \le \frac{1 - q}{q} \equiv \theta^*$$

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¹Pr(proper title $|\hat{s} = 0$) = Pr($\hat{s} = 0$ |proper title) Pr(proper title) / Pr($\hat{s} = 0$) = $\mu/[1 - s(1 - \mu)] = 1 - \Pr(\text{defective title} |\hat{s} = 0).$

such that²

- 1. if $\theta < \overline{\theta}_O^M$, immoral intermediaries choose to steal and charge \overline{p}^l and thus the equilibrium is separating with prices \overline{p}^l and \overline{p}^h , moral buyers only buy legal goods, and the change in social welfare is $\mu\Delta + (1-\mu)^2(1-q)\Delta - \mu(1-\mu)U$, where the last term is an endogenous loss from theft due to the unsold stolen goods;
- 2. if $\theta \geq \overline{\theta}_O^M$, immoral intermediaries choose to buy and charge \overline{p}^h and thus all intermediaries buy and sell for \overline{p}^h and the change in social welfare is Δ .

Similarly, under good-faith buyer protection, we have that

- 1. if $\theta < \overline{\theta}_O^M$, the only equilibrium is separating with prices \overline{p}^l and \overline{p}^h and the change in social welfare is $\mu \Delta + (1-\mu)^2 (1-sq)\Delta \mu(1-\mu)U$;
- 2. if $\theta \geq \overline{\theta}_{O}^{M}$, all intermediaries buy and sell at \overline{p}^{h} and the change in social welfare is Δ .

Under full buyer protection, since a separating equilibrium is not possible, moral buyers remain in the market and buy if the signal they receive is not informative. In particular, there is a value of θ – i.e., $\overline{\theta}_B^M \equiv (1 - \mu s)/\mu s \ge \overline{\theta}_O^M$ but lower than θ^* – such that

- 1. if $\theta < \overline{\theta}_B^M$, immoral intermediaries choose to steal and all the goods are charged at \overline{p}^h and go unsold only when an immoral intermediary meets a moral buyer who happens to be informed and thus the change in social welfare is $[1 - \mu(1 - \mu)s]\Delta - \mu(1 - \mu)sU;^3$
- 2. if $\theta \geq \overline{\theta}_B^M$, immoral intermediaries choose to buy and charge \overline{p}^h and thus all intermediaries buy and sell for \overline{p}^h and the change in social welfare is Δ .

For V = V, there are neither moral intermediaries nor moral buyers on the market. Only stolen goods are sold to immoral buyers for p^l under both owner and good-faith buyer protection and for \underline{p}^h under full buyer protection. The changes in social welfare are

$$\underline{W}_{O}^{M} = -(1-\mu)^{2}(1-q)\Delta - \mu(1-\mu)U,$$

$$\underline{W}_{GF}^{M} = -(1-\mu)^{2}(1-sq)\Delta - \mu(1-\mu)U,$$

$$\underline{W}_{B}^{M} = -(1-\mu)^{2}\Delta - \mu(1-\mu)U.$$

Endogenous Institutions Selection. For $V = \overline{V}$ and $\theta \geq \overline{\theta}_B^M$, we have that

 $P(B \succ O) = P(\varepsilon \ge 0), \quad P(B \succ GF) = P(\varepsilon \ge 0), \quad P(GF \succ O) = P(\varepsilon \ge 0).$

² Note that the function $g(x) \equiv (1 - x)x^{-1}$ is strictly decreasing in x and $q + \mu(1 - q) \ge q$. ³ Again a price convincing moral buyers to buy also stolen goods is not viable because $(1-q)\overline{V} - m < U.$

Since the scope of trade is completely exploited, the probability that society will move toward more protection of the buyer is insensitive to both μ and q. For $\overline{\theta}_O^M \leq \theta < \overline{\theta}_B^M$, instead

$$P(B \succ O) = P(\varepsilon - \mu(1 - \mu)s(U + \Delta) \ge 0),$$

$$P(B \succ GF) = P(\varepsilon - \mu(1 - \mu)s(U + \Delta) \ge 0),$$

$$P(GF \succ O) = P(\varepsilon \ge 0).$$

Because, this time, the price will always equal \underline{p}^h and goods will go unsold when an immoral intermediary meets an informed moral buyer, the probability that society will move toward more protection of the buyer will be a function of the odds of this match – i.e., $\mu(1-\mu)$. Hence, it will fall (increase) with the share of moral agents when the latter is sufficiently small (big) – i.e., $\mu < 1/2$ ($\mu \ge 1/2$). Turning to the $\theta < \overline{\theta}_O^M$ case, it is true that

$$\begin{split} P(B \succ O) &= P([1 - \mu - \mu(1 - \mu)s - (1 - \mu)^2(1 - q)]\Delta \\ &+ \mu(1 - \mu)(1 - s)U + \varepsilon \ge 0), \\ P(B \succ GF) &= P([1 - \mu - \mu(1 - \mu)s - (1 - \mu)^2(1 - sq)]\Delta \\ &+ \mu(1 - \mu)(1 - s)U + \varepsilon - \varepsilon \ge 0), \\ P(GF \succ O) &= P((1 - \mu)^2(1 - s)q\Delta + \varepsilon \ge 0). \end{split}$$

Consistently with the proposition, the probability that society will move toward more protection of the buyer will rise with q and fall, in the most likely case, with μ .⁴ Finally, for $V = \underline{V}$:

$$P(B \succ O) = P(\varepsilon - (1 - \mu)^2 q\Delta \ge 0),$$

$$P(B \succ GF) = P(\varepsilon - (1 - \mu)^2 sq\Delta \ge 0),$$

$$P(GF \succ O) = P(\varepsilon - (1 - \mu)^2 (1 - s)q\Delta \ge 0),$$

which imply that the comparative statics discussed in the proposition remain unaffected.

A.2 The Original Owner has a Buy-Back Option

Noting changes under owner protection. If $V = \overline{V}$, under good-faith buyer protection a buyer in bad faith has to return the good, while a buyer in good faith is subject to the owner's buy-back option. Since buyers in bad faith have to return the good, the equilibrium does not change with respect to Lemma 1. If the compensation to be paid by the owner is equal to the market price, owners do not reclaim stolen property from good-faith buyers and hence nothing changes with respect to the basic model. If instead the compensation is equal to the purchase price, owners reclaim stolen property if the

⁴ Indeed, $\partial P(B \succ O) / \partial \mu < 0$ ($\partial P(B \succ GF) / \partial \mu < 0$) whenever $\theta < (2\mu - 1)(1 - s) / 2\mu s - 1 - s + 2(1 - \mu)(1 - q)$ ($\theta < (2\mu - 1)(1 - s) / 2\mu s - 1 - s + 2(1 - \mu)(1 - sq)$).

purchase price is low enough: $\overline{p}^l < U.^5$ In this case, the change in social welfare is reduced to $\overline{W}_{GF}^L = \mu \Delta + (1 - \mu)(1 - q)\Delta = \overline{W}_O$: when goods revert to the original owner irrespective of the good faith of the buyer, this rule performs in the same way as owner protection. Under full buyer protection, owners do not exercise the buy-back option because both the purchase price and the market price are equal to $\overline{V} > U$. Thus, goods remain with the buyer and model message remains.

If $V = \underline{V}$, under good-faith buyer protection only immoral intermediaries remain on the market: they steal the good and sell it for \underline{p}^l . Owners reclaim stolen property under both compensation measures, because $\underline{p}^l = (1-q)\underline{V} < \underline{V} < U$. Thus, the change in social welfare improves to $\underline{W}_{GF}^L = -(1-\mu)(1-q)\Delta = \underline{W}_O$, since goods revert to the original owner irrespective of the good faith of the buyer. Under full buyer protection, only stolen goods are on the market and they are sold for a high price. Owners exercise the option to buy back and hence all goods are reverted to them if found and $\underline{W}_B^L = \underline{W}_O$.

A.3 Relaxing Assumptions 1, 2, and 3

We first relax Assumptions 1 and 3 holding Assumption 2 and then assess how restrictive the latter is.

A.3.1 Relaxing Assumptions 1 and 3

Table A2 illustrates the equilibria arising in the $V = \overline{V}$ case.⁶

| | $0 \le m < U - q\overline{V}$ | $U - q\overline{V} < 0 \le m < U$ | $0 < U - q\overline{V} \le m < U$ | $U \le \min\{m, q\overline{V}\}$ |
|----|----------------------------------|-----------------------------------|-----------------------------------|----------------------------------|
| 0 | Steal, Steal, \overline{p}^l , | Buy, Buy, \overline{p}^h , | Lemma 1 | Buy, Buy, \overline{p}^h , |
| | $(1-q)\Delta - \mu m$ | Δ | | Δ |
| GF | Steal, Steal, \overline{p}^l , | Buy, Buy, \overline{p}^h , | Lemma 1 | Buy, Buy, \overline{p}^h , |
| | $(1-sq)\Delta - \mu m$ | Δ | | Δ |
| B | Steal, Steal, \overline{p}^h , | Steal, Steal, \overline{p}^h , | Steal, Steal, \overline{p}^h , | Lemma 1 |
| | $\Delta - \mu m$ | $\Delta - \mu m$ | $\Delta - \mu m$ | |

 $Table \ A2$ Moral and Immoral Intermediaries' Actions and Welfare Changes if $s \geq q$ and $V = \overline{V}$

The key patterns can be summarized as follows: (1) being s > q the intermediary's choice under owner and good-faith buyer protection is always between buying and then charging \overline{p}^h and stealing and then selling at \overline{p}^l ; (2) the equilibria under owner and good-faith buyer protection are the same; (3) if $m < U - q\overline{V}$ (m < U), both types of intermediaries steal and then sell for \overline{p}^l (\overline{p}^h) under owner and good-faith buyer (full buyer) protection; (4) if $m \ge 0 > U - q\overline{V}$, both types of intermediaries buy and charge \overline{p}^h ; (5) moral costs induce social losses. As Table A3 shows, in the $V = \underline{V}$ case, if

⁵ Note that this condition is always verified if $q \ge 1/2$ (see Assumption 3).

⁶ Here two categories are excluded from the table: the benchmark case – i.e., $m > U > q\overline{V}$ – and the $m < U - q\overline{V} < 0$ case which is ruled out by the non negativity of m.

 $m < (1-q)\underline{V}$ both types will steal and sell at either \underline{p}^l or \underline{p}^h ; if $(1-q)\underline{V} \le m < U$, the equilibria are the same as in Lemma 2 except under full buyer protection when every intermediary steals and charges \underline{p}^h . Again moral costs produce a social loss. Turning to

 $Table \ A3$ Moral and Immoral Intermediaries' Acts and Welfare Changes if $s \geq q$ and $V = \underline{V}$

| | $m < (1-q)\underline{V}$ | $(1-q)\underline{V} \le m < U$ |
|----|--|---|
| 0 | Steal, Steal, p^l , $-(1-q)\Delta - \mu m$ | Lemma 2 |
| GF | Steal, Steal, $p^{\overline{l}}$, $-(1-sq)\Delta - \mu m$ | Lemma 2 |
| В | Steal, Steal, \underline{p}^h , $-\Delta - \mu m$ | Steal, Steal, \underline{p}^h , $-\Delta - \mu m$ |

the institutional design, for $V = \overline{V}$, we have that

(i)
$$0 \le m < U - q\overline{V}$$
:

$$P(B \succ O) = P(q\Delta + \varepsilon \ge 0),$$

$$P(B \succ GF) = P(sq\Delta + \varepsilon \ge 0),$$

$$P(GF \succ O) = P((q(1-s))\Delta + \varepsilon \ge 0),$$

which are insensitive to μ and increasing with q.

(ii) $U - q\overline{V} < 0 \le m < U$:

$$P(B \succ O) = P(\varepsilon - \mu m \ge 0),$$

$$P(B \succ GF) = P(\varepsilon - \mu m \ge 0),$$

$$P(GF \succ O) = P(\varepsilon \ge 0),$$

which are insensitive to q and falling with μ .

(iii)
$$0 < U - q\overline{V} \le m < U$$
:

$$P(B \succ O) = P((1-\mu)q\Delta - \mu m + \varepsilon \ge 0),$$

$$P(B \succ GF) = P((1-\mu)sq\Delta - \mu m + \varepsilon \ge 0),$$

$$P(GF \succ O) = P((1-\mu)(1-s)q\Delta + \varepsilon \ge 0),$$

which are falling with μ and rising with q.

(iv)
$$U < \min\{m, q\overline{V}\}$$
:

$$P(B \succ O) = P(\varepsilon \ge 0), \quad P(B \succ GF) = P(\varepsilon \ge 0), \quad P(GF \succ O) = P(\varepsilon \ge 0),$$

which are insensitive to both q and μ .

All in all, when $V = \underline{V}$ we have that

(i) m < (1-q)V:

$$P(B \succ O) = P(\varepsilon - q\Delta \ge 0),$$

$$P(B \succ GF) = P(\varepsilon - sq\Delta \ge 0),$$

$$P(GF \succ O) = P(\varepsilon - (1 - s)q\Delta \ge 0)$$

which are insensitive to μ and decreasing with q.

(ii)
$$m \ge (1-q)\underline{V}$$

$$P(B \succ O) = P(\varepsilon - (1 - (1 - \mu)(1 - q))\Delta - \mu m \ge 0),$$

$$P(B \succ GF) = P(\varepsilon - (1 - (1 - \mu)(1 - sq))\Delta - \mu m \ge 0),$$

$$P(GF \succ O) = P(\varepsilon - (1 - \mu)(1 - s)q\Delta \ge 0),$$

which implies a drift towards good-faith buyer protection as μ (q) rises (falls) because of the moral loss under full buyer protection.

A.3.2 Relaxing Assumption 2

While the analysis would remain completely equal to the case just discussed for $V = \underline{V}$, for $V = \overline{V}$ a separating equilibrium cannot be enforced anymore. This means that in the third range of m analyzed in Table A2 – i.e., $0 < U - q\overline{V} \le m < U$ – the equilibria under owner and good-faith buyer protection will be different. In particular, two sub-cases arise depending on whether $U - q\overline{V} \le m < U - s\overline{V}$ or $m > U - s\overline{V} > U - q\overline{V}$.⁷ For $U - q\overline{V} \le m < U - s\overline{V}$ all the intermediaries will steal and the analysis will resemble exactly the case $0 \le m < U - q\overline{V}$ in Table A2. For $U > m > U - s\overline{V} > U - q\overline{V}$, instead, the moral intermediaries will prefer to buy and the immoral ones to steal. This means that if the moral intermediaries remain in the market – i.e., if $\tilde{p} - U \ge 0$ or $\theta \ge (1 - \alpha)\alpha^{-1}$ where $\alpha \equiv (1-q)+q\mu/[1-s(1-\mu)]$ – both types will charge \tilde{p} ; if instead the moral intermediaries find the pooling price impossible to sustain – i.e., if $\theta < (1 - \alpha)\alpha^{-1}$ – only goods stolen by the immoral intermediaries will be sold at p^l . For $U > m > U - s\overline{V} > U - q\overline{V}$ and $\theta \ge (1-\alpha)\alpha^{-1}$ the changes in social welfare will equal $\mu\Delta + (1-\mu)((1-s)(1-q)\Delta - sU)$ under owner protection, $\mu\Delta + (1 - \mu)((1 - s)(1 - sq)\Delta - sU)$ under good-faith buyer protection and thus

$$P(B \succ O) = P((1-\mu)(1-(1-s)(1-q))\Delta + (1-\mu)sU - \mu m + \varepsilon \ge 0),$$

$$P(B \succ GF) = P((1-\mu)(1-(1-s)(1-sq))\Delta + (1-\mu)sU - \mu m + \varepsilon \ge 0),$$

$$P(GF \succ O) = P((1-\mu)(1-s)^2q\Delta + \varepsilon \ge 0),$$

which entail that the comparative statics discussed in the proposition remain unaffected. If $U > m > U - s\overline{V} > U - q\overline{V}$ and $\theta < (1 - \alpha)\alpha^{-1}$, instead, the changes in social welfare

⁷ Since buyers never buy at \overline{p}^h a possibly stolen good, the following cannot constitute an equilibrium: (1) moral intermediaries buy and immoral ones steal and both charge \overline{p}^h ; (2) all intermediaries steal and charge \overline{p}^h .

will equal $(1 - \mu)(1 - q)\Delta$ under owner protection, $(1 - \mu)(1 - sq)\Delta$ under good-faith buyer protection, and $\Delta - \mu m$ under full buyer protection. As a consequence:

$$\begin{split} P(B \succ O) &= P((1 - (1 - \mu)(1 - q))\Delta - \mu m + \varepsilon \ge 0), \\ P(B \succ GF) &= P((1 - (1 - \mu)(1 - sq))\Delta - \mu m + \varepsilon \ge 0), \\ P(GF \succ O) &= P((1 - \mu)(1 - s)q\Delta + \varepsilon \ge 0), \end{split}$$

which imply that only the first (second) comparative statics with respect to μ can differ from that stated in the proposition when $U - s\overline{V} < m < (1 - q)\Delta$ $(U - s\overline{V} < m < (1 - qs)\Delta)$.

A.4 The Owner's Incentives to Protect his Property

While the first (second) column of the Table A4 shows the minimum levels of private protection needed for deterrence when buyers have high (low) valuation, the third column lists the expected loss from the to the original owner. For $V = \overline{V}$, the original owner will protect his property when $\overline{C}_i \leq L_i$ – i.e., under owner protection if $\theta \geq \mu(1-q)/q \equiv \overline{\theta}_O$, under good-faith buyer protection if $\theta \ge \mu(1-sq)/q - 1 + s \equiv \overline{\theta}_{\underline{GF}}$, and never under full buyer protection. Note that $\overline{\theta}_{GF}$ increases with s reaching $\overline{\theta}_O$ when s tends to 1; thus, $\overline{\theta}_{GF} \leq \overline{\theta}_{O}$. There are three cases: (1) if $\theta < \overline{\theta}_{GF}$, the original owner never protects his property; (2) if $\overline{\theta}_{GF} \leq \theta < \overline{\theta}_O$, the original owner protects his property only under good-faith buyer protection; (3) if $\overline{\theta}_O \leq \theta \leq (1-q)/q \equiv \theta^*$, the original owner protects his property under both owner and good-faith buyer protection. For $V = \underline{V}$, private protection materializes if $\underline{C}_i \leq L_i$. This time, the owner will protect his property under owner protection if $\theta \ge \mu \equiv \underline{\theta}_O$, under good-faith buyer protection if $\theta \ge 1 - (1 - \mu)(1 - sq)/(1 - q) \equiv \underline{\theta}_{GF}$, and under full buyer protection if $\theta \ge \mu \equiv \underline{\theta}_B$. Note that $\underline{\theta}_{GF}$ increases with s and approaches $\underline{\theta}_O$ as s goes to 1; thus, $\underline{\theta}_{GF} \leq \underline{\theta}_O = \underline{\theta}_B$. We have three cases: (1) if $\theta < \underline{\theta}_{GF}$, the original owner never protects his property; (2) if $\underline{\theta}_{GF} \leq \theta < \underline{\theta}_B$, the original owner protects his property only under good-faith buyer protection; (3) if $\underline{\theta}_B \leq \theta$ the original owner always protects his property.

Table A4Costs of Protection and Losses from Theft

| i | \overline{C}_i | \underline{C}_i | L_i |
|----|---------------------|----------------------|------------------|
| 0 | $U - q\overline{V}$ | $(1-q)\underline{V}$ | $(1-\mu)(1-q)U$ |
| GF | $U - q\overline{V}$ | $(1-q)\underline{V}$ | $(1-\mu)(1-sq)U$ |
| В | U | \underline{V} | $(1-\mu)U$ |

The changes in social welfare and the institutional design will be affected only when the original owners protect property. When the latter happens and $V = \overline{V}$, the good will be purchased both by moral and immoral intermediaries and resold for \overline{V} and thus the social welfare equals $\overline{V} - U$ minus the cost of protection \overline{C}_i or $(1+q)\Delta - 1 - q)U$. If $\overline{\theta}_{GF} \leq \theta < \overline{\theta}_O$, private protection materializes only under good-faith buyer protection and

$$P(B \succ O) = P((1 - \mu)q\Delta + \varepsilon \ge 0),$$

$$P(B \succ GF) = P((1-q)U - q\Delta + \varepsilon \ge 0),$$

$$P(GF \succ O) = P((2-\mu)q\Delta - (1-q)U + \varepsilon \ge 0).$$

Straightforward algebra applied to these and the following conditions produces the remarks discussed in the paper. If $\theta \geq \overline{\theta}_O$, the original owner protects his property under both good-faith buyer and owner protection and thus

$$P(B \succ O) = P((1-q)U - q\Delta + \varepsilon \ge 0),$$

$$P(B \succ GF) = P((1-q)U - q\Delta + \varepsilon \ge 0),$$

$$P(GF \succ O) = P(\varepsilon \ge 0).$$

If $V = \underline{V}$ and original owners choose to invest in private protection, the good will neither be stolen nor purchased. Thus, social welfare is the cost of private protection \underline{C}_i and thus either $-(1-q)(U-\Delta)$ under owner and good-faith buyer protection or $-U+\Delta$ under buyer protection. If $\theta < \underline{\theta}_{GF}$, there is no private protection under all rules and the proposition applies unchanged. If $\underline{\theta}_{GF} \leq \theta < \underline{\theta}_B$, the original owner protects only under good-faith buyer protection and thus

$$P(B \succ O) = P(\varepsilon - (1 - \mu)q\Delta \ge 0),$$

$$P(B \succ GF) = P((1 - q)(U - \Delta) - (1 - \mu)\Delta + \varepsilon \ge 0),$$

$$P(GF \succ O) = P((1 - q)[(2 - \mu)\Delta - U] + \varepsilon \ge 0).$$

If $\theta \geq \underline{\theta}_B$, the original owner always invest and

$$P(B \succ O) = P(\varepsilon - q(U - \Delta) \ge 0),$$

$$P(B \succ GF) = P(\varepsilon - q(U - \Delta) \ge 0),$$

$$P(GF \succ O) = P(\varepsilon \ge 0).$$

A.5 The Buyer's Incentives to Costly Inquire about Title

For $V = \overline{V}$ and $\theta < \theta^S$, we have that

$$P(B \succ O) = P((\mu + q - \mu q)\Delta + \varepsilon \ge 0),$$

$$P(B \succ GF) = P((1 - \mu)sq\Delta - k + \varepsilon \ge 0),$$

$$P(GF \succ O) = P((\mu + q(1 - \mu)(1 - s))\Delta - k + \varepsilon \ge 0).$$

The difference with respect to the proposition is that owner protection becomes comparatively less attractive if the share of moral intermediaries increases, due to the fact that the only way to transfer goods to high-value buyers under owner protection is through theft.

A.6 Additional Figures and Tables

Figure A1 Measuring Property Rights



Note: We have divided the range of each variable into four equal intervals. See Table 4 for variable definitions and sources.

 $\label{eq:Figure A2} Figure \ A2 \\ \text{Extensive Form Game under Owner Protection}$





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