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Protecting Antiquities: A Role for Long-Term Leases?*

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Most countries prohibit the export of certain antiquities. This practice often leads to illegal excavation and looting for the black market, which damages the items and compromises the archaeological record. We consider the prospect of long-term antiquity leases and sales contracts with a pre-arranged repurchase option. Such mechanisms could raise revenue for the country of origin, while preserving long-term national ownership rights. We show that leases, which leave the country of origin in charge of future recontracting, are optimal mechanisms for resolving adverse selection, and that they have good properties for addressing corruption. Option contracts deliver more revenue now and are therefore useful for reducing credit constraints. Allowing those who disclose the existence of antiquities the right to lease objects overseas for a fixed period could create incentives to reveal the location of hidden objects.

Keywords: Antiquities, Corruption, Hold Up, Illicit Trade, Market Design.
JEL Classification Codes: D02, K42, Q34, Z11

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1 Introduction

To preserve cultural heritage, 140 countries ban the export of certain antiquities. Some see these export bans as vital for preserving cultural heritage and decry the alienation of objects sold abroad.

Others believe these export bans fuel the devastating black market in antiquities, arguing that the large monetary difference in art value at home and abroad coupled with weak enforcement generate incentives for illicit trade.[1] Illegal trade is surreptitious, and actions that conceal antiquity trade often destroy archeological sites, damage objects, and reduce economic value. Looters use fast methods of excavation such as bulldozers, dynamite, and pneumatic drills.[2] They work to keep site locations secret and often obscure the origin of objects by intentionally damaging sites and breaking objects into fragments to pass international borders.[3]

In this paper, we argue that lease markets or markets for sales contracts with explicit repurchase options could create incentives for maintenance and preservation. These mechanisms may also raise revenue for artifact-rich countries while guaranteeing long-term ownership rights for the country of origin. By putting the object in the hands of the highest value consumer at each point in time, such markets would reduce the size of the black market and generate funds that could be used for the legal excavation of at-risk sites or other needs. Further, by restricting transactions to leases or sales contracts with an explicit repurchase option, the future ownership rights of objects can be preserved. This allows a country to manage its cultural heritage, while allowing excavated objects from flowing to highest value use. Such contracts would require clauses mandating proper care, maintenance, and insurance, but such contracts are fairly standard, for example in museum lending programs.[4]

To see why leases might be useful, consider the case of Nigeria. In the last three

[1] An Italian antiquities trafficker was caught offering Hellenistic marble statues of Marsyas and Apollo for $850,000. The statues were originally purchased from a Turkish farmer for $7,000. See Bagli (1993) and Borodkin (1995).

[2] See Coggins (1972), Bator (1982), and Prott & O'Keefe (1990) for many examples.

[3] Ross (1995) estimates that over 50 percent of archaeological sites in Mali have been severely damaged or destroyed by illegal looting. Archeologists, who rely on the stratification of objects to make inferences, have limited access to pristine sites and no access to objects already extracted illegally. Owners of artifacts have no legal channel by which they can return objects back to the public domain, leading to limited knowledge concerning the number of objects still existing and complicating arrangements that might lead to repatriation.

[4] See Bresler & Lerner (2004) for a discussion of insurance and contract requirements for loans between museums.

decades, at least seven large museums in Nigeria have been the victims of major robberies. The most notable occurred at the Ife museum in 1994 with estimated losses of $200-250 million.[5] Illegal excavation of archeological sites has also escalated with the most significant losses occurring from Nok sites in northern Nigeria. Nigeria's museum system has struggled to generate funds to maintain security and preserve objects. Tourism revenue for major exhibits is limited and the total 2008 public budget for museum and monument preservation was under $16 million. A lease program that rotated a portion of Nigeria's collections internationally could potentially generate revenue and reduce the potential of theft by moving at-risk objects abroad and funding museum security.

The standard debate between cultural nationalists and internationalists have focused on the desirability of export bans. The general strategy used in this paper is to first consider why a social planner with preferences corresponding to each of these polar positions might choose to impose or remove an export ban when faced with a choice set consisting only of an export ban or a free market. We then expand the set of possible policies to show that many of the social planner's objectives may be better achieved by restricting transactions to leases or sales contracts with an explicit option to repurchase.

We first consider environments where it is optimal to have some form of international trade and consider two reasons why restricting the market mechanism may yield preferable outcomes. After developing the model primitives in section 2, section 3 considers a case with asymmetric information regarding the value that foreign collectors and the domestic society assign to an object. If a country is initially poor but may become rich later, it may be optimal to initially transfer usage rights to a foreign collector, but for the artifact to return to the country of origin if the home country becomes wealthier. If the social planner is fairly certain that the country will want the object in the long run, but the social planner's future value is private information, sale and repurchase contracts may be inefficient, since attempts by foreign collectors to extract surplus from the government may prevent efficient transactions. Either leases, or a sales contracts with an explicit option to repurchase the object at a *prearranged* price, may help avoid this hold-up problem. In a world without credit constraints, leases dominate both sale-and-repurchase and option contracts. This is because negotiation occurs after uncertainty has been resolved and with the home country in control of the auction. With credit constraints, options often dominate leases since they can relieve

[5]See Akinade (1999) and Shyloon (2000).

credit constraints by allowing objects to be used as collateral for borrowing.

In section 4 we consider the possibility that in each generation, corrupt officials in charge of antiquities can extract value by selling the antiquities abroad at the expense of future generations. We show that in this environment, laws imposing export bans may be preferable to free trade. In an effort to constrain the corrupt officials, a benevolent government may create legislation which limits flexibility of future officials. However, for reasonable parameter values, allowing leases may be preferable to either free trade or complete export bans. Leases prevent the expropriation of value from future generations while still granting freedom to optimally allocate usage rights today.

We next consider reasons why a social planner who has a very high value for keeping objects in the country of origin might prefer lease markets over blanket export bans. Section 5 considers an economy in which objects are in private hands but where at least a subset of high-quality objects generate a positive externality for other citizens if the objects are moved to public institutions. Citizens must be compensated both for their preservation efforts and for the opportunity cost of revealing objects to the government rather than selling them on the illicit market. This moral hazard problem is exacerbated by uncertainty over the quality of goods which requires discretion by potentially corrupt bureaucrats to resolve. When a proportion of bureaucrats are corrupt and are willing to pass off low-quality objects as high quality, a purchase program may become insupportable. A program that allows disclosed objects to be leased can provide information rents while at the same time generating signals of quality based on market prices. Such leases might also be used to locate objects previously smuggled abroad by granting short-term amnesty and public usage rights in exchange for future repatriation.

There is precedent for art being leased internationally. The King Tut exhibit which circulated in the United States and London from 2005-2008 was leased to a private company in order to generate proceeds for Egypt. The lease agreements for the King Tut exhibit specified transportation, display, and storage conditions in order to reduce museum-side moral hazard. Egypt charged a flat fee of $5 million per city and required insurance of roughly $1 million per city. The exhibit was valued at $650 million.[6]

Leases have also recently been used to resolve disputes over ownership. The Menil collection in Houston negotiated a 25-year lease of two 13th century Byzantine frescoes with the Church of Cyprus. These frescoes were recovered in 1982 from sources with

[6]See Boehn (2005).

disputed claims. More recently, the Metropolitan agreed to return a collection of objects believed to be looted from Italy in exchange for a long-term loan of objects with similar value.

Our paper is related to Bator (1982) and Borodkin (1995) who write from a legal perspective, and advocate the use of markets to reduce looting in developing countries. These papers concentrate on the increased information that is revealed when markets are legal and when individuals have private information and partial ownership claims over the location of objects still in the ground. As a way of generating stronger incentives for individuals to report found sites, Wendel (2007) advocates the use of "possessory estates,"a shared trust set up by the government that grants a proportion of proceeds to an individual who reports the location of an antiquity site. Our paper is complementary to these analyses, focusing on the efficiency and preservation incentives generated by different contract structures. Lease contracts have been briefly mentioned in press by Butcher & Gill (1990), Asgari (1993)[7], and Gerstenblith (2001). In all three of these articles, leases are proposed as a way to move objects between museums in order to decrease demand for new pieces from foreign countries. We believe our paper is the first to formally model the effects of export bans and lease markets and to suggest leases and option contracts as a broad alternative to export bans.

2 The Benchmark Model

We first develop a benchmark model, in which citizens care about having objects in the country of origin. This allows us to capture the cultural nationalists' position that objects should remain in the source country despite higher monetary valuations abroad. We allow the size of this domestic externality to vary over time to reflect potential changes in preferences as a country becomes wealthier or as their national identity evolves.[8]

There are $N + 1$ actors — the social planner and N foreign collectors. In the benchmark model, we consider a single antiquity, referred to as the object, which is

[7]As quoted in Erdem (1993), Asgari argues that ten year leases may be used between major museums to reduce incentives to purchase illicit artifacts.

[8]While one might initially question the cultural nationalists' position, introspection suggests that there exists many objects for which citizens value objects being held in the country of origin. Consider, for example, how individuals in the United States might react to the sale of The Liberty Bell or The Statue of Liberty to a collector in Saudi Arabia or China.

initially in the hands of the social planner who must decide whether to keep it or sell it abroad.

The *social planner* is benevolent and maximizes social welfare for its constituents.[9] At each time, $t \in \{0, 1, \ldots, \infty\}$, the government's constituents get utility from domestic antiquity "usage", x_t, and non-antiquity consumption, c_t. Relative to the size of the total budget, the value of the object is assumed to be small. As such, we simplify the problem by assuming a linear tradeoff in each period between art usage and other consumption. Defining D_t as the sum of the *domestic* citizens' valuation for having the object in the country, social utility in each period defined as

$$u(c_t, x_t) = (1 + \gamma_t)c_t + D_t x_t, \tag{1}$$

where $1 + \gamma_t$ represents the marginal utility of consumption.

We allow the marginal utility of consumption to vary over time, as might be the case if countries face constraints on international borrowing. Initially, we abstract from credit constraints such that $\gamma_t = 0$ for all t. Later, we relax this assumption and consider the case where $\gamma_0 > \gamma_t$ for all t. Similarly, we allow the domestic taste for art, D_t, to be stochastic with the potential to change over time. Let D_t be bounded between $\underline{D}$ and $\overline{D}$ and distributed according to the *home* country cdf $H_t(.)$ with associated pdf $h_t(.)$. D_t is unknown to the home country until period t so that any contracting before period t can only take into account the distribution of D_t, but not its actual realization.

All actors in our model share a common intertemporal discount rate of δ and can save on assets at interest rate R; however, some actors might be credit constrained. We assume $\delta R = 1$ so that in the case of no credit constraints ($\gamma_t = 0$ for all t), the social planner would smooth consumption over time and keep the object in the country for domestic use in periods when D_t is greater than the income generated from moving it abroad. In section 3.3 we allow for credit constraints and consider the case where the home country prefers to collateralize objects and consume the proceeds today to better smooth intertemporal consumption.

There are $i \in \{1, \ldots, N\}$ foreign collectors who are potentially interested in using a legally procured object. Each foreign collector has a private per-period value for art consumption F^i bounded between $\underline{F}$ and $\overline{F}$ and distributed according to the time-invariant cdf $A(.)$ with associated pdf $a(.)$. We assume that foreign collectors have a

[9] Section 4 considers a situation in which government officials are not necessarily benevolent.

linear utility function with per-period utility $v_t^i(c_t, z_t) = c_t + F^i z_t$, where $z_t \in \{0, 1\}$ is a binary variable that is 1 when the foreign collector legally keeps the object abroad. Without loss of generality, we assume that the buyers are ordered in ascending value. Thus F^N and F^{N-1} represent the highest and second highest values respectively.

Timing— Our model assumes an initial law-writing phase and a sequence of future periods each divided into a contracting and consumption stage. In the law-writing phase, the social planner can write laws constraining future domestic actors. Initially, we assume that the social planner has a choice only between allowing free trade or passing an export ban which restricts foreign usage to zero. We then expand the set of possible restrictions to allow for explicit restrictions on the types of contracts allowed in the market.

Subsequent to the initial law-writing phase, actors play an infinite sequence of periods each comprised of two stages: a contracting stage and a consumption stage:

1. **Contracting:** In the contracting stage, the owner of the object chooses whether to offer it to potential buyers. We make two key assumptions. First, we assume that the owner of the object determines the selling procedure, thereby maximizing his profits, subject to the laws imposed within their jurisdiction (for instance, using an optimal auction mechanism). Second, we assume that the owner of the object can commit to the selling procedure he selects and does not attempt to price discriminate intertemporally.[10]

2. **Consumption:** All players consume their valuations for the current period and play continues to the next period.

In section 5 we introduce an additional maintenance stage in which parties must also invest in maintenance in order to prevent the destruction of the object. As maintenance pushes policies toward free markets, we do not explicitly consider it in sections 3 and 4 since these sections explore reasons why restrictions on the market structure might make sense even when maintenance is guaranteed. We should note, however, that other forms of moral hazard may be important, such as ensuring the safe transportation of objects and guaranteeing the return of objects in future periods. In countries with high-quality legal systems, experience with loans between museums suggests that these forms of moral hazard may be adequately addressed through contracts. In countries

[10]See section 3 for a brief discussion of commitment.

with low-quality legal systems, however, these types of moral hazard are likely to affect the ability to use antiquities as pledgable assets for loans.[11] In calculating the first best with credit constraints, we therefore make the plausible assumption that the only way to collateralize objects in a period is to move them abroad.

3 Transaction Costs and the Role of Leases

In this section we explore how uncertainty about the future and asymmetric information about valuations shape the optimal contract for sharing objects abroad. It often makes sense for an object to leave in the short run and come back in the long run. For instance, consider the situation of an initially poor and credit-constrained country, which has the potential of becoming wealthier in the future. Selling an object today can generate wealth initially and move the object to its highest value use. However, once sold, it may be hard to repurchase the object in the future, since attempts by foreign collectors to extract surplus from the government may prevent efficient transactions.

We divide our analysis of such transaction costs into three parts. We begin with a simplified version of our benchmark model which illustrates the hold-up problem inherent in sale and repurchase contracts. We then show that in a more general environment, leases and option contracts can resolve the inefficiencies that exist in sales contracts. Finally, we explore the relative efficiency of leases and options in an environment with credit constraints.

Starting with the analysis of sale and repurchase contracts, consider a special case of the model, where initially the domestic taste for art is small so that $D_0 = \underline{D} < \underline{F}$. However, there is potential for the country to value art in the future. Let D_1 be drawn from a distribution with cdf $H_1(.)$ and assume that all exogenous variation is resolved at this point so that $D_t = D_1$ for $t \geq 1$. Further assume that $H_1(\underline{F}) > 0$ and $H_1(\bar{F}) < 1$. That is, there exist future states of the world in which the home country does not value the object so it is efficient to keep it abroad, and there also exist states of the world in which domestic valuation is so high that the home country wishes to repatriate the object with certainty.

Foreign collectors' private values for art consumption $F^1, \ldots, F^N$ are independent

[11] For example, it may be feasible for Mali to seize objects after a contract breach from a private collector abroad but may be very difficult for the collector to seize an object under similar circumstances in Mali.

and identically distributed (*iid*) with cdf $A(.)$ and associated pdf $a(.)$. We assume that foreign buyers are risk-neutral and do not face credit constraints. Under these characteristics, if an object is sold using an optimal auction for sellers, the winner of the auction will be the foreign collector with the highest intrinsic valuation for the object F^N.

As all uncertainty is resolved after the first period, the special case of our model can be thought of as a two period allocation problem with valuations as follows:

$$\begin{array}{ccc} & \underline{\text{Period } 0} & \underline{\text{Period } t > 0} \\ \text{Domestic} & D_0 = \underline{D} & D_t \sim H_1(.) \\ \text{Foreign} & F_0^i \sim A(.) & F_t^i = F_0^i \end{array} \tag{2}$$

In period 0, all foreign collectors have greater value for object than the home country and thus the object should be moved abroad in a first-best world. In period 1, the home country learns its new domestic valuation and may value the object more than foreigners so the first best demands the object to be repatriated in some states of the world.

3.1 Sales Contracts with Future Repurchase

A consequence of selling an object to a foreign collector without specifying repurchase clauses is that the sale of the object also grants the foreign collector the right to choose the mechanism in future repurchase negotiations. To understand how the transfer of contracting power influences efficiency, we separate the analysis into its two contracting phases: a sale phase in which the home country auctions the object to the foreign buyers, and a repurchase phase in which the foreign collector who won the object in period 0 offers the object back to the home country in period 1. In order to analyze the contract, we first construct the optimal mechanism for the foreign collector attempting to sell the object back to the social planner in period 1. Using the expected revenue from this resale auction, we then return to period 0 to analyze the efficiency of the initial sale.

Stage 2: Repurchase Phase. For readability define the hazard rate of the distributions $H_t(.)$ and $A(.)$ as

$$\psi_{H_t}(D_t) = \frac{h_t(D_t)}{1 - H_t(D_t)}, \psi_A(F) = \frac{a(F)}{1 - A(F)}. \tag{3}$$

We assume the problem is "regular" in a mechanism design sense so that both $\psi_{H_t}(D_t)$ and $\psi_A(F_0^i)$ are increasing functions.

The foreign collector in our problem has commitment power and thus selects the mechanism that maximizes his *ex-ante* expected utility.[12] To avoid the decrease in monopoly power associated with intertemporal price discrimination, the foreign buyer commits to offering the object back to the social planner exactly once in period 1. To find the optimal resale price, we first solve the standard per-period monopoly problem for $t \geq 1$,

$$P_t^M = \arg\max_{P_t}[P_t - F_t^N][1 - H_t(P_t)], \tag{4}$$

which yields the first order condition

$$P_t^M(F_t^N) = F_t^N + \frac{1}{\psi_{H_1}(P_t^M(F_t^N))}. \tag{5}$$

Since $F_t^N = F_0^N$ for $t \geq 1$, we have $P_t^M(F_0^N) = P_1^M(F_0^N)$ for $t \geq 1$. Aggregating over all periods, the optimal resale price in period 1 is

$$P_1^R(F_0^N) = \sum_{t=1}^{\infty} \delta^{t-1} P_t^M = \frac{1}{1-\delta}\left[F_0^N + \frac{1}{\psi_{H_1}(P_1^M(F_0^N))}\right] \tag{6}$$

which we note is greater than $\frac{F_0^N}{1-\delta}$ under the assumption that $H_1(\overline{F}) < 1$.

Stage 1: Sale Phase. Returning to the auction in stage 1, a foreign collector with value F^i incorporates the monopoly rents into his valuation when bidding in period 0. Thus, the value of an object to a foreign collector with value F^i is

$$V_0^i(F_0^i) = F_0^i + \delta\left[\left(1 - H_1(P_1^M(F_0^i))\right) P_1^R\left(F_0^i\right) + H_1(P_1^M(F_0^i))\frac{F_0^i}{1-\delta}\right]. \tag{7}$$

This can be rewritten as

$$V_0^i(F_0^i) = \frac{F_0^i}{1-\delta} + \frac{\delta}{1-\delta}\frac{1 - H_1(P_1^M(F_0^i))}{\psi_{H_1}(P_1^M(F_0^i))}. \tag{8}$$

[12] As is well know in the literature on durable goods (e.g. Gul, Sonnenschein & Wilson (1986) and McAfee & Vincent (1997)), a lack of commitment in sequential bargaining or auction settings weakens the ability of the foreign buyer to make offers above their marginal valuation. In our model, less commitment by the foreign buyer increases overall efficiency since bargaining weakness reduces holdup. It is our view that foreign collectors have at least some commitment power due to either sequential rationality or high transaction costs.

Note that since $H_1(\overline{F}) < 1$, there is some probability of resale to the home collector and thus $V_0^i(F_0^i) > F_0^i$ for all N. Further, since all foreign collectors are free to set their second period prices as they see fit, it must be that $V_0^i(F_0^i)$ is weakly increasing in F_0^i. Thus V^i is a positive monotone transformation of F^i and preserves the order of valuations.

We now show that the inefficiently high price set in the resale phase leads to inefficiency in the sale phase regardless of the bidders' valuations. Consider the case when $N \to \infty$ such that $F_0^{N-1} = F_0^N = \overline{F}$. In this environment, the optimal auction will allocate the object to the highest value bidder at a price equal to $V(\overline{F})$ which is greater than $\frac{\overline{F}}{1-\delta}$. As the price is equal to the expected value of the object to the winning bidder, the foreign collectors' expected gain from winning the auction is zero and thus the home country is the recipient of all the rents associated with the object.

Next compare the (expected) domestic welfare generated in the sale and repurchase scheme to the first best outcome. In the first best case, the foreign collector's utility is always zero and his utility is linear. Thus maximizing domestic utility subject to the foreign collector's IR constraint yields the socially optimal repurchase price:

$$P_1^{FB} = \frac{F_0^N}{1-\delta}. \tag{9}$$

In a sale and repurchase scheme, $P_t^R > P_t^{FB}$ and thus there exist realizations of D_1 in which the object is misallocated to the foreign collector although it has a greater value at home. This will be the case any time $D_1 \in \left(F_0^N, P_1^M\right)$.

As can be seen, the monopoly power of the foreign collector in the repurchase phase creates inefficiencies in the initial sale auction. In order to extract rents from the domestic owner, the foreign collector chooses an inefficiently high price in the repurchase phase. Thus, while these rents are recaptured by the domestic owner in the sale phase, the allocation in the future is inefficient, which leads to a permanent loss of possible total welfare.

Whereas objects that leave the country can potentially stay in foreign hands inefficiently, a home country which is restricted to sales contracts may respond to the hold-up problem by restricting sales in the initial period. As a simple example, continue to assume that $N \to \infty$ so that $F_0^N = \overline{F}$. Comparing the revenue that the home country expects to receive in period 1 when it has control of the auction mechanism

versus when it does not, the home country's expected loss from a sale is

$$S^{FB} - S^{Sale} = \frac{\delta}{1-\delta} \underbrace{[H_1(P_1^R(\overline{F})) - H_1(\overline{F})]}_{\substack{Probability\ of \\ Inefficient\ Trade}} \underbrace{[\mathbb{E}(D_1|\overline{F} \leq D_1 \leq P_1^R) - \overline{F}]}_{Expected\ Loss\ per\ Trade}. \tag{10}$$

The magnitude of this inefficiency is equal to the probability of an inefficient trade multiplied by the expected loss when such an event occurs. When patient, the home country may prefer to hold the object until uncertainty is resolved, for example, through an export ban. Such delayed sale comes at the additional cost of lost revenue today which may be of considerable concern for a country which is credit constrained, an issue we return to in section 3.3.

3.2 Leases

At its core, the problem with selling an object and trying to repurchase it in the future is a contractual one. The foreign collector who wins the initial auction has an incentive to distort prices in the second stage which can lead to inefficient allocations and a decrease in social surplus. As long as the initial auction is competitive, however, these rents are already priced into the initial auction and extracted by the home country via competition. Thus, the price distortions lead to pure efficiency losses with minimal changes in the overall share of rents.

Leases diminish the effects of asymmetric information by leaving the choice of mechanism in both periods to the government, which can use auctions to reduce the asymmetric information about the foreign collectors' valuations. Consider a lease auction in which the government leases the object to the foreign collector in the first period but retains future ownership rights. As is well known from the auction literature on sequential auctions, it is weakly welfare decreasing to use information about the value of the winning bidder in one auction for subsequent auctions.[13] We thus assume the government constrains the information generated in the auction by running an optimal English auction in stage 1 in which the second highest bid price but not the winner's bid is revealed.

Given the information revelation of the initial auction, the domestic owner knows the value of the second highest agent F^{N-1} and the density function of the highest

[13]See for instance Hart & Tirole (1988).

bidder:

$$a^N(F) = \begin{cases} \frac{a(F)}{1-A(F^{N-1})} & F > F^{N-1}, \\ 0 & otherwise. \end{cases} \tag{11}$$

Maximizing profits for $t \geq 1$, the home country determines the optimal lease price by solving

$$P_t^* = \arg\max_{P_t} \quad [1 - A^N(P_t)]P_t + A^N(P_t)D_t. \tag{12}$$

The associated first order condition is

$$1 - A^N(P_t^*) + a^N(P_t^*)(D_t - P_t^*) = 0, \tag{13}$$

which yields[14]

$$P_t^* = D_t + \frac{1}{\psi_A(P_t^*)}. \tag{14}$$

Of course, the home country will never choose a price below F^{N-1} such that the optimal pricing rule becomes

$$P_t^L = max\left(P_t^*, F^{N-1}\right). \tag{15}$$

The optimal pricing rule from equation (15) is equivalent to running an English auction in each period with a reservation price dependent only on the home country's valuation and the initial distribution. As the number of bidders goes toward infinity, such a lease auction converges to the socially efficient price $P_t^L = max(D_t, F^N)$.

Proposition 1 *When the government's utility function is linear, the buyers' valuations are iid, and there are no credit constraints, the optimal allocation mechanism is to lease objects each period using an English auction with reservation price:*

$$P_t^* = D_t + \frac{1}{\psi_A(P_t^*)} \tag{16}$$

Proof: Proof is in the appendix.

As indicated in the proposition, the optimal lease contract generalizes readily to a more complicated environment where D_t grows over time.[15] Since the true valuation of the highest valued bidder stays private, there are no incentives for foreign collectors

[14]Note that $A^N(F) = \frac{A(F)-A(F^{N-1})}{1-A(F^{N-1})}$.

[15]That is $D_t = D_{t-1} + Z_t(.)$ where $Z_t(.)$ is bounded below at zero. As with Hart & Tirole (1988), if the value of the home country is decreasing in some periods, the home country may be tempted

to strategically manipulate their bids. Also note, that since contracting in future periods takes place once uncertainty regarding the home country's value is resolved, the reservation price in each period uses the true realization of D_t. As is discussed in the next section and shown in the appendix, setting optimal reserves after uncertainty is resolved improves both the efficiency and expected rent generation of the mechanism relative to alternatives which conduct all contracting in period 0.

3.3 Credit Constraints and Option Contracts

In the environment discussed in the previous section where a country is poor today but has the potential to become rich in the future, the government is likely to be credit constrained. This section considers the case where domestic marginal utility of money varies over time. As described in the benchmark model, we assume that the value of the object is small relative to the nation's budget, and the marginal utility of consumption in each period is $1 + \gamma_t$. Initially, the country is poor and credit constrained such that $\gamma_0 \geq \gamma_t$ for all t.[16] As such, the social planner prefers to (i) consume the value of the object in period 0 and (ii) prevent holdup in future periods.

An alternative to leases in this circumstance is to sell an object to the foreign buyer with an explicit option to repurchase the object in the future at a per-period strike price $s_t(P_t)$ which varies with the purchase price P_t. In the appendix, we show that one optimal option mechanism in such an environment is to run an English auction with a strike price in each period equal to:

$$s_t(P_t) = \left[R^t P_t + \frac{\gamma_0 - \gamma_t}{(1+\gamma_0)(1+\gamma_t)} \frac{H_t(\hat{s_t})}{\psi_{H_t}(\hat{s_t})} \right], \tag{17}$$

where P_t is the winning bid for period t and $\hat{s_t} = (1+\gamma_t)s_t$.

As can be seen by studying equation (17), the strike price is composed of two

to use information from previous periods in current negotiations. This may lead the foreign collector to distort his value in cases where the home country is unable to commit to the mechanism for all future periods. Similar to Dewatripont (1989), increasing the lease length can limit renegotiation and increase efficiency when the domestic government lacks commitment power and D_t can both increase and decrease. As a lease can always mimic a sale contract by setting the number of periods to infinity, the broader set of contracts with leases will still weakly improve efficiency over sale and repurchase contracts even when commitment on the side of the home country is limited.

[16] It is worth noting that γ_t will also likely to be stochastic and negatively correlated with D_t. To keep things simple and highlight the main intuition, we show the deterministic version of the model. The main intuition in this section holds as long as $\gamma_0 > \mathbb{E}[\gamma_t]$.

parts: the first term which corresponds to the efficient allocation of the object in future periods and the second term which sets the strike price above the purchase price thereby increasing the expected bids of the foreign collectors but potentially generating inefficient allocations in the future.

When there are no credit constraints, $\gamma_0 = \gamma_t$ and thus $s_t = R^t P_t$. As the home country does not care about the timing of payments, it sets the option strike price to efficiently allocate the object in future periods thereby maximizing social surplus.

When a country is credit constrained, however, $\gamma_0 > \gamma_t$ and the strike price for repurchase is greater than the price paid. Raising the strike price above the bid price creates some states of the world in which the object stays in the hands of the foreign collector inefficiently. At the same time, however, an increase of the strike price over the winning bid increases the value of the contract to the foreign collector. This second effect increases bids and leads to greater revenue in period 0 but a larger expected repayment in the future. As credit constraints get extreme, for instance when $\gamma_0 \to \infty$, the optimal strike price is set such that the value of the object for a bidder of type i is exactly equal to $V(F^i)$ and the strike price is equal to $P_1^R(F_0^{N-1})$. Thus, as $N \to \infty$, the option contract can mimic both the lease and sale auction through the selection of the strike price s_t.

A second property of the optimal option contract is that the reservation price must be set prior to the home country learning its future valuation. In the absence of credit constraints, the optimal reservation price is implicity described by the following equation:

$$P_t^{Res} = \delta^t \left[\mathbb{E}(D_t | D_t < R^t P_t^{Res}) + \frac{1}{\psi_A(P_t^{Res})} \right]. \tag{18}$$

Comparing this expression to (16), it becomes apparent that the reservation price is analogous to that of the lease auction, with the difference being that the auction takes place in period 0 prior to the revelation of D_t. Conditioning on the expected value of D_t decreases the efficiency of the auction, an inefficiency which is greatest when domestic valuations are most uncertain. Conditioning also may lead to additional problems with commitment, since after high realizations of D_t, the home country would like to exercise the option and offer the object to the winner at a higher reserve price.

Like the lease contract, the optimal option contract eliminates the hold-up problem of the sales contract with future repurchase by settling all negotiations *ex ante*. A careful comparison of equations (16) to (17) and (18) provides intuition concerning the

environments in which the lease or option contract is likely to be preferred. When there are no credit constraints, the home country does not benefit from shifting payments to earlier periods as achieved by an option contract. Since the option's reservation price must be established with less information about the future, an option contract will have an inefficient reserve price relative to the lease auction if there is uncertainty regarding future domestic valuation of an object.

When there are credit constraints, however, the option contract may dominate leases since it allows countries to consume more than the objects per-period value immediately. This will unambiguously be the case if the government knows its future valuation and thus can set its reserve prices optimally. These results are formally described in Proposition 2:

Proposition 2 *When future valuations of the home country are unknown to all parties and there are no credit constraints, a lease auction maximizes social welfare of the home country. When future valuations of the home country are known but private information and credit constraints bind, an auction that sells the object with an option to repurchase maximizes social welfare of the home country.*

Proof: Proof is in the appendix.

While we have discussed leases and options in the context of efficiency, it is worth noting that the implementation of option contracts may be more difficult than lease contracts. To construct the optimal strike price, the home country must have a good sense not only of its future credit constraints, but on the distribution of future valuations. As this distribution may vary by object and country, establishing common contracts may prove difficult.

If option contracts prove intractable from an implementation stand point, credit constraints can also be satisfied by a lease with an extended term length. Such leases are likely to generate revenue similar to an option contract while reducing the complexity of the auction. However, allowing for very long leases opens the door for corruption, a problem which we view as critical to managing cultural heritage. We will discuss this issue in the next section.

4 Corruption

The previous section suggests caution in the use of sales, but provided no justification for rule based interventions — such as an export ban — over case-by-case discretionary interventions by the government. In this section we show that despite the inefficiencies that exist in restricting free trade, the government may want to enact laws restricting international antiquity transactions to prevent future corrupt official from appropriating the value of the object. If the only available policy instrument is an export ban, a benevolent social planner may choose to pass such a law in order to constrain corrupt officials at the cost of restricting honest ones. For reasonable parameter values, less draconian export restrictions that allow one-period leases are superior to both free trade and complete export bans. Sales with repurchase options are not attractive in this environment.

To focus directly on the role of corruption, we depart from the last section by assuming that there are no transaction frictions and that objects may be bought from and sold to foreign buyers at a constant per-period price P.[17] We continue to assume that the object is owned by the government who has domestic valuation for objects, D_t, which is stochastic and may vary over time; we further restrict attention to the case where valuations are drawn iid from a single time invariant cdf $H(.)$. Initially, we assume that there are no credit constraints so that the marginal utility of consumption is normalized to 1.

In the initial law writing phase, a benevolent social planner can pass a law prior to period 0 binding all future "officials" who will each have influence over objects for one period. We first consider the case in which the social planner can only decide between allowing free markets or passing an export ban. We then consider cases in which the social planner has the additional option to restrict foreign transactions to single period leases. Subsequent to the initial law writing phase, and including the contracting stage in period 0, decisions are made by a sequence of officials who each act as a benevolent social planner with probability $1 - \epsilon$, but who maximize their own consumption with no regard for current or future generations with probability ϵ; we assume that the types of officials are uncorrelated over time.

Corrupt officials have access to some portion of the proceeds of sales and leases

[17] We abstract from the issues discussed in the previous section, where the price paid for antiquities depended on the possibility that the object may be resold in the future.

via kickbacks and thus always choose to move objects abroad or into private hands for the maximum amount of time legally possible. For clarity, we study the stark case in which corrupt officials have access to the entire revenue from a transaction and thus consume all the proceeds from the exchange. If markets are free, a corrupt official sells the object and consumes all future rents. Under an export ban, the corrupt official keeps the object for private use for the period he is in office such that the country cannot benefit from it.[18] Finally, if foreign transactions are restricted to single period leases, the corrupt official leases the object abroad and consumes the proceeds.

An *honest official* who has no constraints on her action may act in one of two ways. If the potential for future corruption is small, she allows an object to be used by the foreign collector any time $D_t < P$ and keeps the object local otherwise. As there are no credit constraints, this is most easily accomplished through a one-period lease. Alternatively, if the potential for corruption is large, an honest official may wish to sell an object today and distribute the earnings during his tenure to prevent corrupt officials from expropriating this value in the future. Under an export ban, honest officials simply keep the object at home for domestic use.

Under *free markets*, honest officials sells the object abroad if the price for selling the object today is greater than the expected value of optimally allocating the object until the first corrupt official arrives:

$$\frac{P}{1-\delta} > \sum_{t=0}^{\infty} \delta^t (1-\epsilon)^{t+1} \mathbb{E}_D \left[\max(P, D_t)\right]. \tag{19}$$

Note that for ϵ close to zero, this will never be the case. However, if the chance of future corrupt officials becomes sufficiently large, honest officials will sell the object preemptively. In the absence of preemptive sales by honest officials, the expected net present value of population welfare derived from each object under free trade is:

$$NPV^{FT} = \sum_{t=0}^{\infty} \delta^t (1-\epsilon)^{t+1} \mathbb{E}_D \left[\max(P, D_t)\right]. \tag{20}$$

Under an *export ban*, the object always stays in the country resulting in a value of

[18] In reality, export bans are typically porous and a proportion of objects will be smuggled when officials are corrupt. Thus, it may be difficult for future officials to recover objects which have been expropriated by corrupt officials under an export ban. The assumption here reflects a best case for export bans upon which to compare the advantages and disadvantages of single- or multi-period leases.

$\mathbb{E}[D_t]$ in each period that an honest official is in power. The expected net present value of population welfare derived from each object is

$$NPV^{EB} = \sum_{t=0}^{\infty} \delta^t (1-\epsilon) \mathbb{E}_D \left[D_t \right]. \tag{21}$$

As can be seen by comparing equations (20) and (21), export bans act as a blunt tool to constrain corrupt future officials from acting in a malevolent way. To reduce the ability of future corrupt leaders to steal funds, the government also limits the ability of good officials to make welfare improving trades. This reduces the expected value in a given period to $\mathbb{E}_D(D)$ from the higher expected value of $\mathbb{E}_D \left[\max(P, D_t) \right]$. Vice versa, the lack of control over the actions of corrupt officials leads to a lower probability that an object will exist for the enjoyment of future generations. Thus, under free trade, the valuation of future periods is discounted by $(1-\epsilon)^{t+1}$ as opposed to $(1-\epsilon)$ as in the case of an export ban.

Leases are a way of balancing concerns about corruption with efficiency considerations. In particular, short-term leases can restrict the long-term damage by corrupt officials[19] while still giving benevolent ones the ability to make Pareto-improving short-term trades. To see this, consider the expected net present value of population welfare derive from each object when only one-year leases are permitted:

$$NPV^{L} = \sum_{t=0}^{\infty} \delta^t (1-\epsilon) \mathbb{E}_D \left[\max(P, D_t) \right] \tag{22}$$

Comparing this expression to equation (21), it becomes apparent that allowing one-period leases but no sales dominates passing complete export bans as long as P exceeds D_t in some state of the world.[20] Furthermore, comparing (22) to (20) reveals that one-period leases dominate free-trade as long as $\epsilon > 0$. It follows:

Proposition 3 *If the only law available to a benevolent social planner is an export ban or free trade, there are no credit constraints, and $P < \mathbb{E}[D_t]$, then as $\delta \to 1$, there exist probabilities $\underline{\epsilon}$ and $\overline{\epsilon}$ such that if $\epsilon \in (\underline{\epsilon}, \overline{\epsilon})$ the government passes an export ban. Leases dominate both export bans and free trade as long as $\epsilon > 0$ and there exist some states*

[19] Recall that the foreign collector is in charge of negotiation on objects sold abroad. Since there is no asymmetric information, the home country gains nothing from recovering objects that were sold by a corrupt official.

[20] Leases also dominate preemptive sale as long as NPV^L is greater than $\frac{P}{1-\delta}$.

of the world for which $D_t > P$.

Proof: Proof is in the appendix.

As discussed in section 3.3, one caveat is that allowing leases but not sales dominates free trade only if there are no credit constraints. In a model with credit constraints, it may be desirable to transfer long-run claims to the object in exchange for higher consumption in the short run. However, since the actions of a credit constrained official will resemble those of a corrupt official, discriminating between the two cases may be difficult. Just as with an export ban, commitment to an international standard entails some cost in the flexibility of agents to respond to changes in the overall environment.

A second caveat is that we have considered exogenous levels of corruption; however, in reality, corruption is likely to be greatest when the potential size of a kickback is large and where there is scope for discretion. If officials have the option of choosing the term length of a lease or the return price in an option contract, for instance, corrupt officials will increase the length of the contract or set the return price too high to mimic a sale.

In order for lease and option markets to reduce the negative effects of corruption, commitment must be made both to the type of contracts allowed and to the way in which objects are auctioned. It is vital to establish an external organization standardizing allowable contracts and carrying out auctions via an open and transparent procedure. As in Kremer & Jayachandran (2006) and Pogge (2001), an external international organization that binds itself to specific types of exchanges can limit discretion of corrupt officials. Amending the laws of receiving countries to allow future generations in the source countries to seize objects not sold through the organization reduces incentives of buyers to recontract and purchase goods away from the central exchange. This in turn can generate commitment when corruption is at the level of the government.

5 Maintenance and revelation of objects

In the previous two sections, we considered environments in which it was preferable to have some international trade and considered reasons why restricting the market mechanism might yield preferable outcomes. We now examine things from the alternative position in which complete bans on trade are desirable. We model this in our setup by

assuming a very high domestic usage value and argue that even in this case, restricted trade may yield socially preferable outcomes relative to policies which fully ban trade.

In most countries, both excavated and unexcavated archaeological objects legally belong to the state. However, individuals often possess the objects or have private knowledge of the location of unexcavated archaeological sites.[21] Unlike the previous two sections, this section considers the case where the government has *de jure* rights to objects but where there is asymmetric knowledge as to their location and quality. We concentrate on two information issues: a moral hazard problem where *de facto* owners must be given incentives to both maintain the objects and reveal their existence, and an adverse selection problem, which, in turn allows corruption in purchase programs. We argue that granting lease rights for a set number of years may mitigate the potential moral hazard. It may also preclude corruption that make it untenable for the state to offer cash for objects or information on archeological sites.

The following section is divided into three parts. In section 5.1 we extend the baseline model to take into account object heterogeneity and asymmetric information. We then explore how moral hazard affects the optimal policy. In section 5.2 we discuss the efficacy of purchase programs for providing information on objects that are still in the country and propose leases as an alternative. Finally, we extend this analysis in section 5.3 to consider how leases could be used to locate and reclaim objects which have already left the country of origin but for which the country of origin has some legal claim, perhaps disputed.

5.1 Limitations of Export Bans

Unlike many natural resource problems, the intrinsic and cultural value of antiquities is highly heterogeneous with only a handful of museum quality pieces typically found in an archaeological expedition. To account for this, we consider an extension of the baseline model with high (H) and low (L) quality objects which are distributed randomly across a large number of domestic citizens. Citizens with objects, referred to as

[21] Antiquities law is complicated by the fact that looted antiquities generally do not have an owner and are undocumented. While most countries have laws which make it a crime to transport, receive, or sell foreign goods known to be stolen, smugglers intentionally obfuscate the origin of objects to limit repatriation claims. Artifact-rich countries have responded to the problem of undocumented artifacts by passing laws which declare antiquities as state property. This has allowed for legal recourse using the laws of the importing country such as the National Stolen Property Act (1976) of the United States. See Bator (1982) for a broader legal discussion.

de facto owners, have no value for their objects and would prefer to sell their objects at the highest possible price, but are subject to the enforcement policy within their jurisdiction. The government knows the proportion p of high quality objects and the externality to its constituents from domestic use. It has *de jure* rights to all objects but lacks information on the location of objects and on whether the objects are of high or low quality. A bureaucrat can estimate objects' values and generate a report.

To simplify the contracting environment, we remove all uncertainty regarding efficient future ownership by assuming that the domestic externality is constant over time. Suppressing the time subscript, high- and low-value objects that are discovered and transferred to the government generate a domestic externality $\frac{1}{1-\delta}D^H$ and $\frac{1}{1-\delta}D^L$, respectively, which *de facto* owners do not take into account. For excavated objects, this externality includes the amenity value of having the object in the country of origin, its curatorial value to domestic museums, and information on the location of active looting.

As *de facto* owners may be poor relative to the cost of preserving art, we introduce a new maintenance term to the analysis. Preserving art requires expenditure M at the beginning of each period to *maintain* the object. We consider M to be a reduced form parameter that includes the cost of preventing damage and theft by looters. While in reality, M is best represented by a continuous variable that influences the probability and severity of loss and damage, we make the stark assumption that M is binary and that if it is not paid, the object is immediately destroyed. It is worth noting that in the continuous case, contracts which increase the future value of an object are likely to increase maintenance. We further assume that $F^N > M$ so that there is at least one foreign collector who would prefer the object be maintained.

We further restrict attention to the case in which the number of potential foreign buyers, $N \to \infty$. This ensures that the highest and second highest valuations of foreign collectors both equal the upper bound of the value distribution, denoted as $\overline{F}^L$ and $\overline{F}^H$ respectively. It follows that the foreign market prices are $\frac{\overline{F}^q - \delta M}{1-\delta}$ for $q \in \{L, H\}$ which are fixed and constant over time.

We consider exogenous enforcement policies which shape *de facto* owners' decisions in three ways. Policing efforts reduce both the probability α that a *de facto* owner has access to an intermediary or smuggler and the proportion π^q of the maximum foreign sale price captured by the domestic citizen. In addition, investment in detection and archaeology increases the probability β that an artifact which has not been sold is

detected by the government and can be confiscated.

In a country with export bans, π^q is typically very low relative to the actual value of the objects. For illegally traded object, most of the proceeds from trade are paid to intermediaries.[22] To reflect this, let η be the proportion of final rents which the *de facto* owner receives. Illegally traded objects also sell for less than their maximal value. The value to many potential buyers may be reduced because of limitations on the ability to display the object, the difficulty of resale, and because of the danger of detection and prosecution. To reflect this, let $F^{I,q}$ be the maximum foreign value for an illegally traded object of quality q. Then, as the number of legal bidders grows large,

$$\pi^q = \eta \frac{F^{I,q} - \delta M}{\overline{F}^q - \delta M}. \tag{23}$$

The ordering of actions in each period is as follows. A *de facto* owner holding an object must pay M in order to prevent the object from being destroyed. Next, with probability α the *de facto* owner is matched with an intermediary or smuggler and has the option of selling the object to him. Finally, with exogenous probability β the government can detect the remaining objects and either excavate or confiscate them.

We initially fix β and compare the effects of a free market policy in which $\alpha = 1$ and $\pi^q = 1$ to an export ban in which $\alpha < 1$ and $\pi^q < 1$. We assume that smuggled objects are hidden by foreign collectors and thus cannot be resold back to the government under the export ban policy, but that the government is free to buy objects revealed under a free market policy at the market price.

Under a *free market*, all objects are put up for auction in period 0. If $D^q > \overline{F}^q$, the government will purchase all objects of quality q that are put up for auction leading to a net social utility gain of

$$S^{Free} = \frac{D^q - \overline{F}^q}{1 - \delta} \tag{24}$$

per object. As $\overline{F}^q > M$, all objects are preserved under this scheme.[23]

Under an *export ban*, *de facto* owners will provide ex-ante investment if their expected return is higher than the maintenance cost. This will occur if $\alpha \pi^q \frac{\overline{F}^q - \delta M}{1-\delta} > M$.

[22] For example, Christie's Auction House estimates that the original holder of artifacts typically receive 2 percent of the objects' final sales prices. See Beech (2003).

[23] Note that we are implicitly assuming the government views the transfer of income to *de facto* owners as pure waste. Relaxing this assumption pushes policy toward free markets where *de facto* owners' revenue is highest.

In this case, the government detects a fraction of objects each period, and receives an expected net increase in social utility of

$$S^{Ban} = \frac{(1-\alpha)\beta}{1-\delta[(1-\alpha)(1-\beta)]}\frac{D^q - \delta M}{1-\delta} \tag{25}$$

per object.

Equations (24) and (25) reflect both the benefits and drawbacks of managing cultural heritage purely through export bans and enforcement regimes. When α is low and δ is high, a country which does not value the welfare of *de facto* owners can be made strictly better off by passing an export ban and exercising its *de jure* property rights.

Such policies have drawbacks, however. Objects moved illegally typically disappear from circulation and thus a proportion of cultural heritage is lost. Furthermore, the more draconian the enforcement policy the less incentives *de facto* owners have in *ex ante* preservation and protection. If $\alpha\pi^q\frac{\overline{F}^q - \delta M}{1-\delta}$ falls below M, individuals lose their incentive to protect and maintain objects leading to destruction. As it is inherently difficult to hold individuals directly accountable for actions to unknown sites and π^q is likely to be very small, a policy based purely on enforcement may generate less incentives for protection and ultimately lead to inefficient social outcomes.

5.2 Antiquity Purchases and Leases

The preceding discussion suggests that augmenting an export ban policy with explicit incentives for revealing the location of objects may improve social welfare. Payments for revelation not only resolve the information asymmetry but also provide incentives for *de facto* owners to maintain their objects in the first place. We consider two types of incentive programs: purchase programs which pay cash incentives based on the quality of the good and lease programs which allow *de facto* owners to lease objects abroad for a number of periods in exchange for revealing its location.

Consider first a purchase program which pays cash incentives based on the quality of the good. As the potential values of objects are unknown *ex ante* and must be estimated by bureaucrats, the process of using these cash incentives to pay for revealed object is vulnerable to corruption. We assume that some bureaucrats are corrupt and may adversely alter a report to the government by reporting a low-quality object as high quality. Let b be the proportion of low-quality objects which are passed through

the hands of corrupt officials who will accept a bribe B as compensation for deception.

The disclosure stage of our game is modeled as follows: after choosing whether to maintain the object, the *de facto* owners decide whether to publicly disclose their objects or wait for a potential smuggler. Publicly disclosed objects are randomly assigned to bureaucrats for assessment. If an individual citizen is assigned to a corrupt bureaucrat, the *de facto* owner chooses whether to offer a bribe to certify that an object is of a particular quality. Finally, the bureaucrats generate their reports and the governments incentive mechanism is implemented.

When considering purchase programs we consider two cases. In the first case, $D^q > \overline{F}^q$ for $q \in \{H, L\}$ and the government would like to retain all objects. We view this case as the environment envisioned by cultural nationalists and others who views the value of domestic usage as very high. Second, we consider the case where $D^H > \overline{F}^H$ but where $D^L = \overline{F}^L = 0$. In this case, low-quality objects can be though of as forgeries which can be produced at cost by citizens in the domestic country.

Starting with the case where the government would like to retain all objects, let V^q represent the potential outside option of a *de facto* owner holding an object of quality q and assume that $V^H > V^L + B$ so that owners of high-quality objects prefer to pay bribes to have their objects misreported.[24] The individual rationality constraint for *de facto* owners holding high- or low-quality objects demand that their expected transfers (net of the bribe) weakly exceed the value of their respective outside option. Defining T^H and T^L as the transfers made to *de facto* owners whose objects are reported as high and low respectively, individual rationality requires

$$T^H \geq V^H, \tag{27}$$

$$(1-b)T^L + b(T^H - B) \geq V^L. \tag{28}$$

In the optimal purchase program, both constraints will hold with equality. Thus, rear-

[24] A *de facto* owner has two potential outside options. First, he or she can choose not to maintain the object. To prevent this from being optimal, the purchase program must pay a minimum of M. Second, the owner must prefer revealing the object over waiting for a smuggler. Assuming that the decision to reveal an object occurs directly after paying maintenance costs, the owner's outside option value is

$$V^q = \max\left\{M, \frac{1}{1-\delta[(1-\alpha)(1-\beta)]}\left[\alpha\pi^q\frac{\overline{F}^q - \delta M}{1-\delta} - (1-\alpha)(1-\beta)\delta M\right]\right\} \tag{26}$$

for $q \in \{H, L\}$, respectively.

ranging equation (28) yields

$$T^L = V^L - \frac{b}{1-b}\left(V^H - V^L - B\right), \tag{29}$$

which is strictly less than V^L. For low-quality objects, the possibility of meeting a corrupt bureaucrat reduces the costs of providing incentives for low-quality objects that are publicly disclosed and assigned to an honest bureaucrat.

The expected cost for procuring each object is

$$(1+\kappa)\left([p+(1-p)b]T^H + (1-p)(1-b)T^L\right) \tag{30}$$

where p is the proportion of high quality objects, and κ is the deadweight loss of taxation per dollar of government funds spent. Plugging in (28) and (29) yields an expected cost per item of

$$(1+\kappa)\left(pV^H + (1-p)V^L + (1-p)bB\right). \tag{31}$$

Compared to the case without corruption, a purchase program requires additional transfers of $(1+\kappa)(1-p)bB$ to be paid to bureaucrats which ultimately must be paid by the government. In cases where these transfers are seen as wasteful, such bribes may make the total cost of the program prohibitive.[25] Inefficient taxation can also lead to large deadweight losses which can make such purchase programs untenable.

Let us now consider the second case in which the government only wants high-quality objects and where low-quality objects are interpreted as forgeries with no domestic value. In this case, the social planner only wants to retain high-quality objects but, due to corruption, also ends up purchasing a proportion $(1-p)b$ of forgeries which negatively affect welfare. In this environment, the cost of the program is

$$(1+\kappa)[p+(1-p)b]V^H \tag{32}$$

while the gross value of the high-quality objects is only:

$$p\left(\frac{D^H - \delta M}{1-\delta} - V^H\right). \tag{33}$$

[25]Corrupt bureaucrats could, of course, also charge bribes to individuals with high-quality objects to truthfully reveal quality. In this case the information rents for high types must be increased by bB and the rents to the low types can be decreased by $\frac{b}{1-b}bB$. The total transfers for the project increase by pbB.

As can be seen by comparing these two equations, when p is small relative to $(1-p)$, the cost of this program may be very large relative to its benefit. This will be the case, for instance, if forgeries are generated endogenously and V^H is high relative to the cost of forgeries.

At its core, the problem of the purchase program is one of discretion. By lacking an external price signal upon which valuations can be assessed, bureaucrats generate distortions both in cost and allocation. The advantage of a lease program is that the information rents generated by an object can be linked directly to its value without relying on the discretion of bureaucrats. Further, lease programs do not use public funds to secure objects and thus do not incur the deadweight loss of taxation incurred in purchase programs.

As a precursor to developing lease contracts, define τ as the smallest integer such that

$$\sum_{t=0}^{\tau} \delta^t (\overline{F}^H - \delta M) \geq V^H. \tag{34}$$

This τ is the minimum amount of time necessary for a lease to generate more revenue than the $defacto$ owners outside options. It follows that a policy that allows *de facto* owners to lease objects for a time greater than τ in exchange for future ownership rights generates information rents to individual buyers without the need for intermediation. As can be seen by noting that V^H is a function of the enforcement technology, the length of the lease τ necessary depends on the value that a smuggler can provide to an individual relative to the market price for legally transferred leases. This will be related both to the ability of the country to police illegal markets and to the relative worth of legal leases versus illegal sales.

It is worth noting that lotteries or taxes on sales could allow the value of objects to be split without declaring their value and could create incentives to reveal objects without a need for the state to estimate objects' values, but under lotteries the parties bear more risk. Further, as was argued in section 3, lease arrangements that give ownership rights to the state may also achieve preferable intertemporal allocations since transaction costs for recovering sold objects may be large.

5.3 Recovering Already Smuggled Objects

In addition to export bans and nationalization, source countries have also pushed for the adoption of international conventions which limit the use of illicit antiquities.[26] These convention have had significant impact on the collection practices of public institutions and have lead to a dramatic decrease in the willingness of museums and academics to purchase or study objects without a known history.

While public institutions have reduced their appetite for illicit objects, the size of the illicit art market has continued to expand over the last 30 years generating a large stock of objects which exist abroad but outside the public domain. A downside to the increased cooperation between public institutions and source countries is that there exists limited methods by which these illegally exported objects can reenter the public domain and (potentially) be repatriated by the country of origin. This has the potential to permanently destroy antiquities, particularly in cases where objects are bequeathed to a future generation who does not share the taste of the original collector.

Just as the difference in value between smuggled and legal antiquities made leases attractive for generating information rents, the difference in valuation between legally and illegally owned pieces of art suggest a way in which countries might induce collectors to identify objects and repatriate them in the future. Recall that $F^{I,q}$ was defined as the maximum value of an illegally owned piece of art and $\overline{F}^q$ is the maximum value for a legal piece of art. Let $\hat{\tau}$ be the shortest time period such that:

$$\sum_{t=0}^{\hat{\tau}} \delta^t (\overline{F}^q - \delta M) \geq \frac{(F^{I,q} - \delta M)}{1-\delta}. \tag{35}$$

Then, a collector would be willing to reveal his object in exchange for amnesty and a lease of length $\hat{\tau}$ or greater.

[26] The most important of these conventions has been the 1970 UNESCO Convention on the Means of Prohibiting and Preventing the Illicit Import, Export, and Transfer of Ownership of Cultural Property and the subsequent 1995 UNIDROIT Convention on Stolen or Illegally Exported Cultural Objects. Ratified by 119 countries including the United States and most of Europe, the UNESCO conventions have simplified the litigation process for recovering stolen artifacts and improved enforcement of foreign export laws. The UNIDROIT convention has increased the ability for countries to make private legal claims for repatriation and has increased the due diligence requirements for public institutions purchasing new antiquities. Both conventions are not retroactive meaning that objects traded prior to ratification in a country cannot use the conventions as part of a repatriation challenge.

6 Conclusion

Debates between cultural nationalists and internationalists have focused on the desirability of export bans. We argue that it may be appropriate to consider a broader class of contracts, including leases and perhaps sales with explicit repurchase options. Under three of the potential rationales for export bans we consider — the difficulty of repurchasing objects once sold, the possibility that corrupt officials will expropriate the value of the national patrimony, and the need for external price signals in providing information rents — leases or sales with options to repurchase may protect a countries long-term interest in objects as well or better than export bans while generating more revenue for the country and improving maintenance incentives.

We have noted that leases are likely to be preferable in the presence of corruption or asymmetric information while option contracts are likely to be optimal in an environment with credit constraints.

The simple models we examine here abstract from other important issues. First, while in section 3 we analyzed trade frictions in relation to information asymmetries, it is worth noting that leases and options also help in reducing inefficiencies caused by two other sources: attachment effects and foreign tax law. When collectors' are loss averse, ownership of an object is likely to lead to a change in reference point which increases the value of the object relative to money. In a sale and repurchase scheme, negotiations in the sale and repurchase phase are likely to occur at two different reference points. This may drive a wedge between the price paid for an object and the price at which an object may be repurchased. Leases and options mitigate this effect by fixing the repurchase agreement in the original reference state.

Most art donated to public museums have both formal and informal restrictions placed on their resale. When foreign governments create tax incentives for the donation of antiquities to local museums, restrictions on resale of these objects can lead to difficulty in recovering objects sold abroad. Leases and options overcome this problem by leaving the object in the jurisdiction of the home government.

Second, objections to the sale of important cultural items may relate to unwillingness to alienate objects from the nation or distaste for "commodification" of antiquities.[27] In this case, sales with repurchase options may be unacceptable, but leases may still

[27]See Benabou & Tirole (2007) and Roth (2007) for discussions of behavioral and social effects that might limit the use of markets.

be acceptable. If leases for general revenue are not acceptable, leases which dedicate revenue to the preservation of antiquities may be more acceptable.

Third, we do not address the case of disputed ownership (including when objects are overseas). It seems likely that in these cases, such as between Greece and Britain concerning the Elgin marbles, leases may be a way to effectively split ownership and thus avoid legal costs without declaring the value of the object.

Fourth, we have assumed that the valuation of foreign collectors does not change with respect to the type of contract that they enter into. It may be the case that for some private collectors, ownership itself generates value which is lost under leases and option contracts. In such circumstances, a partial ownership scheme which shares display rights between the foreign collector and the country of origin may be preferable. These schemes may also allay fears of buyer-side moral hazard as objects have a future value to the foreign collector. Partial ownership schemes are likely to require more sophisticated contracting which may be difficult in an international setting. Nonetheless, given the large amount of looted objects moving to private hands, such contracts may be worth exploring.

In some cases, antiquities may effectively be open access resources, that can be extracted by a variety of individuals at some cost. In this case, as with any policy that increases the domestic value of antiquities, there is potential that the introduction of lease markets can exacerbate looting by giving individuals incentives to grab objects today. In principal, the length of the lease can also be used as an incentive for individuals to preserve unexcavated sites. In exchange for the location of an unexcavated site, individuals could be given an extended lease to objects legally excavated by professionals. By providing greater rents to individuals that leave objects in the ground for legal excavation, individuals could be rewarded for the potential risk posed by other looters and for the cost of policing the site prior to excavation.

This paper considers a fairly abstract setting, but before a lease program could be put in place, a host of implementation issues would need to be addressed including lease length, rules governing care of the objects, insurance, and procedures for soliciting bids. The lease length should be long enough to provide information rents to private individuals but short enough to limit rent extraction from future generations of corrupt officials. If transaction costs are substantial, relatively longer leases may be desirable. We also do not address moral hazard in maintenance and return of the object by the receiving country. Based on existing experience with loans between museums, our sense

is that these issues could be adequately addressed contractually, as long as the legal system in the receiving country is sufficiently well-functioning.

A standardized and open procedure for the trade of objects is likely to be very important for the success of a lease or option market. The ability of lease and option contracts to reduce the effects of corruption is predicated on the ability to constrain individuals and limit discretion. Otherwise, objects could be transferred to favored buyers in exchange for kickbacks. Standardized contracts, which fix both the maximum lease length and the option price relative to the sale price are vital for this purpose. The requirement that the leasing procedure be open reduces the incentive to loot new objects and may help deter the illegal sale of objects by allowing for identification of stolen objects moving forward.

Finally, although this analysis has focused on markets for antiquities, it is worth noting that parts of the analysis may have implications for other contracting situations. The argument in section 3 considers dynamic negotiations in environments where values in the future are uncertain and where ownership bequeathes power in future negotiations. We find that in such recursive contracting environments, there is great value in keeping the negotiating power in the hands of the party whose future valuation is most uncertain. Our results may help explain patterns of asset ownership and the features of many debt instruments such as revolving credit and the allowance of multi-source borrowing which increase the renegotiation power of the borrower.

7 Appendix

7.1 Optimal Option Contract

In this section we construct the optimal option mechanism. The construction is taken in two parts. Part 1 starts from a Vickrey Clarke Groves (VCG) mechanism and determines the maximum price that could be charged in an alternative direct mechanism which invokes truth telling but uses a different option strike price rule. By varying the strike price rules, the constructed pairs of sale price and strike price trace out the entire set of possible allocations which are incentive compatible and allocate the object either to the highest valued foreign collector or the seller. Given this set of possible allocation rules, Part 2 determines the optimal direct mechanism from this set and then constructs the corresponding indirect mechanism that uses the bidding procedures of the English auction.

Lemma 1 *Let (p, s) be a purchase and strike price from an efficient VCG mechanism where an object is sold in period 0 at price p, but where the home country has the option to repurchase the object in period t at price $s = R^t p$. Then, an alternative direct mechanism where the contract (p', s') is awarded to the buyer with the highest valuation is also incentive compatible if $s' > s$ and*

$$p' = [1 - H_t(s')]\delta^t s' + H_t(s')p. \tag{36}$$

Proof. In the original direct mechanism, the winner is exactly compensated for any payments that he makes in any situation that he does not win the object. Thus it is a weakly dominant strategy for each buyer type to truthfully bid their present discounted value. Under these conditions, $p = \delta^t F^{N-1}$ and $\delta^t F^N \geq p$. For incentive compatibility to hold in the alternative direct mechanism, it must be the case that for any F^N, the present discounted value of the new contract is at least as good as the present discounted value of the old contract. This occurs if:

$$[1 - H_t(s')][\delta^t s' - p'] + H_t(s')[\delta^t F^N - p'] \geq [1 - H_t(s)][\delta^t s - p] + H_t(s)[\delta^t F^N - p]. \tag{37}$$

For truth telling to be an optimal, it also must be the case that no individual has an incentive to overstate their value. Thus, equation 37 must hold with strict equality when $F^N = F^{N-1}$.

Since $\delta R = 1$, The first term on the RHS is zero. Rewriting the equation with this term removed yields:

$$p' \leq [1 - H_t(s')]\delta^t s' + H_t(s)p + [H_t(s') - H_t(s)]\delta^t F^N. \tag{38}$$

Each of the RHS terms is positive for $s' > s$ with the last term increasing in F^N. For $\delta^t F^N = \delta^t F^{N-1} = p$, equality occurs when:

$$p' = [1 - H_t(s')]\delta^t s' + H_t(s')p. \tag{39}$$

For types with $\delta^t F^N > p$, $H_t(s')p \leq H_t(s)p + [H_t(s') - H_t(s)]\delta^t F^N$ and thus for the case in which $F^N > F^{N-1}$, incentive compatibility holds with strict preference at the new contract price p' for all types with $F^N > F^{N-1}$. These two conditions ensure truth telling remains a weakly dominant strategy in the alternative direct mechanism which offers contracts (p', s'). Note that the payment rules between (p', s') and (p, s) can differ since the allocation rule between the winning buyer and the seller change in response to s. ■

Proposition 4 *When the government's utility function is linear and the buyers' valuations are independent and identically distributed, one optimal mechanism which restricts all contracting to period 0 is to sell future ownerships via an English auction with an option to repurchase in period t at an option* strike *price*

$$s_t(p_t) = \left[R^t p_t + \frac{\gamma_0 - \gamma_t}{(1+\gamma_0)(1+\gamma_t)} \frac{H_t(\hat{s_t})}{\psi_{H_t}(\hat{s_t})}\right], \tag{40}$$

where $\hat{s_t} = (1+\gamma_t)s_t$. *The reservation price for the auction is:*

$$P_t^{Res} = \frac{\delta^t}{1+\gamma_0}\left[H_t(\hat{s_t})\left[E(D_t|D_t < \hat{s_t}) + \frac{1}{\psi_A(F(P_t^{Res}))}\right] + [1 - H_t(\hat{s_t})](1+\gamma_t)s_t(P_t^{Res})\right] \tag{41}$$

where

$$F(P_t^{Res}) = R^t P_t^{Res} - \frac{\gamma_0 - \gamma_t}{(1+\gamma_0)(1+\gamma_t)} \frac{1 - H_t(\hat{s_t})}{\psi_{H_t}(\hat{s_t})}. \tag{42}$$

Proof. Consider the class of direct mechanisms which invoke truth telling. By the envelope theorem, all incentive compatible mechanisms with the same allocation rule must have the same payment rule up to a constant. Lemma 1 provides a class of allocation rules between the highest valued buyer and the seller for $s \in [Rp, \infty]$ which are

incentive compatible. This class of allocation rules exhausts the set of possible allocations which 1) allocates ownership rights to either the highest valued buyer or the seller, 2) limits all contracting to period 0, and 3) has the seller's allocation monotonically increasing in own valuation.

The home country seeks to maximize its welfare subject to satisfying the incentive compatibility constraints of the buyers. For a given reserve price s, the home country will exercise the option if $D_t > s(1+\gamma_t)$. Letting $\hat{s} = s(1+\gamma_t)$, it thus maximizes:

$$max_s(1+\gamma_0)p(s) + [1 - H_t(\hat{s})]\delta^t[E(D_t|D_t > \hat{s}) - \hat{s}] \tag{43}$$

where

$$p(s) = \delta^t\big[[1 - H_t(\hat{s})]s + H_t(\hat{s})F^{N-1}\big]. \tag{44}$$

The equation for $p(s)$ uses the results from Lemma 1, substituting in for p with $\delta^t F^{N-1}$, the price paid in the original VCG mechanism.

Taking the FOC with respect to s yields:[28]

$$\frac{\partial L}{\partial s} : \big[-s+F^{N-1}\big]h_t(\hat{s})(1+\gamma_t)(1+\gamma_0)+[1-H_t(\hat{s})](1+\gamma_0)-[1-H_t(\hat{s})](1+\gamma_t) = 0. \tag{45}$$

Simplifying yields:

$$s = F^{N-1} + \frac{\gamma_0 - \gamma_t}{(1+\gamma_0)(1+\gamma_t)}\frac{1}{\psi_{H_t}(\hat{s})}. \tag{46}$$

Equation 46 provides important intuition as to the effect that credit constraints have on the mechanism chosen by the seller. Without credit constraints, $s = F^{N-1}$ and the home country optimally selects the mechanism which is efficient from an ex-ante standpoint. Increases in the price paid in period 0 does not adequately compensate the home country for potential inefficiencies in the future and thus there is no wedge between the sale price today and the present discounted strike price. Further, if D_1 is known, the optimal option is identical to a lease auction in both reservation price and strike price.

When there are credit constraints, however, revenue received today is more valuable than money used in repurchasing the object in the future. To increase payments today, the home country introduces inefficiencies in the strike price to generate additional funds. The relative markup of the strike price over the purchase price is increasing

[28]Note that $\frac{\partial}{\partial \hat{s}}E(D_t|D_t > \hat{s}) = \frac{\partial}{\partial \hat{s}}\frac{1}{1-H(\hat{s})}\int_{\hat{s}}^{\infty} xh(x)dx = \frac{h(\hat{s})}{1-H(\hat{s})}[E(D_t|D_t > \hat{s}) - \hat{s}]$. Thus $\frac{\partial}{\partial s}[1 - H(\hat{s})][E(D_t|D_t > \hat{s}) - \hat{s}] = -[1 - H(\hat{s})](1+\gamma_t)$.

in the size of the credit constraint and in the amount of distortion that these rents generate in the allocation of the object in the future.

To determine the optimal reservation price, the next step is to determine the bidder type who has the same virtual valuation as the seller taking into consideration the payments that can be used to reduce credit constraints in the first period. This is akin to solving a monopoly problem which compares the gains from trading with a threshold type F^c against the virtual valuations paid out to all types with valuations greater than F^c. The home country solves:

$$\max_{F^c,s} \quad \underbrace{[1-A(F^c)]}_{\substack{Probability\ of \\ Initial\ Sale}} \big[p(s,F^c)(1+\gamma_0)+\underbrace{(1-H_t(\hat{s}))}_{\substack{Probability \\ of\ Exercise}} \underbrace{\delta^t[E(D_t|D_t>\hat{s})-\hat{s}]}_{\substack{Expected\ Value\ Conditional \\ on\ Option\ Exercise}}\big]+A(F^c)\delta^t[E(D_t)], \tag{47}$$

where

$$p(s,F^c)=\delta^t\big[[1-H_t(\hat{s})]s+H_t(\hat{s})F^c\big]. \tag{48}$$

Adding $E(D)-E(D)$ to the end of this maximum and noting that

$$E(D_t)=E(D_t|D_t<\hat{s})H(\hat{s})+E(D_t|D_t>\hat{s})[1-H(\hat{s})], \tag{49}$$

the maximum simplifies to:

$$\max_{F^c,s} \quad \delta^t[1-A(F^c)]\big[[H(s)][-E(D|D<\hat{s})+\hat{s}]+p(s,F^c)(1+\gamma_0)-\hat{s}]+\delta^t E(D). \tag{50}$$

The last term is independent of both choice variables and can be removed. δ^t is also constant across terms and can be excluded. Taking these simplifications and expanding $p(s,F^c)$ yields:

$$\max_{F^c,s} \quad [1-A(F^c)]\Big[[H(\hat{s})][-E(D_t|D_t<\hat{s})+\hat{s}]+[1-H_s(\hat{s})]s(1+\gamma_0)+H_t(\hat{s})F^c(1+\gamma_0)-\hat{s}\Big]. \tag{51}$$

This can be further reduced to:

$$\max_{F^c,s} \quad [1-A(F^c)]\Big[[H(\hat{s})][\hat{s}-E(D_t|D_t<\hat{s})]-H_t(\hat{s})(1+\gamma_0)[s-F^c]+s(\gamma_0-\gamma_t)\Big]. \tag{52}$$

Taking the FOC with respect to the option price s and F^c yields:

$$\begin{aligned}\tfrac{\partial L}{\partial s} : [1-A(F^c)]\big[(1+\gamma_t)H(\hat{s}) - h(\hat{s})(1+\gamma_t)(1+\gamma_0)[s-F^c] \\ -(1+\gamma_0)H(\hat{s}) + [\gamma_0-\gamma_t]\big] = 0, \\ \tfrac{\partial L}{\partial F^c} : -a(F^c)\big[H(\hat{s})[\hat{s}-E(D_t|D_t<\hat{s})] - H_t(\hat{s})(1+\gamma_0)[s-F^c] + s(\gamma_0-\gamma_t)\big] \\ +[1-A(F^c)]H_t(\hat{s}) = 0.\end{aligned} \tag{53}$$

Simplifying the second equation yields

$$F^c = \frac{E(D_t|D_t<\hat{s})}{1+\gamma_0} - \frac{1-H_t(\hat{s})}{H_t(\hat{s})}\frac{\gamma_0-\gamma_t}{1+\gamma_0}s(F^c) + \frac{1}{\psi_A(F^c)}\frac{1}{1+\gamma_0}, \tag{54}$$

where $s(F^c)$ is the optimal strike price for a buyer of type F^c. This optimal strike price is found from the first equation of equation 53 and is identical to the one found in Equation in 46:

$$s(F^c) = F^c + \frac{\gamma_0-\gamma_t}{(1+\gamma_0)(1+\gamma_t)}\frac{1}{\psi_{H_t}(\hat{s})}. \tag{55}$$

For intuition, substituting of the optimal strike price into Equation 54 yields:

$$F^c = \frac{1}{1+\gamma_0}\left[\frac{H_t(\hat{s})}{H_t(\hat{s})+z}\Big[E(D_t|D_t<\hat{s}) + \frac{1}{\psi_A(F^c)}\Big] - \frac{z}{H_t(\hat{s})+z}\Big[\frac{\gamma_0-\gamma_t}{(1+\gamma_0)(1+\gamma_t)}\frac{1}{\psi_{H_t}(\hat{s})}\Big]\right], \tag{56}$$

where

$$z = [1-H_t(\hat{s})]\frac{\gamma_0-\gamma_t}{1+\gamma_0} \tag{57}$$

is a measure of the countries credit constraint. As expected, a home country who is faced with credit constraints is reluctant to set a high reserve price since such reserves increase the probability that the home country will be unable to sell the object. As period 0 credit constraints grow large, the home country solely values the revenue that it can gain in the first period. In the limit as $\gamma_0 \to \infty$, $lim_{\gamma_0\to\infty}F^c = \underline{F}$ and $s(F^{N-1}) = F^{N-1} + \frac{1}{\psi_{H_t}(\hat{s})}$. This result is similar to a sale auction in which the foreign collector has bargaining power in the second period.

As credit constraints grow small, the home country sets the strike price such that there is no hold-up problem in the second period and excludes buyers whose virtual valuations are expected to be zero. When $\gamma_0 = \gamma_t = 0$ and D_t is known, the option contract and lease contracts are identical except for the timing of payments. Further, when there are no credit constraints but D_t is unknown, the optimal reservation price

in a second price auction is:

$$P^{Res} = E(D_t|D_t < P^{Res}) + \frac{1}{\psi_A(P^{Res})}. \tag{58}$$

Note that the reservation price is based on $E(D_t|D_t < P^{Res})$ since D_t is unknown. In contrast to the optimal lease auction, the option auction is inefficient since the auction is done prior to learning the sellers true valuation in the future.

While there are in principle many indirect mechanisms with the same allocation rules as the one considered here, the English auction has the advantage of the valuation of the highest bidder not being revealed in each period. Since the second price auction and English auction are identical in the IPV setting considered here, we next construct the second price auction which corresponds to the optimal direct mechanism shown above. With credit constraints, the strike price of the option will be above the valuation of the object for the foreign buyer. Thus, foreign buyers will bid above their type. Given a strike price $s(\beta(F^{N-1}))$ that is based on the final bid price $\beta(F^{N-1})$, a foreign buyer will bid:

$$\beta(F^{N-1}) = \delta^t\big[[1 - H_t(\hat{s})]s(\beta(F^{N-1})) + H_t(\hat{s})F^{N-1}\big]. \tag{59}$$

Reverse engineering, the type corresponding to a bid of $\beta(F^{N-1})$ in a second price auction with strike price rule $s(\beta(F^{N-1}))$ is:

$$F^{N-1}(\beta(F^{N-1}), s(\beta(F^{N-1}))) = \frac{R^t\beta(F^{N-1})}{H_t(\hat{s})} - \frac{[1 - H_t(\hat{s})]}{H_t(\hat{s})}s(\beta(F^{N-1})). \tag{60}$$

In order for the strike price to be optimal, it must be that:

$$s(\beta(F^{N-1})) = F^{N-1}(\beta(F^{N-1}), s(\beta(F^{N-1}))) + \frac{\gamma_0 - \gamma_t}{(1+\gamma_0)(1+\gamma_t)}\frac{1}{\psi_{H_t}(\hat{s})}. \tag{61}$$

Substitution yields the optimal strike price for the second price auction:

$$s(\beta(F^{N-1})) = R^t\beta(F^{N-1}) + \frac{\gamma_0 - \gamma_t}{(1+\gamma_0)(1+\gamma_t)}\frac{H_t(\hat{s})}{\psi_{H_t}(\hat{s})}. \tag{62}$$

The optimal reserve price is found in an analogous manner by finding the price at which a bidder of type F^c will drop out of the auction. This price is equal to

$$\beta(F^c) = \delta^t\big[[1 - H_t(\hat{s})]s(\beta(F^c)) + H_t(\hat{s})F^c\big], \tag{63}$$

where F^c can be substituted with equation (56) above. Note that since the strike price is strictly above the bid when credit constraints are present, the reservation price is strictly above that of the lease auction. However, as we saw in the direct mechanism, the actual type for which this bid corresponds is strictly below the threshold type in the original auction. Thus, even though at first glance the option contract appears less efficient, credit constraints are actually improving first period efficiency while decreasing efficiency in the second period. ■

7.2 Proofs from Main Text

PROPOSITION 1: This result stems directly from Myerson's optimal mechanism (Myerson (1981)). Let $\phi(F^i) = F^i + \frac{1}{\psi_A(F^i)}$ be the virtual valuation for buyer i. The optimal mechanism (Q, T) is an allocation rule Q and payment rule T such that:

$$\begin{aligned} Q_i &= \begin{cases} 1 & if\, \phi(F^i) > \max_{j \neq i} \phi(F^j)\ and \phi(F^i) > \phi(D_1) \\ 0 & otherwise \end{cases} \\ T_i &= max\{\phi^{-1}(D_1), max_{j \neq i} F^j\} \end{aligned} \tag{64}$$

An English auction with reservation price $P = D_1 + \frac{1}{\psi_A(P)}$ has the same allocation rule as the optimal auction and thus by the revenue equivalence theorem is optimal. It also does not disclose the true valuation of the highest bidder in each period preventing this information from being used in future auctions.

PROPOSITION 2: With no credit constraints, the marginal utility of money is constant over time and thus the country is indifferent to the periods in which the contract generates payment. Leases with an English auction are surplus maximizing for the home country. Since the reservation prices for the option contract differs, the option contract cannot be optimal. The difference between the optimal lease and the optimal option is that under options, contracting is done before the home country knows its valuation D_t. This can generate situations in which the option price results in no trade in future periods even though, upon realization of D_t, trade would be optimal.

When credit constraints exist but the future valuations of the objects are known, the reservation price of the option contract can replicate those of the lease auction perfectly. Further, since $\gamma_0 > \gamma_t$ for all t, the option contract dominates the lease auction by guaranteeing that all payments are received in period 0.

PROPOSITION 3: Under free markets, a generation $t > 0$ that is reached without a corrupt official that is served by a benevolent official gets expected value

$$max[P, E[D_t]] = [1 - H(P)][E(D_t|D_t \geq P)] + H(P)P, \tag{65}$$

where H is the cdf of possible home valuations and we have suppressed the time subscripts. The NPV of an object with a free market is thus:

$$\frac{1-\epsilon}{1-\delta(1-\epsilon)}\big[[1 - H(P)][E(D_t|D_t \geq P)] + H(P)P\big]. \tag{66}$$

The NPV of an export ban is

$$\frac{1-\epsilon}{1-\delta}[E(D_t)]. \tag{67}$$

The home country prefers an export ban if Equation (66) is less than equation (67). This condition is equivalent to requiring that

$$P \leq E(D_t|D_t \leq P) + \frac{\delta\epsilon}{1-\delta}\frac{E(D_t)}{H(P)}. \tag{68}$$

At $\epsilon = 0$, the RHS of (68) is $E(D_t|D_t \leq P)$ which is less than P for $H(P) > 0$. Thus, with no corruption, free trade is optimal. As $\delta \to 1$, for $\epsilon \in (0, 1)$ the right hand side of (68) goes to infinity implying that an export ban is always optimal. Thus, there exists an arbitrarily small $\underline{\epsilon}$ such that an export ban is superior to free trade with no preemption. Intuitively, the more patient a country is, the more it values the losses that occur if an object is stolen. As $\delta \to 1$ the losses that occur if an object is ever stolen weighs heavily in making a decision. This leads to a larger set of ϵ for which an export ban is optimal.

Under free trade, the period zero official also has the option to sell an object in order to preempt future corrupt officials from doing the same. Preemption generates a total surplus of $\frac{P}{1-\delta}$. As $\epsilon \to 1$, the value of an export ban evaluated at the point of contracting converges to $E[D_0] < \frac{P}{1-\delta}$. Since $P < E[D_t]$, there exists a positive ϵ for which an export ban is better than preemption. Thus, as $\delta \to 1$, there exists an $\overline{\epsilon}$ such that for $\epsilon < \overline{\epsilon}$, an export ban is preferred to preemption. Since $\underline{\epsilon}$ is arbitrarily close to zero, $\underline{\epsilon} < \overline{\epsilon}$ and thus there exists a range of corruption levels for which an export ban is preferred.

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