Antiquities: Long-Term Leases as an Alternative to Export Bans

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Abstract

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 destroys important aspects of the archaeological record. We argue that long-term leases of antiquities would raise revenue for the country of origin while preserving its long-term ownership rights. By putting the object into the hands of the highest value consumer in each period, allowing leases would generate incentives for protection of objects.

140 countries ban export of certain antiquities.[1,2] One side effect of export bans is the exacerbation of the black market in antiquities. Artifacts often have a greater monetary value outside their country of origin, especially if that country is poor.[3] With legal markets closed and enforcement weak, owners often turn to illegal markets to sell objects abroad. An estimated $4 billion of stolen art is sold each year, rivaling human trafficking as the third largest black market in the world.[4,5]

Illegal trade is surreptitious, and technologies that conceal antiquity trade often lead to damage to the object, destruction of archeological sites, and destruction of value. Illegal trade is particularly devastating to unexcavated sites because surreptitious looting damages archeological evidence. Archaeology relies heavily on the stratification and spatial relation of objects to make inference about past cultures.[6] In order to avoid detection, smugglers often resort to fast methods of excavation including the use of bulldozers, dynamite, and pneumatic drills. Such methods damage objects and typically leave looted sites completely destroyed. Archeologists in the field estimate that over 50 percent of archaeological sites in Mali have been severely damaged or destroyed by illegal looting.[7]

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[1] See Unesco Handbook (2005).
[2] Pope Pius II declared the first export ban in 1465 in an attempt to stop objects from leaving the Papal State. See Borodkin (1995).
[3] An Italian, antiquities trafficker, was recently 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).
[4] The FBI estimates that art theft may be as high as $6 billion dollars annually based on case study evidence. See the FBI art crime division at www.FBI.gov. The value of stolen art is difficult to estimate due to the large amount of unreported or unidentifiable crime. See the Interpol website at www.Interpol.int.
[5] The International Council of Museums estimates that in excess of 100,000 objects have been stolen from churches and museums since 1980.
[6] See Harris (1989).
[7] See Ross (1995).

Smugglers work to keep site locations secret and often disguise the origin of objects by intentionally damaging sites to camouflage their activities.[8] The geographic and historical record of smuggled objects are typically erased or forged to make the objects more liquid on the global market.[9,10] Such incomplete information makes most illegally excavated objects unsuitable for archeological study.

In addition to physically damaging the object and the archaeological site, surreptitious illegal trade in antiquities may destroy the economic value of the object, relative to legal trade[11] When objects are traded illegally, and therefore surreptitiously, it is difficult to both search for and extract rent from the highest value buyer. The value to many potential buyers may be reduced because of limitations on the ability to display the object and because of danger of detection and prosecution. These factors reduce the price for the object obtained by citizens of the country of origin relative to that which they would obtain under legal trade.

We argue that compared to complete export bans, allowing lease markets could raise revenue for artifact-rich countries and could also create incentives for maintenance and preservation, while maintaining long term ownership rights for the country of origin. By putting the object in the hands of the highest value consumer at each point of time, leases would generate incentives for protection of objects and would generate funds that could be used for the legal excavation of at-risk sites or other needs. Since future

[8] See Coggins (1972), Bator (1981), and Prott & O'Keef (1989) for many examples.
[9] See Borodkin (1995), Howell (1992), and Prott & O'Keef (1989)
[10] 75% of all antiquities sold at Christies do not have a proper provenance, the documents that record the origin and sales history of an object. See Beech (2003).
[11] Christie's Auction House estimates that the original owners of artifacts typically receive 2% of the objects final sale price. See Beech (2003).

ownership rights are preserved, a country could manage its cultural heritage without restricting objects from flowing to highest value use.

We first compare the effects of free trade and export bans in a benchmark model where preserving items requires investment in maintenance. We show that under free trade, a rich owner of an object will have incentives to use an object locally in all periods while a poor owner may have incentives to sell the object to a foreign collector outright. For owners with a moderate level of initial wealth, the optimal policy is to share usage rights intertemporally with a foreign collector, for example through a lease contract. Under free trade owners will invest in maintaining and preserving the object. Under export bans owners with sufficiently low initial wealth will not invest in maintenance.

We then extend the benchmark model slightly to formally model one possible rationale for export bans: a positive externality to fellow citizens from domestic retention of the object. When taxes can be imposed costlessly, it is possible to obtain Pareto optimal allocations by using subsidies for keeping antiquities intact and in the country. However, when taxes are inefficient, quantity constraints that limit the amount of time an object can leave the country may be second best. Export bans may be effective at realigning incentives for wealthier countries but may lead to inadequate maintenance, black markets, and a permanent loss of art in places where owners are poor. For poor countries, allowing intertemporal sharing through a lease contract may increase home usage relative to a pure export ban by generating income and strengthening maintenance incentives.

We then introduce a probability that a corrupt ruler or bureaucrat in each generation tries to extract value from antiquities by selling them abroad at the expense of future generations. We show that in this environment, constitutions or international treaties imposing export bans may be preferable to free trade. In an effort to constrain the bad types, good agents may create legislation which limits both their actions and those of future generations. For reasonable parameter values, allowing leases may be preferable to either free trade or complete export bans.

Finally, we examine a model with no corruption, but with credit constraints and asymmetric information regarding the value agents put on the object. If a country is poor initially, but may become rich later, it may be optimal for use rights to initially be transferred to a foreign collector, but to come back to the country of origin if the home country becomes wealthier. If the government is fairly certain it will want the object in the long run, but its value at that point 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 sales with an option to repurchase may help avoid this hold up problem. There will often be a tradeoff between alleviating short-run credit constraints and reducing ex post inefficiency. Sales contracts with an option to repurchase have the greatest potential for relieving credit constraints while leases are most likely to avoid inefficiency ex post.

Bans on export of antiquities have been explored academically from legal and cultural perspectives. Merryman (1986) contrasts the cultural nationalist viewpoint and the cultural international viewpoint. Cultural nationalists such as Osman (1999) and Greenfield (1996) view cultural artifacts as objects with specific value to the nation of origin. Such authors view national patrimony of art as extremely important to the pride and wellbeing of a nation and tend to support export bans and repatriation of objects found abroad. Internationalists such as Appiah (2006) see art as belonging to the universal domain. Such authors tend to advocate the removal of export bans and the movement of art to places that are best able to protect and preserve. We see a lease approach as helping fulfill the goals of both cultural nationalists and internationalists (local ownership, non-alienation of the object, preservation of the object, reduced looting, and international access).

Bator (1982), Borodkin (1995), and Bednarski (2004) advocate the use of legal markets as a way of reducing looting in the developing country. Lease contracts in particular have been mentioned briefly in the popular press by Asgari[12] and Gerstenblith (2001), but we believe this paper is the first to formally model the effects of export bans and lease markets.

There are precedents in which art has been leased to cross international borders. The Menil collection in Houston negotiated with the Church of Cyprus a 25-year lease for Byzantine frescoes.[13] The King Tut exhibit now circulating the United States was leased to a private company in order to generate proceeds for Egypt. Such lease agreements are typically accompanied by contracts about transportation, display, and storage conditions to reduce moral hazard and are accompanied with a high level of insurance.[14]

[12] Asgari argues that 10 year leases may be used between major museums to reduce incentives to purchase illicit artifacts. See Erdem (2001)

[13] John and Dominique Menil were offered two stolen 13th century Byzantine frescoes from a black market dealer in 1982. They negotiated with the Church of Cyprus a 25 year lease in exchange for purchasing the objects from the black market and restoring them.

[14] The King Tut exhibit was underwritten by AEG, a US company. Egypt charged a flat fee of $5 million dollars per city and required insurance of roughly $1 million dollars per city. The exhibit was valued at $650 million dollars. See Bloen (2005)

The paper proceeds as follows. In Section 1, we develop our benchmark model with perfect markets to compare the impact of free trade and export bans when maintaining art requires investment. In Section 2, we examine optimal policy in an expanded version of the baseline incorporating externalities from keeping art in the country. In Section 2.1 we construct a baseline model in which subsidies can resolve the externality. In Section 2.2 we show that when taxation is inefficient, allowing sharing agreements between the private owner and the foreign collector can often align public and private incentives better than an outright export ban. In Section 3, we build a model in which export bans may be superior to free trade if there is a risk that a government will be corrupt and appropriate the value of the object from future generations. We show that leases lasting a generation may be a strong tool for constraining corrupt governments while allowing flexibility for others. Section 4 shows why leases or option contracts may be superior to sale and repurchase if there is asymmetric information about the government's willingness to pay to repurchase the object. Section 5 concludes.

Section 1: Free Trade and Export Bans in a Benchmark Model

In this section we develop a benchmark model for the decision problem faced by a private owner of an artifact who chooses whether to invest in maintaining the object and whether to sell use rights to a foreign collector. We consider only two policy environments: one with completely free markets and one with a blanket ban on exports.

We consider an ideal environment in which ownership rights of the individual are clear, credit and exchange markets are perfect, and where there are no externalities to keeping an object in the country of origin. We will show that under free trade the owner will retain the object if wealthy enough, sell it if poor enough, and share use with the foreign collector (for example through lease contacts) if of intermediate wealth. Export bans may reduce maintenance and lead to destruction and loss of the object. Depending on parameter values either free trade or export bans may keep the object intact and in the country longer.

1.1: The Owner's Response to Export Bans

Assume owners have a separable utility function with period discount rate δ of the form:

$$\max_{x_t, C_t} \sum \delta^t [U(C_t) + D_O x_t], \qquad (1.1)$$

where D_O is the domestic usage value of an object to the owner of art and $x_t \in \{0,1\}$ is a binary variable that is 1 when the object is held domestically.[15] As is standard, we assume the utility of non-art consumption is concave and infinitely differentiable with $U'(C) > 0, U''(C) < 0$ and that the Inada conditions $U'(0) = \infty, U'(\infty) = 0$ hold.

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 who will damage the object.[16] While in reality, M is best represented by a continuous variable that influences the probability and severity of loss, we make the stark assumption that M is binary and that if it is not paid, the artifact is immediately destroyed.

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[15] Quasi linearity is used in this model to highlight how export bans might affect countries with varying wealth differently and to simplify the transition to models with externalities. The results here are consistent with any utility function where the demand for each piece of art increases with wealth.

[16] With minor redefinition of variables, M can also include opportunity costs such as the revenue passed up from not selling an object to a smuggler or the cost of excavation and restoration of at risk sites.

A foreign collector has value of P > M in each period for the artifact. The foreign collector thus is willing to pay P-M for the use of the object each period, and always maintains the object.

Let $z_t \in \{0,1\}$ denote usage rights for the foreign collector in a period and $x_t \in \{0,1\}$ denote usage for the domestic owner. If maintenance is not undertaken in a period, the object is lost and hence x_t and z_t are both zero in that period and all future periods

The owner of an object has initial assets W_{Total} that he must draw from in every period.[17] We will take W_{Total} as exogenous, but it is worth noting that depending on how well markets function inside the country, the object may wind up in the hands of the highest value domestic owner. This will typically be someone rich.[18] It turns out that it is convenient to write the owners' budget constraint in terms of choices of x_t and z_t instead of in terms of choices of maintenance expenditure. Assuming perfect markets with constant interest rate R such that δR = 1, the owner's budget constraint is:

$$\sum \frac{1}{R^t} C_t + \sum \frac{1}{R^t} x_t M = \sum \frac{1}{R^t} z_t [P - M] + W_{Total} \qquad (1.2)$$
$$x_t + z_t \leq 1,\ \mathrm{x}_{t+1} + z_{t+1} \leq x_t + z_t, x_t, z_t \in \{0,1\}$$

We make the simplifying assumption that δR=1. Given that P > M, an owner of an object who does not use an object in a period will sell use rights to the object abroad. As such, $\mathrm{x}_t + \mathrm{z}_t = 1$ and the owner's optimization problem becomes:

[17] Alternatively, the owner could receives an exogenous stochastic endowment shock ω_t which is iid from a distribution F(.). Since capital markets are perfect, the owner can exchange his stream of future endowments with a single lump sum payment in period 1.

[18] Poor owners of unregistered art may wish to hold on to objects as a way of keeping an informational advantage over the government and increases their chance of being able to sell an object to a smuggler moving the object overseas.

$$\max_{x_t, C_t} \sum \delta^t [U(C_t) + x_t D_O]$$
$$SubjectTo: \sum \frac{1}{R^t} C_t + \sum \frac{1}{R^t} x_t M = \sum \frac{1}{R^t} (1 - x_t)[P - M] + W_{Total} \quad (1.3)$$
$$x_t \in \{0,1\}$$

In the appendix we prove that for $R \leq 2$, there exists $x_1,\ldots,x_t$ such that $\sum \frac{x_t}{R^t} = a$ for any $a \in \left[0, \frac{R}{R-1}\right]$. Thus we can rewrite $\frac{R-1}{R} \sum \frac{1}{R^t} x_t P$ as π_DP where $\pi_D \in [0,1]$. We can think of π_D as the proportion of time that the object is used domestically after adjusting for the discount rate. Using the Euler condition along with this simplification, we can rewrite the optimization problem as:

$$\max_{\pi_D, C_0} U(C_0) + \pi_D D_O$$
$$SubjectTo: C_0 = \frac{R-1}{R} W_{Total} + (P - M) - \pi_D P \quad (1.4)$$
$$\pi_D \in [0,1]$$

Theorem 1: Suppose δR=1. There exists wealth levels $\underline{W}_{Free}$ and $\overline{W}_{Free}$ such that if $W_{total} < \underline{W}_{Free}$ the owner sells the object; if $W_{total} > \overline{W}_{Free}$ the owner holds the object; and if $\underline{W}_{Free} < W_{total} < \overline{W}_{Free}$ the owner shares usage with the foreign collector. Let π_D^* be the solution to:

$$U'\left(\frac{R-1}{R} W_{Total} + (P - M) - \pi_D P\right) = \frac{D_O}{P} \quad (1.5)$$

The optimal usage share for the owner is given by:

$$\pi_D^{Free} = \begin{cases} 0 & if\ \pi_D^* < 0 \\ \pi_D^* & if\ \pi_D^* \in [0,1] \\ 1 & if\ \pi_D^* > 1 \end{cases} \quad (1.6)$$

Proof: All proofs are in the Appendix

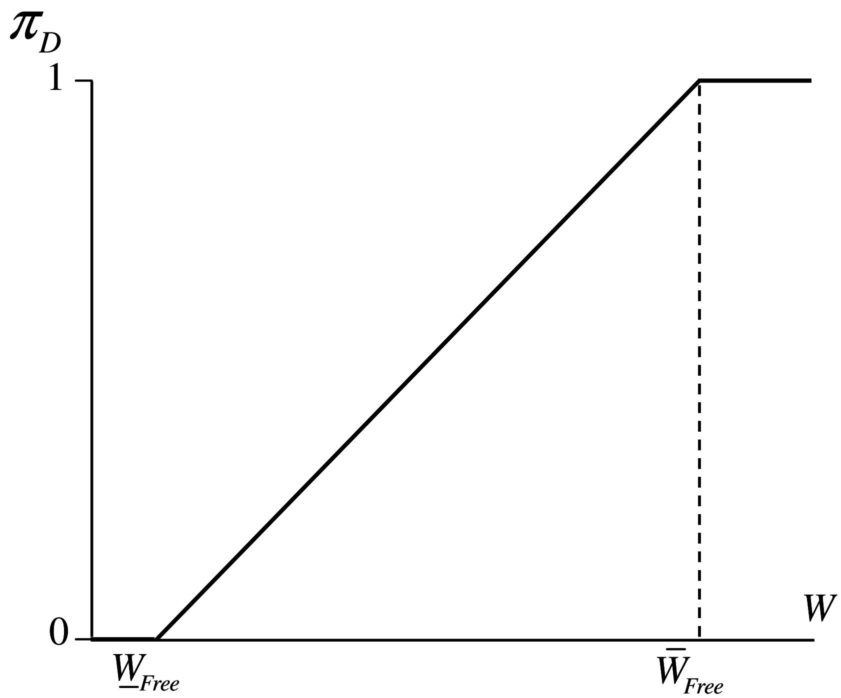

Figure 1: Sharing Rule of an Object as Wealth Varies

Figure 1 shows an example of the relationship between the optimal sharing rule and total expected endowment in the case of a quadratic utility function. When the endowment is low, the owner sells the object to the foreign collector and spreads the income across all periods. As his initial endowment increases the domestic agent's marginal utility of consumption decreases and the owner begins to trade off increased consumption for increased usage.[19]

[19] This tradeoff is linear since $U'(C_0)$ is equal to a constant and $C_0 = \frac{R-1}{R} W_{Total} + P - M - \pi P$ is linear in W_{Total} and π.

We can think of an antiquity as acting as an alternative stream of wealth. Sharing converts a portion of the artifact's inherent value into consumption. Domestic owners with extremely low (high) endowments have an incentive to sell (hold) an artifact since their marginal utility of consumption is high (low). For intermediate endowments, the domestic owner tries to balance the marginal value of use with the marginal value of consumption. Since δR = 1, the agent is indifferent in which subset of periods he rents as long as he is able to construct a π_D that solves (1.5).

We now consider how the owner's behavior is affected by an export ban. Recall that with perfect credit markets the owner faces the following set of constraints:

$$\begin{aligned} &\sum \frac{1}{R^t} C_t + \sum \frac{1}{R^t} x_t M = \sum \frac{1}{R^t} z_t [P - M] + \sum \frac{1}{R^t} W_{Total} \\ &x_t + z_t \leq 1,\ x_{t+1} + z_{t+1} \leq x_t + z_t, x_t, z_t \in \{0,1\} \end{aligned} \tag{1.7}$$

With foreign markets closed, $z_t = 0$ for all t. The owner's maximization problem is thus:

$$\begin{aligned} &Max \sum \delta^t [U(C_t) + x_t D_O] \\ &ST \\ &\sum \frac{1}{R^t} C_t + \sum \frac{1}{R^t} x_t M = W_{Total} \\ &x_t \leq 1, x_{t+1} \leq x_t, x_t \in \{0,1\} \end{aligned} \tag{1.8}$$

As with the case without an export ban we can use the Euler conditions of this problem to simplify (1.8). Assuming δ is close to 1 so that periods are arbitrarily small and ignoring the integer problem, we let $\pi_D = \left[1 - \left(\frac{1}{R}\right)^{T^*+1}\right] + \varepsilon$ where $\pi_D \in [0,1]$.[20]

Since optimal consumption will be constant across periods, (1.8) can thus be replaced by:

[20] Alternatively, we can assume that the agent can hold the unit for part of a period – this would convexify the last period and solve the integer problem. See the Appendix for more details.

$$\begin{aligned} &Max_{c_0,\pi_D} U(C_0) + \pi_D D_O \\ &ST: C_0 = W_{Total} - \pi_D M \\ &\quad \pi_D \in [0,1] \end{aligned} \tag{1.9}$$

Theorem 2: When export bans exist and δR = 1, there exists $\underline{W}_{Ban}$ and $\bar{W}_{Ban}$ such that if $W_{total} < \underline{W}_{Ban}$ the owner immediately fails to maintain the object; if $W_{total} > \bar{W}_{Ban}$ the owner preserves the object; and if $\underline{W}_{Ban} < W_{total} < \bar{W}_{Ban}$ the owner maintains the object for a limited amount of time before allowing it to be lost or stolen. Let π_D^{**} be the solution to:

$$U'\left(\frac{R-1}{R} W_{Total} - \pi_D M\right) = \frac{D_O}{M} \tag{1.10}$$

The optimal usage share for the owner is given by:

$$\pi_D^{Ban} = \begin{cases} 0 & if\ \pi_D^{**} < 0 \\ \pi_D^{**} & if\ \pi_D^{**} \in [0,1] \\ 1 & if\ \pi_D^{**} > 1 \end{cases} \tag{1.11}$$

An owner faced with closed markets considers a tradeoff between preservation and consumption just as the owner facing open markets made decisions between consumption and usage. A poor owner does not invest in maintenance, allows the object to be destroyed immediately, and uses his endowment solely for consumption. For moderate endowments, the owner equates marginal consumption with the marginal utility of owning the object and then sets aside enough reserve to maintain the object for a finite time. In a more realistic setting where theft is probabilistic, we can think of this outcome as an agent exerting a lower amount of effort over time which leads to a higher probability of theft and loss as time goes on.

It is important to note that export bans are a constraint imposed on the owner of an object. If the foreign collector places more value on the object, the constraint is binding and fundamentally reduces the possible utility of the owner.

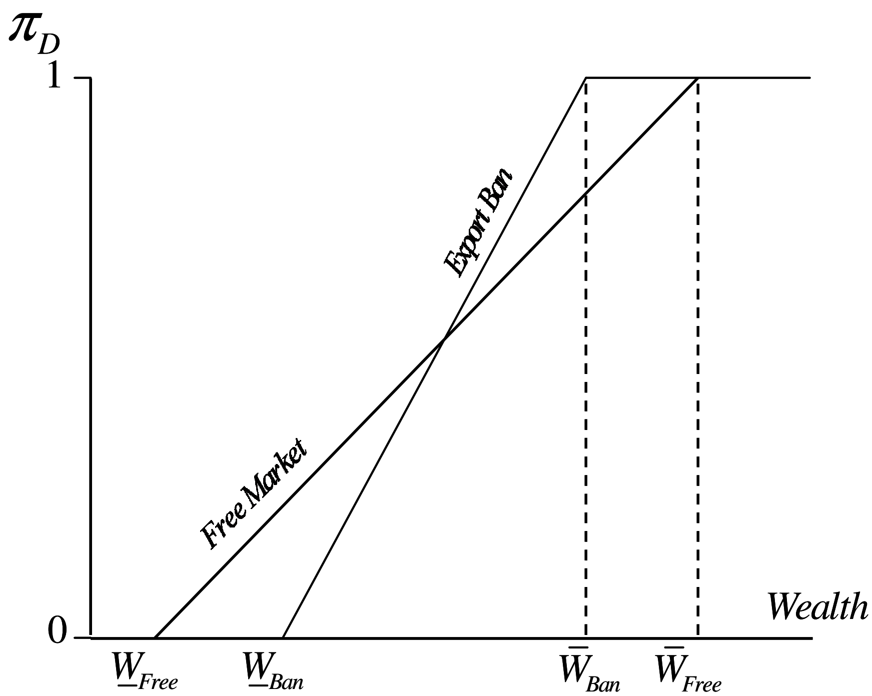

***Figure 2*: Discounted Proportion of the Time Object Remains Intact and In Country Under Free Markets and Export Bans as a Function of Owner's Wealth.**

Figure 2 plots the discounted proportion of time an object stays in the country as a function of the owner's wealth. Recall that the first order condition for the free market and the market with export bans are:

$$\begin{aligned} &\text{Free Market: } U'\left(\frac{R-1}{R}W_{Total} + (P-M) - \pi_D P\right) = \frac{D_O}{P} \\ &\text{Export Ban: } U'\left(\frac{R-1}{R}W_{Total} - \pi_D M\right) = \frac{D_O}{M} \end{aligned} \tag{1.12}$$

Since both these equations are equal to constants, a decrease in wealth in both equations leads to a linear decrease in π_D.

One reason that export bans might exist is as a way to increase the time that objects stay intact in the country of origin. Recall that $\bar{W}_{Free}$ and $\bar{W}_{Ban}$ are the wealth levels such that the FOCs are satisfied with equality and $\pi_D = 1$. Since $P > M$, $\frac{D_O}{P} < \frac{D_O}{M}$ and by the concavity of the utility function $\bar{W}_{Ban} < \bar{W}_{Free}$. For endowments between these values, export bans keep an object in the domestic market forever while free markets lead to some level of shared usage.

Unlike the upper bounds of sharing, the ordering of the lower bounds depends on the concavity of U. Setting $\pi_D = 0$ in (1.12), $\underline{W}_{Free}$ and $\underline{W}_{Ban}$ satisfy:

$$U'\left(\frac{R-1}{R}\underline{W}_{Free} + (P-M)\right) = \frac{D_O}{P} \tag{1.13}$$

$$U'\left(\frac{R-1}{R}\underline{W}_{Ban}\right) = \frac{D_O}{M} \tag{1.14}$$

The ordering of these values varies with the concavity of the utility function and on the relative size of D, P, and M. When the difference between $\bar{W}_{Free}$ and $\bar{W}_{Ban}$ is smaller than $\frac{R[P-M]}{R-1}$, there exists at least one wealth level where the owner of the object is worse off and domestic use decreases under an export ban relative to a free market.[21]

Thus for high endowments, export bans lead to a larger amount of home usage than when there are no bans and may not lead to theft. For moderate to low endowments, export bans may lead to less domestic usage of artifacts because agents are unable to lease the object and use the proceeds for maintenance. Depending on the distribution of wealth and initial allocation of artifacts in a country, an export ban may not only lead to

[21] $\underline{W}_{Free} - \underline{W}_{Ban} = [\bar{W}_{Free} - \bar{W}_{Ban}] - \frac{R[P-M]}{R-1}$. If this is negative, there is a point where the allocation is positive for the free market but zero for the export ban market.

the destruction of artifacts, but to a smaller fraction of objects existing in the country of origin.

The above discussion suggests that export bans may have significantly different effects in rich versus poor countries. In a country such as Italy where artifacts are typically in the hands of the affluent and where the average income is high, export bans may increase the amount of time an object stays in the country without increasing the theft and destruction rate of objects. In a poor country such as Mali, however, many objects are buried in areas of high poverty with the location of objects known only by the local population. At least in the model, this combination leads to a deterioration of protection when bans are put into place.

Section 2: Externalities, Taxes, and Quantity Constraints

In the last section we developed a benchmark model of the decisions of an individual who has ownership of an object. Our benchmark model resulted in three main results:

1) Export bans constrain the decision problem of the owner and may lead to a reduction in maintenance and the destruction of objects.
2) For some parameter values, export bans may increase the amount of time an object persists intact in the country of origin.
3) For some parameter values, it is optimal for the domestic owner to share usage between domestic and foreign usage.

In this section we extend the benchmark to consider the situation in which the object remaining intact in the country of origin creates a positive externality for fellow citizens that the private owner does not consider in his decisions. The government of the country would like to align incentives and can implement subsidy and tax policies and/or export restrictions.

Section 2.1 notes that if the government has access to costless taxation and perfect information on the size of the externality, a subsidy on keeping the object intact and in the country equal to the size of the externality guarantees the optimal allocation and maintenance of an object. Further transfers can achieve any distributional objectives.

Section 2.2 shows that if taxes and subsidies are distortionary, export restrictions may be optimal. Complete export bans keep the object in the country, but may leave the owner too poor to promote maintenance. If owners are poor, sharing schemes that allow objects to leave for a portion of time may be Pareto improving relative to a pure export ban.

Section 2.1: A Model with Externalities

Suppose that there is a per period domestic externality of keeping the object intact and in the country, D_E, which the owner of the good doesn't take into account. Consider the problem of a benevolent social planner who attempts to maximize the joint surplus of an owner of an artifact and the rest of society. The social planner may choose to tax or subsidize the owner of an object for his allocation and consumption decisions.

As is typical with moral hazard problems, when taxation is frictionless, a tax system that can use lump sum transfers for redistribution purposes and taxes and subsidies to resolve the externality can reach the first best. In particular, the externality can be internalized by a subsidy to the owner of D_E for every period the object remains intact and in the country. This will induce optimal maintenance and export decisions. Transfers can be used to achieve any distributional objectives.

Export taxes will also achieve the first best for owners with sufficient wealth but these are inferior to subsidies for owners with low wealth, since they do not provide maintenance incentives.

Section 2.2: Inefficiency in taxation

If taxation is costless, taxes and subsidies can implement the first best allocation and transfers can be used to achieve distributional goals. In reality governements may be reluctant to subsidize wealthy owners of antiquities, estimating the externality is difficult, and bureaucrats in charge of taxes and subsidies may be corrupt. In this section, we determine the optimal policy when taxes and subsidies are distortionary.

For starkness, we assume that taxation is completely inefficient, but the government can regulate the proportion of time an object may be shared abroad.[22] Recall from section 1 that an infinite horizon model with perfect markets and a discount rate larger that ½ can be rewritten as a single period model where the discount weighted share of time an object stays in the home country is between 0 and 1. Define π_D, π_F as the share of time that an object is maintained domestically and leased/sold to a foreign buyer. The social planner's problem reduces to implementing a π_D that solves:

[22] We restrict our attention to regulation that can restrict the percentage of time an object can leave the nation but does not regulate the exact periods. Legislation that requires an object to stay in the country for a certain amount of time before exportation increases the reachable set of domestic usage in this simple model but suffers in more complicated environments with credit constraints, stochastic endowments, or asymmetric information.

$$U\left(\frac{R-1}{R}W_{Total}+P-M-\pi_D P\right)+\pi_D(D_o+D_E) \tag{2.1}$$

The first best solution sets $\pi_D \in [0,1]$ such that:

$$U'\left(\frac{R-1}{R}W_{Total}+P-M-\pi_D P\right)=\frac{D_O+D_E}{\mathrm{P}} \tag{2.2}$$

If the owner's wealth is great enough that the left hand side is less than the right hand side for $\pi_D = 1$, a complete export ban may be optimal

Theorem 3: When taxes are not available, the governments can achieve the second best solution by setting a constraint on the amount of time an object can leave the country.

Theorem 3 may shed some light as to why export bans have become the most common approach to managing cultural heritage. A country that can not efficiently tax the sale of art may find it optimal to use laws forbidding foreign sale as a way of aligning the owner's incentives with that of the country. As the next theorem shows, however, allowing owners to share usage rights with foreign markets may increase both the welfare of the owner and the amount of time an object is maintained domestically.

Theorem 4: Let $\underline{\pi}$ be the solution to:

$$U'\left(\frac{R-1}{R}W_{Total}+[P-M]-\pi_D P\right)=\frac{D_o}{M} \tag{2.3}$$

The largest π_D reachable by a social planner when the owner's wealth is W_{Total} is:

$$\pi_D^{\mathrm{Re}ach}=\begin{cases}0 & \underline{\pi}<0\\ \underline{\pi} & \underline{\pi}\in[0,1]\\ 1 & \underline{\pi}>0\end{cases}$$

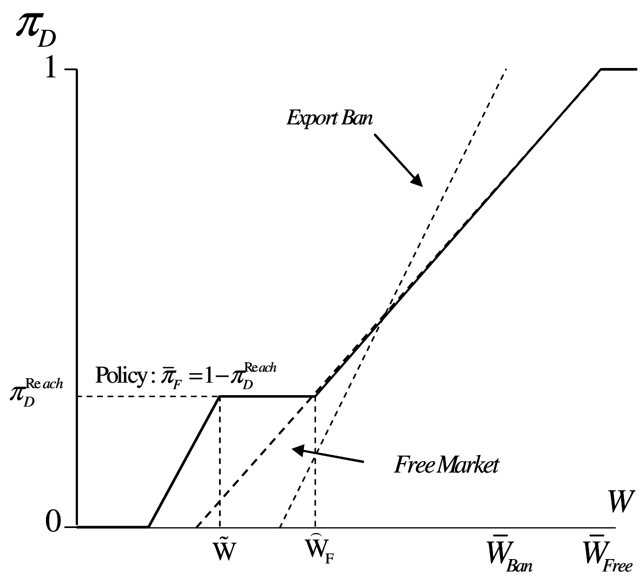

Figure 3a: Owner's decision for policy that maximizes π_D at $\tilde{W}$

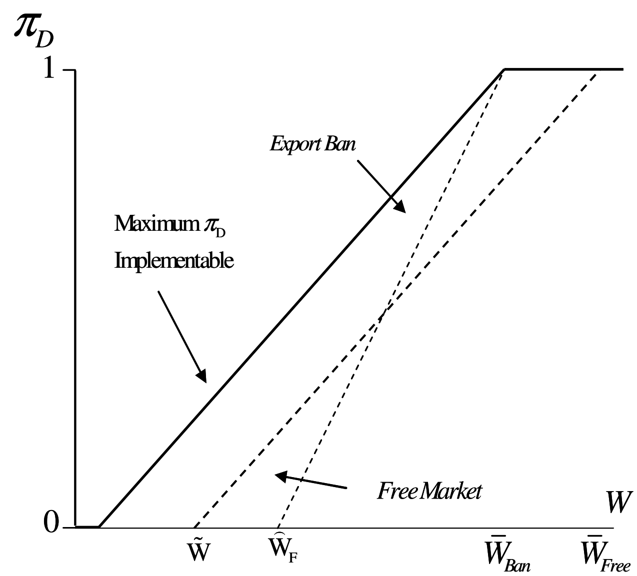

Figure 3b: Maximum Reachable π_D

Figure 3a depicts the optimal policy chosen by a government that seeks to make home usage as large as possible for an owner with initial wealth $\tilde{W}$. Under a free market, the owner of the object would like to sell a larger share of the object than is allowed by the government and thus is constrained. He first leases the object abroad up to the maximal amount of time and then makes a decision on whether to maintain the object for the time he is required to hold it at home. Given the income generated by the foreign lease, the policy that leaves the object in the home country the longest is one that makes the owner of the object just well enough off that he would choose to always maintain the object instead of letting it be stolen.

As shown in Figure 3b, tracing out this policy for any initial wealth level, we see that the maximum reachable set of home usage as a function of wealth is parallel to the free market line but shifted to the left by the distance between $\bar{W}_{Free}$ and $\bar{W}_{Ban}$. In a sense, the optimal policy leverages the income generating power of the free contract while still binding the agent as much as possible before the owner elects to shirk on maintenance. Finding the largest reachable π_D for a given wealth level thus amounts to selecting a sharing rule such that an agent with just slightly less wealth would not maintain the object in all periods.

Tracing out the maximum reachable domestic usages for each initial wealth level, as done in 3b, we find that the reachable set is the area at or below the line starting at $\overline{W}_{Ban}$ and parallel to the line between $\underline{W}_{Free}$ and $\overline{W}_{Free}$. This result leads to the following results:

Lemma 4a: When taxation is not possible, for a given initial wealth $\widehat{W}$ let $\underline{\pi}_D$ be the value of π that solves:

$$U'\left(\frac{R-1}{R}\widehat{W}+[P-M]-\pi P\right)=\min\left(\frac{D_o+D_E}{P},\frac{D_o}{M}\right) \tag{2.4}$$

The optimal sharing rule that is incentive compatible is given by:

$$\pi_D^{SB*}=\begin{cases}0 & \underline{\pi}_D<0\\ \underline{\pi}_D & \underline{\pi}_D\in[0,1]\\ 1 & \underline{\pi}_D>0\end{cases}$$

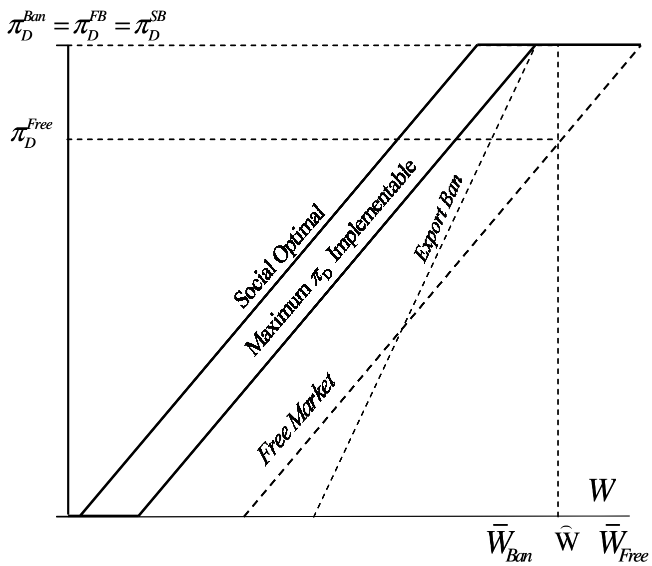

Figure 4a: Effect of policy on π_D when wealth is $\hat{W} > \bar{W}_{Ban}$

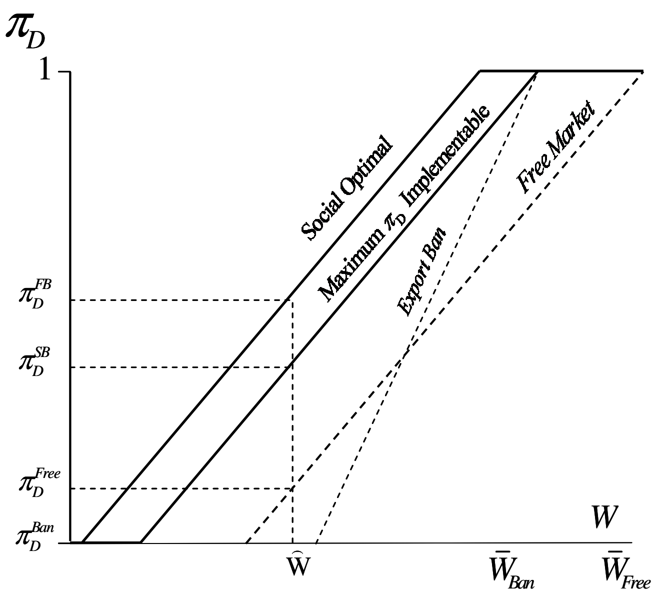

Figure 4b: Effect of policy on π_D when wealth is $\hat{W} < \bar{W}_{Ban}$

Figure 4a and 4b show the amount of domestic usage under the first best policy, the second best policy, export bans, and free markets. When wealth is high, an export ban achieves the socially optimal amount of domestic usage and thus is better than allowing for markets to be free. As wealth decreases, an export ban begins to restrict the ability of the owner to supplement his income and thus creates worse and worse incentives for maintenance. For wealth levels below $\bar{W}_{Ban}$, a policy that allows for some level of foreign sharing will perform better than a straight export ban. This difference will become more and more pronounced as wealth falls until the point where an agent under an export ban will allow the object to be destroyed immediately.

These results are consistent with the relative success that first world countries have had with export bans and the difficulty that third world countries have had in instituting similar laws. Wealth and the ratio of value to maintenance costs both play an important role in defining the optimal policy. Since in the developing world $\frac{D_o}{M}$ tends to be relatively small and the wealth level of owners is low, a straight export ban can lead to a much lower level of domestic usage than a policy that allows for the sharing of usage rights.

Section 3: Corruption and intergenerational conflict

In this section we argue that if there is a probability of a corrupt government each period that seeks to appropriate the value of the object from future generations, constitutions or international treaties restricting international art transactions may be optimal. Complete export bans can be seen a way of attempting to constrain bad agents at the cost of restricting good agents from acting optimally. For reasonable parameter values, less draconian export restrictions that allow one period leases are superior to both free trade and complete export bans.

Suppose that at some initial time, the government can adopt a constitution or sign an international treaty that binds future regimes, but that at all subsequent periods, decisions are made by a leader who acts as a social planner with probability (1-ε) but who maximizes his own consumption with no regard for current or future generations with probability ε. Bad leaders will confiscate and consume all consumable wealth in the country. If they can do so, they will export the object and consume the proceeds. (Although we model the decision maker as the leader of the country who has temporary control over all assets in the country, the analysis would be similar if the decision maker were a corrupt bureaucrat who takes a bribe in exchange for choosing too low an export tax in an environment where an optimal export tax could achieve the first best.)

We assume that the value D_E is stochastic with iid shocks and CDF H(.).[23] A good leader who has no constraints on his action allows an object to be used by the foreign collector any time $D_O + D_E < P$ and keeps the object local otherwise. Under an export ban, the object always stays in the country resulting in a value of $D_O + E[D_E]$

Theorem 6: If export bans are the only policy that may be implemented by the government, there exists a value $\varepsilon^* \in (0,1)$ such that if $\varepsilon < \varepsilon^*$ the government maintains a free market and if $\varepsilon > \varepsilon^*$ the government passes an export ban.

In this model, export bans act as a very blunt tool to constrain bad future leaders from acting in a malevolent way. By attempting to reduce the ability of future corrupt leaders to steal funds, the government limits the ability of good actors to make welfare improving trades.

Leases act as a way of balancing concerns of corruption with efficiency. Such leases may achieve a good balance of restricting the long term damage that corrupt officials can do while still giving benevolent ones the ability to make Pareto-improving short term trades.

To see this, note that with free trade, the country gets max $Max(P, D_O + D_E) - M$ each period before the first bad leader arrives. Afterwards it gets nothing. The Net Present Value of this stream is:

$$\sum \delta^t (1-\varepsilon)^t [Max(P, D_O + D_E) - M] \qquad (3.1)$$

[23] This model can be extended to allow for kickbacks that only take a portion of wealth and for correlated shocks..
.

Under a total export ban, the country receives an NPV of:

$$\sum \delta^t [(D_O + D_E) - M] \tag{3.2}$$

Under a constitution or international treaty that permits one period leases but not sales, the NPV of the stream is:

$$\sum \delta^t (1-\varepsilon)[Max(P, D_O + D_E) - M] \tag{3.3}$$

This implies that for any positive ε, allowing leases but not sales dominates free trade. If P exceeds $D_O + D_E$ by a sufficient amount, and if ε is not too large, then allowing leases but not sales is preferable to a complete export ban.

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 on the object in exchange for higher consumption in the short run.

Section 4: Transaction Costs and the Role of Leases

The tension of the first two sections centered around the delicate balance between allowing individuals to act in their best interest and constraining them to behave in accordance with the well being of society. Too much constraint removed incentives for individuals to maintain art while too little constraint failed to resolve the externality or curtail corruption. We have shown that allowing some flexibility for intertemporal sharing may improve the preservation of cultural heritage by increasing the owner's incentives for protection while at the same time resolving a part of the externality.

In this section we explore a similar tension between credit and art markets that shape the optimal sharing contract. If a country is poor initially, and is credit constrained, it may want to use part of the value of its cultural heritage to loosen credit constraints. If it sees the potential of wanting objects back in the future, it must decide how best to move the object and secure its return. When the government's future valuation for an object is unknown, 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 sales with an option to repurchase may help avoid this hold up problem. Sales contracts with an option to repurchase have the greatest potential for relieving credit constraints while leases are most likely to avoid inefficiency ex post.

4.1: Asymmetric Information

We concentrate here on a situation in which the original owner of a good is a benevolent government so that the object has domestic value $D_D = D_O + D_E$. The country is poor in the initial period and the public value of the good D_D is negligible. However, there is potential for it to grow rich in the future and thus it would like the option to repatriate the object in the future and has the power to design the mechanism in the initial stage.

In order to concentrate on transaction costs, we simplify the benchmark model for the government in two ways. First, we assume that the value D_D changes between period 1 and period 2 but that all exogenous variation is resolved at this point. Second, we ignore the possibility that the home country wants to split ownership in future periods.[24] To avoid confusion between the home country's valuation in period 1 and

[24] Thus post shock, the country is either rich enough that it wants full use or poor enough it wants to buy no use rights.

period 2, let V_D be the value of the object to the home country in period 2. We assume that V_D is distributed according to CDF H(.).[25]

Assume that there are N foreign collectors who share the same linear utility function:[26]

$$V(C,x)=\sum_{t=0}^{\infty}\delta^t[C_t+D_F x_t] \tag{4.1}$$

Each foreign collector has a constant private value for art consumption D_F independently drawn from a bounded distribution F(.).[27] Given linear preferences, with the price of consumption normalized to 1, the value D_F is also the willingness to pay for the foreign collector. Let $\underline{D}_F$ and $\overline{D}_F$ be the minimum and maximum willingness to pay per period by a foreign collector. These are the lower and upper bounds of F(.). So that there are no budget constraints on the buyer side, we assume that all foreign collectors have assets C_{Init} such that $\frac{R-1}{R}C_{Init}\geq \max(\overline{D}_F, V_D)$.

We believe it is most likely that asymmetric information surrounding the government's valuation of an object is more acute than that surrounding the foreign collectors' valuations. In most government decisions, an official is assigned to deal with repatriation and must estimate the net present value of future utility that citizens of its country would get from the object. Given the highly subjective nature of this estimation it may be difficult for a foreign buyer to accurately gauge the willingness to pay of the

[25] To avoid corner solutions, we assume that H has sufficient variance that $H(P)\in(0,1), P\in\{\underline{D}_F, \overline{D}_F\}$.

[26] Note that as the wealth of the foreign collector grows large relative to the price of an object, the standard utility function considered in this paper is approximately linear. We chose to use the linear utility function for collectors to make comparison to other asymmetric information models easy.

[27] Note that there since the foreign collectors may sell an object back to the home country in the future there is still a significant common value component to this auction. We have chosen to avoid winners curse issues by assuming all agents share identical information about the domestic owner's future value distribution.

government. In addition, a government selling an object abroad often has many potential buyers. By using an auction, the government can reduce the inefficiency surrounding the trade.

4.1.1 Sales and Repurchase Contracts

Looking first at sale and repurchase schemes, we assume that at T = 1, a foreign collector who wins the auction with value D_F^N can commit to offering a single per period resale price to the domestic agent.[28] Since the foreign collector's utility function is linear, he solves the standard monopoly problem in each period:[29]

$$\max_P \ [P-(D_F^N-M)][1-H(P+M)] \tag{4.2}$$

For readability, we define:

$$\tilde{P}=P-M$$

And designate the hazard rate of distribution H as:

$$\lambda_H(\tilde{P})=\frac{h(\tilde{P})}{1-H(\tilde{P})}$$

Taking the first order condition of equation (4.2), the solution takes on the familiar monopoly solution:

$$P^M = D_F^N - M + \frac{1}{\lambda_H(\tilde{P}^M)} \tag{4.3}$$

The total utility for the foreign collector in period 2 onward is thus:

[28] The extension to non-linear pricing is straightforward and does not affect the main results of this section.
[29] Note that the foreign collector must set a price that takes into account the maintenance burden imposed on transferring the object, thus he must factor in M in the probability of acceptance at a given price.

$$\frac{1}{1-\delta}\left[D_F^N - M + \frac{[1-H(\tilde{P})]}{\lambda_H(\tilde{P})}\right] \tag{4.4}$$

Returning to the auction in stage 1, a foreign collector with value D_F incorporates the monopoly rents into his original value. Thus, the value of an artifact to an agent with value D_F is:

$$V_F(D_F) = \frac{1}{1-\delta}\left(D_F - M\right) + \frac{\delta}{1-\delta}\left(\frac{[1-H(\tilde{P})]}{\lambda_H(\tilde{P})}\right) \tag{4.5}$$

There is a one-to-one transformation from art values D_F into his actual purchase value V_F. Thus, given independent and private values, there exists a symmetric bid function from values V_F into bids $\beta(V_F)$. Let V_F^{N-1} be the distribution of the second highest value for the artifact. Standard from auction theory, each agent bids:

$$\beta(V_F) = E(V_F^{N-1} \mid V_F^{N-1} < V_F) \tag{4.6}$$

As $\lim_{N\to\infty}$, $\beta(V_F) = V_F$ and the profits of the foreign collector goes to zero. However, the monopoly power of the foreign collector at T=1 creates inefficiencies in total utility. By attempting to extract rents from the domestic owner, the foreign collector offers an inefficiently high price in period 2. While these rents are recaptured by the domestic owner in period 1, the allocation in the future is inefficient which leads to a permanent loss of possible total utility.

Since the collector's utility is always zero and his utility is linear, optimizing total utility subject to the foreign collector's IR constraint yields the socially optimal price:

$$P^{FB} = D_F^N - M.$$

In a sale and repurchase scheme, $P^M \geq P^{FB}$ thus leaving objects in foreign hands for an inefficient amount of time.

4.1.2 Leases

At its core, the problem with a sale and repurchase scheme is a contractual one. Both the foreign collector and the domestic owner have an incentive to distort prices and consumption in order to increase rents in the second stage. However, since these rents are already priced into the initial auction, strategic action leads to pure efficiency losses without any change in the overall share of profits.

Leases diminish the effects of asymmetric information by leaving the choice of mechanism in both periods to the government who can use auctions to significantly reduce the asymmetric information in the problem. Consider a lease auction where the government leases the object to the foreign agent at time zero but retains ownership rights for the future. As is well known from the auction literature, an agent running multiple auctions can not improve his final outcome by using information about the winning bid from the first auction in later auctions. We thus assume the agent constrains the information generated in the auction by running an efficient English Auction in stage 1.[30]

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

$$f^N(D_F) = \begin{cases} \dfrac{f(D_F)}{1 - F(D_F^{N-1})} & D_F > D_F^{N-1} \\ 0 & otherwise \end{cases} \tag{4.7}$$

The home country attempting to maximize profit in the second period solves:

[30] An English auction is also superior to other common auctions when agents have affiliated values or when each agent has loss aversion with a reference point based on expectations.

$$\max_{P,\pi}[1-F^N(\tilde{P})]P+F^N(\tilde{P})[V_D-M] \quad (4.8)$$

Noting that since:

$$F^N(\tilde{P})=\frac{\mathrm{F}(\tilde{P})\text{ - }\mathrm{F}(D_F^{N-1})}{1\text{-}\mathrm{F}(D_F^{N-1})} \quad (4.9)$$

$\mathrm{F}(D_F^{N-1})$ drops out of the FOC leaving an optimal price of:

$$P=\max\left(V_D+\frac{1}{\lambda_F(\tilde{P})},D_F^{N-1}\right)-M \quad (4.10)$$

This equation converges to the socially efficient price $P=\max(V_D,D_F^N)-M$ as the number of bidders goes toward infinity.

4.1.3 Option Contracts

An alternative to leases is to sell an object to the foreign buyer with an option to repurchase the object in the future at a fixed price r. As in 3.1.1, let V_D be the value of the object to the home country in the second period. V_D has distribution H(.) which varies with realizations of wealth and estimates of D_D. As before, assume that there are N foreign collectors with a value D_F in both the first and second period.

Determining the optimal reserve price in period 2 is complicated by the fact that the actual value of the object is unknown ex ante. The home country has two instruments – the reserve price P_{res} and the option price r at which he could rebuy the object in period 2. In order to constrain itself from exercising contracts for arbitrage purchases, the option price of an object must be greater than or equal to its price. Thus $r_t \geq P_t$ and we have the following theorem:

Theorem 6: When the government's utility function is linear, the government sells the object to the foreign buyer at per period price

$$P_t = \delta^t \max\left(E(V_D \mid V_D < \tilde{P}_t) + \frac{1}{\lambda_F(\tilde{P}_t)}, D_F^{N-1} \right) - M \tag{4.11}$$

$$P_t = \delta^t \max\left(E(V_D \mid V_D < \tilde{P}_t) + \frac{1}{\lambda_F(\tilde{P}_t)}, D_F^{N-1} \right) - M$$

It sets an option to repurchase at price [$r_t = P_t$.]

Option auctions differ from lease auctions in that they can generate a much larger surplus in the initial period for consumption. In an option contract, the object is sold in the first period, allowing a country the ability to consume more than D_F^{N-1} in period 1. In cases where the government is credit constrained, the flexibility in consumption that option auctions allow may be advantageous.

In an environment where there is no corruption and where the governments knows it's future valuation the efficiency of the lease and option contracts are the same. In this case, when there is no corruption but credit concerns exist, an option contract dominates both the lease and a sales and repurchase contract.

Option auctions also differ from lease auctions because negotiation about future states is done ex ante. In a model where valuations are private but known to all agents, ex ante negotiation is advantageous because it prevents information from one auction from being used in a second auction. Here, however, because the future valuation of an object is unknown to all parties, ex ante negotiation leads to a change in the optimal reserve price and potentially time inconsistency. Upon realization of V_D, the government may have incentives to exercise the contract and offer to resell the object back to the foreign buyer. Such actions reintroduce problems with information propagation.

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 options to repurchase. Under many of the potential rationales for export bans – externalities from keeping the object intact and in the country, the possibility that corrupt rulers or bureaucrates will expropriate the value of the national patrimony, and the difficulty of repurchasing objects once sold – leases or sales with options to repurchase may perform as well or better than export bans while generating more revenue for the country and improving maintenance incentives.

The simple models we examine here may abstract from important issues. Objections to sale of important cultural items may relate to unwillingness to alienate objects from the nation. In this case, sales with an option to repurchase may be unacceptable, but leases should still be acceptable.

We have abstracted away from endowment effects and loss aversion in this draft, but are exploring these issues in future work, and expect that they strengthen the case for allowing lease contracts.

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. In particular, the argument in section three may help explain other patterns of asset ownership

Bibliography

Appiah, Anthony (2006), “Whose Culture Is It?” *The New York Review of Books*, Feb. 9.

Beech, Hannah (2003) “Spirited Away” *Time*. Oct 20th.

Bulow, Jeremy and Paul Klemperer (1996), “Auctions vs Negotiations.” *American Economic Review* 86 180-194

Coggins, Clemency (1972), “Archaeology and the Art Market”, *Science* 175

Erdem, Sunam (2001), “A New Trojan War”, Reuters Oct 13, 1993.

FBI Website. www.fbi.gov

Greenfield, Jeanette (1996), *The Return of Cultural Treasures.* Cambridge: Cambridge University Press.

Harris, E. C. (1989) *Principles of Archaeological Stratigraphy, 2nd Edition*. Academic Press: London and San Diego.

Heath, Dwight (1973) “Bootleg Archaeology in Costa Rica.” *Archaeology* July.

Howell, Caroll (1992), “Daring to Deal with Huaqueros.” *Archaeology* May/June.

Interpol Website. www.interpol.int

Kaiser, Timothy (1990). "The Antiquities Market." Journal of Field Archaeology, 17 Summer No 2.

Lovett, Richard (2004), "Clues to compulsive collecting: separating useless junk from objects of value." *Psychology Today* 2

Merryman, John Henry (1986). "Two Ways of Thinking about Cultural Property." *American Journal of International Law.* 80

McIntosh, William and Brandon Schmeichel (2004) "Collectors and Collecting A Social Psychological Perspective." Leisure Science 26 85-97.

Moore, Jonathan (1988). "Enforcing Foreign Ownership Claims In The Antiquities Market." The Yale Law Journal, 97 Num 3 Feb.

John Neary, "A Legacy of Wanton Thievery," *Archaeology* 46, no. 5 (September/October 1993): 57.

Prott, Lyndel and P.J. O'Keefe (1990), *Law and Cultural Heritage*.

Ross, Doran H (1995), “Disturbing history: Protecting Mali's cultural heritage.” African Arts, 1995 vol 28

Appendix:

<u>Theorem 1:</u>
Step 1: Solving the Kuhn Tucker Problem w/o integer constraints:

Consider the relaxed problem of (1.3) with the integer constraints replaced by $x_t \geq 0, x_t \leq 1,$. Let μ_t and λ_t be the Lagrangian multipliers for these constraints and ν be the Lagrangian multiplier for the budget constraint. Taking the FOC yields:

$$\begin{aligned} &(1)\quad \partial C_t : \delta^t U'(C_t) - \frac{\nu}{R^t} = 0 \\ &(2)\quad \partial x_t : \delta^t D - \upsilon \frac{1}{R^t} P - \lambda_t + \mu_t = 0 \\ &(3)\quad \partial \lambda_t : x_t \leq 1, \lambda_t \geq 0, \lambda_t [1 - x_t] = 0 \\ &(4)\quad \partial \mu_t : x_t \geq 0, \mu_t \geq 0, x_t \mu_t = 0 \end{aligned} \tag{5.1}$$

Substitution for ν in (1) yields the familiar Euler conditions:

$$U'(C_t) = \delta R U'(C_{t+1}) \tag{5.2}$$

With perfect capital markets and $\delta R = 1$, the Euler condition implies that consumption is constant across periods.[31] Substitution for ν in (2) above yields:

$$D - U'(C_0) P + R_t [\mu_t - \lambda_t] = 0 \tag{5.3}$$

Since $C_0 = C_t$ for all t, we can simplify the budget constraint to find:

$$C_0 = [P - M] - \frac{R-1}{R} \sum \frac{1}{R^t} x_t P + \frac{R-1}{R} W_{Total} \tag{5.4}$$

Step 2: Prove For $R \in [0,2]$, $\exists\, x_1, \ldots, x_t$ such that $\sum \frac{x_t}{R^t} = a$ for any $a \in \left[0, \frac{R}{R-1}\right]$:

Proof: Let **a** be an arbitrary value in $a \in \left[0, \frac{R}{R-1}\right]$ and consider the following algorithm.

Define:

$$S_0 = \begin{cases} 1 & a > \frac{1}{R} \\ 0 & Otherwise \end{cases}$$
$$S_N = \begin{cases} S_{N-1} + \left(\frac{1}{R}\right)^N & a - S_N > \left(\frac{1}{R}\right)^N \\ S_{N-1} & Otherwise \end{cases} \tag{5.5}$$

When $0 \le a - s_N \le \frac{1}{R-1}\left(\frac{1}{R}\right)^N \rightarrow 0 \le a - s_{N+1} \le \frac{1}{R-1}\left(\frac{1}{R}\right)^{N+1}$ since

$\left(\frac{1}{R}\right)^N \le \frac{R}{R-1}\left(\frac{1}{R}\right)^{N+1}$ $when\, R \in (1,2]$. Thus by induction, $S_N \rightarrow a$ since $\frac{1}{R-1}\left(\frac{1}{R}\right)^{N+1}$ converges to zero.

Simplifying the Allocation Space: $(x_1,...,x_t) \in \{0,1\} \rightarrow \pi_D \in [0,1]$ **:**

Using the coefficients of S to construct $x_1,\ldots,x_t$ such that $\sum \frac{x_t}{R^t} = a$ for any $a \in \left[0, \frac{R}{R-1}\right]$, We can rewrite $\frac{R-1}{R}\sum \frac{1}{R^t} x_t P$ as π_DP where $\pi_D \in [0,1]$. We can think of π_D as the percentage of time that the object is used domestically after adjusting for the discount rate. Substituting (5.4) into (5.3) yields:

$$D - PU'\left(\frac{R-1}{R} W_{Total} + (P - M) - \pi_D P\right) + R_t[\mu_t - \lambda_t] = 0 \tag{5.6}$$

Step 3: Existence of the Upper and Lower Cutoffs: Assume that $\pi_D = 0$. Let $\underline{W}_{Free}$ be the value that solves:

$$\frac{D}{P}=U'\left(\frac{R-1}{R}\underline{W}_{Free}+P-M\right) \tag{5.7}$$

For $W \leq \underline{W}_{Free}$, $\frac{D}{P}-U'\left(\frac{R-1}{R}W+(P-M)\right)<0$. Thus $\mu_t > 0$ and the $x_t = 0$ constraint is binding for all t. Likewise let $\overline{W}_{Free}$ be the value that solves:

$$\frac{D}{P}=U'\left(\frac{R-1}{R}\overline{W}_{Free}-M\right) \tag{5.8}$$

When $W_{Total} > \overline{W}_{Free}$, $\lambda_t > 0$ and thus $x_t=1$ for all t. Finally when $\underline{W}_{Free} < W_{Total} < \overline{W}_{Free}$ there exists a π_D such that

$$\frac{D}{P}=U'\left(\frac{R-1}{R}W_{Total}+(P-M)-\pi_D P\right) \tag{5.9}$$

Since π_D is determined by setting a subset of x_i to 1, the owner will share ownership rights with the foreign collector. □

<u>Theorem 2:</u>

Step 1: Solving for T without the Integer Constraint

Since $x_{t+1} \leq x_t$, There is at most one point T where the owner changes from owning an object to not owning an object. We consider the relaxed problem:

$$\begin{aligned} & Max_{c_t,T}\left[\sum \delta^t U(C_t)\right]+\frac{1}{1-\delta}\left[1-\delta^{T+1}\right]D \\ & ST \\ & \sum \frac{1}{R^t}C_t = W_{Total}-\frac{R}{R-1}\left[1-\left(\frac{1}{R}\right)^{T+1}\right]M \\ & T \in R^1 \end{aligned} \tag{5.10}$$

When $\delta R = 1$, the Euler conditions imply $C_0 = C_t$ for all t. Thus:

$$C_0 = \frac{R-1}{R} W_{Total} - \left[1 - \left(\frac{1}{R}\right)^{T+1}\right] M \tag{5.11}$$

Identical to Theorem 1, when $\delta R = 1$, there exists a $\underline{W}_{Ban}$ and $\overline{W}_{Ban}$ such that:

$$\frac{D}{M} = U'\left(\frac{R-1}{R}\underline{W}_{Ban}\right) \text{ and } \frac{\mathrm{D}}{\mathrm{M}} = U'\left(\frac{R-1}{R}\overline{W}_{Ban} - M\right) \tag{5.12}$$

For $W_{total} < \underline{W}_{Ban}$, the owner will allow the object to be stolen immediately while for $W_{total} > \overline{W}_{Ban}$ the owner will never let the object be lost.

Step 2: Finding the optimal T* from T in the interior:

For $\underline{W}_{Ban} < W_{total} < \overline{W}_{Ban}$ note that the optimal T* will be the integer either above or below the value of T that solves

$$\frac{D}{M} = U'\left(\frac{R-1}{R} W_{Total} - \left[1 - \left(\frac{1}{R}\right)^{T^*+1}\right] M\right) \tag{5.13}$$

The owner of the object can not perfectly equate the marginal value of consumption with the marginal value of usage but can get close by choosing to hold the object for a length of time and then discarding it. As $\delta \to 1,$ the difference in utility between the integer above and below T^* becomes arbitrarily close. For future problems, we will assume δ is close to 1 so that periods are arbitrarily small so that we can ignore the integer problem.

Instead we will use the approximation $\pi_D = \left[1-\left(\frac{1}{R}\right)^{T^*+1}\right] + \varepsilon$ where $\pi_D \in [0,1]$.[32] (5.10)

can then be replaced by:

$$\begin{aligned} &Max_{c_0,\pi_D} U(C_0) + \pi_D D \\ &ST: C_0 = W_{Total} - \pi_D M \\ &\qquad \pi_D \in [0,1] \end{aligned} \tag{5.14}$$

This problem can be solved in an identical way as that of theorem 1 and we get back an identical FOC as the one in (5.13) □

Proof of Theorem 3

Let $T(\pi_F)$ be a (possibly nonlinear) penalty imposed on the owner of an object based on the amount of time he legally leases an object out of the country. This penalty is completely wasteful and any money taken from the owner is destroyed. The owner solves:

$$\begin{aligned} &Max_{\pi_D,\pi_F} U(C_0) + \pi_D D_0 \\ &Subject\,To: \begin{cases} \pi_F + \pi_D \leq 1 \\ C_0 = \frac{R-1}{R} W_{Total} + \pi_F [P-M] - \pi_D M - T(\pi_F) \end{cases} \end{aligned} \tag{5.15}$$

Define:

$$\dot{w}(\pi_F) = f(w(\pi_F), T(\pi_F))$$

[32] Alternatively, we can assume that the agent can hold the unit for part of a period – this would convexify the last period and solve the integer problem.

In this problem, $\dot{w}(\pi_F)$ has the greatest slope when $T(\pi_F)=0$ but has a jump of $\overline{W}_{Free}-\overline{W}_{Ban}$ when $T(\pi_F)=\infty$. Thus the largest w for a given $\overline{\pi}_F$ that is reachable comes from a tax policy of the form:

$$T(\overline{\pi}_F)=\begin{matrix} 0 & \pi_F \geq \overline{\pi}_F \\ \infty & otherwise \end{matrix}$$

Proof of Theorem 4

When an owner faces a penalty policy of:

$$T(\overline{\pi}_F)=\begin{matrix} 0 & \pi_F \geq \overline{\pi}_F \\ \infty & otherwise \end{matrix}$$

$T(\overline{\pi}_F)$ acts as a constraint on π_F and thus the owner solves:

$$\begin{aligned} &Max_{\pi_D,\pi_F} U\left(\frac{R-1}{R}\widehat{W}+\pi_F[P-M]-\pi_D M\right)+\pi_D D_0 \\ &Subject To: \pi_F+\pi_D \leq 1, \pi_F \leq \overline{\pi}_F, \pi_F, \pi_D \in [0,1] \end{aligned} \quad (5.16)$$

Ignoring the boundary conditions and taking the derivative with respect to π_D, π_F yields:

$$\begin{aligned} &\frac{\partial}{\partial \pi_F}: \ [P-M]U'\left(\frac{R-1}{R}\widehat{W}+\pi_F[P-M]-\pi_D M\right)=\lambda_{\overline{\pi}_F}+\lambda_{1-(\pi_F+\pi_D)} \\ &\frac{\partial}{\partial \pi_F}: \ [M]U'\left(\frac{R-1}{R}\widehat{W}+\pi_F[P-M]-\pi_D M\right)=-\lambda_{1-(\pi_F+\pi_D)}+D_o \end{aligned} \quad (5.17)$$

Substitution for $\lambda_{1-(\pi_F+\pi_D)}$ yields:

$$[P-M+M]U'\left(\frac{R-1}{R}\widehat{W}+\pi_F[P-M]-\pi_D M\right)=\lambda_{\overline{\pi}_F}+D_o \quad (5.18)$$

When the constraint $\pi_F=\overline{\pi}_F$, the shadow cost is

$$\lambda_{\overline{\pi}_F}=[P-M]U'\left(\frac{R-1}{R}\widehat{W}+\pi_F[P-M]-\pi_D M\right) \quad (5.19)$$

- $\lambda_{1-(\pi_F+\pi_D)}$

Thus if $\pi_{\mathrm{F}}=\overline{\pi}_F$ binds:

$$(1)\ U'\left(\frac{R-1}{R}\widehat{W}+\overline{\pi}_F[P-M]-\pi_H M\right)=\frac{D_o}{M}-\lambda_{1-(\pi_F+\pi_D)} \qquad (5.20)$$

Otherwise, since with no binding constraint we know that $\pi_F+\pi_D=1$,

$$(2)\ U'\left(\frac{R-1}{R}\widehat{W}+\pi_F[P-M]-(1-\pi_F)M\right)=\frac{D_o}{P} \qquad (5.21)$$

Looking for the largest possible π_D, $\pi_F=\overline{\pi}_F$ must bind since $\frac{D_o}{P}<\frac{D_o}{M}$ and U is concave. If $\overline{\pi}_F+\pi_D<1$, $\lambda_{1-(\pi_F+\pi_D)}>0$ and thus increasing $\overline{\pi}_F$ by $\varepsilon[P-M]^{-1}$ will increase π_D by at least εM^{-1}. Thus $\overline{\pi}_F+\pi_D=1$. Substitution of $\overline{\pi}_F=1-\pi_D$ yields:

$$U'\left(\frac{R-1}{R}\widehat{W}+[P-M]-\pi_D M\right)=\frac{D_o}{M} \qquad (5.22)$$

□

Proof of Lemma 4a

If $\frac{D_o+D_E}{P}\in\left[\frac{D_o}{P},\frac{D_o}{M}\right]$ the first best is reachable and thus can be implemented.

Otherwise, the optimal contract is the contract where π_D is as large as possible. From Theorem 3, the maximum reachable element is π^* from theorem 4. □

Proof of Theorem 5:

Without constraints, a generation that is reached without a bad leader that is serviced by a good leader gets expected value:

$$\max[P,D_O+E[D_E]]=[1-H(P-D_O)][D_O+E(D_E\mid D_E\geq P)+H(P-D_O)P$$

The home country prefers an export ban if:

$$\frac{\varepsilon}{(1-\delta)(1-\varepsilon)}\frac{1-H(P)}{H(P)}E(D_E \mid D_E \geq P)+\frac{1-(1-\varepsilon)\delta}{(1-\delta)(1-\varepsilon)}E(D_E \mid D_E \leq P)<P$$

At ε = 0, the LHS is $E(D_E \mid D_E \leq P)$ which is lower than P if H(P) > 0. when ε = 0, the LHS is infinity. By the mean value theorem, there exists an ε^* where the agent is indifferent. □

Theorem 6

$$\max_{p_{res},r}[1-F(\tilde{P}_{res})][(1-H(\tilde{r}))(E(V_D \mid V_D>\tilde{r})-r-M+P_{res})+H(\tilde{r})P_{res}] + F(\tilde{P}_{res})[E(V_D)-M]$$

$$\textit{subject to}: \ \mathrm{r} \geq P_{res}$$

Taking the FOC with respect to the option price r and the inequality constraint we have:

$$\frac{\partial L}{\partial r}:[1-F(\tilde{P}_{res})]\left\{-h(\tilde{r})[E(V_D \mid V_D>\tilde{r})-\tilde{r}]+(1-H(\tilde{r}))[\frac{d}{dr}(E(V_D \mid V_D>r)-r)]+\frac{\lambda}{1-F(p_{res})}\right\}=0$$

$$\frac{\partial L}{\partial \lambda}:(r-P_{res})\geq 0, \lambda \geq 0, \lambda(r-P_{res})=0$$

(5.23)

$[-h(\tilde{r})[E(V_D \mid V_D>\tilde{r})-\tilde{r}]+(1-H(\tilde{r}))[\frac{d}{dr}(E(V_D \mid V_D>\tilde{r})=0$ and thus (5.23) reduces to:

$$-[1-F(\tilde{P}_{res})][1-H(\tilde{r})]+\lambda=0 \qquad (5.24)$$

Since f(r) > 0, the SOC of $F(r)-1$ is positive so that $r=\infty$ is a global minimum. Thus $\lambda>0$ and $r=p_{res}$. This condition is similar to our finding that r = k in the case of full rent extraction. The home country doesn't gain anything in leaving a separation in the price that it sells an object to a foreign collector and the price that it can rebuy the object in the future. The home countries problem thus reduces to:

$$\max_{p_{res}}[1-F(\tilde{P}_{res})][(1-H(\tilde{P}_{res}))(E(V_D \mid V_D>\tilde{P}_{res})-M)+H(\tilde{P}_{res})P_{res}]+F(\tilde{P}_{res})[E(v)-M]$$

Taking the FOC and using the same simplification as above, we find:

$$\frac{[1-F(\tilde{P}_{res})]}{f(\tilde{P}_{res})}=\tilde{P}_{res}+\frac{[(1-H(\tilde{P}_{res}))(E(V_D\,|\,V_D>\tilde{P}_{res}))]-E(V_D)}{H(\tilde{P}_{res})} \tag{5.25}$$

Noting that $E(V_D)=E(V_D\,|\,V_D>\tilde{P}_{res})[1-H(\tilde{P}_{res})]+E(V_D\,|\,V_D<\tilde{P}_{res})H(\tilde{P}_{res})$ this reduces to:

$$Period\ 2: P_{res}=E(V_D\,|\,V_D<\tilde{P}_{res})+\frac{[1-F(\tilde{P}_{res})]}{f(\tilde{P}_{res})}-M \tag{5.26}$$