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Flooding the Antiquities Market with Fakes[1]

Thesis

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1.   Introduction

The antiquities trade circulates ancient artefacts of archaeological, historical, literary, artistic, or scientific significance[2] between individuals often located in different countries and legal jurisdictions. While licit trade of carefully excavated or already-circulating antiquities may enhance welfare, trade in looted antiquities entails the production of several externalities and is illegal in many jurisdictions. Preventing the sale of loot and stemming loot production are particular instances of a general class of problems centered on eliminating equilibria involving trade of unauthorized goods in markets with information asymmetries, and I present a solution to the particular in hopes that it applies to the general.

Looting refers to the unauthorized or unscientific excavation of artefacts. Production of artefacts without concern for archaeological context tends to change the physical layout of ancient sites, damage excavated objects, and prevent subsequent extraction of information about the object, its function, and the people who created it (Bator, 1982; Borodkin, 1995). Looted sites yield fewer production spillovers from tourism and employment than intact sites, and damaged or destroyed objects lose value and consumption externalities from the use of artefacts and ancient sites to build national identity, produce research, or preserve knowledge (Koboldt, 1997). Additionally, proceeds from the sale of loot can form a clandestine revenue stream, as the international nature and peculiarities of the trade make it a prime asset class for money laundering (Steiner, 2017) and terrorist finance (al-Tamimi, 2015). Due in part to these

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[2] See appendix for full definition

undesirable side effects, 134 states so far have become party to the UNESCO 1970 Convention,[3] which serves as the primary international injunction against looting.

Yet looting persists. Analysis of high-resolution satellite imagery from Casana (2014, 2015) shows increases in the frequency and severity of looting in all areas of control in Syria from 2012-2015, with Kurdish areas exhibiting the most frequent and widespread damage and ISIL-held areas exhibiting the highest rate of moderate to severe looting damage. Objects smuggled out of Syria have been confiscated in Lebanon (Jaber and Arbuthnott, 2013), Turkey (Giglio and Awad, 2015) and Switzerland (Faucon et al, 2017), and objects likely looted from Syria have been identified in London galleries (Shabi, 2015; Cox, 2015), sold at coin auctions (Wartenberg Kagan, 2015), and offered to U.S. persons (FBI, 2015). As a crude measure of the aggregate flow of illicit antiquities out of Syria, in the years between 1996 and 2005 more than 10% of the antiques more than 100 years old imported into the United States were not reported to Syrian customs upon export, double the average reporting error rate in less archaeologically fertile countries (Fisman and Wei, 2007). Although some loot from Syria has clearly made its way to international markets, a significant proportion allegedly remains in storage awaiting paperwork and decreased scrutiny during transport (Giglio and Awad, 2015; Brodie and Sabrine, 2018).

Suggested policy remedies to the problem of looting in Syria include mandating a chain of custody for antiquities (US GAO, 2016), publicly denouncing objects as fake (Yates, 2016), increasing salience of buyer warnings and clarifying documentation standards for online sales venues (Brodie, 2017), and increasing enforcement over dark web and cryptocurrency sales

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[3] Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property

(Price, 2018). Despite an abundance of advice on how to prevent looting in Syria and elsewhere, no economic model yet exists to describe how such policy interventions will affect the incentives of participants and equilibrium outcomes in the antiquities trade.

Under what circumstances are looted antiquities produced and sold? Furthermore, what policy interventions would eliminate the production and sale of loot assuming that it is welfare maximizing to do so? Although Syria is by no means the only country experiencing large-scale looting[4], for concreteness and saliency I consider these questions specifically in the context of Syria since the start of the civil war in 2011.

Using stylized facts gathered from news reports and ethnographic literature in criminology and archaeology, I specify a series of three two-player games between participants in the market for Syrian Antiquities. The first two, the Provenance game and the Authenticity game, are signalling games between sellers and buyers. The third, the Crowd-Out game, is a game of imperfect information between producers and buyers. While all three are one-shot games, they each include exogenously given reputation costs. I consider the backwards induction equilibria of the full information baseline case of each of these games, then solve the incomplete or imperfect information cases using a modification of the standard Perfect Bayesian Equilibrium concept.

The PBE modification I introduce is designed to capture variations in the accuracy of players' subjective probabilities regarding the likelihood of receiving a looted or fake good, as the criminological literature suggests that participants in the antiquities trade display trenchant

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[4] Before the problem of cultural heritage looting became attached to ISIL in Syria, it was a cause for concern during and after serious conflicts in Afghanistan (McNamee, 2010), Iraq, and Cambodia (Davis, 2012; Mackenzie and Davis, 2014), and an ongoing but less politically charged issue in stable countries like the UK and Bulgaria (Kersel, 2006; Campbell, 2013).

subjective beliefs about the reliability of provenance and authenticity certifications. The modified solution concept consists of (i) best responses to other players' strategies and (ii) subjective beliefs known to all players but not always formed according to Bayes' rule at nodes on the equilibrium path. Instead of using Bayes' rule whenever possible, players have a motivation level μ where $0 \leq \mu \leq 1$ that determines the point at which they accurately update subjective beliefs at nodes on the equilibrium path (q). The modification uses the following piecewise function describes players' subjective beliefs at nodes on the equilibrium path as a function of objective prior probability ($0 \leq p \leq 1$) and motivation level ($0 \leq \mu \leq 1$).

$$q = p \ \textit{if } p \leq \mu$$

$$q = 1 \ \textit{if } p > \mu$$

I model two extreme buyer types using this solution concept. To capture predictions for perfectly rational players, I model buyers with $\mu = 1$, who I refer to as "sophisticated." To capture predictions for buyers who always take certifications at face value, I model buyers with $\mu = 0$, who I refer to as "naïve." All buyers are assumed to have preference for licit and real antiquities, and would prefer no trade to purchase of a looted or fake antiquity.

Solving the Provenance game using my modified PBE concept yields the result that naïve buyers sustain trade in looted or fake goods when the low probability of meeting a seller of licit goods would cause perfectly rational sophisticated buyers to exit. The intuition behind this result is that naïve buyers have trenchant subjective beliefs which cause them to persist in accepting certified goods even when the expected utility from accepting certified goods falls below the expected value of rejecting them. Knowing that naïve buyers behave in this way, sellers play pooling certification equilibria as long as the reputation cost (a>0) from making a false

certification is smaller than the net gains from selling a certified good. The net gains from selling a certified good are composed of an exogenously given base price set at 2, a certification premium ($x>0$), and a certification cost ($c>0$). The relationship is represented algebraically by $2+x-c>a$. This result suggests that dealers and venues with lower value stock and lower reputations costs are more likely to trade in loot and fakes, that common knowledge about increases in the proportion of looted good on the market can fall on deaf ears and have little impact on equilibrium outcomes, and that increasing the premium associated with certified licit or authentic pieces will not unambiguously prevent the sale of loot. In light of these results, creating a secure certification system for antiquities that increases certification and reputation costs, as has been suggested by art market experts (US GAO, 2016), can be effective in shutting down trade in looted goods.

Solving the Authenticity game using my modified PBE concept yields a result similar to that of the previously discussed Provenance game. The information asymmetry to be bridged in the Authenticity game is whether an object is real or fake. Like trading certified loot, trading certified fake objects incurs a reputation cost from false certification. But fakes do not in theory incur the same costs from enforcement of anti-looting laws ($e>0$), so the conditions under which sellers play pooling certification equilibria obtain when both reputation and enforcement costs are smaller than the net gains from selling a certified good. The net gains from selling a certified good are composed of an exogenously given base price set at 2, a certification premium ($x>0$), and a certification cost ($c>0$).The conditions are described algebraically by $2+x-c>a$ and $2+x-c>e$ and carry the same implications as the conditions in the Provenance game. Yates (2016) points to smear campaigns by the Mexican government alleging that a large proportion of objects at an

auction of Pre-Columbian art were high quality fakes as an example of a policy intervention that targets the market's preoccupation with authenticity. My model suggests that this will have limited efficacy if naïve buyers in the market fail to rationally update objective priors.

Although simply making allegations about the prevalence of fakes has limited power, the Crowd-Out game shows that fakes can play a role in the prevention of looting. In the presence of an information asymmetry about authenticity, strong preferences against fake pieces, and the ability to manipulate the incentives to produce loot and fakes, it is possible to eliminate looting equilibria. Let (d>0) denote the costs of digging for loot, (f>0) denote the costs of creating fake antiquities, (a>0) denote reputation costs associated with claiming a fake is real, and (e>0) denote the differential enforcement costs borne by looters who successfully secure a trade and have to ship their good to the customer. Whenever it is more profitable to produce fakes instead of loot (d>f; d+e>3+f) and the differential enforcement costs are sufficiently high (e>3), sophisticated buyers will correctly infer that sellers will not provide real antiquities and shut down trade. Naïve buyers will fail to make the inference and thus sustain trade in fakes. Looting equilibria become more difficult to sustain if policies increase the cost differential between producing loot and producing fakes (d-f), decrease reputation costs (a>0), and increase the differential enforcement costs borne by looters (e>0). From a policy perspective this implies that increasing the cost of metal detectors or banning them altogether (Brodie and Sabrine, 2018) should make a difference to the looting of some types of objects, that building law enforcement capacity and increasing punishments for transporters of loot (US GAO, 2016) should decrease looting, and that regulating online trade (Brodie, 2017; Price, 2018), which would likely increase reputation costs, can be counterproductive. It also suggests that an effective way to prevent

looting is to fabricate high quality fakes and inject them into areas susceptible to looting, an intervention that has yet to receive public consideration or support but which should be seriously considered.

The paper is structured as follows: Section 2 covers literature on the antiquities trade, markets with asymmetric information about credence goods, and policy interventions that take advantage of information asymmetries. Section 3 describes stylized facts about the market for Syrian antiquities used to specify my models. Section 4 defines my modification of the Perfect Bayesian Equilibrium concept. Section 5 presents two signalling games: the Provenance game, which shows the conditions under which looted antiquities are sold, and the Authenticity game, which shows the conditions under which fake antiquities are sold. Section 6 presents the Crowd-Out game. Section 7 shows graphically the effect of 1) increasing the cost differential between producing loot and producing fakes, 2) decreasing reputation costs, and 3) increasing the differential enforcement costs borne by looters on looting equilibria. It discusses examples of interventions targeting each of the parameters listed above. Section 8 concludes.

2.   Literature

The body of economic literature on the antiquities market is small but has produced empirical work detailing the determinants of international flow of illicit antiquities, sales venues, and auction prices. Fisman and Wei (2007) find a significant correlation between export-country corruption level and customs reporting gaps, and show that gaps are much larger for artefact-rich countries than for other countries. Greenland et al (2018) develop a statistical method for calculating the market value and object composition of ancient sites and predicting the destinations of objects based on characteristics such as size and medium. Marrone (2017) uses

data on Near Eastern antiquities sold in the higher end of the auction market from 2007 and 2015 and shows that while a provenance from 1970 or earlier confers a price premium, the effect does not increase with additional years of provenance pre-1970. Additionally, only individually sold lots exhibit a provenance premium; grouped lots, typically of lower quality or value, show the opposite trend.

A few studies also examine whether the antiquities market responds to signals of increased enforcement. With regards to the effect of court rulings on displayed provenances at auction houses, Kiel and Tedesco (2011) show that after the trial of Marion True in 2005, having a pre-1970 provenance significantly increased the price of an ancient object. The variable constructed for a "good" provenance in Kiel and Tedesco (2011) does not seem to distinguish between largely unreliable private collection histories and more reliable public sales histories, so the results are best interpreted as indication that the market made a greater effort to display provenances that, taken at face value, comply with the standards set out in UNESCO 1970. Beltrametti and Marrone (2016) use a more nuanced provenance variable to show that court rulings pertaining to Egyptian and Classical antiquities increased both the quality of documentation and price premia in the submarkets for Egyptian and Classical pieces, and that the percent increase in price premium was larger for higher quality goods. While they corroborate the result that stronger enforcement changes the proportion of objects offered which have provenance, the enforcement signals did not seem to affect the composition of other submarkets.

It is unclear whether empirical trends in the premia for and supply of provenance indicate decreases in the sale of loot given that fabricated provenances are common (Borodkin, 1995; Mackenzie, 2005; Kersel, 2006) and due diligence at auction houses can be unreliable

(Mackenzie, 2005; Tsirogiannis, 2015). There is also often a years-long lag between the extraction and credible signals from court rulings which may provide an unwanted window of opportunity. The first part of this paper will augment existing literature on the trade by offering a framework for interpreting the impact of empirical trends in provenance premia on the sale of loot, which I will show can have unintended consequences.

Theoretical work specifically on the antiquities trade has examined methods for preventing already looted antiquities from moving across national borders. Kremer and Wilkening (2014) propose long-term leases as a solution to the flow of cultural patrimony from artefact-rich countries to market countries. The authors present a series of models showing the counterproductive effects of export bans on cultural property in an environment where there is ex-ante welfare justification for government regulation but the possibility of foreign hold-up and government corruption. They then show that long-term leases are preferable to both export bans and cash incentives for revelation and maintenance of artefacts as they continue to maximize welfare in the presence of corruption. A limitation of this approach, however, is that by the time looted objects can be exported or leased archaeological context will already have been destroyed. Externalities from looting are realized not upon sale but upon production, so preventing a looting cycle in the first place may be preferable to confiscating looted objects. Additionally, it may occasionally be desirable to prevent funds from reaching the regime in control of a country. The second part of this paper offers a solution operable for situations in which the prime objective is to prevent production and market transactions of looted objects.

Mackenzie (2005, 2014), Kersel (2006, 2015), Campbell (2013), and Brodie (2015a, 2015b) extensively detail the means through which looted antiquities are excavated, smuggled,

and sold as part of the legitimate antiquities trade. This body of literature indicates that whether a particular object was looted is a credence attribute (Darbi and Karni, 1973) unobservable to the consumer and a source of asymmetric information in the market for antiquities. Expert middlemen and certifications can bridge the information asymmetry and sustain markets for credence goods by communicating their knowledge to buyers using credible signals, but the reliability and honesty of a certification signal provided by an information intermediary depends on competitive structure and regulation in the market for expert's services (Wolinksy, 1993; Lizzeri, 1999; Dulleck and Kerschbaumer, 2009; Biglaiser 2013). Markets will not discipline experts if consumers can neither verify the quality of the good they have received nor hold experts liable for misrepresentation (Dulleck and Kerschbaumer, 2009) and when a large enough proportion of buyers take certifications at face value they lower the chances of verification and liability and allow unreliable certifiers to persist in the market (Bolton et al, 2012). The antiquities market does not promise to credibly signal provenance quality. Participants in the antiquities trade profess a great deal of faith in the word of dealers and auction houses (Mackenzie, 2005) and are willing to pay a premium for questionably provenanced objects with a record of auction or dealer sales (Marrone, 2017) even though auction houses only transfer title (Alderman, 2008; Mackenzie, 2005) and have a history of overlooking problems with provenance until asked to revise their opinion by third-party researchers (Yates, 2015; Tsirogiannis, 2015).

The classic signalling model I will use to model the antiquities trade comes from Akerlof (1970) on the market for lemons and Spence (1973) on education as a signal in the labor market. I follow Hirshleifer and Teoh (2003) and Bolton et al. (2012) in adjusting the classic signalling

model by introducing what Bolton et al. refer to as trusting and sophisticated buyer types in order to capture limited attention spans and differing incentives. Bolton et al. model more and less attentive types by exposing sophisticated types to information about the structure of a ratings inflation game in addition to a potentially unreliable quality signal, whereas trusting types take the potentially unreliable quality signal at face value. As I present simpler models than Bolton et al, I model sophisticated and naïve buyer types by defining a potentially defective subjective belief-formation protocol and specifying that such belief profiles are common priors. While the belief formation protocol is likely unrealistic, my results pertain to the two extreme cases that would obtain for any functional form. My models of the market for provenanced goods suggest a potentially perilous relationship between the price premium and the amount of loot traded.

The intervention I suggest is similar to the solution to elephant ivory poaching proposed by Kremer and Morcom (2000). Common anti-poaching interventions focus on increasing the expected costs of producing poached horn. Successful examples include "shoot on sight" policies, but efficacy is generally increasing in bloodiness and decreasing in compatibility with legal institutions (Messer, 2000). Kremer and Morcom (2000) show that a credible threat to release a stockpile of ivory if elephant populations fall below a given level eliminates excessive poaching equilibria without shedding human blood. Flooding the market prevents poaching by disrupting the profitability condition of poaching and storage, and a profitability-disrupting tactic in the same spirit can be applied to the authenticity information asymmetry in the antiquities trade. I contribute a solution that applies to the antiquities trade and which considers the behaviour of buyers who do not update information perfectly.

A number of scholars have informally advocated for the use of a confidence-disrupting market based intervention in the antiquities trade. Stannish (2009) observes from field work in the Andes and monitoring of online forums for antiquities such as Ebay that fakes have become more prevalent and of higher quality in the years since the introduction of digital marketplaces. Pre-Columbian artefact reproduction has a higher profit margins than looting, and Stannish theorizes that the increasing quality of fabrication increases doubt about authenticity in the market, which should depress prices across the board and make looting even less profitable. Yates (2015) points out that authenticity is of paramount importance to collectors and that the value of authenticity has been used as leverage by governments attempting to repatriate objects for sale at auction. After an unsuccessful repatriation lawsuit, experts and representatives from the state's Ministry of Culture publicly denounce a proportion of the goods as high quality fakes without stating which specific lots are suspect. Yates (2015) gives the examples of the Sotheby's Paris 2013 Barbier-Mueller auction and the Bonhams New York 2014 African, Oceanic and Pre-Columbian Art sale, both of which featured pre-Columbian artefacts the Mexican government wanted to repatriate. In both sales the Mexican government claimed in the weeks preceding the auction that at least 50% of the pre-Columbian lots were fakes. The claims may have sown doubt that translated into lower hammer price, but statistical analysis has not been yet completed. Bulos (2016) cites scholar Azm as saying that "One of the ways to break the grip of a looting cycle is to flood the market with fakes, so that confidence in the material coming out of Syria crashes." I formalize the idea of disrupting the profitability of the antiquities trade via sowing doubt about authenticity.

3.   Stylized Facts

Trade in antiquities has proceeded in the West for centuries. The modern tradition of antiquities collecting traces back at least to princes of the Italian Renaissance and gentlemanly owners of Cabinets of Curiosity in the 1700s (Renfrew, 2000). These collectors were initially interested primarily in obtaining physical relics of the Classical civilisations that flourished in the Mediterranean from approximately 1000 BC to 450 CE and which were considered the cultural progenitors of western empire (Mackenzie and Yates, 2013). The earliest archaeologists working in Egypt, Italy, Greece, and the Near East excavated not for knowledge, but for artefacts to ship home as art and curios (Renfrew, 2000). Until the latter part of the twentieth century there was little geopolitical consensus on how cultural heritage (Renfrew, 2000). Participants in the antiquities trade thus initially made little distinction between antiquities produced via organized archaeological expeditions, tomb raiders and semi-professional looters, or opportunistic invading armies. Without any social or legal reason to avoid looted goods, participants in the trade only kept reliable records of the provenance, or chain of custody, for remarkable works or for objects once owned by remarkable collectors (Mackenzie, 2005).

In recent decades, academic practices regarding and legal standards for the production and trade of artefacts have evolved. The mandate of archaeology is no longer to excavate in order to collect information, but to collect information through minimally destructive excavation. Accordingly, archaeological excavation produces artefacts and information far more socially valuable than their looted counterparts, particularly in the case of groups of artefacts found *in situ* that can be analyzed in relation to one another. As the fundamental stakes of unauthorized excavation have increased, advocacy by archaeologists such as Clemency Coggins spurred the creation of an international treatment of the problem of looting (Gerstenblith, 2015). So far 134

states have become party to the UNESCO 1970 Convention,[5] which establishes a common

definition of cultural heritage and lays out cultural property rights for source countries. The year

1970 is a common reference point for acceptable provenances, although legally few countries

have laws that require goods to have been imported before 1970. The United States, for example,

accepted UNESCO 1970 in 1983, and the UK did not accept until 2002 so those respective years

are the minimum legal standards for import documentation (UNESCO, 2018). Because source

countries established anti-looting laws and export controls years before market countries agreed

to enact import controls, bilateral agreements to enforce export bans from other countries and

general property right protections are also critical to ensuring the functionality of legal

mechanisms against the production and sale of loot: without such agreements and institutions the

laws of different countries fail to engage with each other. There are undoubtedly limitations and

holes in the legal apparatus, so the market thus faces a stark underlying justification for avoiding

loot and but somewhat spotty legal standards prohibiting its sale.

Although times and nominal legal standards have changed, the market seems to adjust in

a piecemeal and ultimately unsatisfactory fashion. After a wave of aggressive lawsuits in the

2000's imposed criminal sentences and large fines on a number of major private collectors and

museum directors, tomb-raiding in Italy and Greece noticeably decreased (Felch and

Frammolino, 2011) and market composition of submarkets for Egyptian and Classical[6] objects

shifted towards higher provenance quality and larger provenance premiums (Beltrametti and

Marrone, 2016). Yet satellite imagery captured within years after the start of the civil war in

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[5] Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer
of Ownership of Cultural Property
[6] Material culture from the Mediterranean from approx 800 BCE to 450 CE, typically centered around
Greek and Roman cultures. http://www.visual-arts-cork.com/ancient-art/classical-antiquity.htm#definition

Syria records extensive looting pits (Casana, 2014; 2015) and the sale of these looted Syrian objects continues to elude control.

3.1.   Stylized Facts for the Provenance Game

My first model pertains specifically to the sale of objects looted from Syria since the start of the civil war, but intends to capture market conditions when a state loses control over the excavation and export of its archaeological resources. The model takes the perspective of the Syrian Arab Republic prior to 2011, treating its laws as the default and desired level of control. According to the Antiquities Law passed in 1963, an artefact can be legally traded or exported from Syria only if the state approves its release (Syrian Arab Republic DGAM, 2000). For simplicity I will model all objects as belonging to one of two categories: **Clean**, meaning it was extracted or exported from Syria before the start of the civil war, or **Dirty**, meaning it was extracted or exported from Syria after the start of the civil war.

3.1.1.   Coexistence of Clean and Dirty Goods

There are both clean and dirty objects on the market. Satellite imagery of Syria from 2007 to 2015 indicates that looting of sites containing antiquities in Syria has increased since the start of the civil war, not just in ISIL-held land but also in territories controlled by the Syrian Regime, Kurdish rebels, and various opposition groups. Casana (2015) finds war-related looting in 16.5% of Syrian Regime-held sites, 21.4% in ISIL-held sites, 27% of Kurdish-held sites, and 28% opposition-held archaeological sites with the Syrian regime and ISIL-held sites exhibiting mostly severe looting damage while Kurdish and opposition-held areas exhibiting minor looting damage.

Investigative journalists with the Wall Street Journal, the Guardian, the Independent, The New Yorker, and Buzzfeed News have offered evidence of the export of loot through interviews with the looters, traders, and smugglers in Syria who trade in dirty antiquities. In an investigative report undertaken for BBC Radio Four (Cox, 2015), a 21 year-old smuggler referred to as Mohammed describes an ecosystem of looters and smugglers who smuggle "light and high value artefacts" such as "earrings, rings, small statues, carved stone heads" across the border from Syria to Lebanon using taxis drivers. In the same report, archaeologist David Gill finds atypically large quantities of Seleucid coins and suspiciously intact and dirty late Roman and Byzantine glass in London antiquities shops. Shabi (2015) reporting for The Guardian on London dealerships with archaeologist Mark Altaweel also finds second to fourth century BC artefacts for sale in London which are almost certainly looted. The FBI issued a warning in August 2015 that they had received "credible reports that U.S. persons have been offered cultural property that appears to have been removed from Syria and Iraq recently" (FBI, 2015). These first hand accounts indicate that looters and traders have been able to excavate Syrian artefacts and smuggle them out of the country to sell to collectors. In ISIL-controlled territories, which are often the primary focus of media and government reports about looting in Syria, it appears that ISIL pays out 80% of the trading value of objects looted in their territories and takes on the role of the early stage intermediary (Kantchev, 2017; Tamimi, 2015; Brodie and Sabrine, 2018). A United States military raid in the fall of 2015 on the director of ISIL's Department of Precious Things That Come Out of the Ground, Abu Sayyaf's, home yielded receipts and instructions regarding looting antiquities. Furthermore, Kagan (2015) points out that more examples of a few incredibly rare Palmyrene coin types that had limited circulation outside of what is now central

Syria have shown up at auction between 2010 and 2015 than in the entire two previous decades. Overall, the number of Near Eastern objects sold on the higher end of the market per year have increased since 2011, from an average of 470 to 680 per year (Marrone, 2017).

Loot is able to move from archaeologically-rich source countries to their final destinations via stratified smuggling and trading networks. In Syria, it has become clear that objects are produced by several different parties. Small bands of looters who have lost other forms of income either purchase or rent metal detectors and digging equipment (Brodie and Sabrine, 2018). They then sell their objects to to legally or logistically advantageous "transit" markets through stratified smuggling and trading where they gain the credentials necessary to move on to the demand-heavy and wealthy "destination" market (Kersel, 2015). Markets can coexist within the same national boundaries, but the flow of objects usually proceeds through several countries in order to take advantage of differences in resources, political and economic institutions, and legal codes. There seem to exist four specialized roles for participants within the market for illicit antiquities. The first role is that of a looter, who extracts the artifacts (Kersel, 2015). The second role is the early stage intermediary, who buys the illicit artifacts from looters and smuggles and sells the objects to late stage intermediaries (Kersel, 2015). Late stage intermediaries play the third role in the trade, and are also referred to as "Janus dealers" after the eponymous two-faced god for their power to face downwards to buy illicit artifacts, fabricate a provenance or appearance of legitimacy, then face upwards and sell a seemingly licit object (Mackenzie and Davis, 2014). The final role is that of the collector, who demands and purchases artifacts that they believe to either be above board or illicit (Kersel, 2016). Individuals can fill

more than one role, and completion of a role might be drawn out between multiple individuals (Campbell, 2013).

3.1.2. It Costs to Certify

A reliable, verifiable chain of custody that can demonstrate whether an object is clean or dirty is often referred to as the provenance of an object. Certification of provenance is a relatively new development in the antiquities trade for reasons previously discussed, and as a result only a fraction of objects on the market have documented provenances.The cost of certification can thus either vary for clean and dirty goods or be intrinsically invariant between the two types of goods. In order to have a reliable provenance, an object must have been published with a photograph in a scholarly citation or a sales catalog prior to 2011 (Mackenzie, 2005). Documents showing museum deaccession or a photographic presence on any other kind of immutable record also inspire confidence. Exceptional pieces that retained a paper trail over the years have access to such certification signals, but clean lower quality objects and dirty objects do not. My model will set the exceptional objects aside and focus on the broad swathe of the market that does not have access to incontrovertible documentation.

The majority of objects on the market are either unexceptional or looted, and have access to less secure forms of provenance. These include export documentation, labels or ink inscriptions verifying the name of the collector but not the date of acquisition, claims that the object was held in a private collection that was started at a certain date or acquired into a private collection prior to a certain date, and past sales at auction or from named dealers since the cutoff date (2011 in our case). Such certifications of provenance are not particularly costly to attach to a good of either type. In fact, it is shocking how inexpensive it would be for either type of seller to

produce commonly accepted forms of certification. Export documentation can be vague in their descriptions and easily misattributed (Kersel, 2006; Dealer T, 2017), and labels with the names of collectors can be easily applied to an object. Histories of private ownership are rarely verifiable (Marrone, 2017) because they typically consist of an oral history by the previous owner backed up by a document guaranteeing that the consigner of the object has legal title. For example, a dealer interviewed by Mackenzie (2005) characterizes the kinds of verbal assurances they receive as follows:

> *A lot of it is "so and so told me that such and such came from somewhere, and he got it from their grandfather" and that's very often the only kind of documentation you have. (New York Dealer 5, p36)*

Some consigners produce a warranty of title (Mackenzie, 2005), but titles by Swiss, German, or Hong Kong persons do not mean much as the freeports in those countries have been popular places to launder artifacts due to the tax-free storage and favorable property right laws (Tsirogiannis, 2015; Steiner, 2017). Previous sales at auction or at known dealerships can also appear as provenance (Tsirogiannis, 2015; Katchev, 2018), but dealers and auction houses are often not designed to truly vet and serve as signals of being legitimate (Mackenzie, 2005; Alderman, 2008). Because most dealers and auction houses simply ask the consigner or original owner of a piece to transfer their title to the dealership or auction house (Mackenzie, 2005), these venues do not filter out dirty objects. A good example of the inability of auction houses to filter out dirty objects is the fact that three objects depicted in the archives of a known looting middleman were put up for sale by Christie's London in 2015 (Tsirogiannis, 2015). The objects were eventually pulled from the auction, but were only identified because Swiss and Italian

authorities happened to have confiscated photographic records of that particular middleman's wares in 2002 and 2005. Scholars and law enforcement clearly do not have access to every photographs of every single looted object, so catching the objects before they were sold was a stroke of good luck. Additionally, as Tsirogiannis (2015) points out, if auction houses cannot catch so obvious a flaw in the chain of custody as having appeared in police reports, then it is unclear what assurances their coarse background research offers.

For all of these certifications there may be a small cost associated with producing physical documentation alleging a clean chain of custody. But we would a) not expect there to be large costs, and b) would not expect there to be any systematic difference between these certification costs for clean but unexceptional goods and dirty goods.

3.1.3. Reputation and Enforcement Costs for False Certification Exist

While the cost of making a certification on its own generally does not cost a great deal, there are both reputation and enforcement costs to making a false certification. Sellers of looted goods must take into account the expected disutility of gaining a bad reputation and the subsequent loss of future business in the event that a false signal is discovered. These costs are higher for brick and mortar businesses due to higher overhead costs, large auction houses due to greater volume of business to be lost, and dealers facing greater rates of detection by either law enforcement, the press, or their customers.

Sellers must also take into account the expected disutility from legal penalties in the country of sale. While laws useful in prosecuting vary from country to country, there are generally laws that carry civil forfeiture as well as those that allow criminal prosecution. For example, according to Stephens (2017) the United States has several codes which can be used to

obtain civil forfeiture of a looted or illegally exported object including the Cultural Property

Implementation Act of 1983 (CPIA), which implemented portions of UNESCO 1970 in the

United States and, since 2016, the Protect and Preserve International Cultural Property Act

(PPICP). A handful of codes also allow for criminal prosecution, but both difficult to

successfully argue. The National Stolen Property Act (NSPA) can carry a fine or up to 10 years

of imprisonment, and the fact that ISIL profits from the sale of at least some looted Syrian

antiquities makes it possible to criminally prosecute sellers and buyers of looted objects pursuant

to 18 U.S.C. § 2339A for terrorist financing. The enforcement costs associated with seller a

looted object should be considered expected disutilities from civil confiscation and successful

criminal prosecution.

3.1.4.   Certification Premium

Empirical work establishes that there is a provenance premium for documented

provenance, even unreliable forms of provenance, and no negative impact on prices for goods

without any kind of provenance. Kiel and Tedesco (2011) find that a documented provenance

increases the hammer price of antiquities, and Beltrametti and Marrone (2016) further find that

court rulings increase the proportion and quantity of reliably provenanced goods in the market

for Egyptian and Classical goods. They also find that larger, higher quality objects experienced a

larger percent increase provenance premium due to increased enforcement. Marrone (2017)

analyzes the upper end of the auction market for Near Eastern antiquities since 2011 and finds

that items sold alone are appraised by the auction house with a premium of 34.6% for any kind

of provenance that predates 1970, and with a weakly significant premium of 22.5% for past sales

at auction. There also appears to be premia of about 20% for grouped items previously sold at

auction and about 50% for grouped items previously sold by a dealer[7]. A provenance premium in the market for Syrian antiquities may be tempered by object quality, but it can exist even for weak indicators of cleanliness like past auction and dealer sales. My model stylizes this as a certification premium applicable to all certified sales.

3.2. Stylized Facts for the Authenticity and Crowd-Out Games

The other credence attribute buyers of antiquities must contend with is whether an artefact is authentic. In fact, the trade has historically been far more interested in establishing authenticity than in establishing whether an object was looted. Despite a history of expert authentication, Stannish (2009) notes that the democratization of collecting and the improvements in technology used by fabricators have led to increasingly convincing fakes and no fewer duped collectors than before. Because doubts about authenticity can depress the sales value of antiquities, artifact-rich countries have used "soft-control" strategies involving the dissemination of doubt about authenticity (Yates, 2015). As Yates (2015) notes, auctions for Pre-Colombian antiquities earned half as much as expected following by official statements from Mexico's Instituto Nacional de Antropología e Historia that large proportions of the objects were modern-day handicrafts. Syria may be approaching the looting problem with the soft-control tactics used by Mexico. Bulos (2016), Cockburn (2016) and Kantchev (2017) report an increase in the production of fabricated artefacts in Syria. Maamoun Abdulkarim, quoted in both Bulos (2016) and Kantchev (2017), estimates that 70-80% of artefacts being exported from Syria to Lebanon are fake. This represents an increase from the 20-30% common in previous years.

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[7] Interestingly, Marrone (2017) also finds a premium of about 20% for no provenance at all in grouped lots. This seems odd given that there are also significant premia for past sales by auction house and by dealer, and probably has to do with how the variables for provenance were defined. In any case, the larger significance of dealer certification supports stylizing these empirical results as a certification premium.

Several institutional features of the market for Syrian antiquities are relevant to a model of antiquities trade with private information about authenticity.

3.2.1.   Certification Costs for Authenticity

Certifications of authenticity for antiquities include age testing, expert examination, money-back guarantees, seller generated certificates, and photographic documentation. The most reliable of these is age testing: Radiocarbon dating works for organic material such as ivory, and thermoluminescence testing works for ceramics. These methods determine the age of the material used to produce the antiquity, but are costly and destructive. Thermoluminescence testing costs up to $400 and requires drilling a sample of the material (Oxford Authentication, 2017). These tests are rare, and generally only performed for buyers who have willingnesses to pay above the certification cost, or by sellers with strong preferences for income now rather than later. They are also not completely foolproof, as high quality fakes can use old material to overcome these certifications (Yates, 2015). Expert examination is another tool for determining authenticity, but as Stannish (2009) points out experts are sometimes trained on fakes and are unable to distinguish between the real and the fabricated. Money-back guarantees are also commonly used, but the cost of such guarantees depends on the reliability of other primary methods of authentication and the specific terms of the guarantee. For example, if returns are allowed within 14 days of purchase and without damage to the objects, thermoluminescence testing is unavailable and expert analysis is unlikely. Fay (2011) notes that another form of authenticity certification, albeit a laughingly unreliable one, is a seller-generated certificate of authenticity. Finally, photographic or videographic evidence of an object being excavated and papers documenting the smuggling route taken are also ways that producers can signal

authenticity to the buyer. Producers of fakes in Syria can and do avail themselves of many of these signals but favor in particular photographic evidence of recent excavation. Bulos (2016) reports that dealers can send along photographs of half buried "artefacts" to convince buyers, or allow a trusted looter to dig out the fake object on behalf of the buyer. Smugglers also send the fakes along the same path as authentic pieces to continue the masquerade. Once faked goods reach the buyer, they can be so expertly fabricated they are indistinguishable from real artefacts:

Some are made from pieces of damaged mosaics, reassembled into designs that mimic more valuable pieces. "There are some very good fakers, especially in mosaics.... These workshops are mostly in the area around Idlib, some in Damascus. They're so good they use ancient stones and reset them to get a higher value," [Azm] said. "Unless they make a stylistic error or a technical error, you won't tell it's a fake. If you look at the stone, test the residue, it will all be ancient."

I stylize certifications of authenticity as costing the same to provide for both authentic and inauthentic goods.

3.2.2. Enforcement and Reputation costs

While an actually looted object would be subject to seizure and the smugglers of actually looted pieces would be subject to legal repercussions, there are much lighter enforcement-related costs for fake goods. Cockburn (2016) and Bulos (2016) report that smugglers get reduced sentences for transporting fakes, and Stouton (2015) reports that Lebanese authorities generally try to release fakes. The reputation costs incurred by sellers of fakes should be thought of as expected disutilities from loss of business due to detection of false certifications. Most of the objects looted from Syria are metal, glass, and stone (Brodie and Sabrine, 2018). These materials

cannot be dated by the major forms of absolute age authentication useful on a human time scale as thermoluminescence testing requires ceramic samples and carbon dating requires organic material (Gagné, 2015). Stylistic comparison to known types is the preferred way of establishing authenticity, but . Since discovery of a false certification is unlikely Reputation costs are thus likely to be low.

Francis (2015), Cox (2015), Giglio and Awad (2015) suggest that objects do not ship until certification have been produced and payment has changed hands. I include a parameter for the differential enforcement costs that a real object incurs in transit to its confirmed owner. This cost is typically confiscation of the object itself and an additional punishment for the seller. For example, Cox (2015) reports that smugglers of Syrian antiquities in Lebanon are "pretty spooked right now just because the Government's been cracking down quite a bit on this, and anyone who has antiquities at this point is pretty much being accused of being in league with ISIL, so it's not just the charge of trafficking antiquities, it's also terrorism charges." It differentially applies to loot because a fake good in transit should not incur confiscation or any additional punishment.

3.2.3. Certification Premium

Just as there is a certification premium for various forms of provenance, there is also a certification premium for authenticity. Antiquities derive almost all of their value from authenticity, and certification of authenticity changes the valuation of a good from handicraft to ancient art as in the case of the complete worthlessness of Getty Kouros to the government of Greece once it was established as a fake (Yates, 2015). Some empirical literature on the art market in general also suggests that information shocks about the authenticity of pieces

decreases the price of objects, which indicates an implicit premium for authenticity. Bocart and Oosterlinck (2011) show that after fakes are discovered, objects are more likely to be consigned to the two major auction houses Sotheby's and Christie's and auction prices decrease for about a year after revelation of a fake. The authors suggest the consignment effect is driven by a belief in the credibility of the largest auction houses whereas the price decrease may indicate a belief that the market purges fakes by selling them at a lower price. I capture the difference in price between an authentic object and a fake in a certification premium, as the lay person cannot tell the difference without some form of certification from an information intermediary.

3.2.4. Costs of Production

Interviews with looters in Syria published by Brodie and Sabrine (2018) record some expenditures and incomes for producers of loot. Looters at the beginning of the conflict were allegedly earning $1,300 a month on their finds, but now seem to earn somewhere around $200 a month, $17 a day, or $3-4 a day and 70% of the value of the finds depending on the location (Brodie and Sabrine, 2018). Looting requires metal detectors which cost between $800 and $6000 to buy depending on the model and its capabilities.

The costs of producing fakes is hard to estimate and will vary greatly on the specific object produced. Coins, for example, would require larger fixed costs than mosaics because of the metalworking facilities necessary to strike coins. Some reports allege that there simply is not enough of the right kind of loot to satisfy demand. Bulos (2016) reports Maamoun Abdulkarim, director of the Syrian DGAM as saying the following: "Bibles, coins, statues ... the buyer wants a certain model of artifact. The seller doesn't have it, so you have workshops that produce fakes."

3.3.   Buyer Preferences and Sophistication

Interviews with participants in the market suggest that some buyers of antiquities are more careful evaluators of the reliability of certifications than others. Some participants in the market appear to overestimate the efficacy of auction houses and dealers at rooting out looted objects, and exhibit a reluctance or a delay in updating their beliefs about the reliability of fundamentally flawed certifications of provenance or authenticity. While a variety of behavioural adjustments to the standard model are probably at play for agents in the antiquities trade, I focus my efforts on modeling the trenchant subjective beliefs in the reliability of certification.

Mackenzie (2005) presents several examples of trusting buyer types, who are willing to proceed on trust alone when there is no evidence of a provenance. Such dealers make statements reproduced below, which taken together indicate an unwillingness to come to terms with the fact that the proportion of loot may change, and a reluctance to actually ascertain likelihood of an object being looted.

I like to believe that most people are straight and that you shouldn't be required to prove that you are. That somebody should be required to prove that you aren't. (London Dealer 8, p27)

The payback for investigation, 90% of the time, is you get nothing. So it's done by exception. (New York Dealer 1, p27)

If you buy an object from a reputable dealer in one of the major countries of Europe, you assume that person has title to the object because this business is based a lot on trust. (New York Dealer 5, p27)

And very often they'll say to me, "well, not really, you know, I bought it from a dealer"

and that to me is okay. Because I trust them to buy in the way that I buy. And I'll say the same

thing to them. (London Dealer 8, p38)

Of those 90% of things that I buy that don't have demonstrable provenance (by that I

mean they've never been published) I have to follow my nose. Actually I buy a lot at auction,

where I'm relying to an extent on their good offices, which I think is not unreasonable (London

Dealer 8, p40).

Although Mackenzie's interviews were conducted more than a decade ago, naïve buyers

who take signals of provenance at face value still seem to exist and trade in the market. At an

interview I conducted at the World's Fair of Money in August 2016, approximately one year

after the initial media frenzy about Palmyra, a dealer who specializes in ancient coins of Persia

indicated that he believed that Near Eastern coins were being looted and smuggled since he

noticed an increased supply of them in recent months. He indicated that he did not change his

collecting patterns, however, because he believed that his connection to the illicit trade, and the

connections of other collectors, were already satisfactorily minimized by trading within a select

pool of trusted individuals. In January 2018, a user on a thread about collecting ethics on online

coin collecting forum CoinTalk posted an image of what appears to be a ceramic figurine and the

following description:

I just bought this artifact the other day. Excavated in the early 1950s. I got it from the

official archaeologist's own son. Guess what? He didn't have the paperwork! And I don't expect

my kids to have all of my "paperwork" for my perfectly legal coins. (Nicholas Molinari, 2018)

Other collectors appear to be more sophisticated about the reliability of certifications. Mackenzie (2005) records dealers who acknowledge that sale at an auction house is not such a reliable signal of provenance.

They have a far more complicated from than I have: they have a five-page legal document that people sign swearing up, down, sideways, that they own the thing and they promise not to do this and they promise that they haven't done that and so forth and so on, but basically all that they do is they sign the bottom line. They don't then hire a private investigator to see if I've misled them in any way. It's all done by exception (New York Dealer 1).

Another example of a more sophisticated buyer type is the London dealer I spoke to in August 2017. The dealer also noted that auction houses were not to be trusted, and claims that after the news about Palmyra broke, a number of concerned dealers, herself included, approached the British Museum's Near Eastern head and asked what they ought to do. They were told that they could stop selling Near Eastern objects, and as a result she took off the market every near eastern object in her stock without a pre-1970 paper trail and has refused to deal in them. Other examples of sophisticated agents are any of the archaeologists and scholars who run antiquities trafficking blogs such as Chasing Aphrodite or the Association for Research into Crimes against Art blog, which often take a critical look at recent purchases of objects at auction by more trusting buyers.

4.   Sophistication and Naïveté: PBE Modification

While the Perfect Bayesian Equilibrium concept is the most relevant and suitable solution concept for my models in the incomplete or imperfect information cases, it is unclear that buyers in the market for antiquities are perfectly rational Bayesian updators who fully investigate the

quality of the certification they rely on to determine whether a good is looted. If, as it seems likely given the literature on buyer rationales for participating in the trade[8], some buyers have limited time, attention, and motivation to impartially evaluate the quality of certifications in the trade, they should behave as though they are taking certifications at face value and thus improperly updating their priors. In Definition 1, I specify a modification to the Perfect Bayesian Equilibrium Concept which allows buyers to perform less than perfect Bayesian updating. I will use the two exterior cases in my subsequent analysis.

Definition 1: *Let buyers first decide their motivation level* $\mu \in [0, 1]$*. A buyer's motivation level determines the range of prior objective probabilities p (clean) below which they will carefully and accurately update their subjective probabilities. In other words, motivation level* μ *is increasing in the accuracy of buyers' subjective beliefs.*

Let buyers form subjective belief q according to the following piecewise function:

$$q = p \text{ if } p \leq \mu$$

$$q = 1 \text{ if } p > \mu$$

Subjective belief about r is formed according to standard rules about consistency at nodes reached and not reached. Let "sophisticated" buyers have a motivation level $\mu = 1$*, and "naïve" buyers have a motivation level* $\mu = 0$*.*

5. Signalling Games: Provenance and Authenticity

5.1. Provenance Game

Given that antiquities are a credence good and there are both clean and looted objects on the market with similar levels of provenance documentation, participants in the antiquities trade

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[8] See Section 3.1.5 Buyer Preferences and Sophistication and Section 3.2.5 Buyer Preferences and Sophistication.

face a game of asymmetric information. The following model describes the conditions under which loot is purchased given assumptions based on the above stylized facts.

5.1.1.   Full Information Benchmark

In a world with perfect information, we should see no dirty trade. This state of the world is ideal. Consider the following full information benchmark.

There are two players, a seller (Player 1) and buyer (Player 2). The seller can be one of two types $\Theta = \{clean, loot\}$,where a *clean* seller offers only clean, non-looted stock, and a *loot* seller offers only looted stock. The prior probability of $\Theta = $ clean is $0 < p < 1$. The timing of the game is as follows:

1. Nature moves first to determine the seller's type.

2. The seller, knowing her type, chooses whether to certify that her good is clean

   (C) or not to certify (N).

3. The buyer observes the seller's type as well as any certification the seller offers,

   then chooses whether to accept (A) or reject (R) the object.

4. Payoffs are realized.

Both the seller and buyer seek to maximize payoffs from the transaction. The payoffs should be considered utilities and are as follows. If trade occurs, the seller gains a baseline utility of 2 and a certification premium (x). Otherwise she receives nothing. Certifying a product by producing documentation of past sales or signing a warranty incurs an exogenously given certification cost $c > 0$. If a seller of type *loot* certifies, she incurs an additional exogenously given reputation cost $a > 0$. Reputation cost a is the reduced form of the expected disutility from reputation and enforcement costs for false claims and depends on the magnitude of the

seller's expected income, the probability that the buyer learns of the deception, and the

likelihood and severity of legal repercussions from selling a falsely labeled good.

The buyer can either accept (A) or reject (R) the trade. The buyer gains 2 utiles from

accepting a clean good, 0 utiles from rejecting a trade, and -2 utiles from accepting a looted

good.[9] **Figure 1** depicts the extensive form of the game.

Figure 1.

Assumption 1: *Certification cost* $c = 1$

The parameter *c* captures the costs associated with providing documentation of the

provenance of an object. Mathematically, the value of c only changes the threshold value of x

necessary to support trade. For concreteness, let us set c=1. We assume that it costs some amount

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[9] The cardinal values of the buyer's utilities changes the threshold values at which equilibria
appear, but not the equilibria themselves. See appendix for general version of model.

to offer these documents, be it the costs of digging them out or preserving the documents, but that this cost is not in itself larger than the base value of the object. See Section 3.1.2 It Costs to Certify.

Proposition 1: *Under full information, no trade of loot occurs. For any value of p, if x>c then players play separating equilibrium [CN', AA'R''R'''], otherwise they play pooling equilibrium [NN', AA'R''R'''].*

Under full information, dirty objects are never sold. If buyers preferring clean goods somehow had a costless, faultless capacity to observe whether an object was looted before purchase, they would never purchase looted goods and would always purchase clean goods. Thus, in the full information benchmark when x, the price premium, is larger than c, the certification cost, there exists a separating equilibria in which only clean goods are certified and purchased while dirty goods are neither certified nor purchased. When the price premium is too low to cover the cost of certification, sellers have no incentive to certify even clean goods and there exists a pooling equilibrium in which sellers never certify and buyers only purchase clean goods.

5.1.2. Asymmetric Information

Unfortunately, the world we live in does not yet have a costless, faultless method through which buyers can observe whether an antiquity was looted. The presence of asymmetric information itself changes the equilibrium behavior of participants in the trade, and opens up the possibility of trade in looted goods. The asymmetric information model is exactly the same as the full information baseline, except the seller's type is now private information hidden from the

buyer. I solve the model for two buyer types, naïve and sophisticated. **Figure 2** depicts the

extensive form of the game.

Figure 2.

Assumption 1: *Certification cost c = 1*

PROPOSITION 2: *Suppose **assn 1**. If buyers are sophisticated($\mu = 1$), then when p<0.5 no*

trade of looted goods should occur. When p>0.5, clean trade can occur when 1+x<a, otherwise

only dirty trade is possible.

1. *for all values of p there exists a separating equilibrium [CN'AR' q=1 r=0] when 1+x<a*

2. *for p<0.5 there also exists one pooling equilibrium [NN'RR' r=p<½ q<½]*

3. *for p>0.5 there also exist two pooling certification equilibria and two pooling*

   non-certification equilibria: [CC'AR' q=p>½ r<½] when 1+x>a, [CC'AA' q=p>½

   r>½]when 1+a<x, [NN'AA' r=p>½ r>½] when x<1, and [NN'RA' r=p>½ r<½].

4. *For p=0.5 all of the equilibria listed above exist.*

See appendix for general case.

Sophisticated buyers can always incentivize clean trade, and when p<0.5 they never participate in trade of loot. When p>0.5, however, even sophisticated buyers purchase looted goods since the probability of receiving a clean good is acceptable to them.

Proposition 3: *Suppose **assn 1**. When buyers are naïve ($\mu = 0$) and 1+x<a, there exists a separating equilibrium [CN'AR' q=1 r=0]. Otherwise, when buyers are naïve there exists a pooling certification equilibrium [CC'AR' q=p>½ r<½].*

When buyers are naïve, they take certifications at face value and assume that whenever they reach a certification node, the seller is of type *clean*. They thus always play strategy *AR'* and sellers who realize their customers' limitations will certify fake goods as long as they can afford to do so.

The Provenance Game predicts that sophisticated and naïve types behave differently when p<0.5 and reputation and enforcement disutilities are less than the baseline utility from completing the sale of a certified good. While sophisticated types shut down trade [NN', RR', r=p<0.5, q<0.5], naïve buyers support a pooling equilibrium [CC', AR' q=1 r<0.5]. Reputation costs (a) can be thought of as the expected disutility of lost business from making a false certification of provenance. The parameter is thus increasing in the overhead costs of selling antiquities, and we should expect reputation costs (a) to be lower for seller who operate exclusively online than for sellers who have a brick and mortar storefront. We should expect any trades that occur in such low reputation cost conditions to involve a mixture of loot and real objects and to involve naïve rather than sophisticated buyers.

Proposition 4: *Suppose **assn 1**. For all p<0.5, when reputation costs a and certification costs c inadequately restrain sellers from making false certifications, naïve buyers support trade in looted goods while sophisticated buyers do not.*

The following graph (**Figure 3**) shows the region (red) in which looted goods can be sold to naïve buyers but not to sophisticated ones. The x axis is the certification premium and the y axis is the reputation cost of making a false certification, so higher end segments of the market are represented further from the origin.

Figure 3.

5.2.   Authenticity Game

Provenance is not the only credence attribute buyers might consider when deciding whether to purchase an antiquity. In this section I describe a signalling model in which the seller has private information about the authenticity of her stock instead of its provenance.

5.2.1.   Full Information Case

In this model, Player 1 is the seller and Player 2 is the buyer. Sellers can be one of two types $\Theta = \{loot, fake\}$, where a *loot* type seller offers only looted stock, and a *fake* type seller offers only fake[10] stock. The prior probability of $\Theta = loot$ is $0 < p < 1$. This information is common knowledge. The timing of the game is as follows:

1. Nature moves first to determine the seller's type.

2. After observing her stock quality, the seller chooses whether to certify that her good is real (C), or not certify any such thing (N). Assume that certifying an object as real entails certifying that it is looted.

3. Having observed the actions of Nature and the seller, the buyer chooses whether to accept (A) or reject (R) the object.

4. Payoffs are realized.

The payoffs for the players are as follows. For player 1 the seller, completing a sale without certification garners an exogenously given baseline utility of 2. If she does not complete the sale, she gains 0 utiles. If the seller completes a sale after certifying a good, she gains 3 utiles. This higher price is the result of a certification premium. See Section 3.2.3 Certification Premium for Authenticity. If she does not a complete the certified sale, she incurs -1 utiles. This negative utility comes from a certification cost described in Section 3.2.1 Certification Costs for

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[10] Meaning the object was manufactured in the modern era to resemble an authentic antiquity.

Authenticity. *Loot* sellers incur a differential enforcement cost (e > 0) whenever a good of theirs

is accepted. This differential enforcement cost captures the expected disutility of confiscation or

punishment that sellers of fakes incur during transport of their goods. *Fake* sellers incur a

reputation cost (a > 0) when they falsely certify their good as real. The reputation cost should be

thought of the expected disutility of lost business from making a false certification.

The buyer can either accept (A) or reject (R) the trade. The buyer gains 2 utiles from

accepting a clean good, 0 utiles from rejecting a trade, and 2 utiles from accepting a looted good

[11]. **Figure 4** depicts the extensive form of the game.

Figure 4.

Proposition 4: *Under full information, no trade and no production of fakes occurs. For any value of p, the backwards induction equilibria of the Authenticity Game is*

[CN', AA'R''R''']

5.2.2. Imperfect Information

When we introduce limited information, we see production of and trade in fakes. The imperfect information model is specified as in the full information case, but sellers now have private information about their product type. **Figure 5** depicts the extensive form of the game.

Figure 5.

Proposition 5: *In the presence of asymmetric information, when the proportion of fakes on the market is sufficiently high, sophisticated (μ = 1) buyers sustain pooling equilibria in which they purchase what the sellers are incentivized to produce.*

Sophisticated buyers have the following equilibria:

1. For all p, [CN', AR', q=1, r=0] when 3>e and a>3

2. For p<0.5, [NN', AR', r=p<0.5, q>0.5] when 3<e and 3<a; [NN', RR', r=p<0.5, q<0.5] always

3. For p>0.5, [CC', AR', q=p>0.5, r<0.5] when 3>a and 3>e; [CC', AA', q=p>0.5, r>0.5] when 1>a; [NN', RA', r=p>0.5, q<0.5] when 3>e

4. For p=0.5 all of the equilibria listed above exist.

    Solutions to the Authenticity Game yield the same intuition as the Provenance game. Sophisticated buyers can, in the presence of asymmetric information, support equilibria in which they purchase goods that they would rather not have in a world without information sets. When enforcement and reputation costs are sufficiently low, multiple pooling equilibria become viable.

Proposition 6: *In the presence of asymmetric information, naïve (μ = 0) buyers can always sustain a pooling equilibria in which both fakes and loot are traded when reputation and enforcement costs are sufficiently low.*

The equilibria of the Authenticity model with naïve buyers are:

1. For all p, the separating equilibrium [CN', AR' q=1 r=0]

2. For all p, the pooling equilibria [CC', AR' q=1 r<0.5] when 3>a and 3>e; [NN', AR' q=1, r<0.5] when 3<e and 3<a

In contrast to sophisticated buyers, naïve buyers can sustain a pooling equilibrium for any distribution of fakes on the market so long as enforcement and reputation costs are sufficiently low.

The Authenticity Game predicts that sophisticated and naïve types behave differently when p<0.5 and reputation and enforcement disutilities are less than the baseline utility from completing the sale of a certified good. While sophisticated types shut down trade [NN', RR', r=p<0.5, q<0.5], naïve buyers support a pooling equilibrium [CC', AR' q=1 r<0.5]. Reputation costs (a) can be thought of as the expected disutility of lost business from making a false certification of authenticity. The parameter is thus increasing in the overhead costs of selling antiquities, and we should expect reputation costs (a) to be lower for seller who operate exclusively online than for sellers who have a brick and mortar storefront. We should expect any trades that occur in such low reputation cost conditions to involve a mixture of fakes and real objects and to involve naïve rather than sophisticated buyers.

6. The Crowd Out Game

6.1. Full Information Baseline

In the Crowd-Out game, I model a game between a producer/seller and a buyer of antiquities when it is possible to create fakes. The timing of the full information baseline of the game is as follows:

1. Player 1, the seller, decides whether to loot or fake and whether to certify the object as authentic or not. The seller chooses between four paired actions: Loot and Certify as loot (LC), Loot and Not certify (LN), Fake and Certify as loot (FC), or Fake and Not certify as loot (FN).

2. The buyer observes the actions of the seller and chooses whether to accept (A) or
   reject (R) the object at each node.

3. Payoffs are realized.

The payoffs for the seller are determined as follows: choosing to loot incurs a digging

cost ($d > 0$) while choosing to fake incurs a fabrication cost ($f > 0$). Looters incur an

enforcement cost ($e > 0$) if a buyer accepts their good and they have to ship the product across

treacherous borders. Stockers of fake will incur an additional reputation cost (a> 0). If the seller

completes a sale, she gains an exogenously given baseline utility of 2. If she completes a sale

after certifying a good, she gains an exogenously given baseline utility of 3. If she does not

complete a sale, she gains 0 utiles if she didn't certify and -1 utiles if she did.

The buyer can either accept (A) or reject (R) the trade. The buyer gains 2 utiles from

accepting a clean good, 0 from rejecting a trade, and -2 utiles from accepting a looted good.

Figure 6 depicts the extensive form of the game.

Figure 6.

Proposition 7: *No fakes are traded in the full information Crowd-Out Game.*

The backwards induction equilibria of the full information Crowd-Out Game are

[LC, AR'A''R'''] when d-f<3-e

[FN, AR'A''R'''] when d-f>3-e

because preferences are such that no buyer would accept a fake good. Because no buyer would

accept a fake, it is never a best response for the seller to produce and certify a fake good. If it is

not profitable to produce loot, producers choose to produce and not certify fakes instead of

producing loot, and buyer shut down trade. When it is more profitable to produce loot even with

the burden of differential enforcement costs (d-f<3-e), loot is produced and sold. As there are no information sets, naïve and sophisticated agents behave in the same way.

6.2. Imperfect Information

Buyers rarely know whether an artefact is authentic. The imperfect information Crowd-Out Game captures this feature of the world and shows that though sophisticated buyers do not support trade in fake goods, naïve buyers do. The timing of the game is as follows:

1. Player 1, the seller, decides whether to loot or fake and whether to certify the object as authentic or not. The seller chooses between four paired actions: Loot and Certify as loot (LC), Loot and Not certify (LN), Fake and Certify as loot (FC), or Fake and Not certify as loot (FN).

2. The buyer observes certification but not looting or faking, and so has one information set linking LC and FC, and another linking LN and FN. The buyer chooses whether to accept (A) or reject (R) the object at each of the two information sets.

3. Payoffs are realized.

The payoffs for the seller are determined as follows: choosing to loot incurs a digging cost ($d > 0$) while choosing to fake incurs a fabrication cost ($f > 0$). Looters incur an enforcement cost ($e > 0$) if a buyer accepts their good and they have to ship the product across treacherous borders. Stockers of fake will incur an additional reputation cost (a> 0). If the seller completes a sale, she gains an exogenously given baseline utility of 2. If she completes a sale after certifying a good, she gains an exogenously given baseline utility of 3. If she does not complete a sale, she gains 0 utiles if she didn't certify and -1 utiles if she did.

The buyer can either accept (A) or reject (R) the trade. The buyer gains 2 utiles from accepting a clean good, 0 from rejecting a trade, and -2 utiles from accepting a looted good. **Figure 7** depicts the extensive form of the game.

Figure 7.

Proposition 8: *In the Imperfect Information Crowd-Out Game, sophisticated buyers either sustain trade in looted goods or shut down trade.*

When buyers are Sophisticated ($\mu = 1$) they support the following loot production PBE:

[LC, AA', q=1, r>0.5] when it costs more to produce fakes and incur reputation costs than to produce loot (f+a>d+e; 1-e>d-f)

[LC, AR', q=1 r>0.5] when it costs more to produce fakes and incur reputation costs than to produce loot (f+a>d+e), enforcement costs are lower than the value of any particular certified good (3>e), and the cost difference between digging and looting stays within the following bounds (3-e>d-f).

[LN, RA', q<0.5 r=1] when faking without certifying is more expensive than looting (-e>d-f; 3+a-e>d-f) and enforcement costs are lower than the value of any particular certified good (3>e).

Sophisticated buyer support the following shutdown PBE:

[FN, AR', q>0.5 r=0] when fakes are cheaper to produce than loot (d>f; d-f>3-e) and reputation costs are too high to falsely certify (a>3).

[FN, RR', q<0.5 r=0] when when fakes are cheaper to produce than loot (d-f>0).

Proposition 9. *In the Imperfect Information Crowd-Out Game, naïve buyers sustain trade in fake goods when fakes are more profitable than loot, sustain trade in loot when loot is more profitable than fakes, and shut down the market when no certification is provided.*

When buyers are naïve ($\mu = 0$) the PBE of the game are:

[LC, AR', q=1 r>0.5] when it is more costly to produce fakes and incur reputation costs than to produce loot (f+a>d+e), enforcement costs are lower than the value of any particular certified good (3>e), and the cost difference between digging and looting stays within the following bounds: 3-e>d-f.

[FC, AR' q>0.5 r=0] when it is less costly to produce fakes and incur reputation costs than to produce loot (f+a>d+e; d-f>a-3) and false reputation costs are lower than the gains from the sale of a certified good (a<3).

[FN, AR', q>0.5 r=0] when digging is more expensive than looting (d-f>0;

d-f>3-e) and the reputation costs for making a false certification are sufficiently large

(a>3).

Assumption 2: *Let f>d+a+e+3, so that fakes are never profitable to produce.*

This allows us to model the case in which fakes do not exist.

Proposition 10. *Suppose **Assn 2**. If we assume that fakes do not exist, we are left with only those equilibria in which loot is produced and sold.*

Notice that if *f>d+a+e+3* then it is never a best response for sellers to choose either FC

or FN. Knowing this, the only strategy involving consistent beliefs for sophisticated buyers is

AA'. naïve buyers continue to hold trenchant beliefs and play strategy AR'.

7. Policy Implications

7.1. Provenance Game

The United States Government Accountability Office (2016) surveyed a sample of 35 art

market experts for suggestions about ways to improve the United States' response to wartime

cultural property usage in Iraq and Syria. While most of the interventions listed pertain to

increasing the efficiency of government bureaucracy, a few advocate for the creation of federal

requirements on chain of custody reporting for antiquities and the creation of a certification

process by which law enforcement can clear objects for sale (US GAO, 2016). If these

interventions are secure, they can be interpreted as an increase in certification costs (c) and an

increase in reputation costs (a). This makes it easier to sustain separating equilibria in the

Provenance Game. Recall from **Propositions 2, 3** that separating equilibria exist for

sophisticated and naïve buyers when *2+x<c+a*, where 2 is an exogenously given baseline price,

x is the certification premium, (c) is the certification cost, and (a) is the reputation cost from a false certification. Increasing (c) and (a) makes it possible to sustain separating equilibria for a larger portion of the market, as it becomes rationalizable for types to separate even when transacting lower value objects with smaller certification premia (x).

7.2. Authenticity Game

The results of the Authenticity Game caution against relying on information-based interventions. Yates (2016) notes that asymmetric information about authenticity is a weakness of the antiquities market and that countries like Mexico have made allegations that auction lots were forgeries in an attempt to spook buyers. If the allegations are credible, this type of intervention can be modeled in the authenticity game as a change in the prior probability of an object being fake. As the authenticity game shows, however, whenever the a separating equilibrium in which authentic goods are sold and fake goods are rejected is always possible. A pooling equilibria in which both fakes and loot are sold is always possible for the naïve. Recall from **Proposition 6** that naïve buyers sustain pooling equilibrium *[CC', AR' q>0.5 r<0.5]* when reputation and enforcement costs are low (3>a; 3>e). Changing the common prior probabilities alone will not prevent the sale of authentic, looted goods.

7.3. Crowd-Out Game

The Crowd-Out Game suggests that if participants in markets are subject to information asymmetries about an important attribute like authenticity or efficacy, then encouraging the production of goods with inferior levels of that attribute while making the market less efficient at certifying the superior product helps crowd out the undesirable production process. Encouraging the production of the inferior product can be achieved by increasing (d) the cost of digging,

decreasing (f) the cost of faking, and increasing (e) the differential enforcement cost to selling

loot. Making the market less efficient at certifying the superior product can be achieved in the

antiquities trade by decreasing (a) the reputation cost of false certification. The following

discussion graphically depicts how changing each parameter while holding all else constant

changes the prevalence of looting equilibria. In discussing each parameter I also note proposed

policy remedies and whether they comport with my model's predictions about effective ways to

reduce looting equilibria.

The **Figure 8** shows the region in which looting equilibria[12] exist for both naïve and

sophisticated buyers. As a baseline I set a=1 and e=1. The x axis shows the premium associated

with a certification of authenticity, and the y axis is the cost differential between producing loot

and producing fakes.

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[12][LC', AA', q>0.5 r>0.5]
 [LC', AR' q=1 r<0.5]

Figure 8.

7.4.   Increasing (d-f)

The first way to increase the differential between producing real and fake loot is to increase the cost of producing loot. Decreasing (d-f) while holding all else constant moves the market out of the region in which looting equilibria exist. For example, at $d - f = 1$ no looting equilibria exist for any price point in the market.

If the aim is to increase the production cost differential, the first policy option is to increase the cost of producing loot. Brodie and Sabrine (2018) note that metal detectors are crucial to digging in Syrian sites, and suggest banning the export of metal detectors to Syria. If bans are not feasible, simply hiking up the price of metal detectors sold to Syria should be effective. The other way to increase the differential is to reduce the cost of producing fakes.

Although there are no official advocates for interventions of this form, there are several

possibilities. Brodie and Sabrine (2018) note that major classes of loot exported from Syria are

coins, small metal objects, and glass vessels. Inputs for fakes in the case of Syria should include

both knowledge and human capital, which are necessary to produce a coin or other metal object

of the correct type and weight for the region or to blow glass into the correct shape and oxidize it

in order to produce the characteristic iridescence of Roman-era glassware. Injecting information

about the most cost effective way to produce convincing fakes could thus increase the cost

differential (d-f). Inputs should also include capital inputs such as forges in which to strike coins,

coin dyes, as well as basic materials which are potentially expensive if the item to be faked is

made of precious minerals or stones.

A thus far overlooked[13] option for increasing the cost differential between producing loot

and producing fakes is simply to airdrop caches of fake loot to communities most at risk for

looting. Because a direct injection of finished goods can effectively lower the cost of creating

fakes to zero, it should be effective at eliminating loot equilibria from the crowd-out game.

Preferably these strategic fakes are produced expressly for the purpose of disrupting a looting

cycle. Notice that, per **Proposition 5**, sophisticated buyers sustain trade in the Authenticity game

when p>0.5. If fakes are culled from the existing number already on the market, perhaps through

a buy-back program for coins at some price sufficiently below market value to weed out any

objects that the owner might think is real, then sophisticated buyers should anticipate that the net

number of fakes on the market is the same as before. If, on the other hand, the policy

intervention creates more fakes and the probability of receiving a fake on the market increases

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[13] To the best of my knowledge

above the threshold level for some sophisticated buyers, these participants should drop out of the market and the trade should further constrict.

7.5.   Decreasing reputation costs (a)

Decreasing reputation costs has an unambiguous dampening effect on the existence of looting equilibria. The following two figures on the next page show the baseline looting equilibria regions and the regions after decreasing a to zero while keeping all else constant. Notice that looting equilibria disappear for some $(d-f) < 0$, when the cost of digging for loot is not greater than the cost of producing fakes. **Figure 9** shows the baseline case and the effect of decreasing reputation costs (a) to zero.

Stannish (2009) notes that online forums seemed to help the production of Pre-Columbian artefact fakes flourish. Part of this effect may have been due to the reduced consequences of making a false certification of authenticity on sites such as Ebay. To prevent looting, we should consider interventions as unconventional as obscuring reviews for online sellers of any kind of antiquity from an at-risk zone, or using bots to leave positive reviews for sellers who may otherwise be found out as fakes. This style of intervention may not be possible in all legal jurisdictions, but in a country with few limitations on government censorship online it may be an effective policy option.

Recent policy suggestions have drawn attention to the use of digital marketplaces for transactions of looted antiquities. Brodie (2017) suggests introducing more buyer warnings and documentation expectations for online sales venues and (Price, 2018) calls for increasing enforcement over dark web and cryptocurrency sales. Both of these interventions increase the reputation costs to producing a false certification of authenticity online. By setting higher norms

for authenticity and documentation online and by making what was previously an series of anonymous transactions traceable, these interventions would increase the region in which looting equilibria occur by making it less attractive to pass off fakes as loot.

Figure 9

7.6. Increasing differential enforcement costs (e)

Increasing the differential enforcement costs faced by looters and fakers is a promising category of policy interventions. **Figure 10** depicts the effect of increasing differential enforcement costs to 2 compared to the baseline.

Interventions which increase the differential enforcement cost for transporting real loot appear to already be in place, as police try to release objects that they can identify as fakes (Bulos, 2016; Stouton, 2015). When police are better at telling the difference between real and fake things than buyers (which may be the case when police are from the source country and buyers have seen few representative examples of the objects in question), the market should realize that there is a differential enforcement cost between things that are accepted and dug out

and things which are accepted and faked. Ways to augment this differential enforcement cost could include allowing police or other responsible parties to create a chain of custody between fake factories and customs borders that is then rendered invisible to buyers.

Figure 10.

8. Conclusion

The games specified above formalize the conditions under which looted artefacts and fakes trade on a market with agents who do not perfectly update information. From the Provenance game, we see that when the net gains from selling a certified licit good are greater than the reputation costs from making a false certification of provenance and the probability of receiving loot is too high, sophisticated buyers shut down trade while naïve buyers continue to buy. From the Authenticity game, we see that when the net gains from selling a certified real good are greater than 1) the reputation costs from making a false certification of authenticity, 2)

the differential enforcement costs from transporting looted goods to the buyer, and the probability of receiving fakes is too high, sophisticated buyers again exit the market while naïve buyers continue to trade. The Crowd-Out game shows that in the presence of an information asymmetry about real and fake antiquities, it is possible to depress the market by increasing the cost differential between digging and fabricating loot and making the market less efficient at distinguishing between real and fake artefacts. Whenever it is more profitable to produce fakes instead of loot and the differential enforcement costs are sufficiently high, sophisticated buyers will shut down trade and naïve buyers will sustain trade in fakes. Looting equilibria become more difficult to sustain if policies increase the cost differential between producing loot and producing fakes, decrease reputation costs, and increase the differential enforcement costs borne by looters. In the context of Syria, the model recommends flooding communities at risk of looting with high quality prefabricated fakes, loosening regulation of online sales of antiquities and damaging reputation mechanisms related to authenticity, and increasing law enforcement efficiency and potency at identifying and penalizing transporters of loot.

Results from the Crowd-Out game are generalizable to other undesirable production processes, provided that there is an information asymmetry about a credence attribute of a good, there are strict preferences against not having that credence attribute, and it is possible to manipulate the costs of production of either type of said good. Antiquities and other art objects like decorative ivory or Old Master paintings are unique in that they have a credence attribute, authenticity, the absence of which is truly odious to buyers but which does not seem to inflict physical harm beyond loss of utility from buyer's remorse. Finding such credence attributes for

goods which are ingested or which are addictive, such as rhino horn or heroin, is more difficult

and raises complicated ethical questions.

One limitation of my models is that prices are not endogenous. Endogenizing price would

primarily provide an accuracy advantage when arbitrating between competing policy

interventions. An extension that allows the baseline price and certification premia of a good, both

of which I have simply set exogenously, to be a function of a total demand for looted goods in

equilibrium would alter the parameter conditions under which equilibria exist. My main point

that enticing enterprising producers to deviate to producing fakes can shut down the market

should, however, survive as long as it is possible to entice producers to deviate.

A deeper limitation pertains specifically to the Crowd-Out Game, which does not

describe the circumstances under which it is just or welfare maximizing to depress trade in loot

or any other kind of good. The Crowd-Out Game specifies which interventions are effective at

shutting down trade when there is an information asymmetry about a credence attribute of a

good, strict preferences against not having that credence attribute, and when it is possible to

manipulate the costs of production of either type of good. It is best treated as a tool for

preventing undesirable production processes, and the welfare-maximizing use of this tool

requires satisfactory answers to normative questions such as who has the right to command the

depression of a market and when it is welfare maximizing for responsible parties to do so. An

economic answer to these question requires a model that takes into account the various ways that

antiquities are valued, be it as art objects, the subject of scholarly research, or inputs to a

program of national identity building (O'Hagan and McAndrew, 2001). It may also be necessary

to take into account use by future generations as well as nonuse values (Klamer, 1997), and the

inquiry will likely face challenges similar to those encountered by Costanza et al (1997) in calculating the value of the world's natural capital. Once these questions have been answered, whether through economic analysis or other methods of justification, my model may be used to determine how best to proceed.

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Appendix.

(UNESCO, 1970) *Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property 1970*:
Article 1
For the purposes of this Convention, the term `cultural property' means property which, on religious or secular grounds, is specifically designated by each State as being of importance for archaeology, prehistory, history, literature, art or science and which belongs to the following categories:
(a) Rare collections and specimens of fauna, flora, minerals and anatomy, and objects of palaeontological interest;

(b) property relating to history, including the history of science and technology and military and social history, to the life of national leaders, thinkers, scientists and artist and to events of national importance;
(c) products of archaeological excavations (including regular and clandestine) or of archaeological discoveries ;
(d) elements of artistic or historical monuments or archaeological sites which have been dismembered;
(e) antiquities more than one hundred years old, such as inscriptions, coins and engraved seals;
(f) objects of ethnological interest;
(g) property of artistic interest, such as:
(i) pictures, paintings and drawings produced entirely by hand on any support and in any material (excluding industrial designs and manufactured articles decorated by hand);
(ii) original works of statuary art and sculpture in any material;
(iii) original engravings, prints and lithographs ;
(iv) original artistic assemblages and montages in any material;
(h) rare manuscripts and incunabula, old books, documents and publications of special interest (historical, artistic, scientific, literary, etc.) singly or in collections ;
(i) postage, revenue and similar stamps, singly or in collections;
(j) archives, including sound, photographic and cinematographic archives;
(k) articles of furniture more than one hundred years old and old musical instruments.

General Solutions for Incomplete Info Provenance Game (Section 5.1)

Let b=baseline utility and $\bar{p} = \frac{u_2 - u_3}{u_1 - u_3}$ where $0 < \bar{p} < 1$

No other assumptions made.

	$p > \bar{p}$	$p = \bar{p}$	$p < \bar{p}$

Sophisticated Buyers $\mu = 1$	[CN'AR' q=1 r=0] b+x<c+a and c<b+x [CC'AR' q=p>$\bar{p}$ r<$\bar{p}$] b+x>c+a [CC'AA' q=p>$\bar{p}$ r>$\bar{p}$] x>c+a [NN'AA' r=p>$\bar{p}$ r>$\bar{p}$] x<c [NN'RA' r=p>$\bar{p}$ r<$\bar{p}$] always	[CN'AR' q=1 r=0] b+x<c+a and c<b+x [CC'AR' q=p>$\bar{p}$ r<$\bar{p}$] b+x>c+a [CC'AA' q=p>$\bar{p}$ r>$\bar{p}$] x>c+a [NN'AA' r=p>$\bar{p}$ r>$\bar{p}$] x<c [NN'RA' r=p>$\bar{p}$ r<$\bar{p}$] always [NN'RR' r=p<$\bar{p}$ q<$\bar{p}$] always	[CN'AR' q=1 r=0] b+x<a+c and c<b+x [NN'RR' r=p<$\bar{p}$ q<$\bar{p}$] always
Trusting Buyers $\mu = 0$	[CN'AR' q=1 r=0] b+x<a+c and c<b+x [CC'AR' q=p>$\bar{p}$ r<$\bar{p}$] b+x>c+a	[CN'AR' q=1 r=0] b+x<a+c and c<b+x [CC'AR' q=p>$\bar{p}$ r<$\bar{p}$] b+x>c+a	[CN'AR' q=1 r=0] b+x<a+c and c<b+x [CC'AR' q=p>$\bar{p}$ r<$\bar{p}$] b+x>c+a

Solutions to More General Authenticity Game

Proposition (A1): *Suppose assn 3-5. Under full information, no trade and no production of*

fakes occurs. For any value of p, the backwards induction equilibria of the Authenticity Game is

$$[CN', AA'R''R'''] \text{ when } x>c$$

$$[NN', AA'R''R'''] \text{ when } c>x$$

Let $\bar{p} = \frac{u_2 - u_3}{u_1 - u_3}$ *where* $0 < \bar{p} < 1$

Proposition (A2): *Sophisticated (* $\mu = 1$ *) buyers have the following equilibria*
1. *For all p, [CN', AR' q=1 r=0] when x>c*
2. *For p<$\bar{p}$, [NN', AR' r=p<$\bar{p}$, q>$\bar{p}$] when b+x<c+e and b+x<c+a; [NN', RR' r=p<$\bar{p}$, q<$\bar{p}$] always*
3. *For p>$\bar{p}$, [CC', AR' q=p>$\bar{p}$ r<$\bar{p}$] when b+x>c+a;b+x>c+e [CC'AA' q=p>$\bar{p}$ r>$\bar{p}$] when x>c+a; [NN' AA' r=p>$\bar{p}$ q>$\bar{p}$] when x<c; [NN', RA' r=p>$\bar{p}$ q<$\bar{p}$] when b+c<e*
4. *For p=$\bar{p}$ all of the equilibria listed above exist.*

Proposition (A3): *Suppose **assns 3-5**. Th equilibria of the Authenticity model with naïve (* $\mu = 0$ *)*

buyers are:

1. *Separating equilibrium [CN', AR' q=1 r=0] when x>c*
2. *Pooling equilibrium [CC', AR' q>$\bar{p}$ r<$\bar{p}$] when b+x>c+a;b+x>c+e and [NN', AR' r< $\bar{p}$, q>$\bar{p}$] when b+x<c+e and b+x<c+a*

Solutions to Crowd-Out Game with More Parameters

Proposition (A4)*: In the imperfect information Crowd-Out Game, sophisticated buyers either sustain trade in looted goods or shut down trade. naïve buyers sustain trade in fake goods when fakes are more profitable than loot.*

(i) When buyers are Sophisticated ($\mu = 1$) the Perfect Bayesian Equilibria of the game are:

    [LC, AA', q=1, r>0.5] when a-e>d-f and 1-e>d-f

    [LC, AR', q=1 r>0.5] when a-e>d-f and 3>e and 3-e>d-f

    [LN, RA', q<0.5 r=1] when -e>d-f and 3+a-e>d-f and 3>e

    [FN, AR', q>0.5 r=0] when d-f>0 and a>3 and d-f>3-e

    [FN, RR', q<0.5 r=0] when d-f>0

(ii) When buyers are naïve ($\mu = 0$) the Perfect Bayesian Equilibria of the game are:

[LC', AR' q=1 r<0.5] when 2+x-c-e>d-f and a-e>d-f and 2+x-c-e>0

[FC, AR' q>0.5 r=0] when d-f>a-e and d-f>c+a-(2+x) and c+a<2+x

[FN', AR' q>0.5 r=0] when 2+x-c-e<d-f and a+c>2+x