

VALUATION OF HISTORY: AN ECONOMETRIC ANALYSIS OF ANCIENT ART
PRICES

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Valuation of History: An Econometric Analysis of Ancient Art Prices

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Abstract

In 2018, global sales in the art market increased 6% compared to 2017 (McAndrew, 2019). Without oversight, this art market leaves room for price corruption and unethical transactions. Antiquities and ancient art are then cultural property increasingly vulnerable to illicit trade. While cultural economics seeks to integrate art into working economic theory, little can be said of the price valuation for antiquities. What determines the price of ancient art and antiquities? Valuation of ancient art may be expressed intrinsically based on qualities commonly discussed by art professionals. Econometric methods are used to test the extent of the influence of origin, provenance, material, and literature on price. Empirical results examined present 87% of price variation by these qualities.

KEYWORDS: (Cultural economics, art valuation, ancient art, econometrics)

JEL CODES: (Z11, C10)

ON MY HONOR, I HAVE NEITHER GIVEN NOR RECEIVED
UNAUTHORIZED AID ON THIS THESIS

Amanda Noelle Franks

Signature

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I dedicate this thesis to my mother, my collective 1027, and to Candice, who always supported me in every endeavor I chose to follow. Your belief in my ability has enabled me to find strength that I never knew, and your legacy will never be forgotten.

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Introduction

A record of irreverent history is trapped within museum walls, the ornate shelves of private collectors, and most notably within the minds of those who wish to acquire such goods, with value unmatched to classical scholars. Encapsulated in this category, ancient artifacts and works beg to be valued, priced, traded, shown to the world like the emblems of human history they are. To those outside the world of ancient art valuation, the origins of these values are mythological, a mystery depicted in amphora. Auction houses that provide a platform to assign value to works of sculpture, rich funerary art, and the surviving works of our ancestors, are while namely, only speculative. A speculative good may only allow for price corruption - how could we possibly agree on a price of the stories of the past? Thus, private sellers and auction houses have total control of the value of such artifacts.

To allow such a monopolistic valuation of luxury goods is unethical to the public and eliminates a vast expanse of market accessibility. If there are quantifiable means of measuring variation in price, and such to account for this variation, it is an economist's necessary work that must be completed. In order to examine prices that seem mystical to most, one would hope that there is some underlying mathematical or economic process that determines the relationship between an artwork and its price. For this reason, economists have begun in recent decades to seek the theoretical framework for integrating such cultural goods into the realm of existing economic theory. While the branch of thought is relatively recent in terms of history, cultural economics has seen increased academic credibility and theoretical expansion that provides us with a framework to study the relationship between cultural goods (i.e. art) and price.

Fortunately, there has been some scholarship that has focused on this relationship for contemporary and modern artwork, mostly through art market indices and econometric methods. However, when expanded to ancient art and artifacts, the ability to create an art market index is questionable at best. Thus, I seek to identify another method to study price valuation.

Solidifying a method to approach an analysis for this relationship requires clarification of the topic. Clearly, I seek to answer: What determines price for an ancient artwork? I accept that ancient art and artifacts have intrinsic value through historical, cultural, and aesthetic facets. My aim is then to quantify to what extent this intrinsic value effects price into a working econometric model. I base these hypotheses on relevant literature from leading cultural economists, art investors, professional art organizations, and other relevant economic and art focused academics. In order to test a working theory and develop a model of price valuation, I employ econometric methods to a collected data set of relevant artifacts from major auction houses to yield credibility in our findings. Finally, an analysis of results yields significant expansion into intrinsic cultural economic theory for ancient artifacts, and topics for further research are considered.

Theory

2.1 Context and Background

My motivation for studying this topic began long before I had any concept of econometrics, hypothesis testing, or even had heard of cultural economics. Instead, the impact of ancient works, something that inspires a sense of wonder, a deep-rooted Odyssean call to adventure, a blatant insignia of desire, that which leaves you breathless and with shining eyes struck me inside the Palazzo Massimo in Rome. I remember walking through the ornate halls of this National Museum of Italy, enchanted by ornate marble floors and Corinthian columns, guided by an inexplicable need to discover and experience the breadth of these classical pieces.



Capitoline Venus

I found myself staring for hours at a particular piece, the exquisite Capitoline Venus (see previous), enamored by the intricacy of the design. I poured over the piece in detail; I scanned the ornate pillage of her garments, the richness of composition, the complete evocation of a goddess come to life. The Italian sunshine glistening through the windows leading to the courtyard seemed to hug her form, breezes in the June heat felt as if they had been sent from Aphrodite herself, and I plodded in circles, awestruck by this stone creature that had changed me. I became fascinated by terms foreign to me, expressions of ‘contra-posto’ and ‘late-classical’ that, while I had no conception of their meaning, promised to bring focus to a freshly conceived desire to understand.

I was fortunate enough to spend time studying Roman and Greek Art and Architecture with Sanjaya Thakur and Richard Buxton, two leading classicists that have been fundamentally linked to my interest in art valuation. The routes we took to study the places, pieces, and peoples that constitute a dynamic crossroads of culture lead us from bustling Rome, through history-rich Naples, down the Amalfi Coast, to the quiet sea side towns of Sicily. In these days, we hopped from museum to museum, ruins of colonial Greek agoras and temples, Norman basilicas that dotted the valleys, archaeological masterpieces, and modern cities. I felt a true self come alive from being able to stand in the face of history itself – to be so lucky to truly see the ornaments of our ancestors. At this time, I was writing about historical importance and aesthetic qualities of the art and archaeology we were examining, but in the back of my mind, I knew that my academic pursuits were being transformed.

I came home from this experience having a new appreciation for fields I previously thought I had no interest in, art history and classics. Along with the classes I

was taking for mathematical economics, I found myself signing up for subjects like Latin and Byzantine Art, ideas not typically associated with the world of economic theory. I was enamored with studying classics, and kept finding myself returning to the same questions with different pieces we studied, where did this amazingly beautiful thing come from? How did someone get so lucky to find this? How much could this have possibly cost? I began to seek.

I first thought – why not try museums? After months of many unanswered emails and the unreturned inquires, I began to inquire further. I was directed to auction houses, which I had no idea of what they were or how they operated. After seeing the astronomical prices some of these pieces were realizing, the economic implication of art became apparent. People were choosing to acquire certain pieces because they had some sort of value to them, and perhaps a small number of those had experienced the same pull, heard the whisper of the fates, felt a nostalgic flood of *ἀγάπη* (*agape*) like I had in the center of the gallery of statues. I sought to identify what explained this price, to what extent was it resultant of that life-changing feeling? Or was the value totally fiscal, investment based, tainted by acquisition politics and branding?

To create a functional form to study valuation, one must develop an understanding of the inherent significance of ancient artifacts and the progression of economic theory into the realm of cultural goods. In the following subsections, I will begin by describing the subjective impact of ancient art on the individual and society. Next, the conception and progression of cultural economics and the various issues within the expansion of the realm of thought are considered. Finally, I summarize the market and trends for ancient art, and propose ethical considerations that result from this market.

2.1.1 Importance of Ancient Art

It is a foolish venture to attempt to describe the importance of any given artifact to the unique individual, as the subjective nature of taste is nondeterministic. While I may find a certain piece to be indispensable, another may find it tacky, brash, or unimportant. It is often more productive to examine the cultural context of artifacts and art. One can conclude that through the legal treatment of ancient artifacts, there must be some societal significance of these works. Recently, there has existed a trend for a greater interest in the preservation of cultural property, as reflected by the Convention for the Protection of Cultural Property in the Event of Armed Conflict with Regulations for the Execution of the Convention conducted in 1954 by the United Nations Educational, Scientific and Cultural Organization (UNESCO). This convention defined ‘cultural property’ for objects to be “movable or immovable property of great importance to the cultural heritage of every people, such as monuments of architecture, art or history, whether religious or secular” (UNESCO, 1954). The impact of the significance of such works is represented by the global scale of protection. Under this convention, nations are provided with the ability to “undertake to prepare in time of peace for the safeguarding of cultural property situated within their own territory against the foreseeable effects of an armed conflict, by taking such measures as they consider appropriate” and any infringement on the terms of the agreement are sanctionable by agreement (UNESCO, 1954).

By examining legislature of treatment of cultural property, I found that “the unique treatment of cultural property has led to numerous restrictions on the traditional rights of ownership... many national statutes prohibit the removal of any object of ‘historical value or significance’ without governmental consent” (Lindsay, 1990). These

laws are obviously different nation to nation, but have similar major areas they attempt to address in regards to these artifacts. One of legislation's biggest topics of concern is that of illegal sale or redistribution of this property. Estimates of the size of the antiquities black-market include \$4.5 billion in sales from Interpol data in a 2000 British Parliamentary Inquiry on Cultural Property and Illicit Trade, and there are further claims that the value of this market is the largest only after that of drugs and weapons (Gill, 2017). It follows logically that there is aggregate concern for cultural property in light of the volume of illicit trade and strenuous efforts to prevent its removal.

If there is a blatant aggregate concern for cultural property, then there must be causes of this concern. One of the causes is the historical importance of these pieces. It is hard to refute that cultural property is important historically, as UNESCO clearly recognizes the cultural importance of these objects in their aforementioned definition (1954). I cannot describe the historical importance for every type of ancient art, but I may illuminate that of the ancient pieces I have chosen to examine. Regarding the artifacts originating from the Mediterranean Basin:

There is a vast body of literature on the contributions of these civilizations to our own, but we merely need to look around at our architecture, our institutions, our art, and our values to see the continuity of Western Civilization, all of which has its origin in the Mediterranean region. (Clement, 2012).

The implication of this is that Western Civilization has been significantly influenced by these cultures. Objects that have originated from these cultures then hold historic value as they provide physical record of the values and ideas of their creators. Ideas of cultural importance are also extrapolated into theoretical implications for modeling, and find distinction amongst professional art advisers.

While cultural and historical importance can be determined through literature, the subjective psychological importance of art is more difficult to examine. Nonetheless, in their empirical inquiry on art investment, Frey and Pommerehne found that there is statistically significant evidence that art yields a “psychic reward, or a consumption benefit” (1989). While it is subjective tastes that determine whether someone is struck or impacted by any given art piece, there is notable psychological benefits to art for some individuals. In fact, recent studies on the neurological processes of art evaluation have revealed promise that the routes of perception are measures connected to physical attributes (Hagtvedt, et. al., 2008). The existence of art therapy is instrumental in demonstration of this idea. The American Art Therapy Association notes:

Art therapy, facilitated by a professional art therapist, effectively supports personal and relational treatment goals as well as community concerns. Art therapy is used to improve cognitive and sensorimotor functions, foster self-esteem and self-awareness, cultivate emotional resilience, promote insight, enhance social skills, reduce and resolve conflicts and distress, and advance societal and ecological change. (2019).

Therefore, art as a medium may have inherent psychological benefits that, in the context of professional consultation, yields therapeutic benefits.

It is also worth noting that while the aesthetic impact of art is relative to the person, we can conclude that there is an aggregate style of behavior in which the general public responds to art (Throsby, 1994). Therefore it is acceptable to trace the economic implications of the general agreement in preferences, where aggregate behavior constitutes the beginnings of economic theory. In the next section, I examine the creation of cultural economics with this in mind.

2.1.2 Overview of Cultural Economics

In light of the aforementioned historical, cultural, and psychological impact of ancient art, there is significant cause for economists' motivation to integrate cultural goods into existing economic theory. The conception of cultural economics, definitively economics of the arts, is attributed to William Baumol and William Bowen from their 1966 published work *Performing Arts – The Economic Dilemma* (Throsby, 1994). From this point on, a new frontier for economists' inquiry was created with the aim of compiling a holistic system for describing the motivations and movements of the art market.

Of notable impact were the works of Throsby, Baumol, Ginsburgh, Boulding, and Frey which pioneered the major routes of thought (“About ACEI”, 2019). The major considerations of these economists were to address different economic issues that were presented by such cultural goods and the role of culture in economics. The development of later economic theory may have arisen in conjunction with these works, like the creation of behavioral economics.

The implementation of economic theory and the increasing number of economists interested in this field has led to the creation of the Association for Cultural Economics International, that represents a membership of academics for advancement of the field (“About ACEI”, 2019). Moreover, this group has also actively supported the Journal of Cultural Economics, with the first publication presented in 1977 (Boulding, 1977). Now a subset of the field of behavioral economics, cultural economics finds a place of academic credibility in scholarship.

2.1.3 Market for Ancient Art

In 2018, the total public sales of antiques and decorative artworks is estimated to cap at \$29.1 billion, a significant 30% increase from sales in 2016 (McAndrew, 2018). Additionally, the trend for increased ancient art acquisition is reflected by a 2.5% increase in the fraction of total global art sales that constitute this category from the previous year (McAndrew, 2018). The market for art is made up of three key agents: producers, consumers, and distributors (ADAA, 2019). The industry finds that the production of art is vastly different than other goods, in that “original art objects are, as a commodity group, characterized by a set of attributes that distinguish them from all other goods. They are created by individuals. Every unit of output is differentiated from every other unit of output... Art works can be copied but not reproduced... there is only one unique original of every work of art.” (Throsby, 1994). Therefore, the way in which the art market operates is inherently outside of generalized notions of a market. Supply of ancient arts is perfectly inelastic from this model for any given unique work. In fact, “For the works of artists no longer living, supply is nonaugmentable.” (Throsby, 1994).

Supporting the enigmatic art market is the modes of sale. Sales may be private, public, or have characteristics of both, where public sales have been tarnished by the cloud of private contracts from questionable legality of agents. In fact, the proportion of those who are selling in private, or dealers, is almost 2:1 with public agents (i.e. auction houses) (McAndrew, 2018). The nature of auctions also creates interesting economic implications. Prices are unknown beforehand and are determined by the sale.

The ethical considerations of this mode of delivery are discussed in the following subsection.

2.1.4 Ethical Considerations

Within the realm of economic theory, monopolization can be catastrophic for a competitive market. Common issues associated with monopolies are market inefficiency, reduced consumer benefit, and corruption. A recent analysis conducted by the Federal Reserve Bank of Minneapolis has resulted with empirical evidence that, “Monopoly (and high tariffs) is shown to significantly lower productivity within establishments. It also leads to misallocation within industry: resources are transferred from high to low productivity establishments.” (Schmitz, 2012). In consideration for the art market, there is evidence of a duopoly, a subtype of monopolistic market structure, of the two major auction houses. According to recent investigation of art sales in 2017, 80% of the total market share for works over \$1 million was captured by Christie’s and Sotheby’s (McAndrew. 2018).

While auction houses have historically had monopolistic characteristics as shown above, the trends are optimistic. There is a shift of power from auction houses to private dealers, which in its own respect may be problematic, but can at least allow for competitive pricing. In 2016, we see that:

In trends across the globe, most strikingly in the US, collectors are more inclined to secure deals away from auction publicity as auctioneers facilitate a greater number of exclusive sales for those in the know... Curatorial expertise is shifting more to dealers who have been steadily and surely reshaping the market landscape; securing in the process a significant share of the art market away from auction houses. (McAndrew, 2016).

Therefore there is a power dynamic shift from auction houses to private dealers across the market. It will be interesting to examine how this development affects the efficacy and implementation of the art market in coming years.

The nature of the ancient art market provides us that the origin of these pieces is usually murky. An overview of the market leads many economists and archaeologists to

ask, “How has this material reached this place? Have objects resided in ‘private’ collections for generations, or are they fresh from unknown archaeological contexts?” (Gill, 2017). A significant portion of material is acquired by ambiguous or illicit means, and while this may preserve a historical record of our past, there is cause for concern. In a 2016 National Geographic article, a critique of the antiquities market is that:

While the antiquities trade may have saved many masterpieces from destruction, the gray areas in which it operates leave it open to accusations that it drives looting—and seems to encourage some of its participants to deceive themselves about where their cherished objects come from.(Mueller, 2016).

Mueller also notes that those acquiring these objects through illicit means are usually museums and institutions interested in the safeguarding of history (2016). In fact, looting and subsequent black-market art operations have constituted evaluations of up to an excess of \$6 billion in economic activity (Danziger, 2016).

While there are many greater ethical considerations of the art market, cultural property acquisition, and monopolistic markets, the aforementioned only constitute a small portion of these questionable practices. I find it necessary to investigate the politics and social dynamics at play in the larger framework of the art market, and I encourage the reader to investigate these issues for themselves. For further information on ethics of cultural economics, I direct interested individuals to David Throsby’s *Handbook of Cultural Economics*.

2.2 Literature Review

The increased scholarship of cultural economics has led to some significant modes of inquiry that are useful to note. Additionally, art advisors and institutions have attempted to define the impossible – their qualifications for what determines

compositional quality and valuation. In the following review, I attempt to summarize the major aspects of valuation on part of those advisors and institutions, and valuation techniques of economic inquiry. From these notable works and qualifications, I aim to generate a working hypothesis to the valuation of ancient art in the subsequent section.

2.2.1 Professional Art Valuation

Empirical examination of any question begins with seeking out accredited leading opinions and major thought that pertain to that field. The opinions of experts in valuation begin with those of dealers, curators, and collectors. Qualities that these individuals seek in works are key to determination of intrinsic value. Numerous organizations have been created to collectively reflect the ideas and the opinions of these experts, like the Association of Professional Art Advisors, a nonprofit organization that seeks to achieve “highest possible principles and guidelines for acquiring, maintaining and presenting art.” (APAA, 2019).

Another of these organizations is The Art Dealers Association of America (ADAA), that depicts their qualifications for valuation in their publication *Collector’s Guide to Working with Art Dealers*. According to the ADAA, the key qualities to examine before acquisition are “authenticity, quality, rarity, condition, provenance, and value” (2019). Additionally, Christie’s requires literature information, certificates of authenticity, acquisition history, appraisals, object specifications, and item images to give valuations of objects (Christie’s, 2019). Findlay also asserts the validity of these characteristics in the determination of a piece’s value (2012). If I am to be able to create a

working economic theory of valuation, then considerations of professional art dealers and critics are instrumental to its development.

It is apparent that the authenticity of a work is instrumental in definition of its price. Most have seen the copies of works like that of Monet, Van Gogh, and Da Vinci hanging in various doctors' offices, second-hand stores, and other common destinations, but it is only locations and collectors with significant disposable income that can afford the originals. In 2017, Christie's sold Van Gogh's *Laboureur Dans Un Champ* for \$81.3 million, but today you can get a reproduction of his *Starry Night Over the Rhone* online for \$496 (Christie's, 2017; "Starry Night Over The Rhone", 2019). The price difference between an original and a copy can lead to issues in valuation. In fact, recent discoveries in validity have found that some Modigliani paintings displayed in the Palazzo Ducale estimated to be worth tens of millions were faked (Squires, 2018). Works once thought to be priceless can become that of someone's garage sale without proof of authenticity.

In regard to quality, the ADAA defines it as being within the framework of the piece itself, that "Judgements of quality depend on knowledge and connoisseurship... the relative aesthetic merits of a given work... both within the larger context of art history and the within the specific context of the artist's oeuvre" (ADAA, 2019). This aspect is particularly striking as it discusses the idea that an art piece has not only qualitative and aesthetic value, but that it also tangentially creates the notion of humanistic creational value in a distinct time and place. There are obviously different characteristics for each time frame and media type; it would be silly to discuss the aesthetic merit of a Picasso versus a 5th century white-ground lekythos. Condition is also a qualitative feature in the

same vein. Therefore, object specifications of different pieces that constitute a ‘quality’ piece are intrinsic to their place in a certain cultural history and valuation measure.

Provenance, definitively the historic record of ownership and acquisition, is also noted as an important characteristic to consider before buying an artifact (ADAA, 2019). I have found through review of the motivates this included quality that “Without a detailed provenance—a documented chain of ownership—it’s impossible to know whether an object is fair or foul. (Mueller, 2016). Both Christie’s and Sotheby’s, two major auction houses, list all detailed provenance information in the main description of any piece. Additionally, major museums like the Metropolitan Museum of Art and the Louvre have this information readily available for access via online catalogue (Metropolitan Museum of Art, 2019; Musee du Louvre, 2019). I think of this concept as a certain subset of artistic branding, the iconic slogan of any work’s own brand. In the same way that modern companies choose celebrities to increase sales, the ADAA notes that “the inclusion of an important dealer in the history of a work can significantly augment its provenance (2019).

Identification of the importance of literature on an artifact is almost arbitrary. There are countless books, articles, religions, magazines that are resultant of the literature on ancient pieces. Anything that is written about is solidified as yielding value to some individual, thus it represents a store of this value. A simple practice in comparison of the value of something referenced in many works, such as the disputed Ark of the Covenant, versus that of the many (usually vastly left out of literature on the individual scale) Roman coins apparent in museums demonstrates the impact of literature on the price of a piece. The ADAA adds that “inclusion in significant publications or exhibitions may

enhance a work's pedigree by documenting it and certifying scholarly approval" (2019). Thus, any scholarly form of documentation of an art piece, while maybe inadvertently, still serves to increase its value.

It is notable that branding can have significant implications on the price of art works (Thompson, 2008). From my understanding of literature and provenance, both of these categories constitute a type of branding, whether it be ownership based or scholarly, that may have unmeasured impacts on price. This is definitely true for some pieces gaining substantial media coverage, as is the case of the \$12 million stuffed shark that sold in 2005 (Thompson, 2008).

2.2.2 Art as Financial Investment

Common within the academic study of cultural economics is to look to art as a mode for financial investment, like the works of Frey & Pommerehne 1989, Pensando 1993, Frey & Eichenberger 1995, Stuart 1917, and Hodgson & Vorkink 2004. In creation of an economic model for valuation, it is useful to examine both valuation routes – intrinsic (specifications, provenance, etc.) and investment (rates of return, risk, etc.). The justification for an investment route is determined by economists' in different forms. One of these justifications is that "the psychic benefits from art are, in the few cases they are considered at all, derived from the difference to financial returns on other markets." (Frey & Eichenberger, 1995).

As early as 1980, the market for art investment begins to see major increases. In a financial review from the same year, "a continuing high rate of inflation and loss of faith in currencies and other types of investments have prompted greater interest in the

investment value of artworks” (Podgers, 1980). Where there is increased economic activity, one can expect to see increased academic interest of explaining these phenomena. From these works, there are important implications for what determines price, therefore finding relevance to this study.

Another financial study of importance was conducted by Mei & Moses in 2002. The focus of this investigation was to analyze risk-return characteristics of certain art pieces to that of financial assets (Mei, et. al., 2002). By creation of art market indices from auction house data, they find that there exists underperformance of art pieces return-on-investment to certain investment types, but has outperformed others. The results of this study support that of Frey & Pommerehne. In their 1989 paper *Art Investment: An Empirical Inquiry*, the authors seek to examine the notion of profitability of art investment. Through time-series analysis of the price development of world-renowned paintings by deceased artists, they conclude that:

Our evidence suggests that, contrary to what is often claimed, auctionable paintings are not a particularly good financial investment. Rather, consumption benefits of owning a picture which may consist in pure aesthetic pleasure or in the prestige gained, must play a significant role. (Frey, et. al., 1989).

These two studies have revealed that there is over-anticipated returns on investments in comparison to their relative risk. Furthermore, the implication that there is consumption benefits based on aesthetic or reputation value justify intrinsic routes of analysis.

2.2.3 Econometric Studies

Economics has seen significant increases in affinity to produce theories that are empirically tested. Characteristic of this development is the creation of econometrics, a statistical and mathematical approach to model economic relationships.

One key econometric study that has furthered development in cultural economics is Oliver Channel's 1995 publication on the predictability of art markets. The author uses econometric methods, namely that of Vector Auto Regression and hedonic regression, to determine that there is a causal relationship between stock markets and art markets. They conclude that "the English, Japanese, and American stocks cause art", but that the relationship is never reversed (Channel, 1995). While there are some nuances of the study, the main result is that the aggregate price of pieces is predicted by financial markets with a lag of one year. The author also denotes the aesthetic impact of objects, claiming "art is subject to fashions, tastes and fads and this makes long term forecasts quite difficult." (Channel, 1995).

There have been significant contributions using econometrics to the field of cultural economics. These include McCain 1995, Wuepper & Patry 2017, Macmillan & Smith 2001, and Rushton 1997. While these works employ econometric methods to study different topics in cultural economics with credible results, none present a method for studying price valuation. It is notable that these application of these methods were transformed by the nature of cultural economics. McCain explains:

One can approach the economics of the arts, as any field of applied economics, in either of two ways. First, one can treat economic theory and econometric technique as subjects settled by specialists in those fields, to be used in the economics of the arts as they are given, very much as if one were studying the demand for maize. Alternatively, one can treat the economics of the arts as a field which may need and suggest its own developments in theory and technique, suitable to its special problems and processes, from which general economic theory and econometric theory might in principle learn something. (1995).

This logic allows me to move forward with this econometric study – the opinion of a major contributor to cultural economics advocates for creativity in model creation.

Application and development of economic theory based on novel conceptions is thus deemed appropriate and worthwhile for inspection.

2.3 Hypotheses and Assumptions

From the previously mentioned studies and observed works, it is clear that there is still a substantial need for continued development of a valuation theory that reflects both the interests of both the fields of economics and art. It is necessary that I create a framework for analysis and determine an empirical method for use. Within this framework, I identify the hypothetical relationships I wish to validate, and the logic behind their construction. Finally, I describe the econometric model that I will use to test these hypotheses.

2.3.1 Framework

While the nature of art as a financial investment is useful, I choose to reflect the personal or psychological nature of art by attempting to model price intrinsically – that is, based on the nature of the art work itself. In my creation of this model, I choose to rely heavily on the opinions of collectors, auction houses, and advisors into creation of a predictive model for price. That is, those qualifications that have been identified as reputable in determining completion of a purchase.

Since there is a relative wealth of information in regard to assessment and speculation on contemporary and modern art, I wish to extend these ideas to ancient art and artifacts. My interest in this extension of theory is for two reasons: there is an overwhelming lack in literature and empirical analysis to objects classified as such, and the significant historical and cultural impact of these works. Personal preference and

access to information has led me to study specifically works that mark the origin of Western tradition, that of the historical Mediterranean region.

It is clear that one cannot describe the cultural and aesthetic impacts of a Rothko painting and an Etruscan amphora in the same way; any impact of an art piece is inherently linked to the context in which it is produced, thus the defining characteristics are vastly different. However, there is reason to believe that there are overarching qualifications to all tangible works that we wish to extrapolate. From analysis of previously conducted studies, we see that “Tastes for the arts do seem to be moved by systematic phenomena, such that the aggregate behavior of consumers and of artists can be modeled in ways that are consistent with economic theory” (Throsby, 1994).

Synthesis of the ideas proposed by cultural economics and art theory leads me to believe that there is an ability to model the intrinsic value of art. I propose that this the qualities that predict the art’s price is based off of the opinions most familiar with its study. Namely, these are provenance, literature, cultural origination, and object specifications. Provenance has been identified as indispensable for the validity of a piece, so its existence or lack thereof may have a significant impact on price. Additionally, the branding within provenance may be apparent within the presence of a more renowned or ‘private’ previous owner. In the same way as provenance, a notable body of literature referencing a work should have a positive impact on its value. Cultural consideration is also given. The works and cultural impact of the Greeks is widely known in Western society, but that of Sarmatian or Etruscan artifacts goes unrecognized or forgotten by the general public. I propose that the cultures with the most significant relationship to price augmentation from the Mediterranean basin are Greek, Roman, and Egyptian for their

renowned reputation quality. For object specifications, I theorize that the larger the art, the higher the transactional costs associated with the piece, and finally the price. Material may also affect price, as the aesthetic value associated with different types of pieces may be augmented.

2.3.2 Econometric Model

The above hypothesized relationships call for empirical evidence and hypothesis testing. Econometrics attempts to provide a mathematical method for completion of these tasks. In addition, the literature supports the plausibility of this mode of assessment. Due to these reasons, I assert that econometric modeling may be used to create a predictive model that accounts for variation in price. The model is specified in the Data and Methods section to follow.

Data and Methods

3.1 Data Set

The data, collected from two of the most prominent auction houses that present the artwork being studied, was composed from online access to auction databases from Christie's and Sotheby's. To compile this data, a web scanner was created that pulled observations from the online databases using JAVA and Python code, which processed the information and output them into a Microsoft Excel spreadsheet. Following this process, the data was analyzed by STATA IC 15.

Overall, there were 160 observations acquired from auctions from Sotheby's on July 3rd, 2018 and Christie's on October 25th, 2017. The raw data set includes provenance information, realized price, price estimate range, relevant literature if existent, name, origin, and object specifications. Monetary data included from Sotheby's was listed in GBP, which were aptly converted and analyzed by same-day conversion rates to USD. Analysis of the data set required rigorous categorization of some aforementioned variables, which will be discussed with justification in the following subsections. Due to omitted data from unsold artifacts, this data set was reduced to include 144 observations. Expansion to larger data sets from multiple auction houses is recommended for model validity testing in future research.

3.2 Dependent Variable

The variable we aim to create a predictive model for is price realized during the auction sale. Price is expressed in terms of USD and is continuous with the assumption that all prices are nonnegative. The range of values for price is extensive, from a Roman gold ring that sold for \$1,625 to an Egyptian greywacke portrait head of Amenhotep III

for \$1,392,500. On average, the price realized for this data set is \$78684.65 with standard deviation 155411.3. Statistical summaries of the variables included in the data set are included in Appendix A.

3.3 Independent Variables

In the following subsections, I give the definition of the exogenous variables within the context of my model. I have separated the continuous and categorical variables for independent inspection. All categorical models have been determined by theoretical implications to price. If there are transformation of the variables for empirical study, they are included.

3.3.1 Continuous Independent Variables

The continuous variables included in the data set were constructed from the given observation data. An estimate range for a given piece was included on both Sotheby's and Christie's lot data in their respective currencies. From this estimate range, I created an average estimate which was the mean of the two endpoints. For example, if a piece was estimated to go for \$4000 to \$6000, the average estimate for this piece was declared \$5000. If the object range was given in GBP, same-day conversion rates then were applied to the average estimate data.

Additionally, a category of dimension was created to account for size. The data set included physical attributes of the size based on the type, thus objects may have different dimension data. That is, object A may have been measured in diameter, while object B may have been measured in length. To capture this information, I created the

continuous variable dimension that yielded a ‘total’ size, based on the aggregate recorded size. This means that an object with length of 4cm, width of 2cm, and height of 2 cm is assigned the value of 16 in dimension. Finally, I also include a categorical system to depict the difference measure tactics, with dummy variables for length, height, and diameter. This allows for one degree of freedom with measurement type.

3.3.2 Provenance

I attribute two key characteristics to provenance: whether or not there is an existent sufficient record of origination, and the social level of this provenance. The existence of provenance is captured by the dummy variable ‘provexists’ which takes on the value 1 if there is provenance included in the observation, and 0 else. Similarly, the variable ‘provpriv’ takes on a value of 1 if there exists any indication of private origin in the provenance, and 0 else. By using this variable I hope to explain the impact of biases in favor of higher ‘quality’ provenance, those coming from private collections, which usually originate from those in higher socio-economic classes.

3.3.3 Literature

Since the presence of literature is hypothesized to relate positively with price realized, I created a categorical variable ‘litexists’ to account for this influence. The variable takes on the value 1 if there is literature associated with the object, and 0 else.

3.3.4 Culture

I suspect there is stronger influence on price by the cultures that have stronger influence to Western tradition. Given the observations of the data set, I create extraneous dummy variables for all the cultures present, and propose that the most influential will be Roman, Greek, and Egyptian. The entire set of cultural originations accounted for includes those aforementioned as well as Attic, Coptic, Corinthian, Egyptian, Apulian, Etruscan, Campanian, Faliscian, Sarmatian, and Cypriote. These dummy variables take on the value 1 if they originated from the respective cultures, and 0 else.

3.3.5 Material

I believe that there are influences on price by object type – an amphora that depicts mythology of Dionysos is subjectively worth more to me than a makeup palette from the same culture, with no regard to whether literature and provenance exists for these objects. Based on this intuition, I define dummy variables for material type to analyze the extent that this is true. By the same logic of the other categorical variables, these may either take on values 0 or 1 depending if the piece is observed to be of that type. These include wood, pottery, marble, stone, bronze, and gold. Pottery and stone are inclusive categorical variables, which means that differences in type of clay or limestone are irrelevant in this model.

3.4 Method

Econometrics presupposes collected observations of useful information and employs statistical methods to determine relationships in the data. I choose to employ econometric analysis to study the price of ancient art for two reasons, (1) the practicality

and credibility of empirically testing economic hypotheses, and (2) the success of these methods in the previous bodies of literature. I define the functional form of the model chosen, along with its assumptions and nuances below. Additionally, I examine other statistical models that future research may find useful and dictate my reasoning for exclusion.

3.4.1 Ordinary Least Squares Regression

A well-known econometric model is the Ordinary Least Squares Regression (OLS) model, which yields a predictive equation for a singular dependent variable given observations from exogenous independent variables. This form of regression necessitates major assumptions of form that must be addressed for credibility. I choose to use this model for multiple reasons. One is the exogeneity of the variables collected in the data set. I assume that there is no presence of a relationship between the error term and the independent variables, which is tested in a later section. Another desirable aspect of OLS is the ease of conduction and interpretation. Due to the functional form of these relationships, high presence of categorical variables, as well as executional accessibility, I propose that OLS provides an efficient mode of estimation with relative ease. Validity of this claim is revisited in the Analysis section.

3.4.2 Other Regressions

One method I considered using was the Maximum Likelihood Estimation (MLE) that allows for estimation of regression parameters through given observations. This method maximizes the likelihood function and yields the most probable functional form

and estimation parameters. While clearly useful in some econometric studies, it is not applicable to this case. One of the necessary assumptions of MLE is that observation size tends to infinity. First, the data set chosen does not trend toward infinity, and is even relatively small. It is also not logical that the size of ancient artifacts could allow for an infinite amount of sales to preserve this assumption. The value for an artifact is inherent to its rarity and significance, and often these pieces are not abundant.

In accordance with this data set, time-series data specific models were also discarded. At first I believed sale over time could illuminate important characteristics of price. It has been confirmed that there are significant relationships between time, financial markets, and art prices (Pensando, 1993). Therefore, by necessity of the data which did not include temporal observations, and the lack of investigation of intrinsic value, paneled data methods were not appropriate to include.

Future research may find consideration of these models useful. I also note that the General Method of Moments may be an interesting tool to study this relationship, but I am unfortunately lacking in experience with use of the method.

Analysis

4.1 Results

Development of a theory and testable hypothesis requires empirical evidence and examination to assess its validity. A model proposed has no effect on a body of scholarship without proof. Synthesis of these assumptions, methods, observations, limitations, and theoretical implications follows below. Through data analysis and information software, I find a final model for this data set, given in the subsequent subsection.

4.1.1 Final Model

From the OLS regression model, I propose the model given in Figure 1, which accounts for 87.58% of the variation in selling price at the 95% confidence level. In adjustment of the variables to deal with some model specification issues, all continuous variables underwent logarithmic transformation, including price realized. A robust regression was also used to account for certain econometric issues, discussed in the next section. Therefore, we have

$$\begin{aligned} \hat{Y} = & \hat{\beta}_0 + \hat{\beta}_1 * \ln Estimate + \hat{\beta}_2 * \ln Dimension + \hat{\beta}_3 * ProvExist + \hat{\beta}_4 * ProvPrivate \\ & + \hat{\beta}_5 * LiteratureExists + \hat{\beta}_6 * Greek + \hat{\beta}_7 * Attic + \hat{\beta}_8 * Coptic + \hat{\beta}_9 * Roman \\ & + \hat{\beta}_{10} * Corinthian + \hat{\beta}_{11} * Egyptian + \hat{\beta}_{12} * Apulian + \hat{\beta}_{13} * Etruscan \\ & + \hat{\beta}_{14} * Byzantine + \hat{\beta}_{15} * Campanian + \hat{\beta}_{16} * Faliscian + \hat{\beta}_{17} * Sarmatian \\ & + \hat{\beta}_{18} * Cypriote + \hat{\beta}_{19} * HeightDum + \hat{\beta}_{20} * LengthDum + \hat{\beta}_{21} * DiameterDum \\ & + \hat{\beta}_{22} * Wood + \hat{\beta}_{23} * Pottery + \hat{\beta}_{24} * Marble + \hat{\beta}_{25} * Stone + \hat{\beta}_{26} * Bronze \\ & + \hat{\beta}_{27} * Gold \end{aligned}$$

Figure 1 – OLS regression model with fitted estimators and variables. Data compiled from Sotheby's and Christie's via web crawler application to online databases (2019).

Fitted coefficients for these variables are given in the regression results in Appendix B. This model is then a linear prediction model given continuous variables for dimension and the given average estimate, as well as categorical variables for origination, literature, provenance, and material. For each categorical variable, one degree of freedom was allotted to prevent perfect multicollinearity. In the following subsections, I use this model to identify and analyze key characteristics, econometric problems, and implications for the hypothesis. Ultimately, ideas for extension and correction of this model and price valuation are proposed.

4.1.2 Important Predictors and Statistical Significance

The identification of significant predictors of price can be conducted by analysis of the regression results. The result of running the robust regression of the continuous and categorical variables are given in Appendix B. The types of variables that yielded the most significant results are that of estimation, provenance, cultures, and material type. While not all of the categories listed in the categorical variables are of statistical importance, there are some identifiable entities within these types that provide implications for the model.

It is expected that the average estimate transformation is significantly correlated to the price. The price of any good is determined based on what consumers are willing to pay, thus one expects that professional estimates of value would have influence on price. The low p-value associated with this variable yields statistical significance that there is some positive linear influence of this estimator on price realized. From the same standard for statistical significance, the additional estimators that influence price include the

existence of provenance, origin from Apulian, Campanian, Faliscian, and Sarmatian cultures, and the object type of pottery or marble. The significance of provenance was confirmed by the hypothesis that its influence helps explain variation in price, and examination of the fitted coefficient determines that this relationship is positive.

It is interesting that the cultures most significant are not the predicted cultures. In fact, none of the cultures thought to be most influential have this characteristic. I expect that the implications of this result is that those who are acquiring these pieces have increased information regarding the cultural significance of these pieces, or that the aggregate tastes of the market are different than I previously expected.

Analysis of this model determines how closely the predictors approach the true relationship. A visual representation of the predicted values versus the actual values is given by Figure 2. This shows the biasedness of fit of the model – the R-squared value, or the slope of the line of best fit between these values, is inflated due to the number of variables included in the model. The small root mean square error (root MSE) yields a desirable standard deviation for interpretation, but may be resultant of the categorical and logarithmic variable transformations.

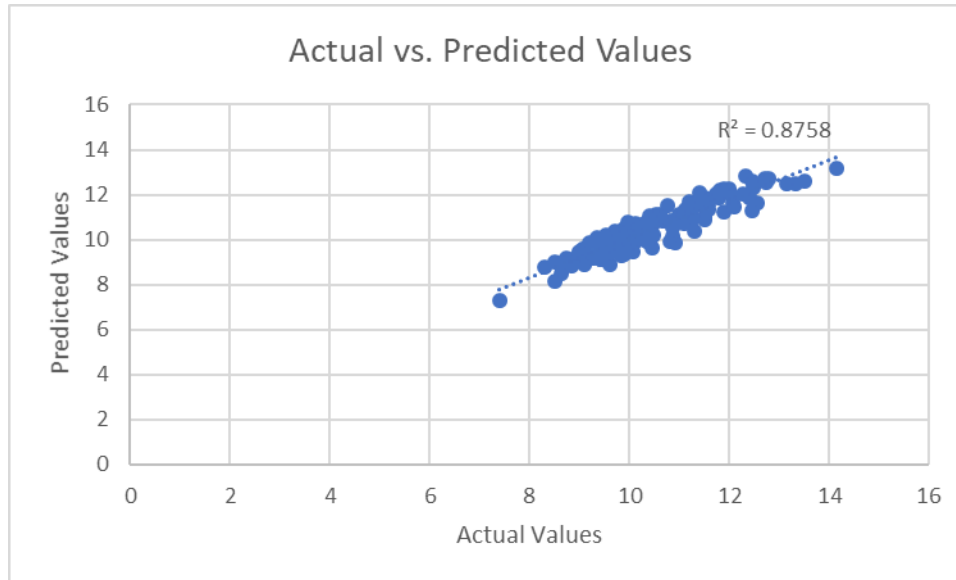


Figure 2 – Actual vs. Predicted values as determined by OLS regression. Data compiled from Sotheby’s and Christie’s via web crawler application to online databases (2019).

Another useful visual of the regression results is given in Figure 3. Shown are the values of the residuals, the difference between the predicted values of price and the actual observed values, versus those actual values. From this figure, we may determine that there is no distinct pattern to the error term, which supports validity of the model. Further issues with the residuals may be present. This is useful in analysis of assumptions of the error term, which are discussed in econometric validity.

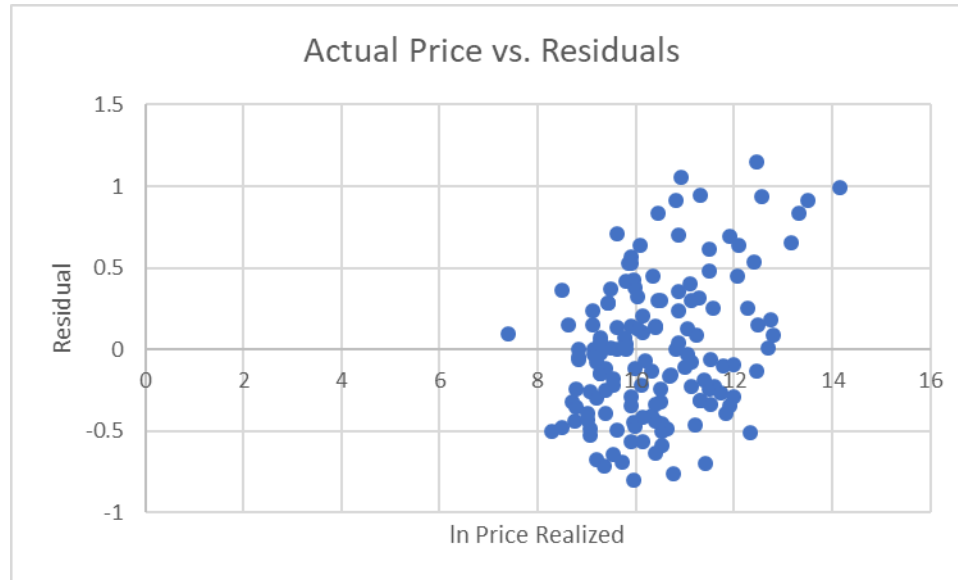


Figure 3 – Logarithmic transformation of price realized versus residuals as calculated by OLS regression. Data compiled from Sotheby’s and Christie’s via web crawler application to online databases (2019).

4.2 Econometric Validity

Any model created by empirical results and data analysis must be checked for econometric validity to interpret results. If our ideas and model is not econometrically sound, the results are inconclusive. It is necessary to discuss potential areas for inconsistencies or issues within the model, tests for the appearance of these issues, and corrections to the model if they are required. One issue of concern for this model was the distribution of the error term. Nonnormality of the error term can yield significant implications for the analysis and the rejection of the model entirely.

When I first completed this regression, the error term was nonnormally distributed, testing positive for both heteroskedasticity and kurtosis. The results of the respective tests for these issues are given in Figures 4 and 5.. Heteroskedasticity leads to decreased reliability of the estimators of the true coefficients of the predictors in the model. This was corrected for by using a robust regression, which prevents the estimators

from becoming too inflated by standard errors. After correcting for heteroskedasticity, there was still appearance of excess kurtosis, where the error term is heavily-tailed on either side. I applied the Jarque-Bera test for the error term, with the results given in Figure 4. The implication of this test is that my error term is still nonnormally distributed and kurtosis is still an issue at a 95% confidence level. A graphical representation of the fitted values of the regression versus their standard errors shows that while the model tests positive for these issues, there is no clear patterns visible, and correction may be possible (See Figure 3). I believe the issue for the nonnormality is resultant of the small observation size of the data; if there was a larger sample size, I would hope to find consistency and efficiency of the estimators.

Skewness/Kurtosis tests for Normality						
Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	adj	joint chi2(2)	Prob>chi2
residuals	144	0.0128	0.5714		6.22	0.0447

Figure 4 – Jarque-Bera test results for normality of the error term resultant from OLS regression. Data compiled from Sotheby’s and Christie’s via web crawler application to online databases (2019).

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Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of lnprice

chi2(1)      =      4.90
Prob > chi2  =      0.0269

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Figure 5 – Breusch-Pagan test for heteroskedasticity of the error term resultant from OLS regression. Data compiled from Sotheby’s and Christie’s via web crawler application to online databases (2019).

Another common econometric problem that is worth consideration is the validity of the model specification. While the model accounts for a large amount of the variation

in price, the model is large and dependent on many different categorical variables. There are more ways than one to redefine the variables to code for different cultures and materials which could yield a simpler model. Moreover, the exogeneity of the variables is crucial for the assumptions of OLS. If the variables are correlated, then multicollinearity and an endogenous error term could arise. To test for these issues, I checked the correlation matrix, given in Appendix C. While there were issues of correlation for some of the categorical variables that have a correlation coefficient greater than 0.5, exclusion of these variables significantly impacts the R-squared value. Ideas for correction of multicollinearity are presented in ideas for future research.

Finally, I note that my model is susceptible to omitted variable bias. There may be significant influences to price that are excluded from the model. However, given the RESET specifications test, the variables I included in the model allow us to claim that there are no significant omitted variables (See Figure 6). While the model does pass this diagnostic, there is still consideration of previous literature. There is significant evidence for a causal relationship between financial markets and art market trends, and one would expect price variation to follow this relationship as well. Suggestions for integration of this relationship is left for future research.

```
Ramsey RESET test using powers of the fitted values of lnprice
Ho: model has no omitted variables
      F(3, 113) =      1.85
      Prob > F =      0.1426
```

Figure 6 – Ramsey RESET test diagnostic for omitted variable bias for the OLS regression. Data compiled from Sotheby’s and Christie’s via web crawler application to online databases (2019).

Given these distinct problems and attempts to correct these issues, there are implications to the model that affect credibility of results. While there are some corrections that are presented for future research following interpretation, there are still inferences that we may make from this model. I move forward with the model knowing that all models are wrong, but some are useful.

4.3 Interpretation

Overall, there have been significant disruptions to the hypothesized results. While the model supported my theory of influence by provenance and some cultural and aesthetic facets, it did not support specific indicator variables thought to be significant. Additionally, the econometric problems that are present disrupt credibility. I leave correction of these issues and ideas of other predictor variables for future research.

The size of the model specifications create a bias of fit. Due to the number of variables included in the model, it is logical that there is an inflated R-squared value. Instead of the overall fit of variation from the model, the important inferences are concluded from the statistical significance of the prominent predictive variables. However, the extrapolation of the method to different data sets may provide an empirical framework to study the relationships deemed significant.

Looking at the distribution of residuals, there is no significant pattern that alludes to significant omitted predictors or to functional relationships with the actual values. This supports the idea that there are a variety of different minor characteristics that explain price, rather than the presence of important omitted variables. Given that the size of the residuals are relatively insignificant, I conclude that there are incalculable parameters that

account for taste that also influence price in infinite ways. For example, the interplay of a color gradient and material may affect the price of an Etruscan piece with strong influence, but may not for Roman pieces. Therefore, there are significant characteristics of object specifications that correlate to price in unknown ways.

4.4 Further Research

There are many routes of modeling valuation that can be taken for expansion of the field. For researchers following my form, there are significant econometric issues that may impact future evaluation. Additional observations may correct for nonnormality of the error term but may also augment these issues. The nature of art prices suggests that outliers for the observations may always be apparent that could disturb the distribution of the standard errors. You may see 100 observations of Roman jewelry, but the Greek funerary stone may throw off your estimators in unknown ways. The functional form I have chosen may also not provide the most efficient or unbiased estimators, as there may be a more apt form from a quadratic or cubic function. I encourage those studying this relationship to attempt modeling based on different functions to determine the most efficient estimation tactic.

Additionally, I encourage data collection from multiple markets. I chose to collect observations from only Sotheby's and Christie's due for reliability and ease of access, but there are implications of biasedness based on branding. An improvement to this model may come from data collection outside these auction houses but requires improvements to data collection completeness by smaller dealers and firms. If it is relatively easy to acquire data sets that are more complete, like those collected by Arts Economics and

artnet (McAndrew, 2019), I implore researchers to use these sets. The implication of a brand may influence the price, but the observations I collected do not allow freedom to study these implications. Further observations will also most likely include other cultures and materials, thus the creation of a new variable to account for these increasing numbers of origin information in a more effective manner may be useful.

Lastly, I would like to propose that the most useful mode of studying the value of art may come from the synthesis of the two routes of study. Those who seek to absolutely define the major influences of price should look to a theoretical application of intrinsic and financial value. That is, how is price accounted for as by viewing art as an investment, and how is it accounted for by its own value.

Conclusion

In effort to express that which might be difficult to impossible to express, the economic value of the intrinsic nature of ancient art, I find there is much to gained by continued rigorous academic inquiry into econometric and financial relationships between art and other goods. The expansion of cultural economics and art advising institutions reflect a general consensus to individuals and organizations interested in these topics. The establishment of a branch between two unlikely disciplines does not go unnoticed. Notable efforts by accredited scholars have defined developments into this field, but like art, the only limitations for the integration of these ideas into economic theory is only that of creativity.

To develop a working model for price valuation, I examined literature from fields of art history, art investment, archaeology, cultural studies, financial forecasting, and econometrics. I processed relevant news articles, magazines, and other databases to determine the scale, context, and nature of the market for ancient art and issues related to its existence. Synthesis of this information led to hypotheses that could be empirically tested. After gathering observations from major auction houses and data analysis, I find that the most significant contribution of this study is evidence that provenance, professional estimate, origin, and object type are correlated to price.

Attempting to study the intrinsic value of art may not be a productive extension for inquiry in cultural economics. The interaction of different qualities of art pieces may hold different weights on the predictors, with the implication that there is no reliable form to examine these relationships. Additionally, the rarity of such objects may not allow for a sample size large enough to present reliable results. Therefore, I find that the traditional

body of literature has been correct to examine art price as a financial investment, as the theoretical implications of aesthetic value are difficult or impossible to determine.

I hope to present justification to the reader of the necessity of expansion of empirical examination of cultural goods into the framework of economic theory. There is much work to be done on the theoretical and empirical ends of this work. I suggest to those interested in these topics to examine art measures as closely as they do the economic literature. One day the field of cultural economics may even have implications for a new field, that which includes archaeological frameworks.

I wish to represent the context in which this problem developed. There was no influence of any empirical analysis or price valuation theory when this problem was conceived – only that inspired by a curious passion for beauty. Any such question, idea, object, or thought that inspires this innate desire to understand is worthy of being explored. The limitations of investigation are only self-created.

Perhaps the most significant final note that I wish to leave with the reader is best interpreted by Roy Neuberger, a fine art collector and investment adviser that provides insight on the art market (Podgers, 1980). He declares, “Buy art because you like it and let it go at that”.

Appendix A: Statistical Summary of Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
provexist	144	.9930556	.0833333	0	1
provpriv	144	.3125	.4651303	0	1
priceUSD	144	78684.65	155411.3	1625	1392500
avgest	144	42179.7	52546.71	1250	250000
litexist	144	.3402778	.4754563	0	1
greek	144	.0763889	.2665464	0	1
attic	144	.2291667	.4217637	0	1
coptic	144	.0069444	.0833333	0	1
roman	144	.2569444	.4384736	0	1
corinthian	144	.0138889	.1174383	0	1
egyptian	144	.2916667	.4561162	0	1
apulian	144	.0555556	.2298609	0	1
etruscan	144	.0208333	.1433247	0	1
byzantine	144	.0069444	.0833333	0	1
campanian	144	.0069444	.0833333	0	1
faliscian	144	.0069444	.0833333	0	1
sarmatian	144	.0138889	.1174383	0	1
cypriote	144	.0138889	.1174383	0	1
heightdum	144	.7222222	.4494666	0	1
lengthdum	144	.0555556	.2298609	0	1
diamdum	144	.0902778	.2875796	0	1
wood	144	.0486111	.2158043	0	1
pottery	144	.4236111	.495855	0	1
marble	144	.2569444	.4384736	0	1
stone	144	.125	.3318733	0	1
bronze	144	.0694444	.2550957	0	1
gold	144	.0347222	.1837144	0	1
dimension	144	33.76986	23.8874	1.9	197
lnprice	144	10.41872	1.22534	7.393263	14.14661
lndim	144	3.301307	.7101861	.6418539	5.283204
lnest	144	10.04002	1.096461	7.130899	12.42922

Appendix B: Regression Results

Linear regression	Number of obs	=	144
	<u>F(22, 116)</u>	=	.
	Prob > F	=	.
	R-squared	=	0.8758
	Root MSE	=	.47937

lnprice	Coef.	Robust Std. Err.	t	P> t	[95% Conf. Interval]	
lnest	.987627	.0619906	15.93	0.000	.8648468	1.110407
lndim	-.046774	.1109133	-0.42	0.674	-.2664518	.1729038
provexist	.4164111	.1433421	2.91	0.004	.132504	.7003183
provpriv	.0698544	.1107065	0.63	0.529	-.1494137	.2891224
litexists	.2091462	.1127198	1.86	0.066	-.0141097	.432402
greek	-.0337297	.2553729	-0.13	0.895	-.5395278	.4720685
attic	-.3675974	.2629686	-1.40	0.165	-.8884398	.153245
coptic	.2323658	.2944815	0.79	0.432	-.350892	.8156235
roman	-.1503407	.2563423	-0.59	0.559	-.6580589	.3573775
corinthian	.0088796	.2856926	0.03	0.975	-.5569706	.5747297
egyptian	.1518929	.2276047	0.67	0.506	-.298907	.6026927
apulian	-.6224192	.2768455	-2.25	0.026	-1.170747	-.0740918
etruscan	-.1973914	.2951287	-0.67	0.505	-.781931	.3871482
byzantine	-.133273	.291645	-0.46	0.649	-.7109126	.4443666
campanian	-.5747759	.2779962	-2.07	0.041	-1.125382	-.0241693
faliscian	-2.850216	.3556631	-8.01	0.000	-3.554651	-2.14578
sarmatian	2.372554	.6453394	3.68	0.000	1.094378	3.65073
cypriote	-.1619166	.4412495	-0.37	0.714	-1.035867	.7120335
heightdum	-.0715367	.1697761	-0.42	0.674	-.4077998	.2647263
lengthdum	.0284071	.2917692	0.10	0.923	-.5494786	.6062928
diamdum	-.1689013	.2410232	-0.70	0.485	-.6462781	.3084755
wood	.1558409	.1959272	0.80	0.428	-.2322176	.5438994
pottery	.4775453	.2025143	2.36	0.020	.0764401	.8786505
marble	.5615508	.1841356	3.05	0.003	.1968471	.9262545
stone	.0967185	.2067933	0.47	0.641	-.3128617	.5062987
bronze	-.0889733	.1921097	-0.46	0.644	-.4694708	.2915241
gold	.0617157	.319546	0.19	0.847	-.5711853	.6946167
_cons	-.0339426	.5724541	-0.06	0.953	-1.16776	1.099875

Appendix C: Correlation Table

	provex~t	provpriv	priceUSD	avgest	litexi~s	greek	attic	coptic	roman
provexist	1.0000								
provpriv	0.0564	1.0000							
priceUSD	0.0155	0.1724	1.0000						
avgest	0.0035	0.1944	0.7351	1.0000					
litexist	-0.1164	0.1166	0.1621	0.2841	1.0000				
greek	0.0240	-0.0247	0.0004	-0.0823	0.0142	1.0000			
attic	0.0456	-0.1537	-0.1342	-0.0522	-0.0080	-0.1568	1.0000		
coptic	0.0070	-0.0564	-0.0374	-0.0578	-0.0601	-0.0240	-0.0456	1.0000	
roman	-0.1422	0.2550	0.1397	0.1385	0.1479	-0.1691	-0.3206	-0.0492	1.0000
corinthian	0.0099	-0.0800	-0.0486	-0.0763	-0.0852	-0.0341	-0.0647	-0.0099	-0.0698
egyptian	0.0537	-0.0041	0.0822	0.0170	-0.0739	-0.1845	-0.3499	-0.0537	-0.3424
apulian	0.0203	-0.0327	-0.0514	0.0484	0.0818	-0.0698	-0.1322	-0.0203	-0.1426
etruscan	0.0122	0.0066	-0.0618	-0.0912	-0.1048	-0.0419	-0.0795	-0.0122	-0.0858
byzantine	0.0070	-0.0564	-0.0371	-0.0474	-0.0601	-0.0240	-0.0456	-0.0070	-0.0492
campanian	0.0070	-0.0564	-0.0388	-0.0546	-0.0601	-0.0240	-0.0456	-0.0070	-0.0492
faliscian	0.0070	-0.0564	-0.0344	0.2121	-0.0601	-0.0240	-0.0456	-0.0070	-0.0492
sarmatian	0.0099	-0.0800	0.0311	-0.0710	-0.0852	-0.0341	-0.0647	-0.0099	-0.0698
cypriot	0.0099	0.0480	-0.0206	-0.0299	0.0400	-0.0341	-0.0647	-0.0099	-0.0698
heightdum	-0.0519	-0.0502	0.0622	0.0559	0.0527	0.0616	0.0430	0.0519	0.0099
lengthdum	0.0203	-0.0327	-0.0424	-0.0445	0.0178	0.0444	-0.1322	-0.0203	-0.0732
diamdum	0.0263	-0.1601	-0.1021	-0.0727	-0.1240	-0.0906	0.2318	-0.0263	-0.1852
wood	0.0189	0.1263	0.0823	0.1681	0.0421	-0.0650	-0.1232	-0.0189	-0.0590
pottery	0.0717	-0.2445	-0.1131	-0.0760	-0.1114	-0.1407	0.6026	-0.0717	-0.5041
marble	-0.1422	0.2550	0.1809	0.1369	0.1144	0.0702	-0.2828	-0.0492	0.8181
stone	0.0316	0.0170	0.0118	0.0294	0.0388	-0.1087	-0.2061	0.2212	-0.2223
bronze	0.0228	0.0516	-0.1073	-0.1372	0.0344	0.1271	-0.1490	-0.0228	-0.0981
gold	0.0159	-0.1279	-0.0194	-0.0989	-0.0562	0.2311	-0.1034	-0.0159	-0.0247
dimension	0.0097	0.3601	0.2124	0.4146	0.1855	-0.1571	-0.0269	-0.0965	0.2145
lnprice	-0.0275	0.2211	0.7269	0.7747	0.3716	-0.0531	-0.0652	-0.0872	0.2408
lndim	-0.0157	0.3367	0.1786	0.3728	0.1615	-0.2503	0.1032	-0.1726	0.2449
lnest	-0.0426	0.1995	0.5876	0.8687	0.3551	-0.0722	0.0153	-0.1026	0.2052
	dimens~n	lnprice	lndim	lnest					
dimension	1.0000								
lnprice	0.4234	1.0000							
lndim	0.8396	0.4195	1.0000						
lnest	0.4896	0.8701	0.5165	1.0000					

Appendix C: Correlation Table

	corint~n	egyptian	apulian	etruscan	byzant~e	campan~n	falisc~n	sarmat~n	cypricote
corinthian	1.0000								
egyptian	-0.0762	1.0000							
apulian	-0.0288	-0.1556	1.0000						
etruscan	-0.0173	-0.0936	-0.0354	1.0000					
byzantine	-0.0099	-0.0537	-0.0203	-0.0122	1.0000				
campanian	-0.0099	-0.0537	-0.0203	-0.0122	-0.0070	1.0000			
faliscian	-0.0099	-0.0537	-0.0203	-0.0122	-0.0070	-0.0070	1.0000		
sarmatian	-0.0141	-0.0762	-0.0288	-0.0173	-0.0099	-0.0099	-0.0099	1.0000	
cypricote	-0.0141	-0.0762	-0.0288	-0.0173	-0.0099	-0.0099	-0.0099	-0.0141	1.0000
heightdum	0.0736	-0.1478	0.1504	-0.0181	0.0519	-0.1348	-0.1348	-0.1914	0.0736
lengthdum	-0.0288	0.1779	-0.0588	0.1769	-0.0203	-0.0203	-0.0203	-0.0288	-0.0288
diamdum	-0.0374	-0.0422	-0.0764	-0.0460	-0.0263	0.2655	0.2655	0.1697	-0.0374
wood	-0.0268	0.2812	-0.0548	-0.0330	-0.0189	-0.0189	-0.0189	-0.0268	-0.0268
pottery	0.1384	-0.1791	0.2829	0.0717	-0.0717	0.0975	0.0975	-0.1017	0.0183
marble	-0.0698	-0.3773	-0.1426	-0.0858	-0.0492	-0.0492	-0.0492	-0.0698	-0.0698
stone	-0.0449	0.4966	-0.0917	-0.0551	-0.0316	-0.0316	-0.0316	-0.0449	0.1346
bronze	-0.0324	0.1252	-0.0663	0.1514	0.3061	-0.0228	-0.0228	-0.0324	-0.0324
gold	-0.0225	-0.1217	-0.0460	-0.0277	-0.0159	-0.0159	-0.0159	0.6257	-0.0225
dimension	-0.0871	-0.0718	0.1386	-0.1128	0.1090	-0.0185	-0.0350	-0.1198	0.0348
lnprice	-0.0808	0.0128	-0.0802	-0.1363	-0.0828	-0.1084	-0.0550	0.1206	-0.0405
lndim	-0.0862	-0.1460	0.1417	-0.1233	0.1028	0.0057	-0.0156	-0.2004	0.0679
lnest	-0.1095	-0.0417	-0.0034	-0.1312	-0.0464	-0.0806	0.1556	-0.0979	-0.0347

	height~m	length~m	diamdum	wood	pottery	marble	stone	bronze	gold
heightdum	1.0000								
lengthdum	-0.3234	1.0000							
diamdum	-0.5080	-0.0764	1.0000						
wood	-0.0761	-0.0548	-0.0712	1.0000					
pottery	0.1551	-0.2079	0.2694	-0.1938	1.0000				
marble	0.1163	-0.0732	-0.1852	-0.1329	-0.5041	1.0000			
stone	-0.2344	0.2750	-0.0458	-0.0854	-0.3240	-0.2223	1.0000		
bronze	0.1084	0.0530	-0.0861	-0.0617	-0.2342	-0.1606	-0.1033	1.0000	
gold	-0.2211	0.1196	0.0726	-0.0429	-0.1626	-0.1115	-0.0717	-0.0518	1.0000
dimension	-0.0959	-0.0383	-0.1072	0.2131	-0.1082	0.2102	-0.0333	-0.1356	-0.2224
lnprice	0.0641	-0.0182	-0.1238	0.1835	-0.1877	0.2760	0.0205	-0.2208	-0.0169
lndim	-0.0020	-0.1039	-0.0686	0.1211	0.0168	0.2832	-0.0702	-0.1722	-0.4890
lnest	0.0838	-0.0244	-0.0740	0.1949	-0.1125	0.2115	0.0103	-0.1810	-0.1557

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