NBER WORKING PAPER SERIES

REAL AND PRIVATE-VALUE ASSETS

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Working Paper 28580
http://www.nber.org/papers/w28580

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
March 2021

This paper is written for a special issue of the Review of Financial Studies on real and private-value assets. Goetzmann and Spaenjers served as the organizers of a conference on the topic at the Yale School of Management in January 2020, with Van Nieuwerburgh acting as the sponsoring RFS Editor. We would like to thank the conference program committee members for their feedback on the submissions, and Leigh Ann Clark and Electra Ferriello for logistical support. We are also thankful to Dragana Cvijanovic, Paul Goldsmith-Pinkham, Ralph Koijen, Matthijs Korevaar, Cameron LaPoint, Candy Martinez, Tarun Ramadorai, Jacob Sagi, Eva Steiner, and Johannes Stroebel for valuable comments on this paper. Michael Leahy provided valuable research assistance. Any remaining errors are ours. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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NBER Working Paper No. 28580
March 2021
JEL No. E01,G0,R0,Z11

ABSTRACT

Real and private-value assets—defined here as the sum of real estate, infrastructure, collectibles, and non-corporate business equity—is an investment class worth an estimated $85 trillion in the U.S. alone. Furthermore, private values can affect pricing in many other financial markets, such as that for sustainable investments. This paper introduces the research on real assets and private values that can be found in this special issue. It also reviews recent advances—and suggests new research directions—on a number of topics in the real assets space that we believe to be particularly important and exciting.

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Financial assets are contractual claims to benefits that flow from ownership or promises from income-producing entities. By contrast, the owner of a *real* asset has the right to possess and personally enjoy a particular piece of durable physical property that is typically unique (or at least in limited supply and subject to heterogeneity in quality). Ownership also gives the right to contract over the use of this property. The most well-known real asset type is of course real estate, be it residential, commercial, or agricultural. Other important real asset categories are physical infrastructure, and collectibles such as artworks.[1]

When can durable physical objects be considered *assets*? Commercial real estate and infrastructure projects yield cashflows, and acquirers' intention is clearly to earn a return commensurate with the risks they are taking. By contrast, one might treat a cabin in the woods or an oil painting as simply a consumption good for which one pays a price and then enjoys a service flow. However, when a residential structure or a collectible is purchased with an expectation of a (possible) future resale—when there is an anticipated dimension of time with attendant concern for the object's financial risk and return—then it becomes an asset.

The price formation and trading process of real assets is unlike that for publicly traded equities. Real assets are characterized by infrequent trading in search and auction markets, market values that are hard to pin down exactly, and investment returns that can only be estimated with noise. Moreover, for assets such as owner-occupied housing and works of art, the use value derived from ownership is non-monetary and non-tradable, and is *private* in the sense that it depends on the identity of the owner. For private-value assets, any two potential buyers will be willing to pay different amounts—reflecting differences in preferences and relative wealth—even when they have identical resale strategies and agree on future monetary cashflows. Because of the illiquidity of the markets in which these assets are traded, variation in private values can translate into systematic differences in transaction prices and thus financial returns between market participants.

[1]Commodities are a well-established asset category on their own, and falls outside of the scope of our analysis. Many commodity markets are relatively liquid; trading often happens through financial contracts such as futures; and the notions of uniqueness and heterogeneity are not as relevant as for the assets discussed in this paper. We also do not cover research on secondary markets for durable consumer goods (e.g., cars) or capital equipment (e.g., aircraft); see Gavazza and Lizzeri (2021) for a recent review of the literature.

Heterogeneity in beliefs about the future dynamics of private preferences—driving potential resale revenues and thus the common-value component of an asset—can further amplify the price uncertainty at any point in time.

Real assets are not the only type of investments with private-value components. In particular, the non-pecuniary private benefits from running one's own business may be an important part of the utility flow from entrepreneurship. Non-corporate businesses also share the aspect of illiquidity with the real assets mentioned before.

We here thus define "real and private-value assets" (RPVA) as the sum of real estate, infrastructure, collectibles, and non-corporate business equity. Not only are such assets pervasive, they represent a significant fraction of the economy. Both institutional and household portfolios have substantial sums of money invested in RPVA. In Section 1 of this paper, we attempt a rough quantification for the United States, which arrives at an aggregate asset class value of $85 trillion.

Private values can also be of importance for the pricing of more traditional financial assets. We can think, for example, of distributions of idiosyncratic preferences around the ESG or impact features of businesses—and how these increasingly impact investment decisions and valuations.

The existing body of published research arguably does not measure up to the importance of RPVA and of the role of private values in asset pricing more generally, even if much progress is currently being made. The *Review of Financial Studies* therefore decided to sponsor a conference and special issue on the topic. The idea was to simultaneously showcase the current work in the area and to stimulate new research, as explained in more detail in Section 2.

The current article, authored by the sponsoring *RFS* Editor and the two organizers of the conference, serves as the introduction to the special issue. In Section 3, we present the eleven original research articles in this issue. We organize our discussion around three research themes: the measurement of risk, return, and liquidity of real assets; drivers of variation in valuations and investment behavior; and private values in other asset markets. In Section 4, we identify a number of research topics that we believe to be particularly promising areas for future work.

1 Size of the Real and Private-Value Asset Class

It is fiendishly difficult to arrive at a precise and internally consistent assessment of the total size of the RPVA class. All methods agree, however, that the asset class is large and growing. Table 1 compiles our—admittedly rough—estimate of its size in the United States, based on the latest available data. The bottom line is that RPVA is a $85 trillion asset class. Appendix A contains the data sources and details of the calculations. Here is a summary of how we arrived at our headline numbers:

Residential real estate. Residential real estate is relatively straightforward to value. According to the Financial Accounts of the United States, it is worth $31.2 trillion in 2020.Q3.

Commercial real estate. The aggregate value of commercial real estate (CRE) assets, including multi-family rental housing, is much harder to measure. We use Financial Accounts data on real estate values held by the non-financial corporate, non-financial non-corporate, non-profit, and equity REIT sectors. This delivers an aggregate U.S. CRE market value of $32.8 trillion.

Table 1 also provides a breakdown into the various subsectors of CRE. We use private (i.e., non-government-owned) fixed asset data from the Bureau of Economic Analysis (BEA) to decompose the CRE value derived from the Financial Accounts into its subsectors. Industrial real estate includes warehouses and manufacturing structures. Many manufacturing structures are owned by end users and rarely trade. Health care includes hospitals, many of which may not trade much either, and which are sometimes classified as social infrastructure instead.

Our estimate exceeds numbers provided by the CRE industry, which tend to be based on "investable" assets. The third column of Table 1 reports one such estimate based on Koijen and Van Nieuwerburgh (2021) for the four main CRE sectors, using data from Real Capital Analytics (RCA). They construct price indices based on all CRE transactions from 2001 until 2020 over $10 million, and then value the stock of all CRE assets that ever traded over this 20-year period as of the end of 2019. The RCA assets add up to $4.7 trillion, an estimate that excludes many assets that never trade, such as office and manufacturing properties owned and used by the corporate sector.

Agricultural real estate. Agricultural real estate (land and structures) is worth an estimated $2.6 trillion in 2020 according to the U.S. Department of Agriculture. Farmland, like other commercial property, is income-producing. However, like for housing, some fraction of its value may have private-value components associated with patrimony, intergenerational ownership, and status.

Infrastructure. The next category of real assets is infrastructure. The World Economic Forum (2014) defines infrastructure as "the physical structures—roads, bridges, airports, electrical grids, schools, hospitals—that are essential for a society to function and an economy to operate." Many infrastructure assets are owned by governments (around 75% according to a report by RARE (2013)). We focus on privately-held assets in the U.S., and use BEA data to arrive at an estimated value of $6.9 trillion for 2019. Table 1 provides a breakdown into various subcategories. Our measure of social infrastructure covers educational, vocational, and religious structures, but excludes hospitals, which we classified as commercial real estate.

Collectibles. For collectibles, we rely on Vorsatz (2020), who estimates the total float of different collectible types based on wealth distribution data and high net worth individuals' reported collectibles ownership. We get to an aggregate value of jewelry, fine art, antique furniture, and classic cars owned by U.S. households of $5.5 trillion.[2] Table 1 reports the estimates for the different components. Goetzmann and Whitaker (2021) use U.S. estate tax records from 2013 to arrive at a year-2020 value for fine art between $1.5 and $2.0 trillion, which is similar to the $1.8 trillion estimate reported here.

Non-corporate business equity. Finally, we include private business wealth. According to the Financial Accounts, household-owned equity in non-financial non-corporate businesses (such as sole proprietorships and partnerships) is worth $12.7 trillion as of 2020.Q3. However, a substantial portion of this estimate represents a claim to real estate assets that are already included in our

[2] This is a conservative estimate as we exclude coins, stamps, wine, and other types of collectibles.

Table 1: Aggregate value of RPVA in the U.S. (in billions of USD)

Asset type	**Aggregate**	**Subtype**	**RCA data**	**Period**
Residential real estate	31,232			2020.Q3
Commercial real estate	32,793			2020.Q3
Multifamily		7,027	1,453	
Office		6,305	1,519	
Retail		7,015	916	
Industrial		5,167	811	
Hospitality		3,466		
Health care		3,522		
Student housing		291		
Agricultural real estate	2,569			2020
Infrastructure	6,901			2019
Power		2,433		
Electrical transmission equipment		564		
Communication		702		
Transportation		515		
Water, sewage, and waste treatment		185		
Petroleum and gas		1,350		
Mining		148		
Social infrastructure		1,004		
Collectibles	5,457			2017
Precious jewelry		2,156		
Fine art		1,798		
Antique furniture		684		
Classic cars		819		
Non-corporate business equity (excl. CRE)	6,055			2020.Q3
Total	85,008			

commercial real estate measure. To avoid double-counting, we subtract the $6.6 trillion in real estate equity owned by the non-financial non-corporate business sector to arrive at a value of $6.1 trillion.[3]

Another way to emphasize the importance of RPVA is to compute their share in household portfolios. If we consider real estate, consumer durable goods, and non-corporate business equity as RPVA for this exercise, then the asset class is worth $50 trillion of household wealth in 2020.Q3, up from $30 trillion in 2012. This represents 38% of overall household assets—a share that has remained fairly constant over the past decade.[4]

[3]To compute the sector's real estate equity, we subtract its total loans from its real estate assets.

[4]We include durables in this calculation as a proxy for collectibles. We include all $12.7 trillion of non-corporate business equity since the double-counting issue does not arise here. Data are from the Financial Accounts of the United States, Table B.101.h for the household sector, for 2020.Q3. This share understates the fraction of RPVA in household portfolios since some of their corporate equity, mutual fund, and pension fund holdings reflect real estate and

Gomes *et al.* (2021) review the available evidence on household balance sheets around the world. They report that shares of real assets are even higher in developing economies than in developed markets—pointing to an "asset tangibility preference" potentially related to the use of real assets as collateral or as a way to ease intergenerational transfers. Similarly, a survey of Barclays (2012) shows that financial motivations for holding art and other collectibles are more important in emerging economies. More research on the drivers of RPVA holdings in global household portfolios is warranted.

2 The Yale-*RFS* Conference and Special Issue

To stimulate new research and showcase important work in the area, the *Review of Financial Studies* decided to sponsor a conference and special issue on the topic of "Real and Private-Value Assets". The conference was held on January 31, 2020 at the Yale School of Management, and co-sponsored by the International Center for Finance. The program committee was co-chaired by the authors of this article.

To allow authors sufficient time to develop new work, a first announcement for the conference went out in January 2019. The final submission deadline was October 15, 2019. We received exactly 100 submissions. Of these, 73 papers were submitted under the dual submission rules of the *RFS*. About 75 papers were sent out for review by a committee of 14 experts. Each paper received two reviews. Based on the review scores and thematic fit with the conference, the program co-chairs chose eight papers for inclusion on the conference program.

Six of the eight papers at the conference were dually submitted to the *RFS*. In addition, the sponsoring *RFS* Editor independently selected six more papers that were dually submitted to proceed to formal submission to the *RFS*. All twelve of these papers went through the regular *RFS* paper review process, independent from the conference evaluation. Paper acceptance decisions were made solely by the *RFS* Editor, based on the recommendations of two referees. Six of the papers in this issue originate from this dual submission process.

infrastructure investments.

In addition, the *RFS* received several more papers that were not submitted to the conference but were thematically a good fit for the special issue. Some of these manuscripts were already under review prior to the conference. Five of the papers in this issue are such regular *RFS* submissions, including a paper co-authored by one of the conference organizers (Chambers *et al.*, 2021).

3 Research in This Special Issue

In this section, we briefly present the papers included in this special issue, highlighting their contributions along three dimensions: the measurement of risk, return, and liquidity in real asset markets; drivers of variation in valuations and investment behavior; and private values in other asset markets.

3.1 Measurement of risk, return, and liquidity in real asset markets

Historically, the evaluation of the investment characteristics of real assets has typically taken place through the construction of market-wide price and total return indices. One challenge that this literature has faced is to control for time-series variation in the quality of the underlying assets—think of the overall improvements in the average quality of housing over time. Prior research has also struggled to estimate average net income yields for housing, as data on actually realized cashflows are hard to obtain. Two papers in this issue, namely Eichholtz *et al.* (2021) and Chambers *et al.* (2021), aggregate from detailed asset-level archival data on property prices and income to asset-class return estimates. Using different empirical settings, both papers come to the conclusion that the return estimates in Jordà *et al.* (2019), which are based on aggregate housing market statistics, may be biased upwards. Eichholtz *et al.* find geometric average annual real total returns of 2.8% and 4.8% for Paris (1871–1943) and Amsterdam (1900–1979)—respectively 1.4% and 2.3% below the estimates of Jordà *et al.* (2019) for the same locations and time periods. Using data from Oxford and Cambridge University college portfolios over the period 1901-1983, Chambers *et al.* report an annualized real total return for U.K. housing of 2.3%—a difference of 2.4% with Jordà *et al.* (2019).

Driven by a growing awareness that most household investors in real assets do not hold diversified portfolios, and that indices are not investible (Chambers *et al.*, 2020), there is also increasing attention to asset-level rather than index-level *risk* measures. Two papers in this issue discuss the idiosyncratic risk associated with real estate investments: Giacoletti (2021) for housing and Sagi (2021) for commercial real estate. Both papers start from the idea that the combination of an illiquid asset market and variation in subjective valuations must lead to substantial transaction-specific risk. Hence, property values do not follow a random walk, and the variance of property-level capital gains does not scale with the holding period. Sagi builds a search model formalizing this idea, and shows that it fits patterns in commercial real estate transaction data well. Giacoletti documents evidence in favor of a causal effect of illiquidity on transaction price dispersion. He also shows that idiosyncratic risk accounts for two thirds of total property-level capital gain risk for 2-year holding periods, but only 45% for 15-year holds. The mean Sharpe ratio on individual houses is just 0.44 for a 2-year holding period, although this increases to 0.57 after 15 years. This compares to a Sharpe ratio estimate of 0.79 when ignoring idiosyncratic risk. Disregarding asset-level capital gains risk thus leads to a biased view on real estate's risk-return trade-off.

Giacoletti and Sagi study real estate, but transaction-specific risk is likely to be important in other real asset markets as well. For example, Lovo and Spaenjers (2018) construct an auction model for artworks in which variation in bidder types is a source of idiosyncratic risk that does not disappear even as the holding period converges to zero. The search model of Sagi, like the auction model of Lovo and Spaenjers (2018), implies that asset owners are more likely to resell quickly if an investor with a much higher valuation comes along. This highlights the crucial role played by arbitrageurs in real asset markets. It also suggests a selection bias in observed returns in real asset markets, where resale decisions and reserve prices are endogenous, at least over short horizons. As such, these theoretical contributions relate to an econometric literature that aims to correct repeat-sales estimators of art and housing returns for selection bias (Goetzmann and Peng, 2006; Korteweg *et al.*, 2016; Korteweg and Sorensen, 2016), and can hopefully inform future work in this area.

Another, related insight following from these papers is that there is never a single, unambiguous market value for an artwork or a house, but that one should think of a menu of possible combinations of (expected) prices and speed of execution ("time on the market"). Recognizing the transactional frictions in real asset markets should thus help in developing measures of liquidity (see, for example, Kotova and Zhang (2020)).

While Giacoletti and Sagi focus on idiosyncratic price dispersion, Eichholtz *et al.* perform an asset-level decomposition of the variance of *total* real estate returns. The total return consists of both the capital gain and the income yield. They find that, while in the short term total return risk is mostly driven by idiosyncratic capital gains, income yield risk becomes an increasingly important component of property-level risk for longer investment horizons. Overall, a better understanding of time-series and cross-sectional variation in the components of property-level returns and risk should also help in studying and modeling, first, how income yields and capital gains correlate with each other and with local housing market characteristics (e.g., Eisfeldt and Demers (2015)), and, second, to what extent different types of risk are priced (e.g., Han (2013); Peng and Thibodeau (2017), Eiling *et al.* (2020)).

A related interesting question is whether returns compensate investors for bearing the risk that is present in nearby cashflows or in cashflows that will materialize in the distant future. This is the central focus of the paper by Giglio *et al.* (2021). Using data on freeholds and (very) long-term leaseholds for the U.K. and Singapore, it deduces that the expected return for cash flows more than 100 years in the future is only 2.6%. This long-run return estimate is substantially below the average return on housing of about 6% that they compute based on various data sources for recent decades for a number of different locations. Hence, they conclude that the term structure of housing returns must be downward sloping. This confirms the evidence for the equity market (van Binsbergen *et al.*, 2012).

Finally, we want to emphasize that several papers in this issue study the investment characteristics of property types other than housing. For commercial real estate, there of course exists a long literature studying the properties of REIT returns (see Van Nieuwerburgh (2019) for a recent example). This literature mostly focuses on aggregate indices. Also, the fact that equity REITs are (modestly) levered and trade in public stock markets affects their liquidity and risk-return characteristics. Ghent *et al.* (2019) recently reviewed the properties of both public and private U.S. commercial real estate indices going back to the 1970s. In this issue, Chambers *et al.* find that both commercial and agricultural real estate outperformed housing over the first eight decades of the twentieth century in the U.K., with agricultural (commercial) real estate exhibiting relatively high capital gains (income yields). Sagi focuses on *asset-level* risk and return in the commercial real estate market, using transactions data from the NCREIF. Andonov *et al.* (2021), also in this issue, study the investment performance of commingled closed-end infrastructure funds, and report relatively low risk-adjusted returns. This is consistent with Gupta and Van Nieuwerburgh (2021), who find similarly poor risk-adjusted performance for both infrastructure and real estate private equity funds. Andonov *et al.* also find that these funds on average fail to match the long-term stable income yields of the underlying infrastructure assets, do not add much diversification to investor portfolios, and have a risk profile more similar to that of other private equity investments. We return to their question of how to best structure investments in infrastructure, and any other real assets for that matter, for long-term institutional investors later in this article.

3.2 Drivers of variation in valuations and investment behavior

As highlighted in the previous subsection, the combination of market illiquidity on the one hand and heterogeneity in subjective valuations between market participants on the other hand can lead to dispersion in acquisition prices. One reason for variation in the willingness-to-pay by investors can be heterogeneity in private preferences or "tastes". Adams *et al.* (2021), speaks directly to this issue by documenting international, culture-driven differences in preferences for male rather than female art. In their large sample of historic auction prices, art produced by women sold at a discount at auction, controlling for a variety of other factors. This discrepancy was larger in countries with higher levels of gender inequality metrics. Their evidence is not merely historical. Experiments reported by the authors provide additional evidence that hypothetical works of art are valued less when they are identified as being made by women. The paper ties in with a growing literature looking at the market's evaluation of female artists (Bocart *et al.*, 2018; Cameron *et al.*, 2019).

Also Andonov *et al.* highlight the importance of investor preferences. They argue that ESG considerations of public pension infrastructure investors can partially explain their underperformance. Such investors thus seem willing to trade off financial returns against non-pecuniary benefits, in a way similar to impact investors in the venture capital industry (Barber *et al.*, 2021). Variation in preferences is more likely to have an effect on investor prices and returns in illiquid markets.

In addition to differences in preference-driven private values, heterogeneity in beliefs about resale values can drive variation in investor behavior in markets for durable assets. Pénasse *et al.* (2021) build a speculative art trading model with short-sale constraints and fluctuating differences in beliefs in the spirit of Hong *et al.* (2006). They then study the effects of the negative shock to the expected (future) asset supply (or "float") caused by an artist's premature death. The model predicts permanent increases in both prices and trading volume as both the value and the frequency of exercise of the "resale option" associated with art ownership go up. Comparing auction price and volume trends for artists that died unexpectedly to those for otherwise similar artists that lived longer, they find evidence in support of these predictions.

The earlier mentioned-paper of Giglio *et al.* highlights another important source of (cross-sectional and time-series) variation in beliefs about the common-value component of residential real estate, namely climate change risk assessment. They find that transaction prices of properties in flood zones correlate negatively with a "climate attention index" constructed from real estate listings. The paper belongs to a fast-growing literature on the pricing of climate risk, explored in the March 2020 issue of the *Review of Financial Studies* on "Climate Finance" (cf. Hong *et al.* (2020) and the references therein). Much of this literature focuses on housing and its exposure to sea level rise and wildfire risk. While the early evidence on the effect of climate risk exposure on housing values is mixed (Bernstein *et al.*, 2019; Murfin and Spiegel, 2020), Garnache (2020) and Eichholtz *et al.* (2019) document lower prices for residential and commercial real estate, respectively, when disaster risk is more salient. Other recent papers focus explicitly on heterogeneity in beliefs between agents. For example, Bernstein *et al.* (2021) provide empirical evidence of the importance of residential sorting based on climate change beliefs, and Baldauf *et al.* (2020) show that houses in "climate change believer neighborhoods" sell at a discount. Keys and Mulder (2020) highlight the differences in beliefs between "optimistic" sellers and "pessimistic" buyers.

The horizon-decomposition of housing returns inferred from very long-horizon leaseholds, as highlighted above, combined with the fact that housing values respond to climate risk, makes housing a suitable asset to infer the discount rates to be applied to climate mitigation investment. Such investments have uncertain benefits that accrue in the distant future, and how to discount these benefits is an issue of both great importance and confusion. Since such investments are hedges and the damages from climate change that they offset are largest in the near term, Giglio *et al.* argue that nearby benefits should be discounted at very low rates and further-out benefits at higher (but still very low) rates. These discount rates change the cost-benefit calculus on climate change mitigation investments relative to the received wisdom on discount rates in Nordhaus (2013).

Finally, Han *et al.* (2021) focus on how financial constraints affect equilibrium behavior of sellers and buyers. Using a regression discontinuity design in the empirical part and a search model in the theoretical part of the paper, they show how regulatory changes on downpayment constraints have subtle effects on the various price segments of the housing market. A macro-prudential policy aimed at curbing price growth in Toronto in the $1 million housing market segment backfired because it generated bidding wars in the segment just below the $1 million cutoff.

3.3 Private values in other asset markets

Private values are not just relevant for real assets. Bellon *et al.* (2021) consider the utility that individuals derive from owning their private business. The authors exploit a quasi-natural experiment in which certain households receive large cash windfalls from mineral right claims, while others do not. The windfalls result in the creation of more incorporated businesses (businesses with employees), helping to overcome liquidity constraints. The windfalls also allow already non-incorporated individuals to remain self-employed for longer. The latter effect does not seem to be driven by the alleviation of financial constraints, but rather by a demand for the non-pecuniary or private benefits of being self-employed (Moskowitz and Vissing-Jørgensen, 2002; Hurst and Pugsley, 2011).

Finally, we want to highlight that private values may affect investment decisions—and thus, potentially, valuations—outside the RPVA class. We already mentioned the recent research on the non-pecuniary benefits derived by impact investors in private equity and venture capital. But even liquid financial assets' valuations may be affected by the non-financial preferences of investors. Bauer *et al.* (2021) survey investors in a Dutch pension fund, who were given a vote on whether the fund should focus more on sustainability issues. The proposal received strong support. This support appeared to be mainly driven by investors' social preferences rather than a belief that sustainability is good for financial performance. A follow-up survey showed that investors' support did not weaken after they learned about the actual implementation of the sustainable investment policy. The findings of the paper are consistent with recent lab experiments showing that investors' moral preferences affect their valuations and allocations (Bonnefon *et al.*, 2019; Humphrey *et al.*, 2020).

4 Moving Forward

In this final section of our paper, we outline some, in our view, particularly exciting research areas that hold promise for much additional work in the near future. Our goal is not to give an exhaustive overview of all current research on RPVA. Instead, we focus on a selective set of issues related to the ownership and trading of real assets. We thus largely ignore research related to, e.g., private values in financial assets, the financing of real asset acquisitions, or the effect of macro factors and credit cycles on price levels in real asset markets. For housing, the latter literature is surveyed in Davis and Van Nieuwerburgh (2014) and Guerrieri and Uhlig (2016).

4.1 Price formation and return heterogeneity in real estate markets

Realistic models of search and bargaining. Real assets are the quintessential illiquid assets, trading infrequently and in thin markets due to the uniqueness of each asset's physical characteristics and the heterogeneity in investors' subjective valuations—which is in turn due to heterogeneity in preferences, financial constraints, and beliefs about future fundamentals. Han and Strange (2015) review the existing literature on search in housing markets. It strikes us as an important task to build richer search and matching models that can be confronted with detailed asset-level data (asset features, buyer and seller characteristics, time on the market, transaction price, etc.). Some papers have recently pushed in the direction of modeling real-world features of housing markets. Ngai and Tenreyro (2014) study the effects of seasonality in housing market thickness (and thus in the quality of buyer-seller matches). Piazzesi *et al.* (2020) focus on geographical segmentation in search. Arefeva (2020) builds a dynamic search model that accounts for bidding wars between potential home buyers with heterogeneous valuations. Burnside *et al.* (2016) present a model of social dynamics in which agents' beliefs about housing market fundamentals change through meetings with other agents; Bailey *et al.* (2018) use social network data demonstrating the empirical relevance of this mechanism. Data from online platforms are helpful to understand the drivers of actual search behavior (e.g., Piazzesi *et al.*, 2020; Gargano *et al.*, 2020).

Researchers have also started to use search models to analyze the commercial real estate market. The paper by Sagi included in this issue is a prime example. Badarinza *et al.* (2020) analyze how affinity with counterparties can mitigate cross-border contracting frictions—leading to a matching of buyers with counterparties of the same (or proximate) nationality. Ghent (2020) focuses on market segmentation by liquidity preferences—explaining why delegated investors concentrate their commercial real estate investments in the most liquid markets. There is scope for much more work in this area, in particular as new empirical work documents variation in preferences (e.g., Cvijanović *et al.* (2020)) or transaction prices (e.g., Spaenjers and Steiner (2020)) across different investor types in the commercial real estate space.

The geography of real estate investing. One group of real estate investors that has been studied increasingly is foreign or non-local buyers. These investors have been blamed for pushing up house prices, aggravating existing housing affordability issues. Favilukis and Van Nieuwerburgh (2021) build a spatial equilibrium model of a city to quantify the effect of an out-of-town inflow on local residents' welfare and house prices. Empirical work by Chinco and Mayer (2016), Badarinza and Ramadorai (2018), Barcelona *et al.* (2019), Davids and Georg (2020), Gorback and Keys (2020), and Li *et al.* (2020) shows that investment demand from out-of-town or out-of-country buyers can drive up local house prices, which gives an interesting contrast with earlier papers on the effects of immigration (Saiz and Wachter, 2011; Sá, 2015).

Asymmetric information is a key characteristic of real estate markets (Garmaise and Moskowitz, 2004; Kurlat and Stroebel, 2015; Stroebel, 2016), and may be particularly important in cross-border transactions. Foreign home buyers may try to lower asymmetries by searching in "preferred habitats" with high proportions of same-nationality households (Badarinza and Ramadorai, 2018). Agarwal *et al.* (2019a) focus on ethnic matching between buyers and sellers. Agarwal *et al.* (2019c) and Badarinza *et al.* (2020) emphasize the importance of investors' nationalities in commercial real estate transactions, highlighting the roles of learning and trust, respectively, when transacting under asymmetric information. There are natural connections between this work and an emerging body of research in the trade literature recognizing the importance of informational frictions (e.g., Chaney (2014)). The international finance literature rarely considers cross-border trade in RPVA. Taking into consideration the specific trading costs and market illiquidity in this asset class strikes us an important direction for future work in international finance.

Non-local investors may differ from local ones on other dimensions than their information set alone. For example, Cvijanović and Spaenjers (2020) argue that wealthy out-of-country buyers in the Paris housing market realize lower capital gains because of their lower bargaining intensity, not because of higher information asymmetries.

Inequality in housing markets. A growing literature studies the role of housing for the dynamics of inequality. Real estate assets and mortgage debt occupy a pre-eminent place in the household wealth portfolio, especially for middle-class households. House price and mortgage rate dynamics therefore trigger large shifts in that part of the wealth distribution (Rognlie, 2016; Knoll *et al.*, 2017; Bach *et al.*, 2020; Fagereng *et al.*, 2020; Kuhn *et al.*, 2020). The wealth-building aspect of home ownership, emphasized in Sodini *et al.* (2017), contributes to rising financial wealth inequality when house prices go up. Existing research also suggests that the location of upbringing (Chetty *et al.*, 2016; Miller and Soo, 2021), as well as home ownership and housing returns (Cooper and Luengo-Prado, 2015; Lovenheim and Mumford, 2013; Been *et al.*, 2021; Hacamo, 2021), may have important intergenerational effects. The full impact of parental experiences in real estate markets remains to be uncovered.

Long-standing issues of racial and ethnic differences in access to the mortgage market and home ownership have received relatively little attention in the finance literature, at least until recently. New work in this area includes Ghent *et al.* (2014), Bayer *et al.* (2017), Bayer *et al.* (2018), Gerardi *et al.* (2020), Stein and Yannelis (2020), Ambrose *et al.* (2021), Bhutta and Hizmo (2021), Giacoletti *et al.* (2021), and, in the context of new FinTech business models, Bartlett *et al.* (2019) and Fuster *et al.* (2020). Appel and Nickerson (2016) study the long-run effects of "redlining" policies that restricted access to credit in poor and minority urban neighborhoods. Avenancio-Leon and Howard (2020) document racial inequalities in property taxation. Future work could dig deeper into demographic variation in the risk-return characteristics of owned housing, and, in the spirit of Agarwal *et al.* (2019a), the role of race and ethnicity in housing search and matching dynamics. It could also analyze how financial contract design can promote durable home ownership across all income levels.

Other dimensions of inequality are worth exploring more as well. For example, Goldsmith-Pinkham and Shue (2020) show a substantial gender gap in housing returns. One reason can be gender differences in negotiation as a driver of the less favorable execution prices for women in the housing market, as also documented by Andersen *et al.* (2020).

4.2 Joint dynamics of prices and quantities

Demand-based asset pricing approaches. The discussion in the previous subsection highlighted the importance of investor heterogeneity. Using the tools of demand-based asset pricing developed by Koijen and Yogo (2019), Koijen and Van Nieuwerburgh (2021) use rich data on the identity of buyers and sellers to study whether different types of investors have different valuations for asset characteristics. The coefficients of the hedonic pricing model come to depend on the investor composition. The ultimate goal for the literature is to build a model that can jointly account for prices, quantities (holdings and transactions), and liquidity measures (e.g., inventory, time on the market) in the time series and in the cross-section.

Endogenous supply. For most real assets, supply changes endogenously and often with long lags. These "hog cycles" in development amplify price cycles in secondary markets. Land, which is an option on a future building or infrastructure asset, is much more volatile than structures (Davis and Heathcote, 2005). Some recent papers emphasize the role of supply in explaining housing price dynamics. Head *et al.* (2014) models the response of housing construction to income shocks in a search-and-matching model. Nathanson and Zwick (2018) study how the interaction between development constraints and disagreement about future demand affects house prices. Ben-David *et al.* (2019) infer the dynamics of house price expectations from the joint dynamics of prices and demand-supply disparities. Combining richer models of supply with demand-based models is a promising area for future work.

Role of speculators and arbitrageurs in art and housing. For both art and housing, there is still a lot to learn about the role played by "investors"—buyers driven by expectations of capital gains rather than consumption motives—in generating the time dynamics of both prices and volume. One type of investor aims to profit from market-wide price increases. Bayer *et al.* (2020) document substantial entry by such (amateur) "speculators" during housing boom periods—completely mistiming the market. DeFusco *et al.* (2020) and Gao *et al.* (2020) argue that variation in speculative activity can play a role in amplifying housing market cycles. By contrast, Griffin *et al.* (2020) find no consistent relation between different proxies for speculation and prices in the early 2000s housing boom and bust. Bayer *et al.* (2021) shows how speculative activity is contagious and spills over geographically. Investors may be subject to larger fluctuations in the availability and cost of credit over time and a have different propensity to default on mortgages (Albanesi *et al.*, 2019). The impact of investors on house prices may thus change over the course of the credit cycle. An interesting question to explore further is how taxes or other regulations targeting speculators affect outcomes and welfare (Chi *et al.*, 2021; Favilukis and Van Nieuwerburgh, 2021). More broadly, there is relatively little work on the public finance aspects of real estate such as property taxation and zoning, and how they affect prices, quantities, and population flows (e.g., Favilukis *et al.* (2019)).

Other financially-driven art and housing buyers act as intermediaries or arbitrageurs, buying undervalued assets—often from forced sellers—and bringing them back to the market quickly. In the art auction model of Lovo and Spaenjers (2018), such “flipping” behavior arises endogenously because of market illiquidity, and happens no matter what the state of the economy is. In the same spirit, Bayer *et al.* (2020) contrast the stabilizing role of liquidity-providing “middlemen” for house prices with the destabilizing role of speculators. Driven by the emergence of machine-learning-based automated property valuation methods (Glaeser *et al.*, 2018; Lindenthal and Johnson, 2020), one of the most important developments in the housing market is the emergence of “iBuyers”, studied recently by Buchak *et al.* (2020). We foresee much more work on the role and (expected) impact of such players on prices and quantities, and their cyclical properties, in the various segments of the housing market.

Role of expectations and behavioral biases. A quickly growing literature looks into how households’ investment choices in the housing market are driven by their (subjective) experiences, their (potentially biased) expectations of future price rises, and the interaction of the two (Piazzesi and Schneider, 2009; Burnside *et al.*, 2016; Glaeser and Nathanson, 2017; Bailey *et al.*, 2018; Armona *et al.*, 2019; Kuchler and Zafar, 2019; Bottan and Perez-Truglia, 2020; Liu and Palmer, 2021). DeFusco *et al.* (2020) and Pénasse and Renneboog (2020) emphasize the role of extrapolative expectations in fueling speculative booms for the housing and the art market, respectively. The two-way feedback loop between (implicit or explicit) expectations on the one hand and investment behavior and outcomes on the other hand deserves further study.

There is also scope for more work on how housing market beliefs drive credit demand (e.g., Bailey *et al.* (2019), De Stefani (2020)) and supply (e.g., Kaplan *et al.* (2020)), which may feed back to price movements. The relative importance of beliefs and credit conditions in accounting for boom and bust dynamics in the housing market remains an unsettled issue (Favilukis *et al.*, 2017; Greenwald and Guren, 2020).

On the seller side, starting with Genesove and Mayer (2001), a literature has developed stressing the importance of loss aversion in explaining the positive correlation between prices and volume observed in the housing market. The loss aversion effect interacts with the downpayment effect, typically attributed to Stein (1995). However, recent work by Bracke and Tenreyo (2020) and Andersen *et al.* (2021) disputes this commonly-accepted explanation, arguing that loss aversion does not play a very significant role over and above simple anchoring. Beggs and Graddy (2009) show evidence for the existence of anchoring in the art market. A better theoretical understanding of household decision-making when it comes to listing/consignment decisions—and the role of behavioral biases therein—clearly would be helpful in order to explain the observed price and volume dynamics.

4.3 Intermediaries

Intermediaries (e.g, real estate agents, art auction houses) play a crucial role in real asset markets. A number of papers study the relation between house prices and (excess) entry into the real estate agent profession (e.g., Hsieh and Moretti (2003), Begley *et al.* (2020)). However, the impact of time-series and cross-sectional variation in broker quality and behavior on transaction outcomes is arguably under-studied. A recent exception is Gilbukh and Goldsmith-Pinkham (2019), who find that houses listed by inexperienced brokers have a lower probability of sale, and that this effect is stronger during a housing bust. They propose a housing search model in which brokers enter and exit endogenously—leading to cyclical variation in the distribution of intermediaries' experience. For the art market, Bruno *et al.* (2018) argue that auction houses with artist-specific experience are better at predicting price outcomes.

Some other research focuses on the distorted incentives and conflicts of interest of real estate agents. Levitt and Syverson (2008) show that brokers sell their clients' houses more quickly and at lower prices than their own. However, recent work that applies textual analysis to broker listings argues this result may due to omitted-variable bias (Liu *et al.*, 2020). Still, it is clear that real estate agents sometimes have informational advantages, for example allowing them to "cherry pick" cheaper listing or to obtain larger discounts from weak sellers (Agarwal *et al.*, 2019b). Barwick *et al.* (2017) find that real estate agents steer buyers to high-commission properties. There is clearly scope for more work here. Related to earlier-mentioned issues, future studies could also dig deeper into the role of real estate agents in the matching (or not) of counterparties of different nationalities or racial or ethnic groups, and the effects on transaction outcomes.

An understudied aspect of intermediaries is their role as information producers or providers. Some recent papers show how real estate advertisements provide otherwise hard to observe information about properties' quality (Liu *et al.*, 2020; Nowak and Smith, 2020; Shen and Ross, 2021). Other work focuses on pre-sale appraisals of items' market values. For example, Aubry *et al.* (2020) show that art auction house estimates are systematically biased, which could be due to behavioral biases, but also to strategic reasons. Similar mechanisms may play a role in housing appraisals as well (Salzman and Zwinkels, 2017). Future research should help improve our understanding of the competitive considerations that underlie intermediaries' asset valuations, and their effects on the equilibrium behavior of buyers and sellers. There is already some evidence that appraisals causally affect transaction prices (Aubry *et al.*, 2020; Lu, 2020).

4.4 Alternative ways to invest in real assets

Institutional investors access real estate and infrastructure investments both through public equity and debt markets and through private equity and debt markets. The general trend seems to be for an increasing allocation to alternative assets held outside public equity vehicles. Andonov *et al.* ask an important question in this issue: do investors hold RPVA investments in the right vehicles? Do commingled closed-end private equity funds provide a good structure for pension funds, sovereign wealth funds, or endowments to invest in real assets given the long-term nature of their liabilities? How does the after-fee performance of such investments compare to co-investments or direct asset investments? Do pension funds have the expertise to pull off such direct investments successfully, maybe by forming consortia, as was done in Canada (Lipshitz and Walter, 2020)? Do investors shy away from public markets since it absolves them from having to mark positions to market, creating an “illiquidity premium," as suggested by Gupta and Van Nieuwerburgh (2021)? More empirical work is needed to carefully measure the risk-adjusted performance (before and after fees) of the various modes of investing in real assets. More theoretical work is needed to develop the optimal contractual structures for different types of institutional investors.

Both for real estate and for collectibles, there has been quite some popular discussion around “tokenization”. There is limited academic research on this topic so far. For collectibles, Vorsatz (2020) develops a model of tokenization, and argues that it can be welfare-improving. A complementary perspective is offered by Whitaker and Kräussl (2020), who argue that a fractional equity system for artworks can be a tool for diversified investment and democratized access to the art market, while allowing artists to retain a share in the upside potential that their work creates. There is room for new models of financing that study how to unlock some of the value and help share the risk in RPVA assets.

4.5 Prices and preferences in collectibles markets

We can think of the private use value associated with the possession of an artwork as an “emotional dividend” (Lovo and Spaenjers, 2018), which is worth what the owner would be willing to pay for one period of enjoyment. Barring pressure from investment demand—including the occasional need for a discrete and portable store of wealth (Oosterlinck, 2017)—prices of artworks and other collectibles are thus determined at the intersection of the distribution of purchasing power and that of tastes. Research has indeed shown a strong impact of wealth dynamics on the willingness-to-pay for collectibles (Aït-Sahalia *et al.*, 2004; Hiraki *et al.*, 2009; Goetzmann *et al.*, 2011; Dimson *et al.*, 2015). Oster and Goetzmann (2003) study the role played by urban concentrations of wealth in the economics of local museums, emphasizing the social dimension of the non-monetary dividends supplied by art. Moving from wealth to tastes, it is clear that common (and seemingly lexicographic) preferences for certain highly-ranked experiences can have unusual economic effects—supporting extreme and puzzling variation in prices for practically indistinguishable goods. The details of collectors' preferences and their associated values are difficult to measure and model economically, but may have first-order effects. Differential preferences can derive from variation in past aesthetic experiences, social signaling, identity construction, and many other factors (Spaenjers *et al.*, 2015).

Research into the pricing of aesthetic features has arguably been hampered by blunt econometric tools. Hedonic regressions typically project the characteristics of artworks to prosaic indicator variables, with the most relevant being the artist. Advances in computer vision and machine learning have opened up new possibilities for studying the subtleties of the pricing of style and features detectable optically (Pownall and Graddy, 2016; Ma *et al.*, 2019; Aubry *et al.*, 2020). Future work may build on new methods that visually compare objects to each other, for example to computationally measure creativity (Elgammal and Saleh, 2015). There may also be scope for research that constructs crowdsourced proxies for attractiveness, as has already been done to evaluate metropolitan areas (Carlino and Saiz, 2019).

Also new statistical methods applied to transaction and art historical data can enable a better understanding of the formation of aesthetic tastes and the dynamics of fashion. Goetzmann *et al.* (2016) develop an empirical classification of styles based on a manifold clustering algorithm applied to auction prices. Fraiberger *et al.* (2018) use network analysis to model the paths of highly successful contemporary artists, showing the importance of early access to prestigious central institutions, suggesting a high level of demand coordination.

Finally, there is definitely room for more experimental research examining the drivers of private enjoyment and willingness-to-pay. As noted before, Adams *et al.*, in this issue, study experimentally how appreciation of artworks depends on the (perceived) gender of the artist. Other recent studies have generated further insights into the aesthetic experience. Ma *et al.* (2019) study how colors can affect emotions and valuations. Newman and Bloom (2012) explore when and for which reasons original artworks and artifacts are considered more valuable than duplicates. Related research finds that people value objects that enhance their sense of proximity to the artist or to collectors with similar preferences (Newman and Smith, 2016; Smith *et al.*, 2016).

As more sophisticated methods for the study of aesthetics become available, future researchers can build on insights from both neuroaesthetics (Chatterjee and Vartanian, 2014) and neuroeconomics. Interestingly, neurological research suggests that the relation between experienced utility and prices may not be a one-way street (Plassmann *et al.*, 2008), arguably providing a biological microfoundation for models in which the price of a collectible directly enters the utility function (Mandel, 2009).

4.6 Big challenges for real estate and infrastructure markets

The Covid-19 crisis has raised important questions about the future of cities and the future of work, with direct and indirect implications for housing markets, commercial real estate markets (office, e-commerce), and infrastructure (e.g., safety and financial viability of public transit). Gupta *et al.* (2021) study changes in residential rents and prices in urban vs. suburban locations resulting from pandemic-induced household migration. Ling *et al.* (2020) study the impact of the pandemic on asset-level commercial real estate across different categories, largely resulting from temporary restrictions on business activity during the pandemic. Delventhal *et al.* (2020) and Davis *et al.* (2021) study housing prices in spatial equilibrium models where households choose where to locate when the technology for working from home improves. The pandemic has also underscored the need for a better understanding of how public health shocks affect real estate markets (e.g., Wong (2008), Custódio *et al.* (2020), D'Lima and Thibodeau (2021), Francke and Korevaar (2021)).

Climate change and the energy transition it has set in motion directly affects the built environment and the infrastructure that supports it. Technological innovations such as driverless cars (Zakharenko, 2016) and the sharing economy (Calder-Wang, 2020) intersect with the climate imperative in interesting ways. Better cost-benefit analysis of investments in energy efficiency and a quantification of the risk of economic obsolescence (stranded real assets) are needed. The increased focus on sustainability by institutional and retail investors in equity and debt markets (green bonds) and in property markets (green buildings) will continue to be an important research theme.

Finally, there are large unmet infrastructure needs in the developed world, but even more so in developing countries where most of the growth in the world population takes place (Walter, 2016). Infrastructure investments run up against fiscal constraints everywhere. Capturing some of the newly created value of infrastructure additions (Gupta *et al.*, 2020), for example through property taxes, can be a useful tool in a broader arsenal of financing options. Much work is needed to assess risk and return of infrastructure projects in emerging markets and to find ways to bridge the financing gap (Gardner and Henry, 2021).

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A Appendix on Size of the Real and Private-Value Asset Class

This appendix describes the data sources and calculations behind Table 1, which computes the total value of the stock of RPVA in the United States. The three main data sources are: the *Financial Accounts of the United States* of the Federal Reserve Board (FAUS); the *Fixed Assets Accounts* of the Bureau of Economic Analysis (FAA); and Vorsatz (2020).

A.1 Residential real estate

We use the 2020.Q3 value for FAUS series LM155035015.Q: *Households; owner-occupied real estate including vacant land and mobile homes at market value*. This series excludes the assets belonging to non-profit organizations from the household and non-profit sector.

A.2 Commercial real estate

We compute the 2020.Q3 value as the sum of:

- FAUS series LM165035005.Q: *Nonprofit organizations; real estate at market value*
- FAUS series LM105035005.Q: *Nonfinancial corporate business; real estate at market value*
- FAUS series LM115035005.Q: *Nonfinancial noncorporate business; real estate at market value*
- the market value of real estate held by equity REITs,

where we calculate the latter component as the sum of the aggregate market capitalization of equity REITs from NAREIT as of November 2020 and financial liabilities of equity REITS (FAUS series FL124190005), and subtract financial assets of equity REITs (FAUS series FL124090005). Real estate assets held by equity REITs are estimated at $1.70 trillion in 2020.Q3.

While we prefer the market valuation methodology used in the FAUS data, it is limited in its breakdown of subcategories of CRE. To estimate the subcategory breakdown, we employ Table 2.1: *Current-Cost Net Stock of Private Fixed Assets, Equipment, Structures, and Intellectual Property Products by Type* in the FAA, which offers detailed estimates of the cost of different types of structures. Because the FAA computes book values (which reflect depreciation) and the FAUS computes market values, we use the FAA data only to compute shares, and then multiply these shares by the aggregate CRE market value from the FAUS. The latest FAA data available are for 2019. We consider the following subcategories:

- Multi-family: *residential structures, 5-or more-unit* (line 71)
- Office (line 38)
- Retail: *multimerchandise shopping* (line 44), *food and beverage establishments* (line 45), and *other commercial* (line 47), which consists of auto dealerships, garages, service stations, drug stores, restaurants, mobile structures, and other structures used for commercial purposes
- Industrial: *warehouses* (line 46) and *manufacturing* (line 48)
- Hospitality: *lodging* (line 60) and *amusement and recreation* (line 61)
- Health care (line 39), which consists of hospitals, special care, and medical buildings
- Student housing: *other residential* (line 75), which consists primarily of dormitories and of fraternity and sorority houses

Alternatively, one can value commercial real estate in a bottom-up manner using data on CRE transactions. Koijen and Van Nieuwerburgh (2021) use data from Real Capital Analytics on all sales above $10 million of CRE assets in the four core sectors (apartments, office, retail, and industrial) between 2001 and 2020 to estimate a hedonic pricing model for each sector and geographic market. They then revalue the stock of all assets that ever traded over this twenty-year period as of the end of 2019. The column labeled "RCA data" in Table 1 reports the results.

The main breakdown in Table 1 shows non-trivial values for non-core CRE sectors. The latter have been growing in importance relative to the four core sectors over the past decade. Some classify cell phone towers and data centers as CRE assets as well. In our calculations, those are included as infrastructure.

A.3 Agricultural real estate

We use the estimate of the year-2020 value of farm real estate according to the *U.S. farm sector financial indicators* published by the U.S. Department of Agriculture in February 2021.

A.4 Infrastructure

We focus on privately-held infrastructure assets in the United States. As before, we use FAA Table 2.1. We decompose infrastructure assets into the following components:

- Power (line 50)
- Electrical transmission equipment (line 17)
- Communication (line 53)
- Transportation (line 62)
- Water, sewage, and waste treatment (line 66)
- Petroleum and gas (line 55)
- Mining (line 56)
- Social infrastructure: *religious* (line 58) and *educational and vocational* (line 59)

A.5 Collectibles

Estimates for the worldwide value of the different collectible categories shown in Table 1 come from Vorsatz (2020). We thank the author for generously sharing his data. To estimate the total value of the float for these items, he combines a survey of the collectibles holdings of high net worth individuals (Barclays, 2012) with year-2017 data on the distribution of wealth (Credit Suisse, 2017). His Appendix C contains the details. To transform his global estimates to U.S. values, we multiply by the estimated share of the U.S. in worldwide household wealth according to Credit Suisse (2017), which is 33%. Finally, we group together "fine art pictures & paintings" and "fine art sculptures".

Apart from the categories shown in the table, Vorsatz (2020) also estimates the aggregate value of worldwide holdings of a number of other collectible types. Using the same methodology as before would lead to the following estimates of the value of U.S. holdings: $480b for tapestries and rugs, $567b for coins, $209b for stamps, and $345b for wine. These numbers strike us as implausibly large given what we know about annual turnover in these markets. One explanation is that wealthy households overestimate the market value of their holdings in these collectible types. Collections of coins, stamps, etc. often consist of large numbers of items with relatively limited resale values.

A.6 Non-corporate business equity

We take the 2020.Q3 value for FAUS series LM112090205.Q: *Nonfinancial noncorporate business; proprietors' equity in noncorporate business (net worth)*, and subtract real estate equity computed as the difference between series LM115035005.Q: *Nonfinancial noncorporate business; real estate at market value* and series FL114123005.Q: *Nonfinancial noncorporate business; loans; liability*.