

Chapter 14 Appendix

14A Danger and Opportunity in Market Inefficiency

The necessity to deal simultaneously with IV and MV value measures in making investment decisions results from real estate's unique asset market characteristics. Now, we want to consider the implications of the fact that informational efficiency and price discovery differ in the private real estate asset market compared with the public exchanges on which securities such as stocks and bonds are traded. Two aspects of these types of **informational inefficiency** considerations are important. One is **random noise** in the asset valuation and pricing process. The other is the presence of more inertia and predictability in real estate's periodic investment returns than one finds in securities returns.

14A.1 Valuation Noise

Real property markets are characterized by infrequent, privately negotiated deals in which whole, unique assets are traded. These are private search markets for whole assets rather than the public auction markets for homogeneous shares that characterize the securities industry. In a private whole-asset market, knowing the precise market value of any given asset at any given time is difficult. A potential buyer or seller of the office building at 100 North Main Street cannot simply pull out her smartphone and look up the latest trade price for a share of ownership in the building. She would have to do some research to estimate the current market value of a given real estate asset or pay someone else to do such research for her. And even then, she wouldn't be sure of the exact MV. Furthermore, to purchase 100 North Main, the buyer must go through a bidding and negotiation process, and the exact price outcome will not likely be known in advance.

In this scarcity of price information lies both danger and opportunity of a type not present in stocks or bonds investing. We can define this danger and opportunity in terms of the NPV and valuation concepts we have been using. In investing in real estate, while the expected NPV is approximately zero when measured on an MV basis, this is not guaranteed.

Real estate investment in the direct (private) property market can involve deals with substantially positive or negative NPVs based on market value.

In part, this is because parties to transactions sometimes make mistakes. They may fail to adequately discover or consider some knowable information relevant to the property's market value. But even when neither side in a deal makes a mistake, the nature of the real estate market is somewhat random. Market values can never be observed definitively in real estate markets; they are theoretical and can only be estimated. Both sides in a deal may have done their homework adequately and equally well. Neither party may have made any mistake in that they both made reasonable use of all the information and resources available to them when the deal was made. Yet, one side gets the better deal. If we could step back after the dust settles and have the deal reviewed by an impartial panel of experts (individually or collectively), with all the information available to the panel, the judgment of the panel would sometimes be that one side got the better deal, relative to the market value at the time.¹

How can this happen? In some cases, one party will have better information. They may not have investigated the deal harder or more diligently than the other side. Still, they just “lucked out” by happening to discover something about, say, expansion plans of a potential tenant or an adjacent property owner. If such information is not private (in the sense that anyone can verify it), then it is arguably relevant to the property's market value, particularly as it may be revealed once the deal is closed. In other cases, one side will be a better negotiator than the other side. A third possibility is that one side may be under duress or greater pressure to close the deal. Perhaps a seller requires cash to pay creditors. Perhaps an investment manager on the buy side of a deal will lose credibility if she cannot place all the capital her client wants to be invested by the end of the year.

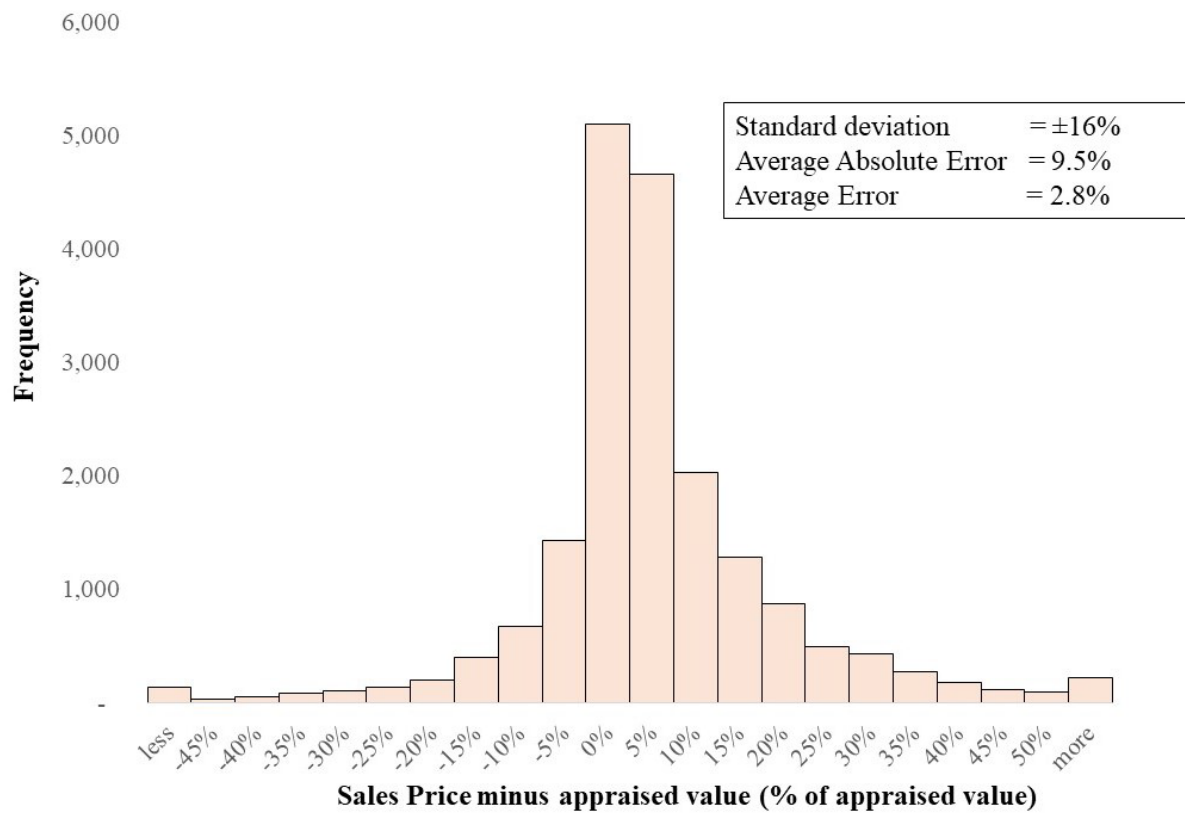
To guard against the danger of substantially negative NPV deals evaluated from an MV perspective, financial institutions engaged in commercial real estate investment, as well as investment managers acting as fiduciaries, mandate specific pre-deal investigation and analysis procedures, often referred to as **due diligence** (which sometimes includes the hiring of a professional appraiser). Investors typically also try to learn as best as possible about the (other) parties' motivations on the other side of the deal. As noted in the previous section, negotiation skills are important in real estate investment. Another implication of real estate's “fuzzy” or

¹ It is important to recognize that individual transaction prices differ from market values. **Chapter 14A.3** at the end of this chapter describes the difference in more depth.

“noisy” values is that it may be optimal to wait longer or until there is a sort of “buffer” beyond the expected outcome of whatever decision one is making. A basic tenet of rational search theory is that when uncertainty surrounds the value of the object being traded, parties on both sides should err on the side of caution (that is, buyers should place a lower reservation price and sellers a higher reservation price, thereby increasing the difficulty of making deals).

It is important to note that the flip side of the negative NPV danger is the positive NPV opportunity. Because MV is the same for everyone, in principle, whenever one side does a negative NPV deal from an MV perspective, the other side of the deal gets a positive NPV deal from the MV perspective (by definition). Part of the uniqueness and excitement of real estate investing lies in the presence of this danger and opportunity. This is different from investing in stocks and bonds. And it is different from corporate capital budgeting. Real estate investors can often reap a reward for individual investigation and research efforts more easily than investors in more efficient markets. As noted in the textbox and **Exhibit 14A-1**, individual property price noise appears to be large, perhaps on the order of +/-15% standard deviation around the MV. This suggests that acquisition and disposition transaction execution at the individual property level can be an important determinant of real estate investment performance.

EXHIBIT 14A-1 Histogram of the Difference between the Appraised Value and the Eventual Sales Price. *(Source: Authors' analysis using NCREIF data.)*



How Big is Random Noise?

How much "randomness" is there in commercial property prices or estimates of market value? Are individual transaction prices or appraisal estimates of individual property values widely dispersed around the "true" property market values? Or is the distribution very tight, with little randomness?

This question is difficult to answer because it is essentially an empirical question. Yet, a key ingredient we need for the answer is empirically unobservable, in principle, namely, the true market value. However, we can say something. First, statistical and experimental techniques allow indirect estimation of the relative magnitude of the random valuation component, the "standard error" in property value estimates. For example, two academic researchers, Julian Diaz, and Martin Wolverton, conducted an experiment in which professional appraisers independently estimated the market value of the same asset at the same point in time based on the same information about the property and its market. The resulting value estimates had a standard deviation of around 5 percent of the average property value estimate. This agrees with statistical estimates of the housing market's magnitude of transaction price noise. Statistical analysis of the NCREIF Property Database suggests an average error magnitude of 5 percent to 15 percent. Second, theory tells us what to expect about the magnitude of random noise. In particular, we believe noise should be greater for more unique assets and assets trading in "thinner," less-active markets. In such circumstances, there is less information on which to base value estimates.

More recently, in the United States, major transactions-based indices of commercial property prices have been published that provide more direct empirical evidence about the "deal noise" magnitude question, and these suggest that the upper end of the above-noted range may be relevant. The histogram shown in **Exhibit 14A-1** gives a typical picture. This shows a histogram of the difference between appraised values and eventual sales prices as a percentage of the appraised value for NCREIF properties between 1980 and 2023. It shows a standard deviation of $\pm 16\%$ and a mean absolute difference of almost 10%. Note that there also exists a bias of 2.8%. This might be interpreted as appraisers systematically underestimating the value of real estate. However, this is because the appraisals are done 3 to 6 months before the sale. Property prices have generally gone up in the meantime, so appraisals are lower on average compared to sales prices.

14A.2 Asset Market Predictability

To the extent that MV-based nonzero NPVs are an essentially random occurrence, their effect on the investor may be greatly reduced if they are well diversified, investing in many different individual properties. Random errors (both positive and negative) tend to average over the long run and across many deals. However, another result of market inefficiency can have a more systematic effect. As noted in previous chapters, informational efficiency in asset markets refers to the tendency of prices to reflect quickly and fully all relevant information or news. Markets with

high informational efficiency, like the stock market, are characterized by asset price changes that are difficult to predict in advance. Although private property markets are generally well-functioning, efficient markets, the nature of price discovery and information aggregation in whole-asset private search markets implies that asset prices move more slowly in response to the arrival of news, only **partially adjusting** within a given short- to medium-time horizon. This results in future asset market price movements at a broad level being more predictable than in the stock market (even if they are less precisely knowable at the micro-level of individual assets).

As with random noise, the **predictability** result of inefficiency brings both danger and opportunity. The opportunity is that investors can take advantage of the predictability to attempt to buy low and sell high. Investors in real estate have a greater opportunity for **market timing** than investors in securities.

However, taking advantage of real estate asset market predictability may not be as easy or profitable as it may first appear. For one thing, real estate asset markets are far from completely predictable. While they are almost certainly not as informationally efficient as the securities market and hence more predictable than such markets, they are not terribly inefficient either and hence cannot be fully predicted.

Second, **transaction costs** in buying and selling assets directly in the property market are much greater than in the securities market. Such costs removes much of the profit investors could otherwise obtain from trading on predictable asset movements. Transaction costs can be mitigated by holding real estate investments for long time periods spreading out the transaction costs over many periods. However, long holding periods also mitigate the per-annum percentage profit that can be earned from timing the ups and downs of the market. This is because long holding periods also spread out over more years of investment, the “windfall” gain from successful timing, and also because the farther in the future one tries to predict, the less accurately it is possible to predict, even for relatively predictable markets. Investment returns over long holding periods will often be more sensitive to how well the property is managed during the holding period than to the timing of when the property was bought or sold.

Finally, at least at the individual property level, the randomness of transaction noise, as described in the preceding section, may swamp much of the advantage of market timing or, in any case, can greatly increase the risk of short-term investments.

For all these reasons, most real estate investors cannot generally or systematically make **supernormal profits** due to the predictability of real estate asset market prices. Indeed, we can be almost certain that supernormal profits are not widespread because there are no major barriers to investors of many types entering the real estate market, either directly or indirectly.² If supernormal profits were widely and readily available, investors would be drawn toward real estate and reallocate their investments toward real estate and away from other asset classes. This would bid up real estate asset prices (and bid down other asset prices) to levels at which supernormal profits were no longer generally available in real estate.

But this does not mean that, as a real estate investor, you can ignore the predictability of real estate returns. That would be foolish, not only because you might miss upside opportunities but because you could get stuck on the losing end of the cyclical swings in the property market. Inertia in the property markets means that when asset prices start rising, they often rise for several years. Similarly, when prices start to fall, they may continue to fall for several years. Wary investors avoid buying near the peaks of such **cycles** and selling near the troughs. In traditional real estate practice, the greatest cause of investors being forced to sell into a down market is using large amounts of debt to finance real estate investment. Investors with low to moderate debt levels can usually ride out prolonged downswings.³

It should be noted that in the twenty-first century, the investment industry has begun to develop vehicles to enable indirect or synthetic trading of claims that can represent the private commercial

² Recall from our discussion in **Chapter 1** about the variety of real estate investment products and vehicles and the incentives facing the investment industry to develop new such products and vehicles to allow investors to place capital directly or indirectly in real estate assets.

³ The causes of large amounts of net real estate investment just before and during the cycle's peak are more of a mystery. Of course, it is always easier to identify the peak after the market has turned, but even so, behavioral and institutional problems may cause excess investment around the market peak. For example, analysts have identified a phenomenon labeled the Santa Claus effect, in which investment and financial institutions tend to reward asset classes that have performed well in the recent past by increasing capital allocations to those types of investments and punish investment managers who have done poorly in the recent past by removing capital allocation from them.

Can Predictability Cause IV to Differ From MV?

It is sometimes suggested that predictability in the real estate asset market can cause investment value to differ from current market value for assets and investors in general. If the property market is somewhat predictable, it will at least sometimes be possible to predict, not with certainty but with relatively high probability, that asset MVs will be headed in one direction or the other over the medium to long run. For example, when asset price/earnings multiples appear to be very high or very low by historical standards, or asset price indices indicate a historically anomalous run-up or crash in price levels, this may be an indication that the asset market is either "overheated" (as in a bubble), or temporarily excessively depressed (sometimes referred to as a "negative bubble"). As IV is based on long-run holdings, the long-run forecast of MV (together with the future operating cash flows the asset will generate) is more relevant to IV than the current prevailing MV. This concept of IV differs from the traditional definition, which is based on differences among individual investors. In this case, the argument is that IV generally differs from MV in the same way for all investors in the market at a given time. In this conception, the current market is viewed as "mispricing" assets from a long-run perspective. The (market-wide) IV would represent a more sustainable or noncyclical price level.

While this conception of IV and MV is interesting, it raises questions that are very difficult to answer rigorously from both a conceptual and empirical perspective. For example, it suggests that the asset market is inefficient and that market participants are acting irrationally or suboptimally in paying (or accepting) prices equal to the current market values. However, from an ex-ante perspective, asset prices may be abnormally low because the risk is abnormally high. Creditors may force sellers to accept low prices. Therefore, it is unclear what the practical implications of this concept of IV should be. Nevertheless, this is an intriguing, even if somewhat nonstandard, use of the IV concept.

property market at a broad level. Beyond REITs (which were developed earlier and will be discussed below and in **Chapter 26**), these vehicles include derivatives, such as property price index swaps or futures, and credit default swaps (CDS) based on market baskets of CMBS bonds (such as the CMBX). Similar products also exist for the housing market. Such synthetics can, at least in principle, do two things that traditionally made profiting from trading on the cyclicity in the private property market difficult: they can greatly reduce the transaction costs of trading and allow short selling (selling first and buying later). Indeed, such vehicles were used by a few shrewd (lucky?) investors to make legendary fortunes during the property market crash of 2008-2009 (in both housing and commercial property).⁴ However, the development and use of these investment

⁴ These exploits were the subject of a popular book by Michael Lewis, "The Big Short" (W.W. Norton, 2010), and the hedge fund founder John Paulson famously made the highest annual personal income in the history of Wall Street (over \$3 billion) in 2008 in part by betting against the housing market using such vehicles. In principle, the ability to sell short can also be used conservatively to hedge real estate risk exposure and manage risk. Real estate investment

vehicles remain formative, with the relevant regulatory landscape in flux. The traditional considerations described above regarding predictability and cyclicity in the property market remain overwhelmingly relevant, particularly for smaller or conservative investors.

14A.3 Valuation Concepts: Transaction Prices, Market Values, and the Model of the Asset Market
Valuation theory has a long history in economics and the appraisal profession. Familiarizing yourself with some of the basics of this theory should help you build your intuition and understanding of value in real estate. In this appendix, we will define and distinguish between several different concepts of value and price.

The most primal concept of value is what is often termed **inherent value**. This refers to the value of an object (in our case, commercial property) to a given owner or user without any consideration of the object's market value or exchange value. Inherent value represents the maximum amount a given person would be willing to pay for a good. From the perspective of a property user, inherent value is the **usage value** of the property. This would apply, for example, to owner/occupiers, as in the case of some corporate real estate, in which ownership and usage are not separated. From the perspective of an investor in a property, defined as a non-user owner, inherent value is essentially the same as what we have been calling investment value (IV).⁵

Now consider two populations of potential user owners or investors for a given property type. One population already owns such property, while the other population does not. These two populations are represented in **Exhibit 14A-2a**. The left-hand distribution consists of potential buyers of this type of property (current nonowners), and the right-hand distribution is that of potential sellers (current owners of such property).⁶ The horizontal axis measures the inherent value (say, in dollars per square foot) for the property type in question. In contrast, the vertical axis shows the number

synthetics and derivatives will be discussed in more depth in **Part VI** in the part of this text that focuses on the macro-level of real estate investment, as such vehicles are much less effective at relating to individual property investments than to large portfolios or entire markets of properties.

⁵ As noted, the terms *inherent value*, *intrinsic value*, and *investment value* overlap in common usage. But in general, the former two terms have more of a usage value connotation, while investment value refers more specifically to values for nonuser owners and landlords rather than owner/occupiers.

⁶ For the potential sellers, the inherent value may be interpreted as the minimum price at which they would be willing to sell the property if they could not sell at a higher price.

of parties in each population, which has the inherent value indicated on the horizontal axis.

Suppose these two populations can interact and trade examples of this type of property among themselves. For a price corresponding to any given value on the horizontal axis, we would have several willing buyers equal to the area underneath the buyer curve to the right of the given price. We would also have several willing sellers equal to the area underneath the seller curve to the left of the given price. The entire potential buyer population would be willing to pay at least A for this property. In contrast, no buyer would be willing to pay more than D. No current owner of this type of property would be willing to sell for less than B, while all owners would be willing to part with their property for the amount E.

If potential buyers and potential sellers randomly find each other, we would observe some transactions, for there is some overlap of the two distributions. All transactions would occur within the price range between B and D. **Transaction prices** are the prices at which deals are actually done, the prices at which examples of the type of property in question change hands. While inherent values are very difficult, if not impossible, to observe empirically, transaction prices can be observed empirically and thus be considered objective information (in contrast to inherent values, which may be more subjective). If we observe many transactions, we expect that the frequency distribution of transaction prices (a histogram of such prices) would have a shape similar to the triangular region that is simultaneously underneath both curves between B and D.⁷

If the property market functioned as a well-ordered double auction, with the auctioneer calling out prices and bidders (both buyers and sellers) revealing their true inherent values, C is the price at which the market would clear, the “equilibrium price.” C is thus the value at which there are as many willing buyers as willing sellers (the area to the right of C under the buyer curve equals the area to the left of C under the seller curve). In a well-ordered auction market with perfect inherent value information revelation, all the transactions for this type of property would take place at a price C, and this price would maximize the aggregate consumer or producer surplus from the usage

⁷ That is, the transaction price frequency distribution would resemble the intersection of the areas underneath the two inherent price distributions, with only a few deals observed around the extreme prices of B and D and many with prices similar to C.

of this type of property.⁸

EXHIBIT 14A-2a Buyer and Seller Populations, Inherent Value Frequency Distributions

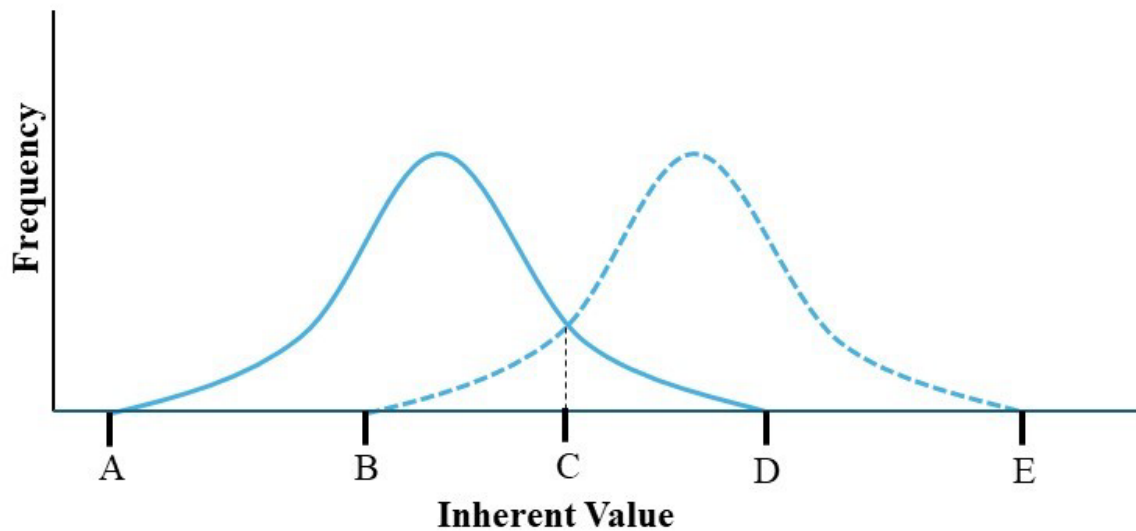
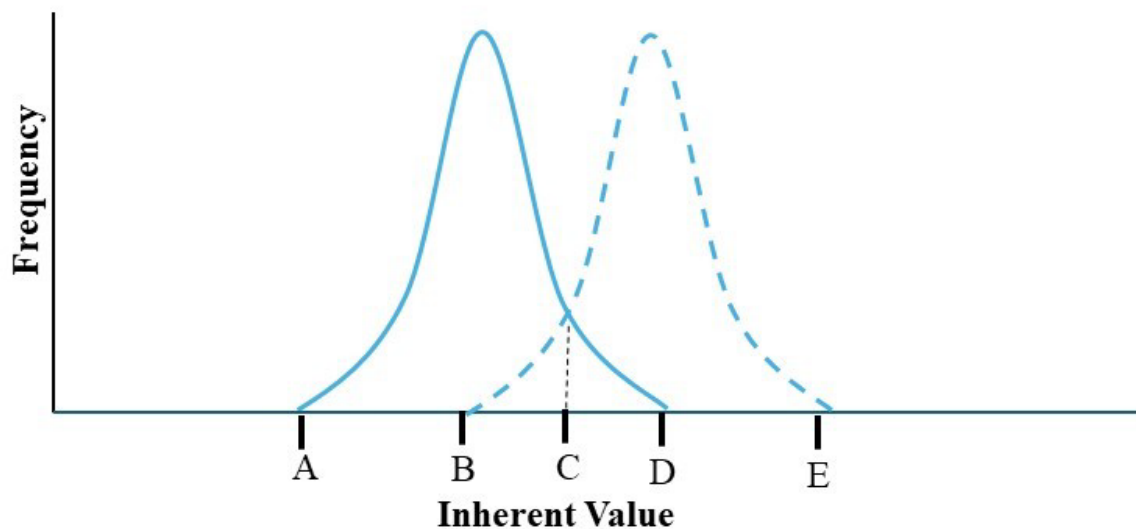


EXHIBIT 14A-2b Buyer and Seller Populations, Reservation Price Frequency Distributions



However, we do not have perfect auction markets to reveal the equilibrium value C in real property markets. But we do usually have reasonably active and well-functioning asset transaction markets. The potential buyers and potential sellers of a given type of property can observe (easily and

⁸ Economic “surplus” in this context refers to the net value or utility obtained by the producer or consumer due to trade—IV minus price for buyers, price minus IV for sellers.

accurately) the prices at which transactions of that (or similar) type of property occur from time to time. Such observation gives potential market participants some information about the equilibrium value (C in our diagram). This allows market participants to put some range around the likely equilibrium value. Potential buyers and sellers rationally use such transaction price information to determine their **reservation prices**, the prices at which they will stop searching for a willing partner and agree to trade. Reservation prices are based on inherent values but also incorporate information about the market, the perceived likely equilibrium value.⁹

Rational buyer reservation prices will be no higher than, but in some cases, may be lower than, inherent values. Seller reservation prices will be no lower than, but in some cases may be higher than, inherent values. Potential buyers who see evidence from the market that their inherent values are above the equilibrium value will reduce their reservation prices below their inherent values because no one should want to pay more than necessary and because the market informs people about values. Sellers who perceive the equilibrium price to be above their inherent values will tend to raise their reservation prices above their inherent values because no one should want to sell for less than necessary. At the other end of the inherent value distributions, nonowners whose inherent values are well below the range of observable transaction prices will effectively drop out of the potential buyer pool. Owners whose inherent values are well above the observed transaction price range will similarly drop out of the potential seller distribution.¹⁰

This causes reservation price distributions to be tighter; less spread out, and closer to the true equilibrium value C than the underlying inherent value distributions. This difference between the reservation price distributions of the effective potential market participant pool, on the one hand, and the underlying inherent value distributions, on the other hand, is the effect of the market

⁹ Reservation prices are also based on the cost of the search process and the uncertainty amount. The more difficult and costly it is to find potentially suitable properties (or buyers), the higher (lower) will be the optimal reservation price for buyers (sellers) of a given type of property, other things being equal. The more uncertainty, the lower (higher) the reservation price for buyers (sellers). Reservation prices also reflect the degree of urgency or pressure (sometimes called “motivation”) to conclude a transaction. Rational search theory has become a well-developed field in economics since the 1970s, leading to the 2010 Nobel Prize in Economics for Peter Diamond, Dale Mortensen, and Christopher Pissarides. Several economists and psychologists have developed theories such as “anchoring”, “loss aversion”, and the “disposition effect” (among others), which suggest that parties might overly bias their reservation prices in response to such considerations as the price the property was purchased for or how much value it has gained since it was bought.

¹⁰ In other words, in both cases, they will stop (or never start) searching for opposite parties to a potential transaction.

“teaching itself about itself” through the information *revealed by transaction prices observable through the functioning of the market itself*.¹¹ In the financial economics literature, this process is often called **price discovery**. The more numerous and frequent the transactions, the more alike or homogeneous the individual properties or assets in the market, and the easier it is to observe quickly and accurately the transaction prices, and the tighter and closer to C will be the reservation price distributions. This is because the information revealed by the observed transactions will be more directly relevant to the valuation of the other assets in the market. This is sometimes referred to as the effect of **market density**.¹²

Let’s consider an extreme case in which homogeneous shares of the same asset are traded continuously in a double-auction market open to the public and always full of numerous buyers and sellers, and in which all transaction prices are reported immediately and publicly, similar to what goes on in a public stock exchange. In such an extreme case, buyer and seller reservation price distributions might effectively collapse onto the single value of C, the market-clearing equilibrium value. Then (but only then, in such a hypothetical extreme case), the unique observed transaction price would exactly equal the asset’s equilibrium value as of the transaction’s time. This would be an extreme case of maximum overlap between buyer and seller reservation prices and, hence, maximum trading volume or liquidity due to eliminating any uncertainty about the market value of the assets being traded.¹³

Exhibit 14A-2b illustrates a more realistic case of reservation price distributions for property markets. The scale on the horizontal axis is meant to be the same as that in **Exhibit 14A-2a** so that

¹¹ The astute reader will realize that this mechanism of market self-learning through transaction price observation holds implications for our previous assertion at the beginning of **Chapter 3**: that the price at which an investor can expect to sell a property in the future is independent of the price paid for the property in the past by the investor. In fact, in a market of thinly traded unique assets, the price paid by the current owner may have some relevance as an indication of value for the property. However, this relevance diminishes with the passage of time and, in any case, would be far from determinative.

¹² Note that an implication of this is that when there is less price discovery and more uncertainty about what the market equilibrium value is, there is likely to be less overlap between the buyer and seller reservation price distributions and, hence, less scope for trading and therefore less turnover or “liquidity” in the market. Conversely, greater liquidity is associated with better or easier price discovery (which can stimulate liquidity in a virtuous spiral). The positive feedback loop represented by the relation between liquidity and price discovery can cause the property market to have more tendency toward boom-and-bust cycles, at least regarding trading volume.

¹³ In the context of this simple asset market model, it is only in this extreme case of complete buyer and seller overlap that asset price and trading volume are unrelated (complete demand and supply price elasticity, as will be explained shortly).

the narrower frequency distributions in **Exhibit 14A-2b** indicate that the reservation price distributions shrink the transaction price distribution range from what it would be with no market information available to buyers and sellers. More and better transaction price information improves reservation price formation and asset price discovery, thereby improving market liquidity. The observable transaction price range from B to D around C is narrower in **Exhibit 14A-2b** than in **14A-2a** based only on the inherent value distributions. This is the effect of market density and is related in both cause and effect to liquidity and price discovery. In the typical property market situation depicted in **Exhibit 14A-2b**, some dispersion of observed transaction prices around the equilibrium value still occurs because the market is not sufficiently dense and liquid enough to eliminate all such dispersion. (This is, in principle—and with some oversimplification—a key difference between private property markets and public securities markets like the stock market, including the REIT market.)

It is important to recognize that the value C in this model is normally defined as the market value or the exchange value of the type of property in question.¹⁴ Recognizing that **Exhibit 14A-2b** represents a snapshot of the property market as of one point in time, we see that even if several transactions were occurring at precisely that point in time, these observable transaction prices would be merely “drawings” from the transaction price distribution (which ranges between B and D). No single transaction price necessarily equals C, nor is there any guarantee that the average among the observed transaction prices will exactly equal C. We thus arrive at a fundamental principle of the valuation of thinly traded objects:

Observed transaction prices are dispersed around the contemporaneous market value.

This principle underlies the application of modern statistics to the empirical study of market values in real estate. It suggests a statistical-based definition of market value as the mean of the ex-ante (i.e., potential) transaction price distribution at a given time point. This allows us to employ basic statistical inference and sampling theory, for example, to enlighten the process of estimating

¹⁴ Recall that, as we are talking about a type of property, this value would be measured in some normalized units, such as dollars per square foot or dollars per dollar of current income (the inverse of the cap rate or current yield). At the micro-level of individual assets, one must account for specific unique features of individual properties in their valuations.

market values. In particular, we may assume that the arithmetic average of randomly observed transaction prices is a statistic whose ex-ante mean is the market value (C).¹⁵ The standard deviation of this statistic is $(1/\sqrt{n})$ times the standard deviation of the potential transaction price distribution, where n is the number of transaction price observations.¹⁶ This is sometimes called “the square root of n rule.” The general implication of this statistical perspective is that the average of the observed transaction prices at a single point in time is a statistically unbiased estimate of the true market value, C , as of that point in time, and the more transaction observations we include in computing this average, the more precise will be our estimate.

We should also note at this point the relationship between the reservation price frequency distributions in **Exhibit 14A-2b** and the asset market supply and demand functions in **Exhibit 14-2** in the main body of this chapter. The supply function in **Exhibit 14-2** is the cumulative distribution under the sellers’ reservation price frequency distribution in **Exhibit 14A-2b**, and similarly, the demand function in **14-2** is the cumulative distribution under the potential buyers’ reservation price frequency distribution in **14A-2b**. The horizontal axis in **Exhibit 14A-2b** corresponds to the vertical axis in **Exhibit 14-2** (the graphs are transposed). The market value (MV) on the vertical axis in **Exhibit 14-2** corresponds to the market-clearing equilibrium price “ C ” on the horizontal axis in **Exhibit 14A-2b**. The equilibrium quantity of trading on the horizontal axis of **Exhibit 14-2** (Q^*) reflects the area of overlap simultaneously under both the buyers’ and sellers’ reservation price frequency distributions (the intersection of those two sets) in **Exhibit 14A-2b**.

Reservation price distributions that are more spread out horizontally in **Exhibit 14A-2b**, when there is less liquidity and less price discovery or a thinner market, correspond to demand and supply functions in **Exhibit 14-2** that are steeper and exhibit less price elasticity. Conversely, tight,

¹⁵ Here, we assume that all observed transactions occur simultaneously (a market snapshot). As market values change over time, a sample of observed transaction prices occurring at different points in time will be drawn from the potential price distribution centered around the (longitudinally varying) market value as of the time each transaction occurred. Such a sample mean would represent a “moving average” of market values across time. The implications this holds for real estate price index time-series return and risk statistics will be discussed in **Chapter 24**.

¹⁶ For the mean of the potential transaction price distribution to equal exactly the equilibrium value C , we require that the mean of that distribution equal its median, that is, that the distribution be symmetrical, which in turn requires that the buyer and seller reservation price distributions are symmetrical in their relevant tails. In this case, the mode of the transaction price distribution, or the single most likely price, will also coincide with C .

narrowly spread reservation price frequency distributions in **Exhibit 14A-2b** resulting from a denser, more liquid market with greater price discovery will correspond to less steeply rising or falling, more price-elastic supply and demand functions in **Exhibit 14-2**.

In the extreme, if both reservation price frequency distributions collapsed onto the single price C (as in our simple conception of a perfectly functioning stock market), there would be infinite price elasticity, and asset prices would not be influenced by or related to trading volume. In reality, such a condition is not perfectly true even in the stock market (though some classical models of the stock market assumed it so). In the private property market, we observe more relationship between price and trading volume, typically with volume and price moving together pro-cyclically, and often with changes in volume slightly leading to changes in price in time.