Universidad de San Andrés

Departamento de Economía

Maestría en Economía

Public Versus Private Pricing of Real Estate and Fundamental Value Discovery

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Buenos Aires, Argentina

27 de Septiembre, 2019

Tesis de Maestría en Economía de

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"Precios Públicos Contra Privados de Bienes Raíces y Descubrimiento de Valuación Verdadera"

Resumen

Este trabajo examina la relación entre precios de acciones de Real Estate Investment Trusts ("REITs") y el valor de las propiedades de las que los REITs son dueñas para los últimos 8 años. Usando modelos de panel VAR, argumentamos y encontramos evidencia de que los precios de las acciones de los REITs explican las valuaciones en el mercado privado y que pueden ser usados como indicadores predictores de cambios en tasas de capitalización nominal y, efectivamente, de valores netos de los activos de estas empresas. De hecho, demostramos que no habría información nueva que afecte los valores respectivos de las acciones de los REITs en las estimaciones hechas por la comunidad de analistas de investigación sobre valuaciones en el mercado privado. Logramos llegar a estas conclusiones basando el análisis de datos semanales de Green Street Advisors (la firma de investigación de bienes raíces más respetada de Wall Street) sobre tasas de capitalización nominales e implícitas y el valor neto de activos desde Noviembre del 2011 hasta Agosto del 2019.

Palabras clave: Bienes Raíces, Valor Neto de Activos, Tasa de Capitalización, Precio de Acción

"Public Versus Private Pricing of Real Estate and Fundamental Value Discovery"

Abstract

This paper examines the relationship between Real Estate Investment Trust ("REIT") stock prices and the value of direct real estate owned by REITs for the past 8 years. Using panel VAR models, we argue and find evidence that REIT prices explain private market valuations and can be used as a leading indicator of nominal cap rate movements and, effectively, net asset values. In fact, we show that no new information on values that affects REITs trading performance is baked into research estimates of private market valuations. We are able to get to these conclusions based on weekly data from Green Street Advisors (Wall Street's most respected real estate research firm) on nominal and implied capitalization rates as well as net asset values from November, 2011 through August, 2019.

Keywords: Real Estate, NAV, Capitalization Rate, Stock Price

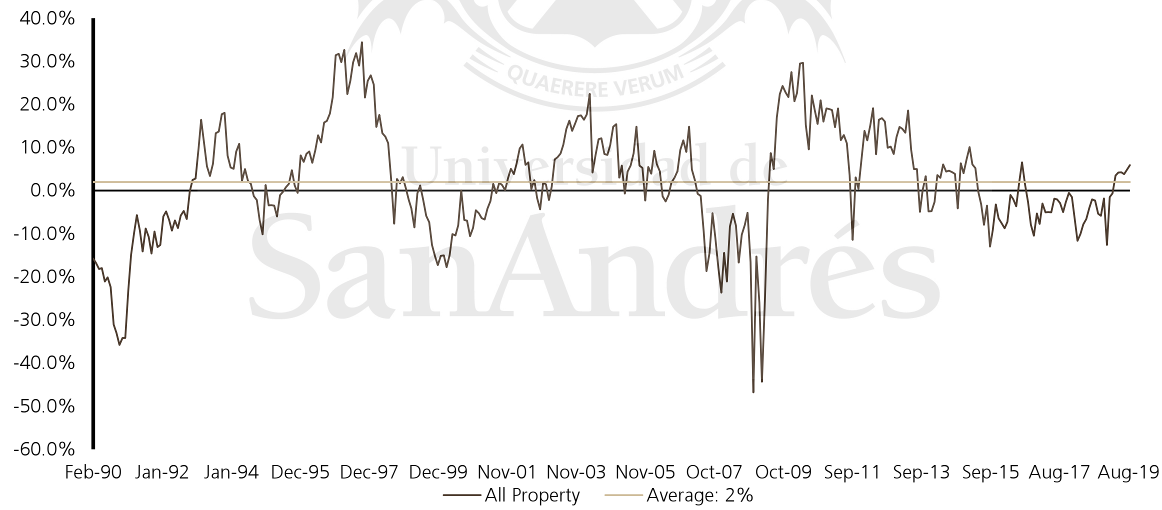
Códigos JEL: C32, C33, G12, G14, R32, R33

Section 1. Introduction

Real Estate Investment Trust ("REIT") share prices have always been conceptually in a war between real estate and common stocks. Even though REIT stocks show high daily trading volatility and high correlation with equities over short time spans, over extended periods of time, REITs behave as real estate and enable managers to achieve superior returns to those achieved by other institutional investors in private real estate investing. This is why we believe REITs are a good way to analyze the relationship between public equity markets and fundamental values of assets, as this dual property markets (public and private) make net asset value ("NAV") an important valuation data point in the real estate sector.

It is worth asking whether for REITs the price of the publicly traded common stock should equal NAV. The fact is that, based on Wall Street research estimates for NAVs and trading share prices for REITs, private and public market values fluctuate dissimilarly, as shown in Figure 1, which allows for arbitration among both values by overweighting/underweighting stocks.

Figure 1. All REIT Premium to NAV[1]



Historically in REIT world, property-market players have gathered useful information that is reflected in NAV calculations and has led to the conclusion that NAV can be used to derive reasonable share price estimations for REITs. In fact, many industry participants believe that changes in NAV serve as a good predictor of total returns for REITs as it could anticipate movements in share prices. The two key determinants in REIT values are the net value of its real estate holdings and future investment opportunities and whatever management might be expected to contribute (positively or negatively) in the future. Indeed, investors frequently cite high NAV premiums/discounts as a reason to underweight/overweight certain property sectors or companies assuming there is a strong

Note:

1. Weighted average (weighted by NAV*shares outstanding) of all US-listed companies in Green Street's coverage universe, excluding those without a published opinion. Equal-weighted average prior to Jan '93. Dates correspond to the publication of Green Street Advisors' Real Estate Securities Monthly report, typically published after the close on the first business day of each month.

correlation between average NAV premiums and subsequent total returns. In fact, there is some evidence that it is profitable to buy REITs trading at a relative discount, and short REITs trading at a relative premium to NAV (Gentry, Jones, Mayer 2004).

It is our view in this paper that while it is not rare to see large NAV premium/discounts in the public market, these premiums/discounts predict news to come regarding pricing changes in private real estate markets. It could be argued that due to the lack of liquidity in private markets when compared with public markets, it might take longer to incorporate newly available information into pricing. There is no reason to believe that private-market pricing conveys information that has not already been digested by the public market and, therefore, there shouldn't be any discernable difference in the returns REITs have delivered after they have traded at big discounts to NAV versus when instead of discounts, premiums have been large. This would suggest that public market valuations could be used as a lead indicator to pricing performance in the private market.

What we do in this paper is trying to assess the explanatory impact of one variable on the other. For this, we look at the statistical significance of coefficients in panel VAR models of implied cap rates and stock prices versus nominal cap rates and NAVs, respectively, and vice versa. We find that public market metrics precede private market estimates allowing for implied cap rates and share prices to have predictive power over nominal cap rates and NAVs, respectively. Implied cap rates and stock prices Granger-cause nominal cap rates and NAVs, respectively, and not the other way around. We do this with more updated information than Gentry, Jones and Mayer which might help explain the difference in results.

We will not ignore that fundamental information about REIT assets is incorporated into stock pricing. As previously demonstrated by Womack (1996), stock prices react strongly and quickly to changes in analyst recommendations. That is why we test how new NAV estimates influence public market valuations. We find that, for our set of estimates, NAV changes are not statistically significant for explaining changes in stock price (for both opening and closing values) in the next business day to the announcement. When NAVs are released, public market participants with access to those estimates can immediately trade on that information. But given the evidence found, most of the newly disclosed pricing information on the private market, seems to have already been incorporated in stock pricing. Therefore, we found strong evidence of how public markets are able to incorporate information faster than private markets and how public market data can be more precise when looking for indications of assets "true" value.

In section 2, we included a basic explanation of REITs and main metrics used in this study, together with an overview of relevant literature. In section 3, we describe the data used for this study. In section 4, we walk through the methodology used and, in section 5, we present the results of the analysis done. In section 6, we present the news shock analysis previously described and finish, in section 7, with concluding remarks.

Section 2. Understanding REITs and Literature Review

First and foremost, a REIT is a tax election as real estate companies elect REIT status for tax purposes. REITs are pass-through entities and do not pay corporate taxes. Instead, taxes are paid by shareholders on the dividends received and any capital gains. Beyond its tax advantages, a REIT represents a company that owns, and often operates, income-producing real estate or real estate-related assets, such as mortgages or loans[2]. In order for a stock to qualify for REIT status, and benefit from the elimination of corporate taxes, it must comply with several distribution and income stream requirements, as well as major ownership restrictions. Core requirements include 1) Pay out at least 90% of its taxable income annually in the form of shareholder dividends (any retained income will be taxed normally); 2) Be an entity that would be taxable as a corporation but for its REIT status; 3) Be managed by a board of directors or trustees; 4) Have shares that are fully transferable; 5) Have a minimum of 100 shareholders after its first year as a REIT and; 6) Have no more than 50% of its shares held by five or fewer individuals during the last half of the taxable year. Other requirements which are potentially more relevant include the Income Tests and the Asset Tests. The first one dictates that REITs have to derive at least 75% of its gross income from real estate related sources, including rents from real property and interest on mortgages financing real property. Additionally, REITs must derive at least 95% of its gross income from such real estate sources and dividends or interest from any source. The Asset Tests mandates that REITs must invest at least 75% of its total assets in real estate assets and cash and that REITs should have no more than 25% of its assets consist of non-qualifying securities or stock in taxable REIT subsidiaries.

The law providing for REITs was enacted by the US Congress in 1960 and was created to provide a way for individual investors to earn a share of the income produced through commercial real estate ownership without actually having to go out and buy commercial real estate. It is worth noting that in December 1999, President Clinton signed into law the REIT Modernization Act and the legislation became effective January 1, 2001. The new legislation enabled all REIT organizations to form and own up to 100% a "taxable REIT subsidiary", thereby allowing REITs to capitalize on adjunct service opportunities.

Note:

2. It is worth noting that in this paper will only focus our analysis on equity REITs and exclude those that own mortgages or loans, given the availability of data.

The value of any REIT can be calculated by adding the marked-to-market value of assets and liabilities. This results in the marked-to-market equity value or, on a per share basis, NAV. NAV is therefore an attempt to approximate the liquidation value of a REIT and its underlying real estate assets. In order to arrive to the marked-to market value of assets, the operating real estate value needs to be calculated thoroughly. This is usually the most important part of an NAV analysis. For this, a 12-month look-forward estimate of net operating income ("NOI") is calculated which can be done relatively accurately based on in-place lease contracts and forecasted market rents and occupancy. Additionally, the magnitude of an appropriate capital expenditure ("cap-ex") reserve is determined and an appropriate capitalization rate ("cap rate") is applied to economic NOI (NOI less cap-ex). The quality of the analysis rests on an in-depth knowledge of prevailing cap rates, the appropriate cap-ex treatment for each REIT, and other required industry and company specific adjustments such as seasonality, one-time items, etc.

Nominal cap rates are probably the most critical input of an NAV calculation. The quality of a NAV depends on how reliable cap rates are which depend on an understanding of submarkets, talking to market participants (like brokers, real estate executives, etc.), property visits, lease structures, among other things.

Needless to say, real estate appraisals are imperfect but one could argue that, on average, REIT prices and NAVs should be similar. The straightforward nature of REIT operations makes it even more plausible that, on average, the public and private market valuation should be the same. But it can also be argued that one or the other should be higher if there are additional costs associated with operating a REIT versus other forms of owning real estate, conflicts between managers and investors, quality of management teams, cost of capital differences due to liquidity, etc. Additional justified reasons why stock prices might differ from NAV where there has been significant work done include expected future trading and management costs (Malkiel, 1977), expected manager performance as previously suggested (Chay and Trzcinka, 1999), tax liability and tax timing (Brickley, Manaster, and Schallheim, 1991), and market segmentation (Bonser-Neal, Brauer, Neal, and Wheatley, 1990). In any case, most of these variables do not change through time which helps the argument that a behavioral explanation is needed to explain time variations of discounts and premiums in trading to NAV. These arguments are about average levels of common stocks and NAV but do not give much information about why the relationship between these levels could change.

But, probably, strong arguments in favor can be made for work done by Rehkugler, Schindler and Zajonz (2012) who argue that market sentiment, in particular, substantially improves estimations of stock prices premiums/discounts to NAV, explaining more than 76% of the spread. They argue that the model they developed, tested for European real estate, constitutes a significant improvement over previous studies on the explanation of NAV spreads. In this same lines, Clayton and MacKinnon (2002) find a significant role for sentiment in REIT prices, returns, and the timing of REIT equity offerings. They also find evidence of a significant liquidity premium in REIT prices relative to property NAV that varies systematically with the liquidity of private real estate. Real estate investors value the liquidity provided by REITs, relative to direct real estate, when liquidity in the private real estate market is low (i.e. when property values are low). On the other hand, we don't need to underestimate the power of arguments such as Chiang's (2009) who found evidence consistent with the notion that public markets are more efficient in processing information for REITs. This argument has been deeply debated and is probably one of the strongest explanations of the results that we find.

Consistent with our results, Oikarinen, Hoesli and Serrano (2013) find that the generalized impulse responses from estimated vector error-correction models provide evidence of REIT returns leading private returns in the office, retail, and apartment sectors, but not in the industrial sector. It is worth noting that they use sector level indexes and, therefore, our dataset is richer as we can use firm level variations. On the other hand, Letdin, Sirmans and Sirmans found that there is a mispricing-based explanation for the value return premium in REITs.

Regardless of arguments supporting different views on REIT stock prices premiums/discounts to NAV, Boudry, Coulson, Kallberg and Liu (2012) found that the relation between REIT and direct real estate returns appears to be stronger at longer horizons. More specifically they found robust evidence that REITs and the underlying real estate are related and that they share a long-run equilibrium. Interestingly, they find that both REITs and direct real estate returns adjust towards this long run relationship. When they examine property type level data, results are similar.

Section 3. Data Description

Throughout this paper, we rely on Green Street Advisors' ("GSA") data for our empirical work. Green Street computes NAV for many publicly traded REITs. Their goal is to compare the market value of REIT´s commons stock with the private market value of the underlying assets in order to advise clients on selecting REIT investments. We use Green Street data because this company is almost unanimously regarded as the best research firm in the street that produces the most careful and accurate estimates in REIT world. It is also the only research firm to have a consistent set of estimates since 2011 and focuses exclusively on real estate firms.

An important point to discuss is whether these "private" estimates are publicly available information. One could argue that even though GSA information is only available to institutions in return for commission trading business, for a fee, and that that information is not released to non-clients, given the reputation of the firm, the existence of GSA and its data is well-known to the institutional investor community and most likely Green Street Advisors' clients are those institutional investors that affect share prices the most.

We use weekly[3] data on GSA's nominal and implied cap rates as well as NAV estimates from November, 2011 through August, 2019. The number of REITs expanded over the course of the sample period to 81 with market capitalization of $940 billion as of August 2019. It is worth noting that GSA does not cover all REITs in the industry. Currently, the company covers REITs that represent approximately 90% of the capitalization in the industry, including all large REITs.

Section 4. Methodology

The goal is to use REITs to analyze the relationship between public equity markets and fundamental values of assets. The main objective is to better understand the relationship between public and private market real estate valuations and how, if our main hypothesis is true, the former can be used as a lead indicator to pricing performance in the latter.

In order to test this properly, we start by testing for stationarity. As it is well known, there exists the possibility of observing a spurious correlation if variables are non-stationary. Therefore, in this paper, we first provide three main tests to analyze if, in fact, these series are I(1) for each specific firm time series: Augmented Dickey-Fuller (ADF) test (Said and Dickey 1984); Phillips and Perron (1986) statistic; and Kwiatkowski, Phillips, Schmidt, Shin (KPSS) test. The first two tests evaluate the null hypothesis of presence of a unit root in a time series sample; rejecting the null hypothesis in these tests can be used as evidence of stationarity in the sample. Nonetheless, the ADF test and the Phillips-Perron test guarantees that the null is not rejected unless there is strong evidence in favor of stationarity and it is difficult to reject the null hypothesis of having a unit root, in some cases, if we have values extremely close to 1. Therefore, it is interesting to use the Kwiatkowski, Phillips, Schmidt, Shin ("KPSS") test which tests the null hypothesis that there is no unit root to compare the results. Moreover, we conduct unit root test for panel data following Levin, Li and Chu (2002), Harris and Tzavalis (1999), Breitung and Das (2005), Im-Pesaran-Shin (2003), and Fisher-type (Choi 2001) tests. As we should observe, the changes in stock prices and cap rates are stationary and, therefore, we will use these variables to conduct the analysis intended in this paper.

Note:

3. Some observations in the data do not have a weekly frequency due to the fact that when Green Street makes a change in an NAV model (material or otherwise) it is automatically pushed up to their databases. It is typically a weekly time series but there will be some dates that fall outside of the weekly series as a result of sector teams making changes in their models on those days. The series of dates is the same across all companies so if there is a date outside of the weekly series, there was not necessarily a change made to all of the companies but there may have been a change made to a different company in their coverage universe that is causing that date to show up across all companies.

In this analysis, we are focusing on the significance of variables rather than on the levels of the coefficients themselves. In order to assess the explanatory impact of one variable on the other, we run panel VAR models of implied cap rates and stock prices versus nominal cap rates and NAVs, respectively, and vice versa. What we will be looking at is the statistical significance of coefficients. In these regressions, we use panel VAR with controls, also called panel VARX. We run the following model shown in Equation 1:

Equation 1. $$\Delta y_{i,t} = \sum_{k=0}^{K} \beta_{Y,k} \ \Delta y_{i,t-k} + \sum_{k=0}^{K} \beta_{X,k} \ \Delta x_{i,t-k} + \sum_{k=0}^{K} \beta_{Z,k} \ \Delta Z_{i,t-k} + \gamma_i + \varepsilon_{i,t}$$

Where $\Delta y_{i,t}$ and $\Delta x_{i,t}$ are the changes in y and x respectively of firm i in period t; K is the number of lags, $Z_{i,t}$ are the control variables and γ_i are firm fixed effects. Finally, β_j is the vector of coefficients for each one of the variables. We conduct 4 specifications: first we regress the nominal cap rate on the lags of that variable and the implied cap rate and then we regress the implied cap rate on the lags of that variable and the nominal cap rate to understand which granger cause the other. We develop the same analysis for the public stock prices and the NAV. As it was clarified, all the variables are used in changes. Moreover, for each of the 4 specifications we show the results for 4 models: adding only 1 lag, 2 lags, 3 lags and 4 lags. As control we include the change in the price of the S&P500 index to capture the change in stocks and implied cap rate that respond to the change in the broader market. Note that this control has only temporal dimension. For all firms, the change in this index at each time period is the same.

With these regressions we will be able to analyze Granger causality and therefore if past values of x are significant predictors of the current value of y even when past values of y have been included in the econometric model. Then we would conclude that x exerts a causal influence on y.

Additionally, we ventured to analyze REITs stock price reaction to newly available public information on private market valuations when GSA publishes its NAVs. The idea behind this analysis is to see whether the new information published generates a change in public valuations. Note that if there is information in the private valuation that was not yet incorporated by the public market, this news shock should have an impact on stock prices. Therefore, the public market should react using this new information the next business day. We conduct two models, keeping all publication days to analyze what happens with the opening price and closing price of stock prices that next day. In the first model, we regress the change in the stock closing price from the closing price of the day of the publication (before the new information becomes publicly available by Green Street Advisors) on the change of the NAV. We also add, for a second specification, the change in the opening price of the S&P500 index with respect to the closing price of the day of the publication and we add a third specification adding the same change for the opening price of the RMZ index which is a REIT specific index[4]. We then conduct the same analysis but using all the opening prices for all variables.

Section 5.1. Results

The critical values for the Augmented Dickey-Fuller (ADF), Phillips-Perron and KPSS tests are given by Table 1.

Table 1. Critical values for ADF, Phillips-Perron and KPSS test statistic for non-stationarity for T = 487

Test	Null Hypothesis	Critical Values (T = 500)		
		1%	5%	10%
Augmented Dicky Fuller	Non-stationary trend	-3.44	-2.87	-2.57
Phillips-Perron	Non-stationary trend	-3.44	-2.87	-2.57
Kwiatkowski, Phillips, Schmidt, Shin	Stationary trend	0.216	0.176	0.146

When looking at the ADF and Z_t statistics, we reject the null hypothesis of non-stationarity if the statistics are lower than the critical values and, for the KPSS test, if the statistic is above the critical value, we reject the null hypothesis of the variable being stationary. We provide in Table 2 the share of firms that reject each one of the null hypothesis for each test.

Table 2. Share of firms that reject hypothesis

Variable	rejectADF_mean	rejectZt_mean	rejectKPSS_mean
Nominal Cap Rate	0.05	0.05	1
Δ Nominal Cap Rate	0.98	0.98	0.06
NAV	0.01	0.02	1
Δ NAV	0.98	0.98	0.07
Implied Cap Rate	0.14	0.21	0.98
Δ Implied Cap Rate	0.98	0.99	0.02
Stock Price	0.04	0.06	1
Δ Stock Price	1	1	0

Table 2 shows that there is evidence that cap rates and stock prices are non-stationary in the sample, as we reject the null hypothesis for a very large share of firms for the ADF and Phillips-Perron test and we do not reject the null for a large share of firms as well for the KPSS test. Moreover, as the panel dataset may have different features than the specific time series for each firm, we conduct unit root test for panel data following Levin, Li and Chu (2002), Harris and Tzavalis

Note:

4. The MSCI US REIT Index is a free float-adjusted market capitalization weighted index that is comprised of equity Real Estate Investment Trusts (REITs). The index is based on the MSCI USA Investable Market Index (IMI), its parent index, which captures the large, mid and small cap segments of the USA market. With 151 constituents, it represents about 99% of the US REIT universe and securities are classified under the Equity REITs Industry (under the Real Estate Sector) according to the Global Industry Classification Standard (GICS®), have core real estate exposure (i.e., only selected Specialized REITs are eligible) and carry REIT tax status.

(1999), Breitung and Das (2005), Im-Pesaran-Shin (2003), and Fisher-type (Choi 2001) tests which have as the null hypothesis that all the panels contain a unit root. These tests require a strongly balanced panel and therefore we need to drop some of the firms for which we have fewer observations, thus keeping 55 out of the 81 firms. We do not have the same number of observations for all firms throughout the sample period as some firms might not have been public or covered by GSA at the beginning of the sample, or might have been acquired/liquidated or dropped coverage by GSA by the end of the sample.

Table 3. Panel Unit Tests

Variable	Levin, Li & Chu	Harris-Tzavalis	Breitung	Im-Pesaran-Shin	Fisher w/PP	Fisher w/ADF
Implied Cap Rate	0.04	0.00	0.02	0.00	0.00	0.00
Nominal Cap Rate	0.00	1.00	1.00	0.99	0.79	0.80
NAV	0.42	1.00	1.00	1.00	1.00	1.00
Stock Price	0.99	0.98	1.00	0.78	0.15	0.41
Δ Implied Cap Rate	0.00	0.00	0.00	0.00	0.00	0.00
Δ Nominal Cap Rate	0.00	0.00	0.00	0.00	0.00	0.00
Δ NAV	0.00	0.00	0.00	0.00	0.00	0.00
Δ Stock Price	0.00	0.00	0.00	0.00	0.00	0.00

Table 3 shows the results for the panel with 55 firms. As before the changes in all variables are stationary but the public stock prices and NAV are not. Nevertheless, for the implied and nominal cap rates, some tests do not reject the null hypothesis which suggests that these may be stationary variables. In order to take a conservative approach, we use the changes of stock prices, NAV and cap rates.

We believe that it is easy to argue that public company share prices and private real estate values are non-stationary, as seen in Figure 2, but, specifically for cap rates, it could be the case that in longer sample periods these variables are stationary. Cap rates are effectively yields/returns of real estate and generally correlate well with US treasuries and bond yields, as can be seen in Figure 3, and there is evidence that these variables are stationary in the long run.

Figure 2. Historical Commercial Property Price Index[5, 6]

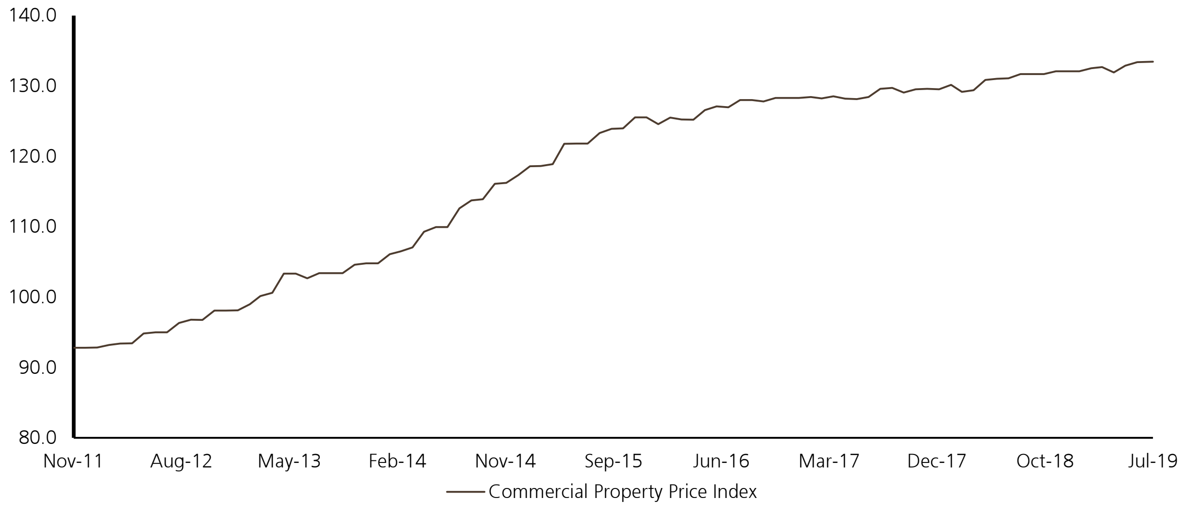
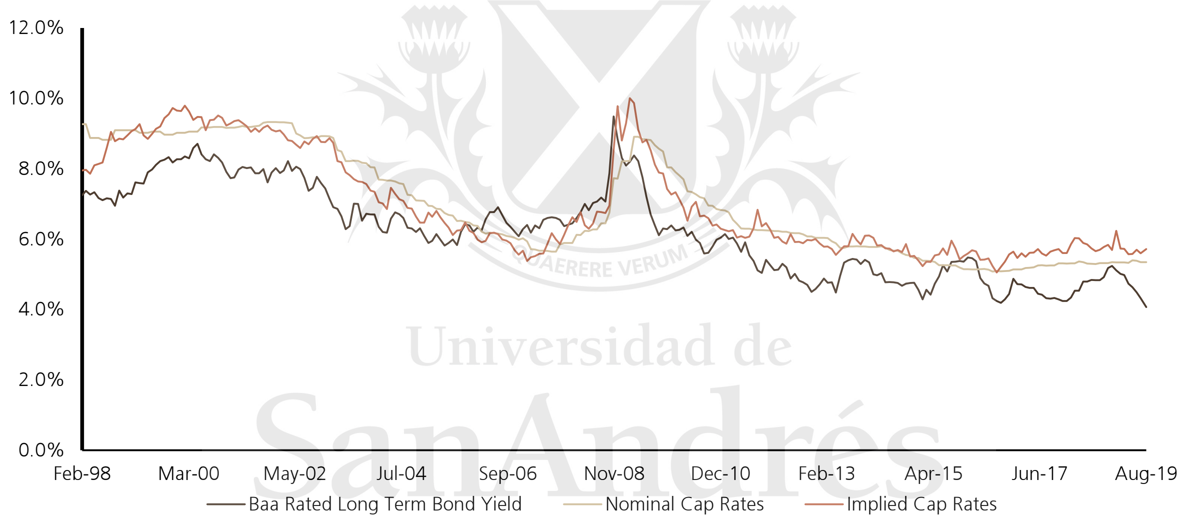


Figure 3. Historical Capitalization Rates and Long Term Bond Yields[7, 8, 9, 10]



We run the panel VARX models of implied cap rates and stock prices versus nominal cap rates and NAVs, respectively, and vice versa, and show the results in tables 4 through 7.

In Table 4, we can see how nominal cap rates are not statistically significant at any confidence level and for any lag period when explaining implied cap rates. Not surprisingly, the movement of the market overall (represented here with the S&P 500) conditions implied cap rates of REITs which are affected by the daily changes in stock prices.

Notes:

5. All Property CPPI weights: retail (20%), office (17.5%), apartment (15%), health care (15%), industrial (10%), lodging (7.5%), net lease (5%), self storage (5%), manufactured home park (2.5%), and student housing (2.5%). Retail is mall (50%) and strip retail (50%).
6. Dates correspond to the last day of the month (e.g. 2002-10-01 is actually 2002-10-31).
7. Dates correspond to the publication of Green Street Advisors' Real Estate Securities Monthly report, typically published after the close on the first business day of each month.
8. Nominal Cap rates shown is the average of the major property sectors: Apartment, Industrial, Mall, Office, & Strip Retail. Each sector is given a 20% weight.
9. For implied cap rates, each of the five major sectors is given a 20% weight; weighting within each sector is based on total public market value of assets (i.e., market cap + debt). Other assets are assumed to experience the same percentage change in value as operating real estate.
10. Source for Baa Rate: Moody's.

Table 4. Panel VAR Results for Implied Capitalization Rate

	Implied Cap Rate			
	1	2	3	4
VARIABLES	Lag	Lag	Lag	Lag
Δ S&P500	-0.41***	-0.41***	-0.41***	-0.41***
	(0.014)	(0.014)	(0.014)	(0.014)
Δ Implied Cap Rate $_{t-1}$	-0.025***	-0.024***	-0.024***	-0.026***
	(0.0057)	(0.0058)	(0.0058)	(0.0057)
Δ Implied Cap Rate $_{t-2}$		-0.0093**	-0.0100**	-0.011***
		(0.0041)	(0.0041)	(0.0042)
Δ Implied Cap Rate $_{t-3}$			-0.0095*	-0.0087*
			(0.005)	(0.005)
Δ Implied Cap Rate $_{t-4}$				-0.034***
				(0.0042)
Δ Nominal Cap Rate $_{t-1}$	0.019	0.018	0.019	0.019
	(0.012)	(0.012)	(0.012)	(0.012)
Δ Nominal Cap Rate $_{t-2}$		-0.021	-0.02	-0.016
		(0.017)	(0.017)	(0.017)
Δ Nominal Cap Rate $_{t-3}$			-0.0027	-0.0036
			(0.014)	(0.014)
Δ Nominal Cap Rate $_{t-4}$				-0.00049
				(0.014)
Constant	0.00063***	0.00061***	0.00062***	0.00058***
	(0.000025)	(0.000025)	(0.000026)	(0.000028)
Observations	33,792	33,711	33,630	33,549
R-squared	0.165	0.165	0.164	0.161
Number of firm_id	81	81	81	80
Firm FE	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

In Table 5, we can see the effect of lagged nominal and implied cap rates on spot nominal cap rates. It is worth noticing how, as we anticipated, lagged implied cap rates have predictive power at different confidence levels over nominal cap rates.

Table 5. Panel VAR Results for Nominal Capitalization Rate

	Nominal Cap Rate			
	1	2	3	4
VARIABLES	Lag	Lag	Lag	Lag
Δ S&P500	0.0015	0.0014	0.0019	0.0021
	(0.0022)	(0.0022)	(0.0022)	(0.0022)
Δ Implied Cap Rate $_{t-1}$	-0.0034	-0.0034	-0.0032	-0.0032
	(0.0021)	(0.0021)	(0.0021)	(0.0021)
Δ Implied Cap Rate $_{t-2}$		0.0055*	0.0062*	0.0062*
		(0.0033)	(0.0034)	(0.0034)
Δ Implied Cap Rate $_{t-3}$			0.0069***	0.0071***
			(0.0022)	(0.0022)
Δ Implied Cap Rate $_{t-4}$				0.0040**
				(0.0017)
Δ Nominal Cap Rate $_{t-1}$	-0.023***	-0.023***	-0.024***	-0.024***
	(0.0081)	(0.0082)	(0.0082)	(0.0082)
Δ Nominal Cap Rate $_{t-2}$		-0.013***	-0.013***	-0.013***
		(0.004)	(0.004)	(0.0041)
Δ Nominal Cap Rate $_{t-3}$			-0.0088**	-0.0090**
			(0.0038)	(0.0038)
Δ Nominal Cap Rate $_{t-4}$				-0.0076*
				(0.0042)
Constant	-0.00027***	-0.00027***	-0.00027***	-0.00028***
	(0.0000045)	(0.0000046)	(0.0000051)	(0.0000055)
Observations	33,792	33,711	33,630	33,549
R-squared	0.001	0.001	0.001	0.002
Number of firm_id	81	81	81	80
Firm FE	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Tables 6 and 7 show the same analysis as 4 and 5 but over changes of NAV and stock prices. Just like with table 4, in table 6 we see that stock prices cannot be explained by NAVs at any confidence level for any of the four lag periods but the fourth one for the specification with 4 lags which is hard to explain from a theoretical standpoint. Finally, Table 7 shows how stock prices are statistically significant for explaining NAVs, in particular for the second and third lag.

Table 6. Panel VAR Results for Stock Prices

	Δ Public Stock			
	1	2	3	4
VARIABLES	Lag	Lag	Lag	Lag
Δ S&P500	0.70***	0.71***	0.70***	0.70***
	(0.024)	(0.024)	(0.024)	(0.024)
Δ Public Stock Price $_{t-1}$	-0.017***	-0.015***	-0.016***	-0.019***
	(0.0038)	(0.0039)	(0.0040)	(0.0038)
Δ Public Stock Price $_{t-2}$		-0.00097	-0.0018	-0.0032
		(0.0043)	(0.0042)	(0.0043)
Δ Public Stock Price $_{t-3}$			-0.017***	-0.015***
			(0.0054)	(0.0055)
Δ Public Stock Price $_{t-4}$				-0.040***
				(0.0044)
Δ NAV $_{t-1}$	-0.0072	-0.0072	-0.0069	-0.0068
	(0.0054)	(0.0054)	(0.0055)	(0.0057)
Δ NAV $_{t-2}$		0.00063	0.00071	0.0015
		(0.0066)	(0.0067)	(0.0068)
Δ NAV $_{t-3}$			0.0014	0.0014
			(0.0034)	(0.0035)
Δ NAV $_{t-4}$				0.011**
				(0.0053)
Constant	-0.00012***	-0.00010**	-0.000080*	0.000034
	(0.000042)	(0.000045)	(0.000047)	(0.000051)
Observations	33,794	33,713	33,632	33,551
R-squared	0.193	0.193	0.192	0.189
Number of firm_id	81	81	81	80
Firm FE	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7. Panel VAR Results for NAV

	Δ NAV			
	1	2	3	4
VARIABLES	Lag	Lag	Lag	Lag
Δ S&P500	0.0033	0.0044	0.0042	0.0045
	(0.012)	(0.012)	(0.012)	(0.012)
Δ Public Stock Price $_{t-1}$	0.0091	0.0099	0.01	0.0098
	(0.0091)	(0.0094)	(0.0094)	(0.0094)
Δ Public Stock Price $_{t-2}$		0.026**	0.027**	0.027**
		(0.01)	(0.01)	(0.01)
Δ Public Stock Price $_{t-3}$			0.011*	0.010*
			(0.0054)	(0.0054)
Δ Public Stock Price $_{t-4}$				-0.0098
				(0.0074)
Δ NAV $_{t-1}$	-0.0043***	-0.0044***	-0.0046***	-0.0045***
	(0.0013)	(0.0013)	(0.0013)	(0.0013)
Δ NAV $_{t-2}$		-0.0035***	-0.0036***	-0.0034***
		(0.00091)	(0.00091)	(0.001)
Δ NAV $_{t-3}$			0.00003	0.000043
			(0.0031)	(0.0031)
Δ NAV $_{t-4}$				-0.0018*
				(0.001)
Constant	0.0011***	0.0011***	0.0010***	0.0011***
	(0.000028)	(0.000034)	(0.000037)	(0.000039)
Observations	33,794	33,713	33,632	33,551
R-squared	0	0.001	0.001	0.001
Number of firm_id	81	81	81	80
Firm FE	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

As can be seen in Tables 4 through 7 based on this sample, public market metrics precede private market estimates allowing for implied cap rates and share prices to have predictive power over nominal cap rates and NAVs, respectively, as we were expecting. In the opposite regressions (nominal cap rate and NAV predictive power over implied cap rates and share prices), private market metrics are not significant for explaining public market variables. We can then confidently state that implied cap rates and stock prices Granger-cause nominal cap rates and NAVs, respectively, and not the other way around. With Granger causality (Granger 1969), we refer to a statistical concept of causality that is based on prediction. According to Granger causality, if a signal X1 "Granger-causes" a signal X2, then past values of X1 should contain information that helps predict X2 above and beyond the information contained in past values of X2 alone.

Section 5.2. Sensitivity Analysis

In the appendix, we included additional versions of Tables 4 and 7 without including the change in the S&P500 index given the variable is not significant and could lead to noise in the results of the regression. As can be seen in Tables 10 and 11, the same results hold.

Moreover, we also conduct robustness checks to control for possible serial correlation and cross-sectional dependence. We run the same regressions separately with robust standard errors, clustering the standard errors by firm, using Newey West and Driscoll-Kraay standard errors and the same results hold. For expositional purposes we show the results in Tables 12 through 15 in the appendix using Driscoll-Kraay standard errors and see that results are similar to the ones we show in the main body of this paper.

When looking at the implied cap rate regressions, the same variable losses significance at every lag when using cross-sectional dependence but, most importantly, there is no change in the significance of nominal cap rates as can be seen in table 12. When looking at tables 5 and 13, the relevance of implied cap rates to explain nominal cap rates fades. But again, when we focus on prices and compare tables 6 and 14, the same results hold in terms of explaining changes in stock prices with changes in NAVs but as with tables 4 and 12, the same variable losses significance for explaining the contemporary changes of stock prices. For the NAV regressions, there are no changes in results in Table 7 versus 15. Overall, we see intrinsically the same results even though the nominal cap rate results seem to be weaker.

Section 6. News Shocks: Fundamental Value Discovery

As explained in the previous sections of this paper, we also analyze stock price reaction to newly available public information on private market valuations when GSA publishes its NAV. Consistent with the data presented in Tables 4 through 7, research estimates do not seem to explain stock price performance. As can be seen in Table 8, NAV changes are not statistically significant for explaining changes in stock price when looking at the next business day to announcement closing value. As expected, S&P500 is statistically significant for explaining price performance at all test confidence intervals but loses relevance when we include the RMZ.

Table 8. News shock: Public stock closing price

	Public stock close change		
	1	2	3
VARIABLES	Lag	Lag	Lag
Δ NAV	-0.0058	-0.0049	-0.00075
	(0.0041)	(0.0031)	(0.0016)
Δ S&P500 Close		0.60***	0.00092
		(0.011)	(0.0073)
Δ RMZ Close			1.03***
			(0.008)
Constant	0.0011**	0.0011**	0.00070*
	(0.00055)	(0.0005)	(0.00036)
Observations	30,653	30,653	30,653
R-squared	0.002	0.162	0.536

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

As previously mentioned, we also tested the same metrics versus the opening value of REITs stock prices. When doing so, as shown in Table 9, again NAV changes are not statistically significant and S&P500 is statistically significant for explaining price performance at all test confidence intervals but loses relevance when we include the RMZ.

Table 9. News shock: Public stock opening price

	Public stock open change		
	1	2	3
VARIABLES	Lag	Lag	Lag
Δ NAV	-0.028	-0.028	-0.027
	(0.017)	(0.017)	(0.018)
Δ S&P500 Open		0.54***	0.072
		(0.065)	(0.075)
Δ RMZ Open			1.07***
			(0.078)
Constant	0.00042	0.00037	0.00021
	(0.00032)	(0.00031)	(0.00028)
Observations	30,653	30,653	30,653
R-squared	0.642	0.643	0.645

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

This additional analysis serves as incremental evidence for our hypothesis and supports the conclusion that, likely, all relevant information on real estate pricing was already absorbed by public markets before it was reflected in private markets.

Section 7. Conclusions

In this paper, we focused on analyzing asset values and, specifically, we compared public with private market valuations. We focused on REITs for which fairly reliable estimates of NAV are compiled and we used data from Green Street Advisors, a very respected real estate research firm, to look at pricing over an 8 year timeframe for 81 REITs representing roughly 90% of the market. As REIT stock prices deviate from their NAVs, we use panel VAR models to understand Granger causality among these metrics. When looking at weekly data on cap rates and equity values since 2011, we find that public market valuations Granger-cause private market estimates. We found strong evidence suggesting that public markets are able to incorporate information faster than private markets and, therefore, when looking for indications of assets "true" value, public market data can be more precise.

To build stronger evidence supporting our thesis, we looked at stock price reaction to newly published Green Street estimates. We found that the pricing information contained in new NAVs did not affect stock prices on the following trading day.

The evidenced presented in this paper seems to suggest that when investors cite high NAV premiums/discounts as a reason to underweight/overweight certain property sectors or companies, they would be failing to pursue a profitable trading strategy that yields higher than average returns as NAV generally trails stock prices and not the other way around. Even though fundamental value is easier to assess for REITs, newly available information that affects pricing, tends to take longer to be fully incorporated into private market transactions. This could arguably be due to liquidity constrains when compared with public markets, distinctions in shareholder basis and institutional ownership, etc. but further research on these fronts is needed to better understand what drives this difference. Moreover, it is worth noting that it would be interesting to look at the long and short term relation among variables by using a vector error correction model (VECM). But again, we will leave this as an additional route for future research.

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Appendix

Table 10. Panel VAR Results for Nominal Capitalization Rate

	Nominal Cap Rate			
	1	2	3	4
VARIABLES	Lag	Lag	Lag	Lag
Δ Implied Cap Rate $_{t-1}$	-0.0034	-0.0033	-0.0031	-0.0031
	(0.0021)	(0.0021)	(0.002)	(0.0021)
Δ Implied Cap Rate $_{t-2}$		0.0055*	0.0062*	0.0063*
		(0.0033)	(0.0034)	(0.0034)
Δ Implied Cap Rate $_{t-3}$			0.0069***	0.0071***
			(0.0022)	(0.0022)
Δ Implied Cap Rate $_{t-4}$				0.0040**
				(0.0017)
Δ Nominal Cap Rate $_{t-1}$	-0.023***	-0.023***	-0.024***	-0.024***
	(0.0081)	(0.0082)	(0.0082)	(0.0082)
Δ Nominal Cap Rate $_{t-2}$		-0.013***	-0.013***	-0.013***
		(0.004)	(0.004)	(0.0041)
Δ Nominal Cap Rate $_{t-3}$			-0.0088**	-0.0089**
			(0.0038)	(0.0038)
Δ Nominal Cap Rate $_{t-4}$				-0.0076*
				(0.0042)
Constant	-0.00026***	-0.00026***	-0.00027***	-0.00027***
	(0.00000217)	(0.0000027)	(0.00000322)	(0.00000358)
Observations	33,792	33,711	33,630	33,549
R-squared	0.001	0.001	0.001	0.002
Number of firm_id	81	81	81	80
Firm FE	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 11. Panel VAR Results for NAV

	Δ NAV			
	1	2	3	4
VARIABLES	Lag	Lag	Lag	Lag
Δ Public Stock Price $_{t-1}$	0.009	0.0098	0.0099	0.0097
	(0.009)	(0.0092)	(0.0093)	(0.0093)
Δ Public Stock Price $_{t-2}$		0.026**	0.027**	0.027**
		(0.01)	(0.01)	(0.01)
Δ Public Stock Price $_{t-3}$			0.011*	0.010*
			(0.0053)	(0.0054)
Δ Public Stock Price $_{t-4}$				-0.0097
				(0.0075)
Δ NAV $_{t-1}$	-0.0043***	-0.0044***	-0.0046***	-0.0046***
	(0.0013)	(0.0012)	(0.0013)	(0.0013)
Δ NAV $_{t-2}$		-0.0035***	-0.0036***	-0.0034***
		(0.00092)	(0.00091)	(0.001)
Δ NAV $_{t-3}$			0.000024	0.000035
			(0.0031)	(0.0031)
Δ NAV $_{t-4}$				-0.0018*
				(0.001)
Constant	0.0011***	0.0011***	0.0011***	0.0011***
	(0.000012)	(0.000022)	(0.000025)	(0.000022)
Observations	33,794	33,713	33,632	33,551
R-squared	0	0.001	0.001	0.001
Number of firm_id	81	81	81	80
Firm FE	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 12. Panel VAR with Cross-Sectional Dependence Results for Implied Capitalization Rate

	Implied Cap Rate			
	1	2	3	4
VARIABLES	Lag	Lag	Lag	Lag
Δ S&P500	-0.41***	-0.41***	-0.41***	-0.41***
	(0.027)	(0.027)	(0.027)	(0.028)
Δ Implied Cap Rate $_{t-1}$	-0.025	-0.024	-0.024	-0.026
	(0.022)	(0.022)	(0.022)	(0.022)
Δ Implied Cap Rate $_{t-2}$		-0.0093	-0.01	-0.011
		(0.018)	(0.019)	(0.019)
Δ Implied Cap Rate $_{t-3}$			-0.0095	-0.0087
			(0.02)	(0.02)
Δ Implied Cap Rate $_{t-4}$				-0.034*
				(0.02)
Δ Nominal Cap Rate $_{t-1}$	0.019	0.018	0.019	0.019
	(0.02)	(0.02)	(0.021)	(0.021)
Δ Nominal Cap Rate $_{t-2}$		-0.021	-0.02	-0.016
		(0.03)	(0.03)	(0.03)
Δ Nominal Cap Rate $_{t-3}$			-0.0027	-0.0036
			(0.03)	(0.031)
Δ Nominal Cap Rate $_{t-4}$				-0.00049
				(0.03)
Constant	0.00063	0.00061	0.00062	0.00058
	(0.00045)	(0.00045)	(0.00045)	(0.00046)
Observations	33,792	33,711	33,630	33,549
Number of groups	81	81	81	80
Firm FE	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 13. Panel VAR with Cross-Sectional Dependence Results for Nominal Capitalization Rate

	Nominal Cap Rate			
	1	2	3	4
VARIABLES	Lag	Lag	Lag	Lag
Δ S&P500	0.0015	0.0014	0.0019	0.0021
	(0.0041)	(0.0041)	(0.004)	(0.0041)
Δ Implied Cap Rate $_{t-1}$	-0.0034	-0.0034	-0.0032	-0.0032
	(0.0048)	(0.0048)	(0.0049)	(0.0049)
Δ Implied Cap Rate $_{t-2}$		0.0055	0.0062	0.0062
		(0.0069)	(0.007)	(0.007)
Δ Implied Cap Rate $_{t-3}$			0.0069	0.0071
			(0.0051)	(0.0052)
Δ Implied Cap Rate $_{t-4}$				0.004
				(0.0028)
Δ Nominal Cap Rate $_{t-1}$	-0.023**	-0.023**	-0.024**	-0.024**
	(0.0098)	(0.01)	(0.01)	(0.01)
Δ Nominal Cap Rate $_{t-2}$		-0.013**	-0.013***	-0.013***
		(0.005)	(0.005)	(0.005)
Δ Nominal Cap Rate $_{t-3}$			-0.0088**	-0.0090**
			(0.0036)	(0.0036)
Δ Nominal Cap Rate $_{t-4}$				-0.0076
				(0.0047)
Constant	-0.00027***	-0.00027***	-0.00027***	-0.00028***
	(0.000084)	(0.000084)	(0.000085)	(0.000086)
Observations	33,792	33,711	33,630	33,549
Number of groups	81	81	81	80
Firm FE	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 14. Panel VAR with Cross-Sectional Dependence Results for Stock Prices

	Δ Public Stock			
	1	2	3	4
VARIABLES	Lag	Lag	Lag	Lag
Δ S&P500	0.70***	0.71***	0.70***	0.70***
	(0.047)	(0.047)	(0.048)	(0.047)
Δ Public Stock Price $_{t-1}$	-0.017	-0.015	-0.016	-0.019
	(0.022)	(0.022)	(0.022)	(0.022)
Δ Public Stock Price $_{t-2}$		-0.00097	-0.0018	-0.0032
		(0.018)	(0.019)	(0.019)
Δ Public Stock Price $_{t-3}$			-0.017	-0.015
			(0.02)	(0.02)
Δ Public Stock Price $_{t-4}$				-0.040*
				(0.021)
Δ NAV $_{t-1}$	-0.0072	-0.0072	-0.0069	-0.0068
	(0.0056)	(0.0056)	(0.0056)	(0.0057)
Δ NAV $_{t-2}$		0.00063	0.00071	0.0015
		(0.0074)	(0.0074)	(0.0074)
Δ NAV $_{t-3}$			0.0014	0.0014
			(0.0051)	(0.0052)
Δ NAV $_{t-4}$				0.011*
				(0.0063)
Constant	-0.00012	-0.0001	-0.00008	0.000034
	(0.0007)	(0.0007)	(0.00071)	(0.00072)
Observations	33,794	33,713	33,632	33,551
Number of groups	81	81	81	80
Firm FE	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 15. Panel VAR with Cross-Sectional Dependence Results for NAV

	Δ NAV			
	1	2	3	4
VARIABLES	Lag	Lag	Lag	Lag
Δ S&P500	0.0033	0.0044	0.0042	0.0045
	(0.014)	(0.015)	(0.015)	(0.015)
Δ Public Stock Price $_{t-1}$	0.0091	0.0099	0.01	0.0098
	(0.0093)	(0.0096)	(0.0097)	(0.0097)
Δ Public Stock Price $_{t-2}$		0.026**	0.027**	0.027**
		(0.013)	(0.013)	(0.013)
Δ Public Stock Price $_{t-3}$			0.011	0.01
			(0.0087)	(0.0088)
Δ Public Stock Price $_{t-4}$				-0.0098
				(0.0094)
Δ NAV $_{t-1}$	-0.0043***	-0.0044***	-0.0046***	-0.0045***
	(0.0016)	(0.0016)	(0.0015)	(0.0015)
Δ NAV $_{t-2}$		-0.0035*	-0.0036*	-0.0034*
		(0.0019)	(0.0019)	(0.0018)
Δ NAV $_{t-3}$			0.00003	0.000043
			(0.0022)	(0.0022)
Δ NAV $_{t-4}$				-0.0018
				(0.0022)
Constant	0.0011***	0.0011***	0.0010***	0.0011***
	(0.00026)	(0.00026)	(0.00027)	(0.00027)
Observations	33,794	33,713	33,632	33,551
Number of groups	81	81	81	80
Firm FE	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1