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Robert H. Edelstein, University of California, Berkeley

Konstantin Magin, University of California, Berkeley

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University of California
Berkeley

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Robert H. Edelstein[2]

The University of California at Berkeley, Haas School of Business

Konstantin Magin[3]

The University of California at Berkeley, Center for Risk Management Research

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[2] edelstein@berkeley.edu

[3] magin@berkeley.edu

Abstract

This paper examines three issues relating to US REITs pricing. First, using a modified Consumption Capital Asset Pricing Model (CCAPM) with stochastic taxation and money supply, we compute the fundamental values for United States Real Estate Investment Trusts (REITs) for our data sample, 1972-2013. Our empirical analysis for US REIT pricing is statistically consistent with the CCAPM with stochastic taxation and monetary policy. Second, for our purposes, for publicly traded equity REITs, we define a bubble at a point in time to be the difference between the actual stock market price and the fundamental value derived from our theoretical model. United States REITs have, among other corporate structural features, special rules governing dividend distributions and corporate taxation treatment that make them an especially attractive and preferred vehicle for testing for the presence of pricing bubbles. Our study suggests that during the sample time horizon, United States REITs experienced many price bubbles, some of which were quite large. Third, our empirical results imply that monetary policy, in the short run, plays a role in the formation of these pricing bubbles.

Keywords: Bubbles, Equity Premium, REITs, Risk Aversion, Stochastic Tax, Monetary Policy

I. Introduction

Economists and others have toiled and lucubrated for literally hundreds of years in order to identify, analyze, and explain asset market bubbles, booms and busts. From these efforts have emerged numerous studies and substantial and substantive academic and practitioner debates. This paper uses the infinite horizon Capital Consumption Asset Pricing Model (CCAPM) with stochastic taxation and money supply derived in Magin (2016) and the relatively idiosyncratic corporate structural features of the US Equity REIT market to identify and statistically analyze bubbles for US equity REITs between 1972 and 2013. As employed in this study, an economic bubble occurs when significant trading occurs at prices that appear to be inconsistent with intrinsic fundamental value.

Our study suggests that during the sample time horizon 1972-2013, United States REITs experienced many price bubbles, some of which were quite large. Fundamental, intrinsic REITs values are derived from our prior analysis related to the CCAPM with stochastic taxation and a new modified infinite horizon CCAPM with stochastic taxation and money supply, assuming reasonable parametric modeling values.[4] Our statistical results identify price bubbles, and discuss plausible explanations for the observed bubbles.

How and why is this pricing-bubble study different from the multitude of predecessors. First, while it should almost go without saying, corporate managing, organizing, and planning as well as shareholder-investor decision-making tend to be tax sensitive. Any analysis of stock prices that does not take into account the impacts and effects of corporate and investor taxation is likely to be ignoring an important explanatory element for market behavior. Our analysis in this paper attempts to take into account that taxation is both stochastic and important; our analysis integrates stochastic taxation into an asset-pricing model employing the CCAPM theoretical framework.

Second, publicly traded Equity REITs vis-à-vis publicly traded C–corporations provide a natural laboratory for analyzing and evaluating bubbles for the following reasons: a) REITs, if they follow regulatory requirements, effectively do not pay taxation on net income at the corporate level; b) REITs are required to pay at least 90% of net income in the form of dividends. In essence, REITs distribute a substantial amount of cash flow in the form of dividends, and do not pay dividends from after-tax earnings, unlike "normal" profitable C-corporations. While corporations and shareholders – investors are typically carefully planning and monitoring taxation, in the case of REITs, corporate taxes de facto are inconsequential. These factors obviate our need to develop a pricing model for both corporate and investor taxation. Instead our models will be able to focus on taxation at the shareholder-investor level only.

Third, in order to identify and evaluate asset price bubbles, one needs to have a reliable fundamental theory of value (price) in order to compare with the observed market value (price). It is the difference between the observed contemporaneous market value and the theoretical, fundamental value that is

[4] See Magin (2015b) for the original derivation of the CCAPM with stochastic taxation. See Magin (2016) for the derivation of the infinite horizon CCAPM with stochastic taxation and money supply. See Edelstein and Magin (2013) for our prior analysis of REITs.

the measure for the magnitude of the asset price bubble. Many asset bubble pricing studies either do not provide an explicit theory of price (value) and/or simply compare market prices to data related to economic fundamentals. For example, several studies of housing price bubbles simply compare the rates of change of observed housing sales prices to changes in household incomes and so forth. In essence, any statistical analyses for pricing bubbles is a joint test of the theoretical fundamental price metric and its differential from observed market prices. In contrast, we calibrate fundamental theoretical values for US REITs by employing a research tested measure of value, the CCAPM with stochastic taxation. As explained below, we utilize this modified CCAPM with stochastic taxation to explain a substantial portion of the Equity Premium Puzzle in real estate;[5] the obverse side of this puzzle relates to fundamental pricing.

Fourth, many well-respected analyses of the booms and busts (and bubbles) claimed that debt (often the growth in the money supply) frequently plays a paramount role in the generation of these boom, bust, bubble cycles. To address possible effects of monetary policy on the real asset prices, we use a new modified infinite horizon CCAPM with stochastic taxation and real money supply.[6] Thus, by incorporating the real money supply into our theoretical price model, we provide a benchmark for the theoretical asset price, taking into account the real money supply.

The remainder of the paper is organized as follows. Section II provides a selective, targeted review of the voluminous booms, busts, bubbles and debt literature as well as that for stochastic taxation and the Equity Premium Puzzle, and how these subject areas relate to this paper. Section III, first, reviews theoretical foundations of this paper – the CCAPM with stochastic taxation and real money supply. Then, in the same section, employing a set of reasonable parametric values for key variables, we quantify and statistically test the theoretical pricing equations derived in Magin (2016). Section IV uses the theoretical values (prices) for REITs implied by the CCAPM with stochastic taxation and the real money supply to identify and statistically analyze possible asset pricing bubbles. Section V contains a brief conclusion and summary.

II. A Targeted Selected Literature Review

This research paper spans, interfaces, and extends several well-developed, extensive and expansive financial economic research subject areas. Our analysis has benefited from an existing diverse, substantial set of research works on economic booms, busts and bubbles. Our paper is especially influenced by several interesting and important analyses pertaining to real estate market booms and busts. In addition, our research is intertwined with asset pricing models with concomitant issues, such as the Equity Premium Puzzle, the coefficient of

[5] See Magin (2015b) for the original derivation of the CCAPM with stochastic taxation and a resolution of a substantial part of the Equity Premium Puzzle for general stocks. See Edelstein-Magin (2013) for an application of the CCAPM with stochastic taxation to resolve a substantial part of the Equity Premium Puzzle for REITs.

[6] See Magin (2016) for the original derivation of the infinite horizon CCAPM with stochastic taxation and money supply.

relative risk aversion for investors, and the impacts of stochastic taxation on investment decision-making. We will now provide a very brief selective review of pertinent prior research.

1. Booms, Busts Bubbles and Debt

As a starting point for understanding bubbles, one should acknowledge the monumental contribution made by Charles Kindleberger in his book, *Manias, Panics and Crashes*. Kindleberger, an extraordinary economic historian, traces and analyzes various bubbles episodes across history in which economic outcomes are speculative, and in no way reflective of the underlying fundamental economic values. His analyses of the northern European tulipmania in 1636-1637, and the English South Seas bubble in the early 1700s are captivating, and reminiscent of alleged bubbles through history to the modern day. During the peak of Tulipmania in March 1637, tulip bulbs were transacting for values that were about 10 times the annual income of a skilled craftsman. Suddenly, in 1637 the tulip bulb values started to decline precipitously to levels of 2 to 5% of their peak. The South Sea Company, a British stock company founded in 1711, was a public-private partnership that was granted a monopoly for British trade with South America. However, England was at war with Spain, and Spain controlled South America. Hence, there was little real prospects that trade would take place for the company is South America. However, the company stock skyrocketed as it expanded its transactions in British government debt. The company's value peaked in 1720 ,before collapsing to approximately the original flotation price; hence, the so-called South Sea Bubble. Because of the public outcry, Britain in 1720 past the Bubble Act which forbade the creation of such stock companies without royal chartering.

Milton Friedman and Anna Schwartz in their monumental study of the great depression, *The Great Contraction: 1929–1933*, demonstrates that a series of extraordinarily inept mismanagement of monetary policy exacerbated an economic downturn, creating a downward spiral bubble for the monetary system as well as the real economy. They claim that "a moderately informed understanding of them (the monetary economics of the banking panic) would have cut short the liquidity crisis before it had gone very far, and perhaps before the end of 1930 (page 112)." They also aver that bubbles – collapses can sometime be readily avoided, but once underway are difficult to control and rectify: "... Economic collapse often has the character of a cumulative process. Let it go beyond a certain point, and it will tend to for a time to gain strength from its own development as its effects spread and return to intensify the process of collapse. Because no great strength would be required to hold back the rock that starts a landslide, it does not follow that the landslide will not be of major proportions (page 123)."

Later, however, in his famous and highly influential 1968 AER paper *The Role of Monetary Policy,* Milton Friedman concludes that monetary policy cannot affect real variables in the long run. He writes "...It cannot use its control over nominal quantities to peg a real quantity-the real rate of interest, the rate of unemployment, the level of real national income, the real quantity of money, the rate of growth of real national income, or the rate of growth of the real quantity of money."

More recently, in a speech (2012) Federal Reserve Chairman, Ben Bernanke, citing research by Krishnamurthy and Vissig-Jorgensen (2011), Wright (2012), Fuster and Willen (2010), and Hancock and Passmore (2011) claims "early skeptics of balance sheet (monetary) policies worried that any effects on treasury yields would not be transmitted to other interest rates and asset prices. The evidence reported in these papers refutes this concern. . . " In the same speech, he recognizes that stimulative monetary policy may have potential for creating "risks to financial stability." In his 2015 working paper, Swanson indicates that monetary policy, and especially large – scale asset purchases, during 2009 – 2015 has had large effects on corporate yields (raising corporate bond prices) and stock market asset prices. Swanson suggests that these monetary policy impacts may not be persistent (i.e., generate short run asset price effects). In sum, more recent research suggests that monetary policy has the potential to play a substantive part in the genesis of bubbles, booms and busts.

Reinhardt and Rogoff (2009), in their book *This Time Is Different: Eight Centuries of Financial Folly* explore the interrelationship between speculative bubbles, inflation, debt, and monetary crises over the last 800 years. As in the Kindleberger book, they examine several historical episodes of speculative bubbles, and attribute many the bubbles to unrealistic expectations, speculative behavior, and over leverage. They conclude that public and private sector mishandling of debt is frequently the cause for these speculative bubbles. The most recent work by Mian and Sufi (2014) examines how the Great Recession of 2008 and the housing market were intertwined with the financial sector, especially because of overzealous mortgage debt issuance.

Robert Shiller (2005) in the second edition of his book, *Irrational Exuberance*, a phrase coined by a now infamous quote from then Federal Reserve chieftain Alan Greenspan, develops several arguments demonstrating how the stock market was "over valued." In this book, he also suggests that the U.S. real estate market at the time (2005) was likely to be a bubble, a bubble that was punctured three or four years after the book!

It is often thought that "bubbles" are relatively short-term phenomena, and quickly come down to earth. The U.S. residential real estate bubble commenced in 2001, and did not reach its peak until 2006. This real estate bubble was replicated in many parts of the world, coming to a crashing halt in 2007 (see Bardhan, Edelstein, and Kroll (2012)). In fact, bubbles can last decades as documented by Ambrose, et al (2012). In their study of 300+ years of housing price behavior in Holland, they find that bubbles can have elongated lives, lasting 70 or 80 years where housing prices systematically do not reflect rental fundamentals.

While there are many explanations, ranging from overleverage – loose monetary policy, crowd herding, animal spirits, and heterogeneous expectations, the upshot is that observed asset prices can differ significantly, sometimes for prolonged periods, from intrinsic underlying fundamental economic value. This said, it is sometimes difficult to determine what is the underlying intrinsic fundamental economic value, irrespective of the mechanism causing the speculative bubble.

2. Fundamental Asset Prices, Stochastic Taxation and the Equity Premium Puzzle

Paradoxically, almost no research has been done about the effects of stochastic taxes on asset prices and allocations. The research that has been done was primarily motivated by the Equity Premium Puzzle. The Equity Premium Puzzle was originally identified by Mehra and Prescott (1985), using historical data for the stock market portfolio $\beta = 1$. The traditional CCAPM, with an isoelastic Constant Relative Risk Aversion (CRRA) utility function and an expected equity risk premium of 6% for the S&P 500, using average historical stock returns, produces a coefficient of relative risk aversion of roughly 47.6. This unbelievably high coefficient of relative risk aversion constitutes the so-called "Equity Premium Puzzle". There have been many attempts to resolve the Equity Premium Puzzle.[7] The introduction of taxation into the standard macroeconomic models seemed to pave one of the most promising ways to approach the puzzle. McGrattan and Prescott (2005), Sialm (2006) and (2011) were among the first to introduce taxation into the General Equilibrium models. However, their work does not resolve or directly address the puzzle.

Magin (2016) derives the infinite horizon CCAPM with heterogeneous agents, stochastic dividend taxation and monetary policy. He finds that under reasonable assumptions on assets' dividends and probability distributions of the future dividend taxes and consumption, the model implies the constant price/after-tax dividend ratios. He also obtains that the higher current and expected dividend tax rates imply lower current asset prices. Finally, he derives that, contrary to popular belief, monetary policy is neutral, in the long run, with respect to the real equilibrium asset prices.

Magin (2015a) proves the existence of equilibria in the infinite horizon general equilibrium with incomplete markets (GEI) model with insecure property rights. Insecure property rights come in the form of the stochastic taxes imposed on agents' endowments and assets' dividends. He finds that under reasonable assumptions, Financial Markets (FM) equilibria exist for most of the stochastic tax rates. Moreover, sufficiently small changes in stochastic taxation preserve the existence and completeness of FM equilibria.

Magin (2015b), recognizing that taxation uncertainty plays a major role for investors, introduced a modified CCAPM with a stochastic tax rate τ_t imposed on the income and capital wealth of stock holders. Using this modified model, he finds that for a typical investor, who realizes after-tax dividend income as well as short-term and long-term gains in accordance with historical patterns, the coefficient of relative risk aversion is 3.76. Since earlier studies suggest that a coefficient of relative risk aversion, a, between 2 and 4 would seem reasonable[8], the Magin estimate for $a = 3.76$ is believable.

[7] See DeLong and Magin (2009) for a review, for example.

[8] Mehra (2003), Mehra and Prescott (2003)

The risk premium puzzle for asset classes other than $\beta = 1$ stock market portfolios has been largely unexplored. The known exceptions for real estate assets are Shilling (2003) and Edelstein and Magin (2013, 2014). In his study, Shilling (2003) deploys the CCAPM and two different real estate value data sets; but he does not take into account the possible impacts of taxation. He confirms the existence of the Equity Premium Puzzle for real estate assets, and concludes that the "puzzle" is even more pronounced for real estate than for general stock market.

In contrast, employing a novel modeling twist by applying the CCAPM with stochastic taxation derived in Magin (2015b) to NAREIT data, Edelstein and Magin (2013) demonstrate that, for a range of reasonable stochastic tax burdens, the coefficient of relative risk aversion for US Equity REITs shareholders is likely to fall within the interval of 4.32 to 6.29, values significantly lower than those reported in most prior studies for real estate and other asset markets. These results imply that the CCAPM with stochastic taxation will generate reasonable fundamentally determined REIT asset prices.

III. Developing and Testing CCAPM for REITs Pricing

In this section, we review two related theoretical models for computing the fundamental value for REITs. We then examine statistically for each of our REIT fundamental values how well the theory fits actual, observed REIT market prices. In this way, by presenting an explicit theory for asset pricing first and then testing it empirically, we are following the time honored recommended practices advocated by economists, such as Lucas (1976) and Koopmans (1947). Since the CCAPM with stochastic taxation generates a reasonable coefficient of risk aversion, a first natural application is to use this model to create theoretical REITs asset prices. We dub this first theoretical price to be the “Fundamental REIT Value, without money.” The money supply, as discussed above, is believed by many to have a special impact on asset prices. Hence, we use here a second extension of the CCAPM with stochastic taxation and money supply to derive a second measure for REIT fundamental value. We dub this second theoretical price to be the “Fundamental REIT Value, with money.”

1. CCAPM with Stochastic Dividend Taxation and without Monetary Policy

According to Magin (2016), CCAPM with stochastic dividend taxation and without monetary policy implies

$$p_{kt} = \left[\frac{e^{\mu_c + \frac{1}{2}\sigma_c^2}}{1 - e^{\mu_c + \frac{1}{2}\sigma_c^2}} \right] \cdot (1 - \tau_t) \cdot d_{kt} \ \forall k \in \{1, ..., n\}\,, \tag{1}$$

where p_{kt} is the price per share of an asset k at period t,

d_{kt} is the dividend per share paid by an asset k at period t,

τ_t is the dividend tax at period t,

$\mu_c = E\left[\ln b(\frac{c_{t+l+1}}{c_{t+l}})^{(1-a)}\right]$,

$\sigma_c^2 = VAR\left[\ln b(\frac{c_{t+l+1}}{c_{t+l}})^{(1-a)}\right]$.
Taking logarithms of both sides, we obtain

$$\ln\left[p_{kt}\right] = \ln\left[\frac{e^{\mu_c+\frac{1}{2}\sigma_c^2}}{1-e^{\mu_c+\frac{1}{2}\sigma_c^2}}\right] + \ln\left[(1-\tau_t)\cdot d_{kt}\right]\ \ \forall k\in\{1,...,n\}. \qquad (2)$$

Let us quantify now this theoretical model.
Historically[9],

$$E\left[\ln(\frac{c_{t+l+1}}{c_{t+l}})\right] = 0.02,$$
$$VAR\left[\ln(\frac{c_{t+l+1}}{c_{t+l}})\right] = 0.00125.$$

Set

$$b = \frac{1}{R_f} = \frac{1}{1.01} = 0.99.$$

Therefore, we estimate

$$\mu_c = \ln(0.99) + (1-a)\cdot 0.02,$$
$$\sigma_c^2 = (1-a)^2\cdot 0.00125.$$

Thus,

$$\mu_c + \frac{1}{2}\sigma_c^2 = \ln(0.99) + (1-a)\cdot 0.02 + \frac{1}{2}\cdot(1-a)^2\cdot 0.00125.$$

Hence,

$$e^{\mu_c+\frac{1}{2}\sigma_c^2} = e^{\ln(0.99)+(1-a)\cdot 0.02+\frac{1}{2}\cdot(1-a)^2\cdot 0.00125}.$$

Edelstein and Magin (2013) estimated that for Equity REITs holders

$$4.32 < a < 6.29.$$

Therefore, it is reasonable for the purposes of our analyses to set

$$a = 5.$$

So

$$\left[\frac{e^{\mu_c+\frac{1}{2}\sigma_c^2}}{1-e^{\mu_c+\frac{1}{2}\sigma_c^2}}\right] = \left[\frac{e^{\ln(0.99)+(1-5)\cdot 0.02+\frac{1}{2}\cdot(1-5)^2\cdot 0.00125}}{1-e^{\ln(0.99)+(1-5)\cdot 0.02+\frac{1}{2}\cdot(1-5)^2\cdot 0.00125}}\right] = 13.8$$

and

$$\ln\left[\frac{e^{\mu_c+\frac{1}{2}\sigma_c^2}}{1-e^{\mu_c+\frac{1}{2}\sigma_c^2}}\right] = \ln\left[\frac{e^{\ln(0.99)+(1-5)\cdot 0.02+\frac{1}{2}\cdot(1-5)^2\cdot 0.00125}}{1-e^{\ln(0.99)+(1-5)\cdot 0.02+\frac{1}{2}\cdot(1-5)^2\cdot 0.00125}}\right] = 2.6247.$$

[9] Mehra (2003) and Mehra and Prescott (2003)

As in Edelstein and Magin (2013, 2014), we are assuming that the typical investor in REITs, who has below average ordinary income tax rates, pays an overall effective dividend tax rate $\tau^{d}_{re\ kt}$ of half of that of an investor in general stocks.[10] Therefore, using equation (2), we obtain the following expression for calculating theoretical prices of Equity REITs

$$\boxed{\ln[p_{kt}] = \mathbf{2.6247} + \mathbf{1.0000} \cdot \ln\left[(1-\tau^{d}_{re\ kt}) \cdot d_{kt}\right] \ \forall k \in \{1, ..., n\}.} \quad (3)$$

Thus, equation (3) represents the resultant of applying the CCAPM with stochastic taxation, with our parametric assumptions, to REITs.

In order to test statically the empirical validity of our theory, we regress, using OLS, the logarithm of the annual NAREIT real price index $\ln[\overline{p}_{kt}]$ for equity REITs against the logarithm of the annual after-tax real REIT dividend payout $\ln\left[(1-\tau^{d}_{re\ kt}) \cdot d_{kt}\right]$ for the 1972-2013 time period.[11] We obtain the following OLS regression for 1972-2013:

$$\boxed{\ln[\overline{p}_{kt}] = \underset{(0.2935)}{\mathbf{3.3409}} + \underset{(0.1259)}{\mathbf{0.8902}} \cdot \ln[(1-\tau_t) \cdot d_{kt}] + \epsilon_{kt} \ \forall k \in \{1, ..., n\}.} \quad (4)$$

$$Adjusted\ R^2 = 0.55,\ F - statistic = 49.98$$

Equation (4) is the regression output, analogous to the theoretical REIT pricing model equation (3). The empirical results are partially consistent with the theoretical model. In particular, the coefficient for after-tax REIT dividend payouts is statistically different from zero, but not statistically different from unity (both at the 1% confidence levels). On the other hand, the estimated value of the intercept term is statistically different from zero (at the 1% significance level) and statistically different (at the 5% level) from the theoretical model intercept value. The adjusted R^2 is 0.55. Hence, the empirical model explain a little more than half of the of the REIT price variation, during an era with several significant perceived bubbles in real estate markets.

It is claimed that monetary policy may have had a significant influence on the pricing of real estate assets at various times during the data sample time horizon, 1972-2013. In order to examine the influence of the real money supply on REIT prices, we will apply now the CCAPM with both stochastic taxation and real money supply.

2. CCAPM with Stochastic Dividend Taxation and without Monetary Policy

According to Magin (2016), CCAPM with stochastic dividend taxation and monetary policy implies

[10] Effective dividend tax rates for investors in general stocks can be found at http://users.nber.org/~taxsim/marginal-tax-rates/af.html

[11] Calculations are based on monthly NAREIT ALL EQUITY REITs INDEX data for Equity REITs prices and dividends.

$$p_{kt} = e^{\mu_\tau + \frac{1}{2}\sigma_\tau^2} \cdot \left[\frac{e^{\mu_c + \frac{1}{2}\sigma_c^2}}{1 - e^{\mu_c + \frac{1}{2}\sigma_c^2}} \right] \cdot d_{kt} \ \forall k \in \{1, ..., n\}. \tag{5}$$

Taking logarithms of both sides, we obtain

$$\ln[p_{kt}] = \ln\left[e^{\mu_\tau + \frac{1}{2}\sigma_\tau^2} \cdot \frac{e^{\mu_c + \frac{1}{2}\sigma_c^2}}{1 - e^{\mu_c + \frac{1}{2}\sigma_c^2}} \right] + \ln[d_{kt}] \ \ \forall k \in \{1, ..., n\}, \tag{6}$$

where $\mu_\tau = E[\ln[1 - \tau_t]]$,
$\sigma_\tau^2 = VAR[\ln[1 - \tau_t]]$.
We also know that

$$\mu_\tau = -0.3560,$$
$$\sigma_\tau^2 = 0.0090.$$

So

$$\left[e^{\mu_\tau + \frac{1}{2}\sigma_\tau^2} \cdot \frac{e^{\mu_c + \frac{1}{2}\sigma_c^2}}{1 - e^{\mu_c + \frac{1}{2}\sigma_c^2}} \right] =$$
$$\left[e^{-0.3560 + \frac{1}{2}\cdot 0.0090} \cdot \frac{e^{\ln(0.99) + (1-5)\cdot 0.02 + \frac{1}{2}\cdot(1-5)^2 \cdot 0.00125}}{1 - e^{\ln(0.99) + (1-5)\cdot 0.02 + \frac{1}{2}\cdot(1-5)^2 \cdot 0.00125}} \right] = e^{-0.3560 + \frac{1}{2}\cdot 0.0090} \cdot 13.8$$

and

$$\ln\left[e^{\mu_\tau + \frac{1}{2}\sigma_\tau^2} \cdot \frac{e^{\mu_c + \frac{1}{2}\sigma_c^2}}{1 - e^{\mu_c + \frac{1}{2}\sigma_c^2}} \right] =$$
$$\ln\left[e^{-0.3560 + \frac{1}{2}\cdot 0.0090} \cdot \frac{e^{\ln(0.99) + (1-5)\cdot 0.02 + \frac{1}{2}\cdot(1-5)^2 \cdot 0.00125}}{1 - e^{\ln(0.99) + (1-5)\cdot 0.02 + \frac{1}{2}\cdot(1-5)^2 \cdot 0.00125}} \right] =$$
$$-0.3560 + \frac{1}{2} \cdot 0.0090 + 2.6247 = 2.2732.$$

Using equation (6), we obtain the following expression for calculating theoretical prices of Equity REITs

$$\boxed{\ln[p_{kt}] = \mathbf{2.7232} + \mathbf{1.0000} \cdot \ln[d_{kt}] \ \ \forall k \in \{1, ..., n\}.} \tag{7}$$

Thus, Equation (7) represents the resultant of applying the CCAPM with stochastic taxation and monetary policy, with our parametric assumptions, to Real Estate Investment Trusts.

In order to test statically the empirical validity of our theory, we regress, using OLS, the logarithm of the annual NAREIT real price index $\ln[\overline{p}_{kt}]$ for equity REITs against the logarithm of the annual real REIT dividend payout $\ln[(d_{kt}]$ for the 1972-2013 time period. We obtain the following OLS regression for 1972-2013:

$$\boxed{\ln\left[\overline{p}_{kt}\right] = \underset{(0.4271)}{\mathbf{2.8089}} + \underset{(0.1604)}{\mathbf{0.9729}} \cdot \ln\left[d_{kt}\right] + \epsilon_{kt} \ \forall k \in \{1, ..., n\}.} \tag{8}$$

$$Adjusted\ R^2 = 0.47,\ F - statistic = 36.81$$

Analogous to Equation (4), Equation (8) is the OLS regression for empirically testing the validity of the theoretical REIT pricing model, inclusive of the real money supply, Equation (7). In Equation (8), the values of the regression intercept and the coefficient for the REIT real annual dividend payouts are statistically different from zero (at the 1% level), but not statistically different from the theoretical numerical values computed in Equation (7). That is, the statistical results are consistent with the theoretical REIT pricing model, with the inclusion of the real money supply. The overall fit for the OLS regression is 0.47.

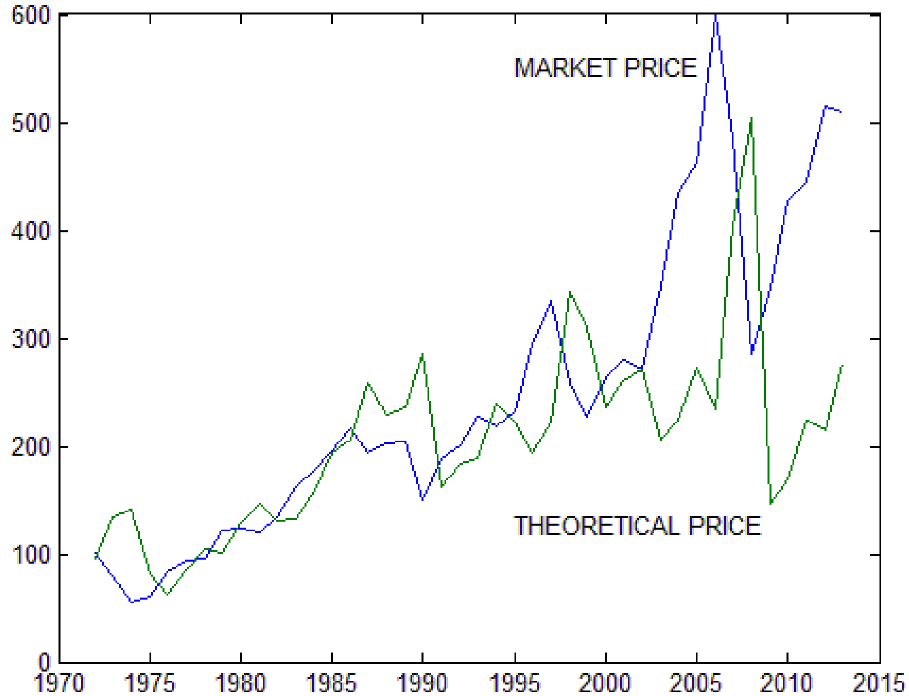
IV. Analyzing REITs Bubbles

Let us turn now to the analysis of REITs bubbles. Conventionally, the asset-pricing bubble for an asset k at time t is defined as the difference $\overline{p}_{kt} - p_{kt}$ between the actual market price $\overline{p}_{kt}$ of an asset and its fundamentals p_{kt}.

To provide a visual sense for REIT bubbles during the 1972-2013 time period, Figures 1 and 2 track actual market prices $\overline{p}_{kt}$ versus theoretical prices p_{kt}. Figure 1 charts theoretical REITs prices p_{kt} generated by the CCAPM with stochastic taxation τ_t and without the real money supply $\frac{M_t}{P_t}$, i.e., equation (1) and actual market prices $\overline{p}_{kt}$ for Equity REITs for the period of 1972–2013[12].

[12] Calculations are based on monthly NAREIT ALL EQUITY REITs INDEX data for Equity REITs prices and dividends.

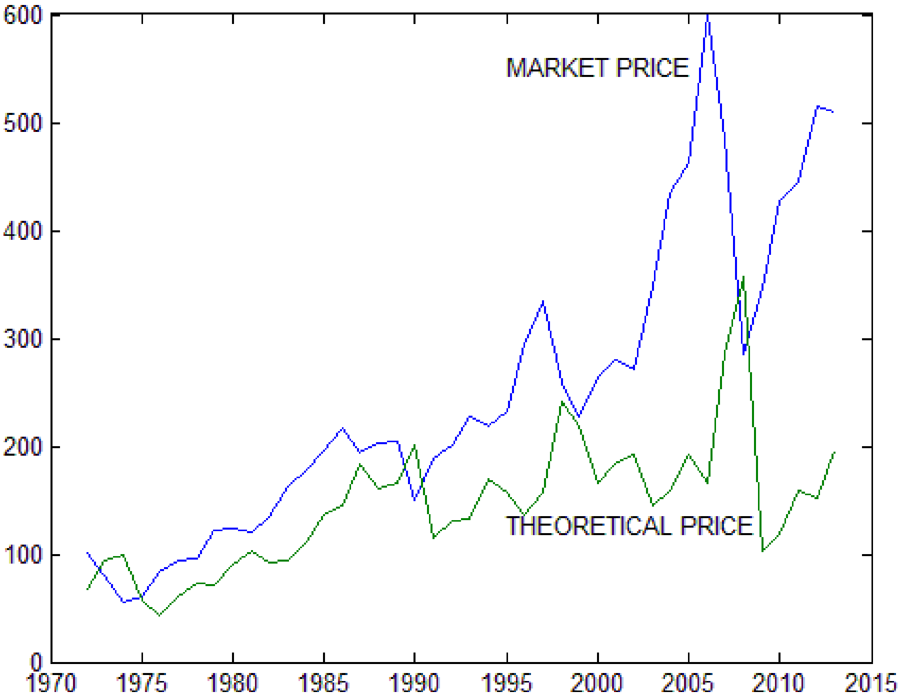
FIGURE 1: THEORETICAL AND MARKET PRICES FOR EQUITY REITs FOR 1972-2013



Similarly, Figure 2 below charts theoretical REITs prices p_{kt} generated by the CCAPM with stochastic taxation τ_t and with real money supply $\frac{M_t}{P_t}$, i.e., equation (5) and actual market prices $\overline{p}_{kt}$ for Equity REITs for the period of 1972–2013[13].

[13] Calculations are based on monthly NAREIT ALL EQUITY REITs INDEX data for Equity REITs prices and dividends.

FIGURE 2: THEORETICAL AND MARKET PRICES FOR EQUITY REITs FOR 1972-2013



As discussed above, a large prevalent quantum of earlier research indicates that, in the short run, a driving force for the generation of asset price bubbles is the unanticipated rapid growth in debt instruments, in general, and the money supply, in particular. Given the log-linear nature of the CCAPM, as is evident by Equations (3) and (7), It is natural then to create a simple statistical test to examine the empirical impact of the log of the money supply $\ln\left[\frac{M_t}{P_t}\right]$ upon the differential $\ln\left[\overline{p}_{kt}\right] - \ln\left[p_{kt}\right]$. Therefore, for the purposes of this analysis, it makes sense to define the asset-pricing bubble as $\ln\left[\overline{p}_{kt}\right] - \ln\left[p_{kt}\right]$. Equations (9) and (10) represent partial statistical tests for the effect of changes in the log of the US real money supply $\ln\left[\frac{M_t}{P_t}\right]$ upon US REITs bubbles $\ln\left[\overline{p}_{kt}\right] - \ln\left[p_{kt}\right]$ during the 1972-2013 time horizon.

$$\ln\left[\overline{p}_{kt}\right] - \ln\left[p_{kt}\right] = \underset{(0.6556)}{-\mathbf{2.4998}} + \underset{(0.2015)}{\mathbf{0.8588}} \cdot \ln\left[\frac{M_t}{P_t}\right] + \epsilon_{kt}\ \forall k \in \{1, ..., n\}. \tag{9}$$

$$Adjusted\ R^2 = 0.30,\ F - statistic = 18.17$$

In Equation (9), using OLS, the dependent variable is $\ln\left[\overline{p}_{kt}\right] - \ln\left[p_{kt}\right]$, where $\ln\left[p_{kt}\right]$ is given by Equation (3), i.e., it is derived from the CCAPM with stochastic taxation but without money supply. The independent variable is $\ln\left[\frac{M_t}{P_t}\right]$. This regression suggests that increases in the real money supply statistically explain, in part, the US REIT price bubbles; the coefficient for the money supply is statistically significant at the 1% level. The positive coefficient for the money supply implies that the difference between the observed actual REIT market price and the theoretical REIT price increases as the money supply grows. Put somewhat differently, ceteris paribus, increases in the real money supply explain a portion of the variation in $\ln[\overline{p}_{kt}] - \ln[p_{kt}]$. The adjusted R^2 implies that, in the short run, the money supply explains almost 30% of the variation in $\ln[\overline{p}_{kt}] - \ln[p_{kt}]$.

$$\ln[\overline{p}_{kt}] - \ln[p_{kt}] = \underset{(0.6466)}{-\mathbf{2.8936}} + \underset{(0.1987)}{\mathbf{0.9799}} \cdot \ln\left[\frac{M_t}{P_t}\right] + \epsilon_{kt}\ \forall k \in \{1, ..., n\}\,. \qquad (10)$$

$$Adjusted\ R^2 = 0.36,\ F - statistic = 24.31$$

Similar to Equation (9), in Equation (10), using OLS, the dependent variable is $\ln[\overline{p}_{kt}] - \ln[p_{kt}]$, where $\ln[p_{kt}]$ is now given by Equation (7), i.e., it is derived from the CCAPM with both stochastic taxation and money supply. Again, the independent variable is $\ln\left[\frac{M_t}{P_t}\right]$. The statistical results from Equation (10) are similar to those found for Equation (9). The coefficients for the log money supply is statistically significantly positive at the 1% level. The overall fit for Equation (10) explains more than 35% of the variation between the REIT market price and the theoretical model REIT price.

Taken together, the statistical results from Equations (9) and (10) are consistent with the notion that, in the short run, the money supply (monetary policy) can have a significant impact upon the magnitude of US REIT pricing bubbles. While the statistical findings are for a particular market, the US REIT market during a relatively short time horizon, they do provide a new confirming evidence for earlier research that claims that the money supply is an important determinant of the magnitude of asset pricing bubbles.

V. Conclusion

This paper identifies United States REITs price bubbles using the NAREIT database, 1972-2013. For this analysis, a bubble is defined for publicly traded REITs to be the difference between the log of the actual, observed stock price and the log of the intrinsic, fundamental value at a point in time. We employ two similar models for estimating fundamental value. The first fundamental, intrinsic value is calculated by utilizing the CCAPM with stochastic taxation and with reasonable parametric assumptions. Since the money supply (and other debt instruments) are believed by many to play a crucial role in the generation of asset bubbles, we extend our earlier analysis to calculate a second measure of fundamental value by utilizing the CCAPM with both stochastic taxation and money supply. For analytical purposes, REITs provide a preferred natural laboratory experiment for bubble testing because of the rules governing net income taxation and dividend distributions; in essence, REITs basically are pass-through vehicles without taxation at the entity level, permitting our theoretical modeling to focus upon the inclusion of shareholder – investor taxation, without the additional complications of investment vehicle taxation. Taken together, the two modified CCAPM fundamental value measures we are using and the special structure of REITs create a setting for streamlined statistical analyses for testing for the presence of asset price bubbles.

Our analysis and findings suggest that REITs price bubbles are omnipresent and statistically significant during our sample time horizon. Moreover, changes in the money supply appear to play a role in generating REIT bubbles. While we provide plausible macroeconomic rationales for the various sequences of bubbles, our research should be characterized as identifying but not necessarily explaining the root causes, the intensities and/or the persistency of these bubbles. We leave the determining of causal explanations and the intensity – persistency relationships between REITs bubbles and other variables as a task for future research.

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