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Abstract

In this paper, we analyze the effects of monetary policy on the bubbles in the Real Estate Investment Trusts (REITs) sector of the United States. We use a time-varying vector autoregressive (VAR) model over the quarterly period of 1972:1 to 2018:1. We find protracted periods, starting from the onset of the recent financial crisis to the end of the sample period, where contractionary monetary policy is associated with increases in the bubble component in the REITs of the US economy. This result, which is robust to alternative REITs indexes, is contrary to the “conventional” view, as well as to the predictions of standard models of bubbles.

Keywords: REITs, Bubbles, VAR, Monetary Policy

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1. Introduction

The root of the global economic and financial crisis of 2008-2009 is commonly associated with the rapid decline in real estate prices, following a prolonged boom. Since there exists a large literature on the impact of monetary policy on general real estate prices and vice versa (see for example, Del Negro and Otrok (2007), Bjørnland and Jacobsen (2010), Bjørnland and Jacobsen (2013), Rahal (2016), Simo-Kengne, Miller, Gupta, and Balciar (2016), Marfatia, Gupta, and Cakan (2017)), Huber and Punzi (2018), Plakandaras, Gupta, Katrakilidis, and Wohar (2018), it is not surprising that there is now a revived interest in the long standing debate on whether and how monetary policy should respond to perceived deviations of real prices from fundamentals. Given the beliefs that asset price bubbles are difficult to detect and measure, and that interest rates are a blunt instrument to prick a bubble resulting in unintended collateral damages, the consensus view is that central banks should focus on stabilizing inflation and the output gap only (Bernanke and Gertler (1999); Bernanke and Gertler (2001); Kohn (2006)). The recent crisis has, however, challenged this consensus and strengthened the viewpoint that monetary authorities should raise the interest rate to counteract asset price bubbles, even at the cost of temporarily deviating from their (inflation or output gap) targets, since any losses associated with such deviations would be more than offset by the avoidance of the consequences of a future burst of the bubble (this has come to be known as “leaning against the wind”).

A central assumption of the case for the above “leaning against the wind” monetary policy is the belief that an increase in interest rates will reduce the size of an asset price bubble. Barring the cases of Gali and Gambetti (2015) and Caraiiani and Calin (2018), who analyze the impact of monetary policy on stock market bubbles, and find empirical evidences contradicting this view,¹ to the best of our knowledge, no empirical testing of the same has

¹Caraiiani and Calin (2018) revisited the results in Gali and Gambetti (2015) by re-estimating their time-varying vector autoregressive (TVP-VAR) model, including a measure of shadow rate instead of the Federal funds rate to capture monetary policy during the zero lower bound. These authors, when looking at the results during and in the aftermath of the crisis, found that, with the shadow rate, the impact of monetary policy shocks on asset prices became negative, unlike Gali and Gambetti (2015)’s observation of protracted episodes in which stock prices end up increasing persistently in response to an exogenous tightening of monetary policy. In addition, Caraiiani and Calin (2018) also detected a much lower positive impact of monetary policy shocks on bubbles, when using the shadow rate.

been conducted for real estate markets. This we find quite baffling, given that the recent global crisis originated from the burst of the bubble in the real estate market of the US.²

Against this backdrop, following Gali and Gambetti (2015) and Caraianni and Calin (2018), we provide evidence on the dynamic time-varying response of Real Estate Investment Trusts (REITs) prices³ to monetary policy shocks using a time-varying vector autoregressive (TVP-VAR) model,⁴ and try to use that evidence to infer the nature of the impact of interest rate changes on the (possible) bubble component of REITs prices. Based on a TVP-VAR comprising of quarterly data (on measures of output, general and commodity prices, dividends, interest rate and REITs), over the period of 1972:1 to 2018:1, our goal is to assess the empirical merits of the “conventional” view, which predicts that the size of the bubble component of REITs prices should decline in response to an exogenous increase in interest rates. Since the fundamental component is expected to go down in response to the same policy intervention, any evidence pointing to a positive response of observed (sum of the fundamental and bubble components) REITs prices to an exogenous interest rate hike would call into question the conventional view regarding the effects of monetary policy on REITs price bubbles. The remainder of the paper is organized as follows: In Section 2 we provide the theoretical and empirical frameworks, while Section 3 lays data and the results, with Section 4 concluding the paper.

2. Theoretical and Empirical Frameworks

The following section is dedicated to the theoretical model employed in order to identify the impact of monetary policy shocks on asset prices and

²For detailed discussions on detection of bubbles in US REITs, see for example, Anderson, Brooks, , and Tsolacos (2011), Nneji, Brooks, , and Ward (2013), Escobari and Jafarinejad (2016), and Pavlidis, Yusupova, Paya, Peel, Martinez-Garcia, Mack, and Grossman (2016) for bubbles in international housing markets.

³The decision to use REITs prices instead of housing prices, in this paper at this stage, is primarily because of the fact that, unlike the REITs price index, which is homogenous across the country, housing markets are regional in nature, with tremendous heterogeneity in terms of their response to monetary policy (Gupta and Kabundi (2010); Gupta, Jurgilas, Kabundi, and Miller (2012a); Gupta, Miller, and van Wyk (2012b)).

⁴The TVP-VAR model, not only allows us to accommodate for structural changes, but also model empirically the fact that the overall effect on the observed stock price may change over time as the relative size of the bubble changes, since changes in interest rates have a different impact on the fundamental and bubble components.

asset price bubbles. In addition to the theoretical construct, the section also documents on the VAR approach used.

2.1. A Theoretical Framework for Analysis

We start from the partial equilibrium asset pricing model introduced by Gali and Gambetti (2015), which is devised for an economy populated by risk neutral investors, where R_t stands for the riskless real interest rate, Q_t denotes prices at time t and D_t represents the dividend stream. We treat the prices at any moment as a sum between a "fundamental" component and a "bubble" component, as shown in the following equation.

$$Q_t = Q_t^F + Q_t^B \quad (1)$$

We next consider that the fundamental component of the above expression is given by the present discounted value of future dividends, as reflected by Equation 2. This in turn can be expressed in log-linear form as in Equation 3.

$$Q_t^F = E_t \left\{ \sum_{k=1}^{\infty} \left(\prod_{j=0}^{k-1} \frac{1}{R_{t+j}} \right) D_{t+k} \right\} \quad (2)$$

$$q_t^F = c + \sum_{k=0}^{\infty} \lambda^k [(1 - \lambda) E_t \{ d_{t+k+1} \} - E_t \{ r_{t+k} \}] \quad (3)$$

In the above context, c is a constant and $\lambda = \frac{\Gamma}{R}$. Γ and R represent the growth rates for the dividend and interest rate. In this setup, we assume that the responses of the two components described above to an exogenous shock ϵ_t^m will yield the impact of interest rate shocks on asset prices and bubbles. Therefore, we differentiate Equation 3 with respect to the exogenous shock and obtain:

$$\frac{\partial q_{t+k}^F}{\partial \epsilon_t^m} = (1 - \gamma_{t-1}) \frac{\partial q_{t+k}^F}{\partial \epsilon_t^m} + \gamma_{t-1} \frac{\partial q_{t+k}^B}{\partial \epsilon_t^m} \quad (4)$$

We consider that $\gamma_t = Q_t^B / Q_t$ shows the fraction of the bubble component in a certain price, at time t . Using this specification and Equation 2, we can assert that the response of the fundamental component can be formally expressed as:

$$\frac{\partial q_{t+k}^F}{\partial \epsilon_t^m} = \sum_{j=0}^{\infty} \lambda^j \left((1 - \lambda) \frac{\partial d_{t+k+j+1}}{\partial \epsilon_t^m} + \frac{\partial r_{t+k+j}}{\partial \epsilon_t^m} \right) \quad (5)$$

Gali and Gambetti (2015) note that both standard economic reasoning and the associated empirical literature consider a contraction of the fundamental component as a result of a rise in the real interest rate such that: $\frac{\partial q_{t+k}^F}{\partial \epsilon_t^m} \leq 0$. Moreover, the same effect is expected also for the bubble component, and therefore: $\frac{\partial q_{t+k}^B}{\partial \epsilon_t^m} \leq 0$. In this light, the aggregate impact on a certain asset price should be negative:

$$\frac{\partial q_{t+k}}{\partial \epsilon_t^m} \leq 0 \quad (6)$$

Gali and Gambetti (2015) revisit the arguments found in Gali (2014) and point out the fact that the hypothesis of a negative reaction of a bubble to interest rate expansions lacks theoretical support and falls on the opposite spectrum of normal intuition. In order to explore this, we assume that Equation 7 holds in a rational expectations equilibrium, and that the expression of the fundamental component (Equation 2) satisfies Equation 8.

$$Q_t R_t = E_t\{D_{t+1} + Q_{t+1}\} \quad (7)$$

$$Q_t^F R_t = E_t\{D_{t+1} + Q_{t+1}^F\} \quad (8)$$

By considering Equation 1 in conjunction with the last two equations, we can rapidly confirm that the bubble component satisfies the following expression:

$$Q_t^B R_t = E_t\{Q_{t+1}^B\} \quad (9)$$

In log-linear form, Equation 9 becomes:

$$E\{\Delta q_{t+1}^b\} = r_t \quad (10)$$

Therefore, a hike in the interest rate will be translated into an escalation of the bubble component, which falls against mainstream considerations on the linkages between interest rates and bubbles. Moreover, Gali and Gambetti (2015) assert that interest rates could also influence bubbles through a comovement channel, and in order to expand this logic we consider the above expression at $t - 1$ while discarding the expectation operator.

$$\Delta q_t^b = r_{t-1} + \epsilon_t \quad (11)$$

In Equation 11, $\xi_t = q_t^B - E_{t-1}q_t^B$ is an arbitrary process that satisfies the martingale-difference feature. Gali and Gambetti (2015) also note

that the innovation in bubble magnitude ξ_t , is not necessarily connected to fundamentals or interest rate dynamics and therefore:

$$\xi_t = \psi_t(r_t - E_{t-1}[(r_t)]) + \xi_t^* \quad (12)$$

In the above set-up, ψ_t is a random parameter without theoretical restrictions in terms of sign, size or dependence on policy regime. Hence, the reaction of the bubble component to monetary shocks is formulated as:

$$\frac{\partial q_{t+k}^B}{\partial \epsilon_t^m} = \begin{cases} \psi_t \frac{\partial r_t}{\partial \epsilon_t^m}, & \text{for } k = 0 \\ \psi_t \frac{\partial r_t}{\partial \epsilon_t^m} + \sum_{j=0}^{k-1} \frac{\partial r_{t+j}}{\partial \epsilon_t^m}, & \text{for } k = 1, 2, \dots \end{cases} \quad (13)$$

As specified by Gali and Gambetti (2015) although the initial reaction given by ψ_t is indeterminate, the long run influence of monetary policy shocks on bubble magnitude will be either positive or negative, should the dimension of the real interest rate response be large enough to offset any initial impact.

2.2. A Bayesian Time-Varying VAR Approach

We model the impact of monetary policy shocks on bubbles through the use of a time-varying Bayesian VAR approach which is inspired by the earlier specifications of Primiceri (2005). Following in the footsteps of Gali and Gambetti (2015) we also adopt the identification scheme developed by Christiano, Eichenbaum, and Evans (2005). Formally, the model can be expressed in the following way:

The following time-varying specification is used for the autoregressive model:

$$x_t = A_{0,t} + A_{1,t}x_{t-1} + \dots + A_{p,t}x_{t-p} + u_t \quad (14)$$

In Equation 14, $A_{0,t}$ represents a vector of time-varying intercepts and the $A_{i,t}$ matrices quarter the time-varying coefficients. Moreover, the innovation vector u_t follows a zero mean and Σ_t covariance matrix white noise Gaussian process. We consider that the above mentioned innovations are linear transformations of the structural shocks, such that: $E\{\epsilon_t \epsilon_t'\} = I$, $E\{\epsilon_t \epsilon_{t-k}'\} = 0$ and also $S_t S_t' = \Sigma_t$.

3. Empirical Analysis

3.1. Data

Our Bayesian VAR model relies on seven US variables, observed at quarterly frequency over the period of 1972:1 to 2018:1, following the specification

introduced by Gali and Gambetti (2015). The macroeconomic variables used are real GDP, the GDP deflator and the effective Federal funds rate. These variables have been obtained from FRED database of the Federal Reserve Bank of St. Louis. However, as suggested by Caraianni and Calin (2018), given the zero lower bound situation of the monetary policy instrument in the wake of the “Great Recession”, we use the shadow short rate developed by Wu and Xia (2016) between 2009:1 to 2015:4. Note that, the shadow short rate is the nominal interest rate that would prevail in the absence of its effective lower bound, with it derived by modelling the (three-factors) term structure of the yield curve, and has been shown by Wu and Xia (2016) to be a close approximation of the effective Federal funds rate during the conventional periods of monetary policy decision-making. Secondly, we incorporate a non-energy commodity price index acquired from the World Bank. Finally, we utilize total returns index and dividends for the FTSE Nareit U.S. REITs. While we focus on the All REITs⁵ index in the main text, robustness analyses are presented in the Appendix for Composite,⁶ All Equity,⁷ Equity,⁸ and Mortgage⁹ REITs indices, considered in turn. The data on the various REITs and corresponding dividends are derived from the official website of Nareit (www.reit.com).

3.2. Bayesian VAR Model

The econometric framework is based on the reference time-varying Bayesian VAR due to Primiceri (2005). Following Gali and Gambetti (2015), we identify the monetary policy shocks using the econometric approach outlined by Christiano et al. (2005).

To summarize once again the data series used, we employ the following series: $y_t, p_t, p_t^e, i_t, q_t, d_t$, standing for, respectively log of output, log of the

⁵This is a market capitalization-weighted index that includes all tax-qualified real estate investment trusts (REITs) that are listed on the New York Stock Exchange, the American Stock Exchange or the NASDAQ National Market List.

⁶This is a free-float adjusted, market capitalization-weighted index of U.S. Equity and Mortgage REITs.

⁷This is a free-float adjusted, market capitalization-weighted index of U.S. equity REITs. Constituents of the index include all tax-qualified REITs with more than 50 percent of total assets in qualifying real estate assets other than mortgages secured by real property.

⁸This index contains All Equity REITs not designated as Timber REITs or Infrastructure REITs.

⁹This is a free-float adjusted, market capitalization-weighted index including all tax-qualified REITs with more than 50 percent of total assets invested in mortgage loans or mortgage-backed securities secured by interests in real property.

price level, the log of commodity prices index, the central bank's interest rate, log of the REITs index, as well as the corresponding log of the dividend series (both in real terms). The following vector of endogenous variables is employed: $x = [\Delta y_t, \Delta d_t, \Delta p_t, \Delta p_t^e, i_t, \Delta d_t]$.

The equation summarizing the vector is given in Eq. 15. We also can write $\theta_t = \text{vec}(A_t')$ with $A_t = [A_{0,t}, A_{1,t}, \dots, A_{p,t}]$, where $\text{vec}()$ denotes the column stacking operator. We use the following process for θ_t :

$$\theta_t = \theta_{t-1} + \omega_t \quad (15)$$

Here ω_t denotes a Gaussian process characterized by a zero mean and a constant covariance Ω .

We decompose the time-varying covariance matrix Σ_t in $\Sigma_t = F_t D_t F_t'$. Here, F_t is lower-triangular with a main diagonal consisting of ones, while D_t is a diagonal matrix. The vector σ_t is characterized by diagonal elements of $D_t^{1/2}$, and by $\phi_{i,t}$ the column vector. The latter has nonzero elements of the row $(i + 1)$ of F_t^{-1} for $i = 1, \dots, 5$. We further assume that:

$$\begin{aligned} \log \sigma_t &= \log \sigma_{t-1} + \zeta_t \\ \phi_{i,t} &= \phi_{i,t-1} + \nu_{i,t} \end{aligned} \quad (16)$$

Furthermore, we consider that the innovations ζ_t, ν_t are assumed to follow a Gaussian process characterized by a zero mean and a constant covariances denoted by Ξ and by Ψ_i .

A key issue here with respect to the main results pertains to the identification of monetary policy shocks. We mentioned that we follow Gali and Gambetti (2015) who used the identification scheme of Christiano et al. (2005). The main ingredient here is the assumptions that the monetary policy shocks do not affect contemporaneously the GDP, the dividends or the inflation and that the central bank interest rates do not respond immediately (contemporaneously) to changes in REITs prices.

3.2.1. Time-Varying Impulse Responses

Our focus here is on the changing responses of the ALL REITs index, and the associated behavior of the bubble component of the same, following the contractionary monetary policy shock, displayed in Figures 1-3.¹⁰ As

¹⁰The responses of all the other variables in the TVP-VAR are qualitatively similar to those in Gali and Gambetti (2015) and Caraianni and Calin (2018), and are available upon request from the authors.

observed from Figure 1, the ALL REITs returns tend to decline in general on impact and over the various horizons over the entire sample period considered. The only exception is at longer horizons, at the early part of the sample period. In Figure 2, we present the response of the gap between the observed and the fundamental values (underlying dividends) of the ALL REITs index. With the exception of the early part of the sample and the period during- and post- the financial crisis, the contractionary monetary policy reduces the bubble component, i.e., the result for the bulk of the sample period is in line with the “conventional” view. However, the dynamics observed for the extreme ends of the sample, where the responses of the bubbles are found to be positive and growing is consistent with the theory of rational bubbles as outlined by Gali (2014) or Gali and Gambetti (2015). Figure 3 shows the estimated (bootstrap-based) probability that the gap between observed and fundamental REITs index is positive. As observed in Figure 2, the probability is well above 50 percent (and often close to unity on impact of the monetary shock) at the early part and from the onset of the financial crisis until the end of the sample period (barring at the 3-years-ahead horizon) - a result in line with Gali and Gambetti (2015).

As a robustness check, we re-conducted the above analysis using Composite, All Equity, Equity, and Mortgage REITs indexes, instead of the ALL REITs index. In Figures 4-7, we present the estimated (bootstrap-based) probability that the gap between the observed and fundamental REITs index is positive following a contractionary monetary policy shock for the Composite, All Equity, Equity, and Mortgage REITs indices, respectively. As can be seen from these figures, the results are qualitatively comparable with those reported for the ALL REITs index in Figure 3. In other words, the probability is generally high at the early part of the sample, and from the beginning of the financial crisis till the end of our sample period.

4. Conclusions

The “conventional” view of monetary policy suggests that the size of the bubble component of asset prices should decline in response to an exogenous increase in interest rates. Realizing the role played by the real estate sector in the “Great Recession”, we use a vector autoregressive model with time-varying coefficients to analyze the impact of monetary policy shocks on US REITs over the quarterly period of 1972:1 to 2018:1. Using an identification scheme which assumes no contemporaneous response of monetary policy to REITs prices, the evidence points to protracted periods, starting from the onset of the recent financial crisis to the end of the sample period,

where contractionary monetary policy is associated with increases in the bubble component in the REITs of the US economy. In other words, this result, which is robust to alternative REITs indices, is at odds with the “conventional” view, as well as with the predictions of standard bubble models. In sum, proposals for a “leaning against the wind” monetary policy in response to perceived deviations of asset prices from fundamentals, which in turn, rely on the assumption that increases in interest rates will succeed in shrinking the size of an emerging asset price bubble, are not supported by our study, especially in the period associated with the recent global financial crisis and thereafter.

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The Impact of Monetary Policy Shocks on Bubbles Using ALL REITs Index

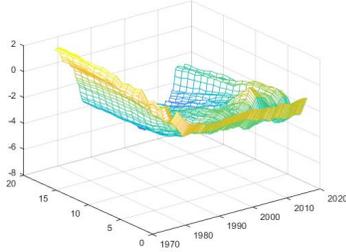


Figure 1: ALL REITs Index Response

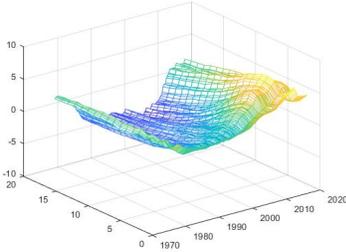


Figure 2: Bubble Response of ALL REITs Index

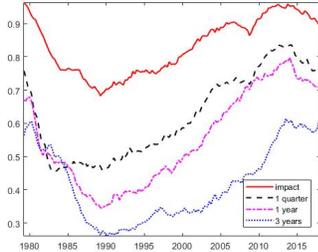


Figure 3: Probability of a Positive Response in All REITs Index

The Impact of Monetary Policy Shocks on Bubbles Using Alternative REITs Indices

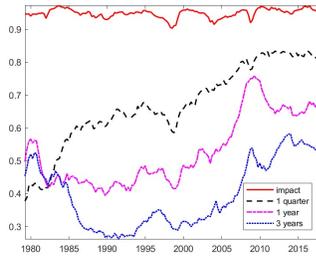


Figure 4: Probability of a Positive Response of Bubbles in All Equity REITs Index

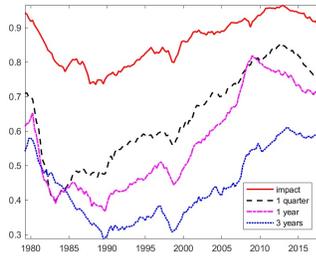


Figure 5: Probability of a Positive Response of Bubbles in Composite REITs Index

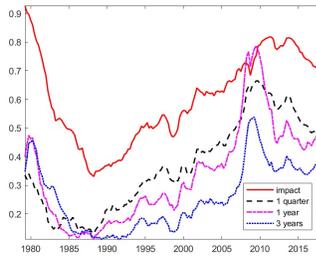


Figure 6: Probability of a Positive Response of Bubbles in Equity REITs Index

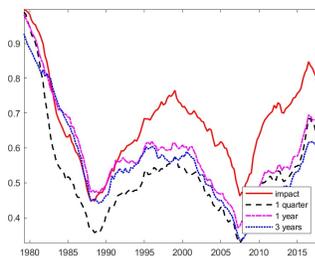


Figure 7: Probability of a Positive Response of Bubbles in Mortgage REITs Index