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Dynamic impact of unconventional monetary policy on international REITs

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Abstract

In this paper, we estimate the dynamic impact of unconventional monetary policy in the US on international REITs. Unlike existing studies which are limited to conventional policy tools and/or undertake a static approach, we estimate the dynamic time-varying impact of forward guidance and large-scale asset purchases (LSAP) shocks on the international REIT returns. We compare the effects of these unconventional tools with the effects of conventional federal funds rate shocks. Results show that the response of international REITs to the unconventional policy shocks significantly depends on the time under consideration. Forward guidance shocks have greater time variation in the impact on REIT returns compared to LSAP shocks, particularly in the case of Australia, Belgium, and the US REIT markets. We also find that in most countries, REITs time-varying response is related to the gold price changes.

JEL Classifications: E44, E52, C32, F42, G14.

Keywords: Unconventional monetary policy; Forward guidance; LSAP; REITs; Time varying parameter model.

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1 Introduction

The role of monetary policy in affecting the housing markets was central in the recent global financial crisis and the following recovery. The Federal Reserve cut its key policy rate, the Federal funds rate, to near-zero levels (often referred to as zero lower bound or ZLB conditions) in its December 16, 2008 meeting. These conditions led to adoption of unconventional monetary policy tools to further support economic recovery. These tools included forward guidance (FG) and large-scale asset purchases (LSAP). Both FG and LSAP impacted global financial markets, including real estate markets. This paper estimates the dynamic impact of US unconventional monetary policy on international REITs, and also contrasts it with the effects of conventional monetary policy.

Forward guidance is an explicit announcement of the likely future path of the federal fund rate. LSAP involves the announcement of large-scale purchases of long-term US treasuries and mortgage-backed securities with the goal of lowering long-term interest rates. In the presence of increased global financial and economic linkages, the transmission of US monetary policy shocks into international financial markets is well documented in the literature.

Ray and Agrippino (2019) show that US monetary policy shocks induce co-movement in international financial variables, including asset prices. Shocks of unconventional monetary policy are transmitted to financial markets including REITs through the signaling and portfolio re-balancing channels, which are both subsumed in the interest rate channel. The signaling channel operates through influencing investors' expectations about the future path of interest rates, which is what forward guidance is intended to achieve. LSAP also has significant signaling effects that reduce future short-term interest rates (Bauer and Rudebusch, 2014). The portfolio

rebalancing channel refers to the purchase of long-term securities by central banks that reduce the supply of bonds in the secondary market leading to an increase in bond prices and a fall in bond yields. As a result, investors will adjust their portfolios by buying alternative assets, such as equities, in search for higher returns (Gagnon et al. 2011; Bauer and Neely, 2014).

The global REIT market has experienced substantial growth with a market capitalization value of US $1.7 trillion in 2016 from US $734 billion in 2010 (Global REITs Market, EY Global Real Estate Report, 2016). The growth in REIT market and trading of REITs also follows institutional changes in the 1990s which involved changes to the law which allowed the use of internal advisors or self-managed REITs and made REIT companies more operation oriented. REIT stocks behave more like general stocks (Chan et al. 2005), however their value is tied to the underlying real estate market and monetary policy changes which affect rental values of real estate, the portfolio of asset underlying REITs, will also influence the REIT returns (Chen and Chou, 2014).

Existing literature that estimates the impact of monetary policy on international REIT markets is limited to either conventional tools or use a static approach. For example, Marfatia et al. (2017) use the federal funds futures rate as a proxy for market expectations of changes in US monetary policy and test the dynamic impact of unexpected US monetary policy surprises on global REITs. They found that the effect of US monetary policy on global REITs varied widely across time and between countries. Earlier work by Xu and Yang (2011) using Seemingly Unrelated Regressions (SUR) found that REIT returns for 18 developed countries responded positively to unexpected cuts in the federal funds rate as well as downside surprises to the future path of federal fund rate, (also see Ghysels et al. 2013; Akinsomi et al. 2016).

Other studies are limited to the use of a static approach. Gupta and Marfatia (2018) explore the response of REIT returns in emerging markets to unconventional US monetary policy shocks measured as a binary indicator variable, which takes the value of one in the month of a QE announcement and zero otherwise, and estimate a qualitative VAR model which combines this binary information of the US Fed's quantitative easing (QE). Punzi and Huber (2016) estimated a time-varying impulse responses with stochastic volatility of unconventional monetary policy effects, measured using shadow short rates by Krippner (2013b), on house prices and mortgage lending in the US, UK, Japan and Euro area. Other studies that focus on unconventional monetary policy using a static approach include Swanson (2017) and Gabriel and Lutz (2017).

However, understanding the response of international REITs to these new unconventional policy tools is at least, if not more, important as the conventional tool of federal funds rate. We estimate the response of REIT returns to FG and LSAP policy decisions and also contrast it to the effects of the conventional tool - the federal funds rate. In line with many studies in the literature, we use an event study approach, looking at changes in the returns of international REITs over a one day window on the FOMC announcement following their meetings.[1]

Our results broadly suggest that conventional monetary policy shocks (Federal funds rate changes) had a stronger impact on international REITs than unconventional monetary policy (FG and LSAP changes). The effect of unconventional policy shocks on financial markets may vary over time as the Fed's actions become better anticipated by markets and as financial

[1]The event study approach has been proved to be one of the most superior approaches because it address the two most challenging problems in assessing monetary policy impact, namely, identification and endogeneity. Several studies use this approach including, Cook and Hahn (1989), Kuttner (2001), Bernanke and Kuttner (2005), and Hausman and Wongswan (2011), Marfatia (2014, 2015), Nyakabawo et al. (2018), and Gupta et al. (2019).

market conditions stabilize after the great financial crisis. Haldane et al. (2016) showed that the effectiveness of asset purchases is state-contingent, that is the impact of the Fed's quantitative easing on US financial markets including equities was larger when markets were more stressed between 2008 and 2010 compared to when market conditions improved relatively post 2010 (Hesse et al. 2018).

Focusing on unconventional monetary policy, the impact of FG and LSAP on international REITs varies by regions. Forward guidance which argued for interest rates to remain low during 2008 to 2014 had a negative impact of REIT returns for Asian countries in line with expectations based on the signaling channel. European REITs were mostly less responsive to dynamic FG shocks. The effect of LSAP was largely mixed, European REIT returns increased as the Fed expanded their asset buying program in as predicted by the portfolio balance channel regarding the relationship between monetary policy and equity prices while for most of Asia, positive LSAP is associated with a decline in REIT returns.

The paper contributes to the literature in multiple ways. First, this is the first paper to explore the dynamic impact of forward guidance and large-scale asset purchases on international REIT returns. Second, most existing studies focus on a single or few REIT market. In contrast, we include REIT markets that make 96.2% of the global REIT index based on market capitalization (European Public Real Estate Association, 2016). This brings the most comprehensive analysis of the impact of monetary policy on international REITs. Third, in contrast to existing literature that focus on a static impact or only a special case of time variation, our modeling approach is flexible to uncover the gradual impact of monetary policy shocks at each point in time. This increases the precision of estimates and provides a finer view of the impact.

Fourth, we also explore the relationship between the time varying impact of forward guidance and LSAP as well as a possible explanation of the impact.

2 Methodology and Data

2.1 Methodology

In estimating the precise impact of monetary policy on international REIT returns, one of the main challenges is to control the joint influence of several other macroeconomic variables that potentially affect real estate markets. To tackle this problem of joint effects, we use the widely accepted event study approach popular in the literature (Cook and Hahn 1989; Bernanke and Kuttner 2005; Hausman and Wongswan 2011; Kishor and Marfatia, 2013; Marfatia, 2014, 2015; Marfatia et al. 2017; among others). We use a one-day event window on the FOMC meeting day.

The approach has several advantages. First, it addresses the endogeneity issue, that can particularly be problematic in international markets. Second, it eliminates the risks other events that might inflcune REIT markets in a wider window. And third, it captures the forward-looking nature of unconventional monetary policy announcements. Following this popular conventional Cook and Hahn (1989) style approach, we study the effects of unconventional monetary policy in the US on international REIT returns.

In the past three decades, the international REIT markets and particularly the unconventional policy tools effect has witnessed significant structural changes. During this time period,

every international REIT market have evolved in its sophistication and maturity.[2] Moreover, the role of US monetary policy on the international platform has also evolved in the last 30 years (Hausman and Wongswan 2011; Kishor and Marfatia 2013; Marfatia 2014). It is no surprise then that studies find that factors which explain the movements REIT market differ greatly in the turbulent times as compared to normal periods (Ghysels et al. 2013; Akinsomi et al. 2016).

The existing evidence indicates that there are significant structural changes in the relationship between monetary policy and real estate markets (Ghysels et al. 2013; Akinsomi et al. 2016; Marfatia et al. 2017). Therefore, a static approach (like standard regression models) is inadequate and a more sophisticated approach is needed to capture the dynamic impact of monetary policy. We adopt a time-varying parameter (TVP) framework to precisely estimate the dynamics impact of monetary policy on international REIT across time. The TVP model has the advantage of flexibly as well as clearly discerning the impact of monetary policy over time. In particular, for every (i) country, we estimate

$$R_t^i = \beta_{0t}^i + \beta_{1t}^i MP_t + e_t^i \quad where, e_t^i \sim N(0, \sigma_e^i) \tag{1}$$

$$R_t^i = \begin{bmatrix} c & MP_t \end{bmatrix} \begin{bmatrix} \beta_{0t}^i \\ \beta_{1t}^i \end{bmatrix} + e_t^i \tag{2}$$

We follow the pioneering work of Cooley and Prescott (1976) to model time-variation and assume β_t^i to follow a random walk process. The transition equation representing the evolution

[2] An overview of key developments can be found in publications of the European Public Real Estate Association.

of the unobserved state vector is then given by:

$$\beta_t^i = \beta_{t-1}^i + v_t^i \quad where, v_t^i \sim N(0, Q) \tag{3}$$

$$\begin{bmatrix} \beta_{0t}^i \\ \beta_{1t}^i \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \beta_{0t-1}^i \\ \beta_{1t-1}^i \end{bmatrix} + \begin{bmatrix} v_{0t} \\ v_{1t} \end{bmatrix} \tag{4}$$

Here, Q is the variance-covariance matrix of the uncorrelated disturbance terms. The Kalman filter is applied to the above state-space model and the parameters are estimated using maximum likelihood.

2.2 Data

The dataset for the study includes 11 leading REIT markets which constitute 96.2% of the global REIT index based on market capitalization. These 11 markets include Australia (7.47%), Belgium (0.57%), Canada (2.95%), Germany (0.19%), France (1.93%), Hong Kong (1.58%), Japan (7.43%), Netherlands (2.64%), Singapore (1.68%), the UK (4.58%) and the US (65.19%) (European Public Real Estate Association, 2016). These are also the top 10 REIT markets in the world, with the exclusion of South Africa but the inclusion of Belgium and Germany (Ntuli & Akinsomi, 2016). These countries are also defined as 'established and mature markets' based on the following 9 different criteria: capital flows, financial reporting, corporate governance, risk management, regulatory environment, cross-border issues, transaction activity, financing, and property specifics (EY Global perspectives: 2016 REIT report). The only exception is Belgium, which is classified as emerging as per these criteria.

Unlike most studies that focus on one or few international REIT markets, the present

study thus covers almost the entire international REIT market. The study provides the most comprehensive analysis of the impact of unconventional monetary policy on REIT returns. This is also another contribution of the present study. The REITs data is sourced from the DataStream database of Thomson Reuters, with the real estate data corresponding to the S&P REITs indices for each country.

Table 1 provides a preliminary overview of the data. The summary statistics shows that the leading REIT markets in the world have yield positive returns on average but the three Asian markets - Australia, Hong Kong, and Japan, have registered negative returns. The top five REIT returns on average is in the case of France and the UK (0.51% each), Netherlands (0.27%) and the US (0.21%). However, the REIT market of France is less risky compared to these markets. Interestingly, Germany's REIT market is most risky but also have lower mean returns relative to the other markets.

The data for unexpected changes in conventional and unconventional monetary policy are from Swanson (2017). This includes surprise changes in the federal funds rate, forward guidance, and LSAP announcements. The exchange rate and gold price data that are used to explain the time-variation are sourced from the Federal Reserve Bank of St Louis, FRED database. We consider the exchange of the country with the US dollar, and in the case of the US we use the trade-weighted US dollar index.

3 Empirical results

3.1 Dynamic impact of unconventional monetary policy

Figures 1, 2 and 3 present the time-varying impact of surprise changes in Federal funds rate (FFR), forward guidance (FG), and large-scale asset purchases (LSAP), respectively, on international REIT returns in each of the 11 countries. Evidence suggests that the impact of FFR surprise on REITs is stronger than the effect of unconventional monetary policy shocks. The impact of a surprise change in the FFR on REITs could be driven by the signaling channel (positive coefficient) or the borrowings channel (negative coefficient).

The evidence in Figure 1 suggests that REITs response to the shocks to Federal funds rate surprise is largely positive in European countries which include Belgium, Germany, and France. A surprise increase (decrease) in the Federal funds rate led to an increase (decrease) in REIT returns. Thus, Federal funds rate shocks in these cases work through the signaling channel. A surprise interest rate hike (cut) signals a stronger (weaker) US economy and this gets reflected on global growth. This provides impetus to housing demand particularly in the case of Japan, Germany, and France. These countries also share strong trade ties with the US. In the US, we find borrowings channel to be more dominant. A surprise rate hike (cut) reduces (increases) the US REIT returns. A higher (lower) policy rate has the corresponding effects of the cost of borrowing, and consequently, it negatively impacts REIT returns.

Unconventional monetary policy shocks in the US has significant implications on the international REIT returns (Gabriel et al., 2014; Gupta and Marfatia, 2018). However, unlike the impact of conventional Federal funds rate shocks, identifying the response of REIT returns to

FG and LSAP is not immediately identifiable. This is because FG also contains information about the asset purchase program. Swanson (2017) extended the high frequency approach of Gürkaynak, Sack and Swanson (2005) and identified the individual effects of FG and LSAP on various asset prices. The study found that during the zero lower bound period, FG had a negative and statistically significant effect on stock prices while the effect of unexpected LSAP announcements was positive but not statistically significant.

Shocks to FG and LSAP are expected to have significant implications on REIT returns. A negative FG shock, for example, indicates an unexpected Fed communication that short-term rates will remain low. This signals a benign economic outlook which in-turn leads to a lower REIT returns through its signaling effect. On the other hand, a positive LSAP or an expansion of asset purchases, for example, would lower long term interest rates. This reduces mortgage rates and boost REIT return.

Forward guidance shocks (Fig. 2), which is the communication on the future policy path by the Fed, have larger time variation than large-scale asset purchase shocks (Fig. 3). These variations are particularly pronounced in the case of the US after the 2008-2009 period. We find that the impact of FG on REIT returns is mostly negative. This is in line with the findings of Swanson (2017) who found a negative relationship between FG and stock prices. One reason to this could be the timing of unconventional monetary policy. Between December 2008 and December 2012, before the US Fed formerly announced plans to taper its asset purchases in December 2013, FG emphasized keeping the Fed funds rate at exceptionally low levels (near zero) due to prevailing weak economic conditions (Smith and Becker, 2015). This signaled a subdued growth environment which negatively affected investor sentiments. Nakamura and Steinsson

(2018) find that communication by the Fed affects the private sector's beliefs about economic fundamentals. This implies FG which signaled an accommodative interest rate environment "for some time" will make investors also update their own beliefs on economic conditions, in line with the Fed's assessment. This is then reflected in corresponding movements in assets prices. In the latter case, low interest rates for long signals weak economic outlook .

The impact of FG is negative for Asian REITs including Japan, Hong Kong, and Singapore. That is, an unanticipated communication from the US Fed., particularly over the period 2008-2014 that argued maintaining the Fed funds rate at its prevailing low levels, signaled to investors that economic conditions remain subdued and Asian REIT investors were most sensitive to this. In contrast, the European REITs are less responsive to FG shocks.

The dynamic effect of LSAP is shown in Figure 3. Evidence suggests that international REIT returns' response to LSAP are relatively mixed. LSAP are intended to reduce longer term interest rates. Swanson (2017) found LSAP announcements did not statistically influence stock prices, although the relationship was positive. Earlier evidence by Rosa (2012) found that the surprise component of LSAP announcement boosted stock prices in the US. The coefficient of LSAP shocks is positive in the case of France, Germany, Australia, US, and the UK. This indicates that an expansion of LSAP increased REIT returns these countries. This reflects the effects of portfolio re-balancing channel. Lower interest rates on fixed income assets as a result of LSAP shocks make investors re-weight their portfolios by buying stocks including REITs. This raises stock and REIT returns. However, the impact of LSAP is negative in most parts of Asia which include Japan, Singapore, Hong Kong. These results provide further motivation to delve into the nature of relationship in the time varying response of the three policy tools.

3.2 Dynamic impact, gold prices, and exchange rates

Given the unique nature of conventional and unconventional policy tools, we now study the possible correlation in the response of REIT to these shocks. Table 2 presents the correlation between the time-varying response of international REIT to each monetary policy tool for each country. FG and LSAP policies are both a part of unconventional tools. Hence, we would expect the response of REITs to be similar. Interestingly, this is not the case. In the case of Australia, Belgium, France, and Japan we find a strong positive correlation in the response of REIT shocks to FG and LSAP shocks. In these countries, an expansionary unconventional monetary shock raises REIT returns. These results are consistent with existing findings (Gabriel et al., 2014; Gupta and Marfatia, 2018).

In contrast, the time-varying impact of FG is inversely related to the time-varying impact of LSAP on REITs of Germany, the UK, and the United States. This suggests at least two things. First, unlike Gabriel et al. (2014) and others, it is important to distinguish between the surprise changes in FG and LSAP, because these two policy tools have a very different impact on REIT returns. Second, in Germany, the UK and the US, the monetary policy impact through the signaling channel and the asset price channel.

Next, we explore possible explanations for the time-varying response of REITs to policy shocks. Real estate investments are akin to gold in the sense of their function as a safe haven instrument. Thus, we consider the possibility of gold price changes being able to explain the time-varying response of REITs to conventional and unconventional monetary policy shocks. Exchange rate is the other key variable central to international REIT investments. At least in the case of the US, Ngo (2017) finds that the strength/weakness of the US dollar significantly

impacts US REIT returns. Hence, the other possibility is that a stronger/weaker currency of the country impacts the extent to which unexpected changes in monetary policy affect international REIT markets.

To study these effects, we regress the TVP coefficients on each of these two drivers - exchange rates and gold price changes. In each regression, we also include a constant and lagged value of the dependent variable to control for the model specification on in equation 3. Table 3 present the regression results are for each estimation. Evidence suggests that between exchange rates and gold, the latter holds more power to explain the time-variation in the impact of monetary policy on international REITs returns. Between the three policy instruments, the time varying impact of FG shocks can be explained by changes in gold prices in 6 out of the 11 markets. One intuitive explanation to this could be the nature of FG and gold market dynamics. Forward guidance are the Fed's announcements of the future path of interest rates. In this sense, it aims to reduce the uncertainty amongst investors and economic agents. Gold market dynamics are also uncertainty driven. Consequently, we find that gold price changes explain the time-varying impact of FG on international REITs returns.

In nearly all cases, the two variables explain the time-varying impact of one or more monetary policy shocks. In cases where gold price changes explain time-variation, we find that bullion market cycles is synchronous with the effectiveness of FG. An increase (decrease) in gold prices increases (decreases) the impact of FG on REITs returns in the case of Belgium, Hong Kong, Singapore, and the United Kingdom. Only in the case of Canada, Germany and the US, time varying impact of all the three monetary policy shocks are independent of exchange rates and gold price changes.

4 Conclusion

The dynamic role of unconventional monetary policy in driving international REIT returns is unexplored in the existing literature. In this paper, we estimate the time-varying impact of unconventional monetary policy in the US on international REIT returns. REIT markets across the world have witnessed significant changes both due to increased dominance of REIT in the financial markets and due to the recent global financial crisis. To capture these dynamics, we use a time-varying parameter model to estimate the impact of the unconventional monetary policy shocks of the US on international REIT returns. Evidence suggests that the response of international REITs to policy shocks has significantly changed over time. The time variation is more pronounced in the case of unexpected changes in forward guidance as compared to unexpected changes in the LSAP announcements. This is true particularly for the REIT returns of Australia, Belgium, and the United States. We also find that the time-varying impact of forward guidance is negatively correlated with the time-varying impact of the LSAP shocks in the case of Germany, the UK, and the US REITs. Also, between gold and exchange rates, two most closely related financial variables related to REITs, gold price changes explain time-varying REITs response in most countries.

Data Availability Statement: The data that support the findings of this study are openly available in Datastream and Swanson (2017).

References

Akinsomi, Omokolade, Goodness C Aye, Vassilios Babalos, Fotini Economou, and Rangan Gupta. 2016. "Real estate returns predictability revisited: novel evidence from the US REITs market." *Empirical Economics*, 51 (3): 1165–1190.

Bauer, Michael and Rudebusch, Glenn D. 2014. "The Signaling Channel for Federal Reserve Bond Purchases." *International Journal of Central Banking*, vol. 10(3), pages 233-289.

Bauer, Michael D and Neely, Christopher J. 2014. " International channels of the Fed's unconventional monetary policy. " *Journal of International Money And Finance*, 44: 24- 46.

Bernanke, Ben S and Kenneth N Kuttner. 2005. "What explains the stock market's reaction to Federal Reserve policy?" *The Journal of Finance*, 60 (3): 1221–1257.

Chan, S H., Leung, W K, and Ko, W. 2005. " Changes in REIT Structure and Stock Performance, Evidence from the Monday Stock Anomaly." *Real Estate Economics*, 33, 89–120.

Cook, Timothy and Thomas Hahn. 1989. "The effect of changes in the federal funds rate target on market interest rates in the 1970s." *Journal of Monetary Economics*, 24 (3): 331–351.

Cooley, Thomas F and Edward C Prescott. 1976. "Estimation in the presence of stochastic parameter variation." *Econometrica: journal of the Econometric Society*, pp. 167–184.

Gabriel, Stuart A and Chandler Lutz. 2017. "The impact of unconventional monetary policy on real estate markets." *Available at SSRN 2493873.*

Gagnon, J., M. Raskin, J. Remache, and B. Sack. 2011. " The Financial Market Effects of the Federal Reserve's Large-Scale Asset Purchases." *International Journal of Central Banking*, 7, 3–43.

Ghysels, Eric, Alberto Plazzi, Rossen Valkanov, Walter Torous et al. 2013. "Forecasting Real Estate Prices." *Handbook of Economic Forecasting*, 2, 509–580.

Gupta, Rangan and Hardik A Marfatia. 2018. "The impact of unconventional monetary policy shocks in the US on emerging market REITs." *Journal of Real Estate Literature*, 26 (1): 175–188.

Gupta, Rangan, Chi Keng Marco Lau, Ruipeng Liu, and Hardik A Marfatia. 2019. "Price jumps in developed stock markets: the role of monetary policy committee meetings." *Journal of Economics and Finance*, 43 (2): 298–312.

Gürkaynak, Refet S, Brian Sack, and Eric T Swansonc. 2005. "Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements." *International Journal of Central Banking.*

Haldane, Andrew & Roberts-Sklar, Matt & Wieladek, Tomasz & Young, Chris. 2016. "QE: The Story so far." *Bank of England working papers 624*, Bank of England.

Hesse, Henning & Hofmann, Boris & Weber, James Michael. 2018. " The macroeconomic effects of asset purchases revisited. " *Journal of Macroeconomics*, Elsevier, vol. 58(C), pages 115-138.

Hausman, Joshua & Wongswan, Jon, 2011. "Global asset prices and FOMC announcements" *Journal of International Money and Finance*, Elsevier, vol. 30(3), pages 547-571.

Huber, Florian & Punzi, Maria Teresa. 2016. "International housing markets, unconventional monetary policy and the zero lower bound." *FinMaP- Working Papers 58*, Collaborative EU Project FinMaP - Financial Distortions and Macroeconomic Performance: Expectations, Constraints and Interaction of Agents

Hausman, Joshua and Jon Wongswan. 2011. "Global asset prices and FOMC announcements." *Journal of International Money and Finance*, 30 (3): 547–571.

Kishor, N Kundan and Hardik A Marfatia. 2013. "The time-varying response of foreign stock markets to US monetary policy surprises: Evidence from the Federal funds futures market." *Journal of International Financial Markets, Institutions and Money*, 24, 1–24.

Kuttner, Kenneth N., 2001. "Monetary policy surprises and interest rates: Evidence from the Fed funds futures market. " *Journal of Monetary Economics*, Elsevier, vol. 47(3), pages 523-544.

Marfatia, Hardik A. 2014. "Impact of uncertainty on high frequency response of the US stock markets to the Fed's policy surprises." *The Quarterly Review of Economics and Finance*, 54 (3): 382–392.

Marfatia, Hardik A. 2015. "Monetary policy's time-varying impact on the US bond markets: Role of financial stress and risks." *The North American Journal of Economics and Finance*, 34, 103–123.

Marfatia, Hardik A, Rangan Gupta, and Esin Cakan. 2017. "The international REIT's time-varying response to the US monetary policy and macroeconomic surprises." *The North American Journal of Economics and Finance*, 42, 640–653.

Nakamura, Emi and Jón Steinsson. 2018. "High-frequency identification of monetary non-neutrality: the information effect." *The Quarterly Journal of Economics*, 133 (3): 1283–1330.

Neely, Christopher J. 2015. " Unconventional monetary policy had large international effects." *Journal of Banking & Finance*, vol. 10(3), 52: 101-111.

Ngo, Thanh. 2017. "Exchange rate exposure of REITs." *The Quarterly Review of Economics and Finance*, 64, 249–258.

Nyakabawo, Wendy, Rangan Gupta, and Hardik A Marfatia. 2018. "High frequency impact of monetary policy and macroeconomic surprises on US MSAs, aggregate US housing returns and asymmetric volatility." *Advances in Decision Sciences*, 22, 1–25.

Rosa, Carlo. 2012. "How 'unconventional'are large-scale asset purchases? The impact of monetary policy on asset prices." *The Impact of Monetary Policy on Asset Prices (May 1, 2012). FRB of New York Staff Report*, (560).

Silvia Miranda-Agrippino and Hélène Rey. 2019. "US Monetary Policy and the Global Financial Cycle." *NBER Working Papers 21722*, National Bureau of Economic Research, Inc.

Smith, A Lee and Thealexa Becker. 2015. "Has forward guidance been effective?" *Economic Review-Federal Reserve Bank of Kansas City*, p. 57.

Swanson, Eric T. 2017. “Measuring the effects of Federal Reserve forward guidance and asset purchases on financial markets.” Technical Report, National Bureau of Economic Research.

Xu, Pisun and Jian Yang. 2011. “ US monetary policy surprises and international securitized real estate markets.” *The Journal of Real Estate Finance and Economics*, 43 (4): 459–490.

Yu-Hsi Chou and Yi-Chi Chen. 2014. “ Is the Response of REIT Returns to Monetary Policy Asymmetric?” *Journal of Real Estate Research, American Real Estate Society*, vol. 36(1), pages 109-136.

[Dataset] Datastream and Swanson (2017)

Table 1: Summary Statistics
The table presents summary statistics of the 11 leading international REIT returns.

Country	Code	Mean	Median	Max.	Min.	S.D.	Obs
Australia	AU	-0.080	0.000	4.419	-11.097	1.454	213
Belgium	BE	0.173	0.157	6.403	-7.574	1.383	172
Canada	CA	0.196	0.127	6.867	-8.487	1.532	165
Germany	DE	0.202	0.401	7.387	-16.128	3.619	69
France	FR	0.507	0.392	4.684	-4.922	1.731	103
Hong Kong	HK	-0.220	0.000	3.122	-10.061	1.502	97
Japan	JP	-0.308	-0.116	7.892	-8.506	2.073	120
Netherlands	NL	0.270	0.251	8.621	-7.539	1.485	213
Singapore	SG	0.063	0.089	5.710	-7.869	1.575	105
UK	UK	0.509	0.457	7.696	-9.179	2.550	76
USA	US	0.216	0.079	13.347	-21.945	2.441	213

Table 2: Correlation matrix: TVP impact

The table presents correlation matrix of the TVP response of REIT to each monetary policy shock, that is, federal funds rate (FFR), forward guidance, (FG), and large scale asset purchases (LSAP).

	Australia			Belgium			Canada		
	FFR	FG	LSAP	FFR	FG	LSAP	FFR	FG	LSAP
FFR	1.00			1.00			1.00		
FG	0.52	1.00		-0.04	1.00		0.05	1.00	
LSAP	0.62	0.91	1.00	0.28	0.71	1.00	-0.06	0.43	1.00

	Germany			France			Hong Kong		
	FFR	FG	LSAP	FFR	FG	LSAP	FFR	FG	LSAP
FFR	1.00			1.00			1.00		
FG	0.09	1.00		-0.06	1.00		-0.45	1.00	
LSAP	-0.33	-0.30	1.00	-0.06	0.52	1.00	-0.17	0.67	1.00

	Japan			Netherlands			Singapore		
	FFR	FG	LSAP	FFR	FG	LSAP	FFR	FG	LSAP
FFR	1.00			1.00			1.00		
FG	0.73	1.00		-0.07	1.00		-0.47	1.00	
LSAP	0.56	0.63	1.00	-0.27	0.30	1.00	-0.28	0.07	1.00

	UK			USA		
	FFR	FG	LSAP	FFR	FG	LSAP
FFR	1.00			1.00		
FG	-0.01	1.00		-0.01	1.00	
LSAP	0.03	-0.38	1.00	0.45	-0.23	1.00

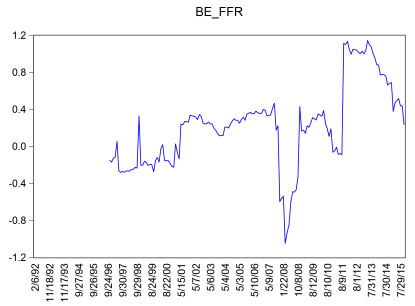
Table 3: Impact of exchange rate and gold prices on TVP response of international REITs

The table presents the OLS estimates of the regression of time-varying parameter estimates on country's exchange rate with the US dollar and separately on gold price changes. Given the construction of the TVP model, each regression includes a lag of the dependent variable and a constant. The table reports the coefficient estimates, standard error (SE), P-value of regression.

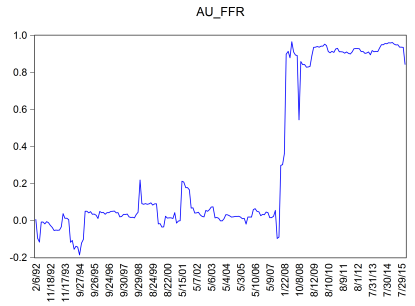
	Exchange rate					Gold prices				
					Federal funds rate					
Country	Esti.	SE	P-val	R^2	Obs.	Esti.	SE	P-val	R^2	Obs.
Australia	0.105	0.045	0.02	0.97	202	-0.082	0.085	0.34	0.97	202
Belgium	0.003	0.075	0.96	0.86	143	-0.582	0.213	0.01	0.86	161
Canada	-0.066	0.059	0.26	0.91	154	-0.015	0.198	0.94	0.91	154
Germany	3.045	2.123	0.16	0.74	58	-8.947	3.466	0.01	0.76	58
France	-0.331	0.322	0.31	0.26	92	-0.474	0.486	0.33	0.26	92
Hong Kong	-5.045	1.508	0.00	0.75	86	0.250	0.431	0.56	0.71	86
Japan	-0.001	0.002	0.47	0.59	109	-0.667	0.389	0.09	0.60	109
Netherlands	-0.058	0.025	0.02	0.94	143	-0.135	0.059	0.02	0.93	202
Singapore	0.079	0.202	0.70	0.84	94	-0.039	0.321	0.90	0.84	94
UK	-0.030	0.077	0.70	0.69	65	-0.402	0.127	0.00	0.73	65
USA	0.016	0.044	0.73	0.69	85	-0.023	0.022	0.30	0.96	202
					Forward guidance					
Country	Esti.	SE	P-val	R^2	Obs.	Esti.	SE	P-val	R^2	Obs.
Australia	-0.034	0.022	0.13	0.83	202	0.031	0.052	0.56	0.83	202
Belgium	0.100	0.338	0.77	0.51	143	1.878	0.910	0.04	0.52	161
Canada	-0.027	0.114	0.81	0.84	154	-0.100	0.371	0.79	0.84	154
Germany	-0.448	2.123	0.83	0.47	58	6.435	3.554	0.08	0.50	58
France	0.064	0.034	0.06	0.78	92	0.078	0.049	0.12	0.78	92
Hong Kong	3.003	5.085	0.56	0.40	86	4.886	1.493	0.00	0.47	86
Japan	0.002	0.001	0.11	0.92	109	0.076	0.143	0.60	0.92	109
Netherlands	0.053	0.016	0.00	0.95	143	0.022	0.039	0.58	0.98	202
Singapore	0.015	0.016	0.36	0.89	94	0.084	0.026	0.00	0.90	94
UK	0.209	0.073	0.01	0.92	65	0.237	0.092	0.01	0.92	65
USA	-0.813	1.632	0.62	0.73	85	0.343	0.687	0.62	0.78	202
					LSAP					
Country	Esti.	SE	P-val	R^2	Obs.	Esti.	SE	P-val	R^2	Obs.
Australia	-0.001	0.048	0.98	0.79	202	0.017	0.121	0.89	0.79	202
Belgium	0.130	0.063	0.04	0.67	143	-0.215	0.211	0.31	0.70	161
Canada	-0.215	0.134	0.11	0.90	154	-0.164	0.365	0.65	0.90	154
Germany	0.443	0.417	0.29	0.28	58	1.408	0.683	0.04	0.31	58
France	0.216	0.225	0.34	0.88	92	0.298	0.299	0.32	0.88	92
Hong Kong	1.688	0.919	0.07	0.65	86	-0.225	0.253	0.38	0.63	86
Japan	0.000	0.001	0.90	0.87	109	-0.162	0.148	0.28	0.87	109
Netherlands	-0.020	0.023	0.39	0.96	143	0.008	0.127	0.95	0.95	202
Singapore	-0.242	0.113	0.03	0.88	94	-0.194	0.156	0.22	0.87	94
UK	0.015	0.115	0.89	0.08	65	-0.048	0.218	0.83	0.08	65
USA	-1.206	1.203	0.32	0.71	85	0.532	0.507	0.30	0.75	202

Figure 1: Time-Varying Impact of Federal Funds Rate Shocks

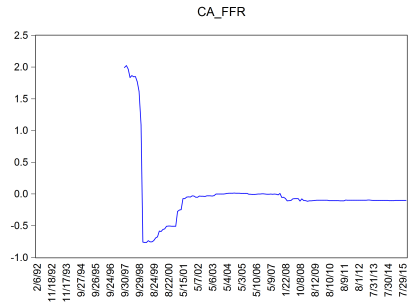
The plots show the time-varying response of international REITs to federal funds rate shocks.



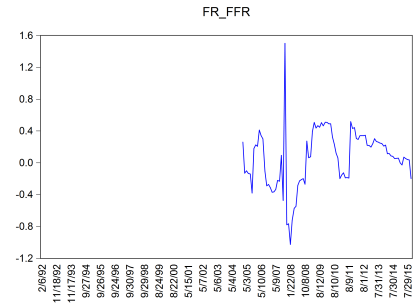
(a) Belgium: FFR



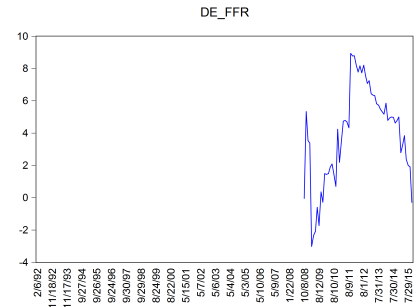
(b) Australia: FFR



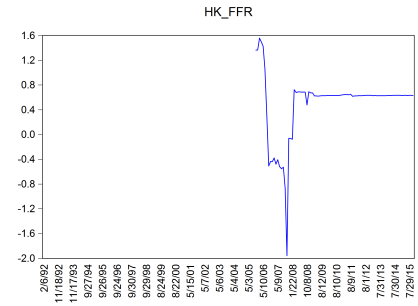
(c) Canada: FFR



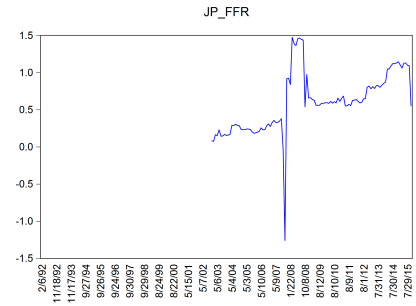
(d) France: FFR



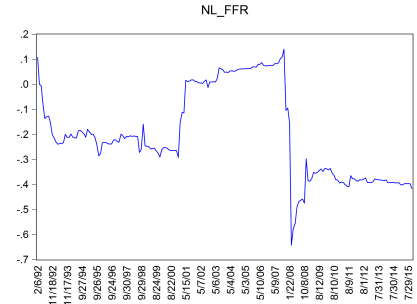
(e) Germany: FFR



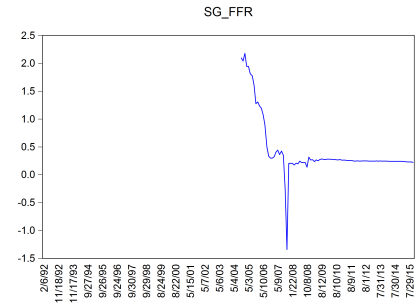
(f) Hong Kong: FFR



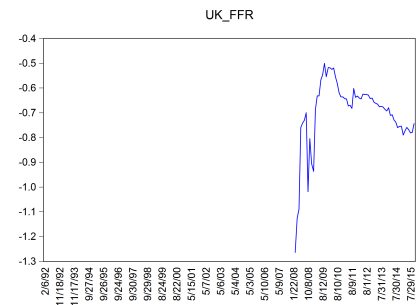
(g) Japan: FFR



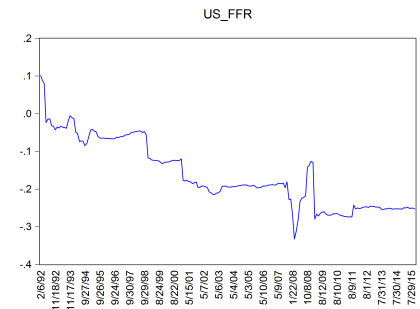
(h) Netherlands: FFR



(i) Singapore: FFR



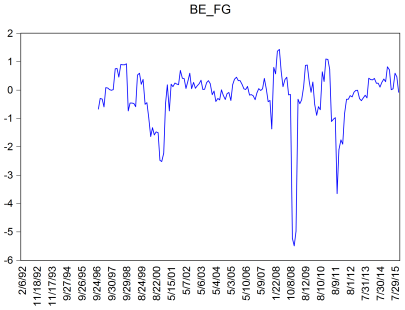
(j) UK: FFR



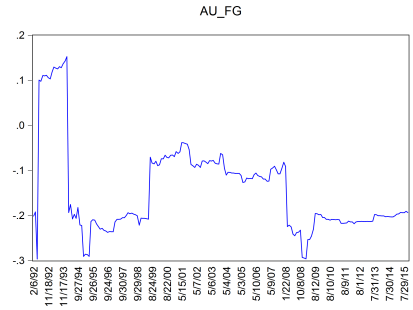
(k) USA: FFR

Figure 2: Time-Varying Impact of Forward Guidance Shocks

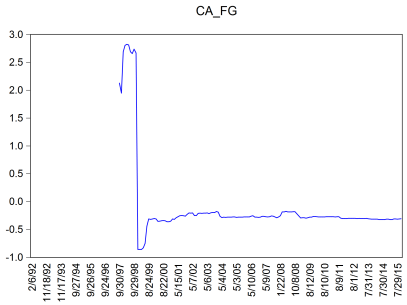
The plots show the time-varying response of international REITs to forward guidance shocks.



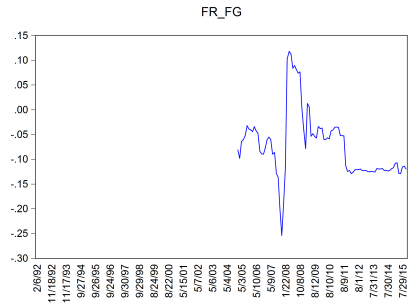
(a) Belgium: FG



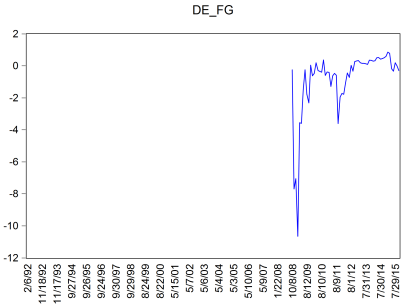
(b) Australia: FG



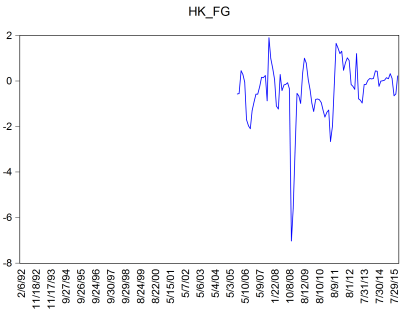
(c) Canada: FG



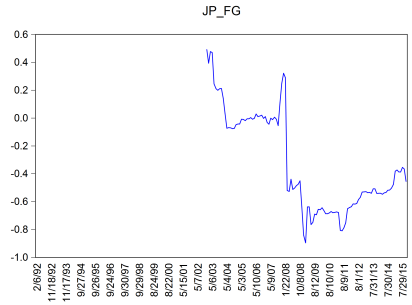
(d) France: FG



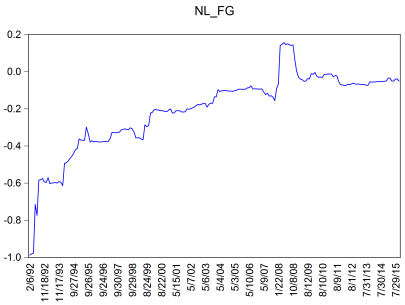
(e) Germany: FG



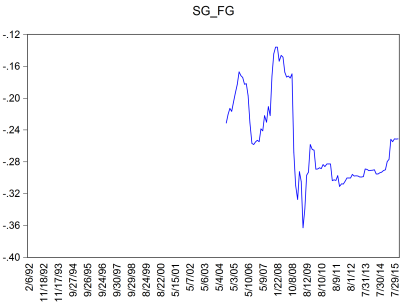
(f) Hong Kong: FG



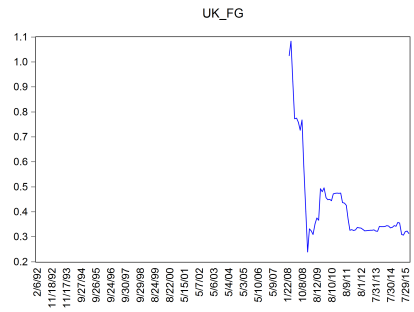
(g) Japan: FG



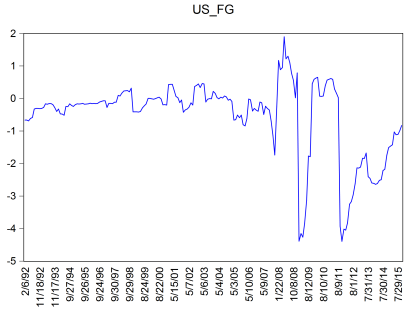
(h) Netherlands: FG



(i) Singapore: FG



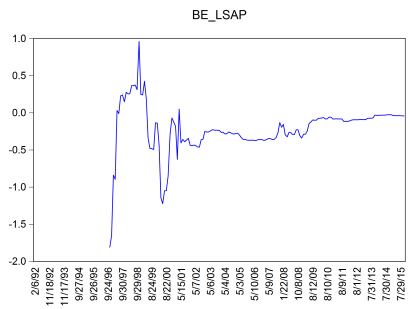
(j) UK: FG



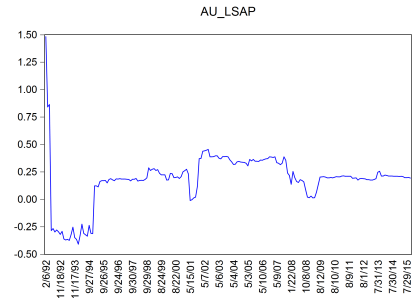
(k) USA: FG

Figure 3: Time-Varying Impact of LSAP Shocks

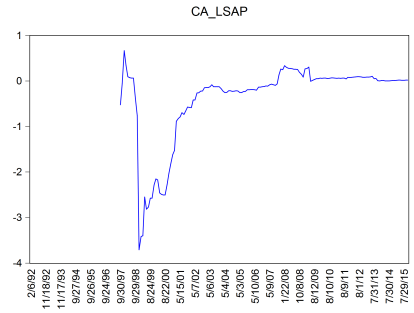
The plots show the time-varying response of international REITs to LSAP shocks.



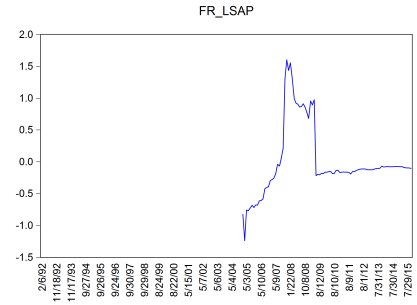
(a) Belgium: LSAP



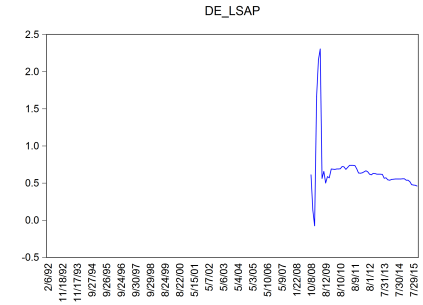
(b) Australia: LSAP



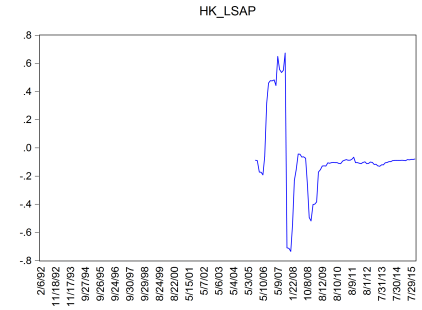
(c) Canada: LSAP



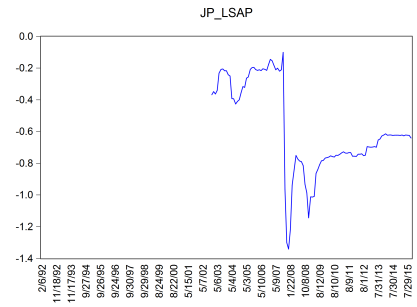
(d) France: LSAP



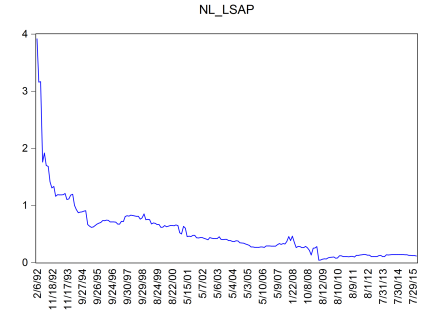
(e) Germany: LSAP



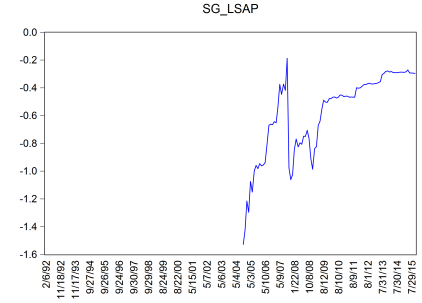
(f) Hong Kong: LSAP



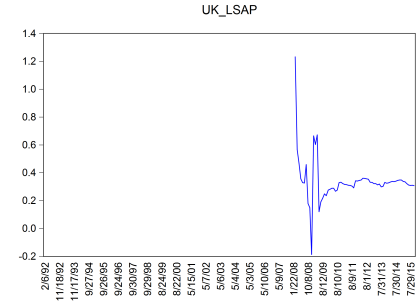
(g) Japan: LSAP



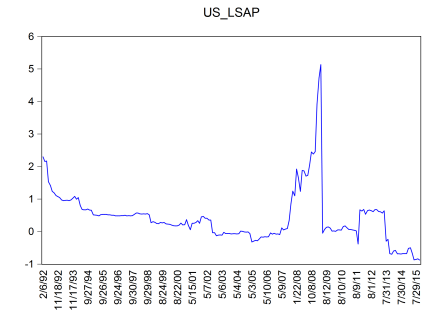
(h) Netherlands: LSAP



(i) Singapore: LSAP



(j) UK: LSAP



(k) USA: LSAP