Feedback trading strategies in international real estate markets*[1]

Chrysanthi Balomenou (Department of Banking and Finance, Epoka University, Tirana, Albania)
Vassilios Babalos (Department of Accounting and Finance, University of the Peloponnese – Kalamata, Kalamata, Greece)
Dimitrios Vortelinos (School of Social Sciences, Hellenic Open University, Patra, Greece)
Athanasios Koulakiotis (Department of Balkan, Slavic and Oriental Studies, University of Macedonia, Thessaloniki, Greece)

Abstract

Motivated by recent evidence that securitized real estate returns exhibit higher levels of predictability than stock market returns and that feedback trading can induce returns autocorrelation and market volatility we set off to examine the impact of feedback trading strategies on long-term market volatility of eight international real estate markets (UK, Germany, France, Italy, Sweden, Australia, Japan and Hong Kong). Assuming that the return autocorrelation may vary over time and the impact of positive or negative feedback trading could be a function of return volatility we employ a combination of a feedback trading model and a fractionally integrated GARCH model.The results are mixed, revealing that both positive and negative feedback trading strategies persist. Specifically, we detect positive feedback trading in the real estate markets of France, Hong Kong and Italy as opposed to the real estate markets of Australia, Germany, Japan, and Sweden where negative feedback trading were present. A noteworthy exception is the UK real estate market, with important and rational feedback trading strategies to sustain. With respect to the long-term volatility persistence, this seems to capture the mean reversion of real estate returns in the UK, and Hong Kong markets. In general, our results are not consistent with those reported in previous studies since negative feedback trading dominates positive feedback trading in the majority of real estate markets under consideration. Our results yield important insights into the behavior of real estate investors and the functioning of real estate markets in general.

Keywords: Feedback Trading, Long-Memory volatility, Real Estate Markets, GARCH
JEL Classification: G1, R2, C5

1Authors would like to thank the Editor and two anonymous referees that their comments improved significantly the paper. All remaining errors are own.

I. Introduction

Since the seminal paper of Fama (1970) on market efficiency the role of feedback trading on market dynamics and its destabilizing effect on stock prices has received the attention of researchers and academics (DeLong, Shleifer, Summers, & Waldman, 1990). Consistent with the existence of positive feedback traders, anumber of studies have found significant links between autocorrelation and the volatility of stock returns (Koutmos, 1997, LeBaron, 1992). Cutler et al. (1990) even argues that the autocorrelation properties of a large number of assets can be explained by a simple model which allows for the existence of both rational investors and feedback traders. Feedback traders are those market participants whose actions are motivated by price expectations formed by past values of price as opposed to expected market fundamentals such as income, interest rates, and demographics. Despite its growing appeal as a financial asset, real estate has received little attention with respect to the existence of feedback traders. Only a few researchers have attempted to test the feedback trading hypothesis in the real estate sector. For example, Riddel (1999) attempted to test the feedback trading hypothesis using direct real estate prices on the Santa Barbara South Coast. His approach aimed at disentangling the effect of economic forces and speculative trading on house prices for a period that ran from 1983 through 1997.His results revealed that feedback trading was present in the specific real estate market. On the other hand, Kyriakou et al. (2019) using securitized real estate prices confirmed the existence of feedback trading and volatility asymmetry for several OECD countries for a long period covering different market phases.

Investors and policy makers are heavily concerned with price volatility in real estate sector (see inter alia Lee, 2009). Rising or falling real estate prices could trigger severe economic implications with respect to lifetime consumption and investment decisions of the consumers (Dolde & Tirtiroglu, 2002). Moreover, real estate falling prices could pose threat to the stability of the banking industry (Davis and Zhu, 2009). Moreover, if we combine evidence presented above with the findings by Serrano &Hoesli (2010) who claimed that securitized real estate returns exhibit higher levels of predictability than stock market returns in countries with mature and developed REITs markets it is natural to expect the existence of irrational behavior in real estate markets that forms predictable patterns in the price series (see inter alia Pan (2019) for testing the presence of bubbles in the Chinese housing market).

Therefore in the context of the current study we set off to examine the existence of feedback trading in real estate market and their effect on long term volatility allowing volatility to be stationary or long-term reverting. Moreover, in the context of our analysis returns' autocorrelation is allowed to interact with 'momentum effects' and returns volatility. In more detail, we split feedback (buy-sell shortly) traders to two groups: risk averse utility maximizers, along the lines of CAPM, and positive ornegative traders. On the one hand, risk-averse utility maximizers respond rationally toexpected returns subject to their wealth limitation. On the other hand, feedback (buysell shortly) traders consider the history of the returns and trading volumes in order to decide. Feedback trading (positive or negative) might be responsible for the documented inverse relationship between volatility and autocorrelation. In particular, positive traders buy (sell) when prices rise (fall). Thus, positive feedback trading is expected to induce negative first order autocorrelation in stock returns. This effect, in turn, grows at a proportional rate to the level of volatility. Furthermore, nonsynchronous trading and negative first order feedback trading cause positive autocorrelation in stock returns. Negative feedback trading might result from profits gained when the market rises or from investment strategies on shares of different assets, accounting for wealth maximization. In this case, negative feedback traders consider a price rise (drop) as a signal to sell (buy) stocks. Following this behavior, both groups provide the rationale for serial correlation in return series and the importance of volatility on the return autocorrelation. While negative feedback trading helps make markets less volatile, positive feedback trading is a source of market volatility. In particular, when a cycle of positive feedback continues for too long, it can create an asset bubble or a market crash as investors seem to speculate on the shorter term and avoid longer term investments.

We support the notion that the return autocorrelation may vary over time and the impact of positive or negative feedback trading could be a function of return volatility. In order to introduce a volatility term in the mean return equation of positive feedback trading or negative feedback trading model we use the original FIGARCH (1,d,1) methodology which was initially proposed by Baillie et al. (1996).

In effect, in the context of the present study we use the original FIGARCH model, as we aim to examine the relationship between long-term volatility and short-term feedback strategies in real estate markets. Our main contribution is the investigation of the link between short-term positive or negative feedback trading and long-term volatility in eight international real estate markets, symmetrically. Particular attention has been placed to the link between short-term feedback trading and long-term volatility, by means of a fractionally integrated GARCH approach, a symmetric one.

Moreover, investigating the relationship between returns' volatility and investors' strategies based on feedback trading entails significant implications since real estate assets offer a good alternative investment for many investors and speculators. According to the stock returns literature, if this relationship is negative then investors will buy when stock prices go up. On the contrary, if this relationship is positive, investors will buy when stock prices decrease. So, it is interesting to examine whether these two channels of strategies exist in our study, or whether more complex investing channels arise. Our goal is to reveal the short-term investing strategies that may arise from trading in real estate markets, when the fluctuation of volatility persists for a long period and thus it is easier-through our methodology-to capture the short-term traders' symmetric behavior for the whole period.

Previewing our findings, we report mixed results concerning the link between autocorrelation and long-term volatility across the sample of national real estate markets. The FIGARCH model allows us to unveil the nature of the shocks in real estate markets. Our study provides evidence in favor of the hypothesis that real estate markets are characterized by persistence in the volatility and in the autocorrelation of the returns. The evidence of this paper is not fully consistent with the previous literature. In particular, our results state that real estate markets are influenced by the two channels of strategies, without markets always being long-term reverting. We document that in some cases real estate markets are stationary. This means that in some real estate markets the findings are similar to the stock market literature; these are the cases for the real estate markets of France, Hong Kong and Italy with the original FIGACRH model. For these markets, the positive feedback trading strategy plays a significant role and these results are consistent with those of Sentana and Wadwani (1992) and Koutmos (1997) for the USA, developed and emerging stock markets.

In contrast to the above findings, for the restofreal estate markets, negative strategies are prevalent, although these results contradict those of the stock market literature. In particular, for the real estate markets of Australia, Germany, Japan and Sweden two factors play a significant role; the long-term reverting of volatility and the negative feedback trading strategy. This evidence is not in line with the results found by many previous studies.Moreover, the real estate market of UKis influenced by negative feedback strategies; however, there is a mean reverting volatility process. This means that short-term effects are important in these markets and allowing us to characterize them as efficient markets due to negative feedback strategies.

The rest of the paper is organized as follows: Section 2 outlines the main findings of the relevant literature, section 3 describes the sample data and the methodology. Section 4 discusses the empirical results of the feedback trading models while section 5 presents the results for long-term volatility of the cumulative impulse response functions for the real estate markets under study. Section 6 summarizes the main findings of the empirical analysis and discusses the policy implications for investors.

II. Literature Review

Following the findings of Sentana and Wadhwani (1992), positive feedback trading is an important source of short-term variability of the US stock market. In addition, previous researchers have investigated the feedback trading activities using a behavioral CAPM model for the US stock market. Their approach was rooted in the premise that some investors follow expected utility maximizing behavior, and others follow feedback trading strategies as a result of trends that are prevalent in asset markets. However, the single factor model misses some aspects of financial market pricing and is outperformed by the multifactor ICAPM which incorporates a larger investment opportunity (Cifarelli and Paladino, 2010).

In this respect, Koutmos (1997) reports similar findings for the developed as well as the emerging stock markets. In contrast, DeLong et al. (1990) find that positive feedback trading is associated with positive return autocorrelation, because traders push stock prices away from their fundamental values in the short run. Other studies, such as Shiller (1990) point out that positive feedback trading produces negative return autocorrelations and agree with the findings of Sentana and Wadwhwani (1992) and Koutmos (1997). According to the two previous researchers, feedback trading seems to be a stylized aspect of stock market behavior.

Along the same lines, a subject of continuing empirical investigation is the existence of feedback trading in international asset markets. Studies of this type are mainly focused on positive feedback strategy whereby investors buy (sell) when prices rise (fall). Since the seminal study of Sentana and Wadhwani (1992, SW hereafter) there has been a dramatic growth in related articles. SW developed a heterogeneous trader model to prove that the existence of rational arbitrageurs and feedback traders results in bubble-like patterns. Moreover, positive feedback trading together with arbitrageurs' actions is responsible for positive autocorrelation of returns at short horizons. The opposite holds for longer horizons where the unavoidable adjustment of prices to fundamentals results in a negative autocorrelation of returns. News is affected by price changes and is reinforced by positive feedback traders, who overreact to this specific news and produce excessive volatility in markets.

Therefore, it is believed that price variability is exacerbated by positive feedback trading. Feedback trading is observed not only among individual but among institutional investors (Nofsinger and Sias, 1999). Moreover, this kind of behavior by investors is encountered across different markets; see, for example, Sentana and Wadhwani (1992) for evidence of feedback trading in the U.S. stock market, Antoniou et al. (2005) for the G-7 stock markets, Laopodis (2005) for foreign exchange markets, Salm and Schuppli (2010) for index futures markets, and Chau et al. (2011) for exchange-traded fund (ETF) markets. In particular, Antoniou et al. (2005) find that positive feedback trading is observed at high levels of volatility and thus feedback traders influence market prices.

When it comes to commodity markets, Cifarelli and Paladino (2010) documented a significant feedback trading in crude oil market. They find that oil price shifts related negatively to exchange rate and stock price changes and also that both the CAPM and feedback trading components of the methodology are connected with a complex web of time-varying first and second order conditional moment interactions. In particular, the serial correlation of oil returns is influenced by Dow Jones industrial index return and the US dollar exchange rate change. In addition, feedback traders in the equity markets are influenced in their investment decisions by the conditional covariance of stock and oil returns. They use weekly data which is insufficient for the study of short-run feedback trading strategies based on the previous literature.

Most recently Chau et al. (2015) reported substantial evidence of feedback trading in coal and electricity markets of the European continent with the level of arbitrage opportunities and the market regime to play significant role in the intensity of the effect. They find that feedback trading is related to arbitrage opportunities and these relationships depend on the market regimes due to inefficiency and instability in asset prices. Arbitrage opportunities are a good signal for investors to trade. In addition, many investors believe that arbitrage and hedging are two components very important for motivating them to trade in markets.

Following the early findings of SW predicting a negative relationship between volatility and autocorrelation in US market a series of studies unveil a negative relationship between autocorrelation and volatility in both mature and emerging stock markets (Bohl and Siklos, 2008), foreign exchange markets (Laopodis, 2005), index futures markets (Salm and Schuppli, 2010), ETF markets considering the effect of investor sentiment (Chau et al., 2011), and crude oil market (Cifarelli and Paladino, 2010).

Another strand of literature has attempted to extend the feedback trading model, see for instance, Faff et al. (2005) who extends the standard feedback trading model by introducing a cross-market feedback trader, with a demand function that varies according to price movements in the foreign markets. In a similar study, Chau et al. (2011) accounts for the effect of investor sentiment on the feedback traders' demand function and builds an augmented model with sentiment while Koutmos, D. (2012) incorporates the role of a separate group of investors i.e., the fundamental traders, in the process of stock return dynamics. More recently, Chau and Deesomsak (2015) reports a significant feedback trading behavior in the major stock exchanges of G-7 countries and the magnitude of feedback trading is tied to the overall macroeconomic conditions. In a similar context, the relationship between feedback trading strategies and market volatility for real estate prices was the focus of Koulakiotis and Kiohos

(2016). Employing a sample of developed real estate markets they confirmed the existence of positive feedback trading and that volatility is negatively linked to autocorrelation returns in the real estate markets under study. Their results carry important implications for diversification strategies.

Qureshi et al. (2017) examine the effect of institutional investors' trading behavior on stock market volatility. Their empirical design consists of aggregate fund flows both of equity and balanced funds for Asian emerging markets. Their findings revealed a mixed picture, in particular equity funds follow the market volatility positively, suggesting positive feedback trading (momentum) behavior whereas balanced funds follow market volatility negatively and exhibit negative feedback trading behaviour (contrarian behaviour). Their results are very helpful for shedding light on the role of institutional investors in the developing economies.

Pearson et al. (2017) investigated the role of an event related to stock market tax legislation combined with the existence of feedback trading strategies in the creation of a bubble in the Chinese stock market in 2007. In particular, the authors reached the conclusion that it was the tax change that gave rise to the bubble and not the feedback trading followed by investor which is a dimension previously neglected in bubble studies. Motivated by two well-known stylized facts encountered in financial markets, namely fat tails and volatility clustering, Cheng and Kim (2017) suggested a return generating model that is based on the interaction of fundamentalists and positive feedback traders. Taking it one step further the authors claim that the fundamentalist's attitude towards risk along with the cost of capital faced by positive feedback traders are key factors for the determination of prices. Finally, according to their model predictions positive-feedback traders cause the formation of speculative bubbles.

Kyrkilis et al. (2018) examined the validity of feedback trading hypothesis and volatility spillovers for three size-based (small, medium and large) stock portfolios of the Greek stock market during the Greek debt crisis period. The main findings confirm the existence of feedback trading across the three stock portfolios along with a leverage effect originating from small size stocks to medium and large stocks.

Alkali et al. (2019) examine the sensitivity of real estate prices variability to the existence of negative information in the market. The authors attempted to examine the existence of a leverage effect in the property prices volatility and to this end they employed a sample from a Nigerian property market named Abuja. Their approach consist of multiple tests using the EGARCH model and they discovered different patterns of volatility across real estate prices while the leverage effect was present only in two and three bedroom flats.

III. Data and Methodology

Data sample

We employ daily prices of the FTSE EPRA/NAREIT real estate indices for eight countries namely UK, Germany, France, Italy, Sweden, Australia, Japan and Hong Kong. It should be noted that the real estate indices employed consist of both securitized and listed companies that specialize in real estate activities (REITs and non-REITS). Our sample spans from January 1990 through February 2019allowing us to draw conclusions regarding the effect of the recent global financial crisis on the distribution of real estate returns.

Positive and Negative Feedback Trading (PFT and NFT)

Sentana and Wadhwani (1992) seminal model assumes there are two heterogeneous groups of investors: one is a group of rational 'smart-money' investors whose demand for shares in period t, is consistent with utility maximization theory. The other is a group of 'feedback traders' whose demand for shares depends only on the previous period's return.
Within this model setting, it can be argued that the sign and strength of parameter β_3 reflect the relative market dominance of one type of feedback traders over another. If $\beta_3 > 0$ then positive feedback traders outweigh and outnumber negative feedback traders and vice versa.Equilibrium in the stock market requires that all shares are held.In a market with rational investors as well as feedback traders the resulting returns exhibit autocorrelation and the degree of autocorrelation depends on volatility.

Therefore the FT (Feedback Trading) model proposed by Sentana and Wadhwani (1992) assumes the following empirical form:

$$r_t = \beta_0 + \beta_1 \sigma_t^2 + (\beta_2 + \beta_3 \sigma_t^2) r_{t-1} + \varepsilon_t \tag{1}$$

Where coefficient β_2 captures the possibility that constant autocorrelation is present in the model, β_3 should be both negative and statistically significant under the assumption of positive feedback trading, The term $\beta_1 \sigma_t^2$ equals $-\beta_3 \sigma_t^2$ and implies that there is positive feedback trading and negative autocorrelation in returns.

The model, as stated above, offers new insights since it accommodates both the feedback trading strategies and any relationship between returns' autocorrelation and long-memory volatility. At low volatility levels, negative feedback trading will dominate and induce positive serial correlation in real estate returns due to the relative magnitude of constant autocorrelation (β_2) compared to $\beta_1 \sigma_t^2$. As risk increases, the larger impact of $\beta_1 \sigma_t^2$ compared to β_2 implies negative autocorrelation in real estate returns due to the effect of positive feedback trading. Thus, negative feedback trading is expected to account for the positive autocorrelation in daily real estate returns.

The original FIGARCH (1,d,1) approach

Following Cotter and Stevenson (2008) we believe that the FIGARCH(1,d,1) model best captures the volatility in the real estate markets. The conditional variance of the FIGARCH (1,d,1) assumes the following form:

$$\sigma_t^2 = c + \beta \sigma_{t-1}^2 + [1 - \beta L - (1 - eL)(1 - L)^d] \varepsilon_t^2 \tag{2}$$

The FIGARCH (p,d,q) model accommodates two different models for two different values of d. Assigning the value 0 to d we get the covariance-stationary GARCH(p,q) model while the IGARCH model results from d=1. Values of d vary between 1 and 0 allowing us to account for the long-term dependence in the conditional variance. If 0<d<0.5, the series are long-term reverting with respect to covariance, and if 0.5<d<1, the series are then stationary, however the shocks die away in the short-run rather than

in the long-run. The FIGARCH approach can be calculated in terms of I(d) parameter, when d is lower than the value of 1 and greater than the value of 0. Therefore, the series maybe stationary or may revert in the long-run.
This paper fits a long memory volatility model, the Fractional Integrated GARCH (FIGARCH), developed by Baillie et al. (1996) who claims that the FIGARCH (p,d,q) model can capture the long memory of financial volatility for daily equity returns through the fractional differencing parameter (d). As shown in Baillie et al. (1996), for 0<d<1, the conditional volatility $-\sigma_t^2$ will decay at a slow hyperbolic rate, which is a characteristic of a long memory. Numerous studies (see Stevenson (2002), Liow (2009))have provided convincing evidence that a long-term fractionally heteroskedastic (FIGARCH) process could adequately model the long-run dependence in real estate market volatility.
Uncovering a robust and permanent relationship between real estate volatility and returns' autocorrelation remains our primary purpose. Taylor (1986) supports the use of absolute stock returns as they exhibit slowly decaying autocorrelations, and Ding, Granger and Engle (1993) note the same result for daily stock returns.
Equation (1) and (2) are estimated for each market separately using Maximum Log-Likelihood functions and the SIMPLE and BFGS algorithms taking into account the fact that the d parameter is estimated as a late function.

IV. Empirical Results

The parameters of the model that capture any autocorrelation in the real estate returns are the β_2 and β_3 . The statistical significance of the constant term of autocorrelation, β_2 , is indisputable across all markets. This finding might be attributed to non-synchronous trading or inefficiencies of the real estate market. Moving a step further the negative sign and the statistical significance of β_3 requires inspection. Following this one could claim that **positive or negative feedback trading is an important component of long-term movements in the real estate markets**. Stated differently do real estate return dynamics share common features across national real estate markets?

Positive Feedback Trading (PFT) and FIGARCH Results
The cases of France,Hong Kong and Italy

The results of the real estate markets for France and Hong Kong suggest that returns exhibit positive serial correlation. Here, the positive feedback trading is important as the sign changes from (+) to (-) and $\beta_1$has a negative sign.The result of the real estate marketofItaly suggests that returns exhibit negative serial correlation. Here, the positive feedback trading is important and the sign changes from (+) to (-) and$\beta_1$has a positive sign.
In terms of volatility persistence, it is strong in France and equal to 0.46, having a long-term reverting effect. In Hong Kong, there is a stationary effect which is equal to 0.60. In Italy, the volatility persistence is mediocre and equal to 0.30, having a long-term reverting effect. This slight difference in the long-volatility memory in the three markets is due to the economic and institutional differences between the three countries. Campbell et al. (1997) support that long-memory effects could be explained

by non-synchronous trading. An implication of long-term dependence in volatility is that it is inappropriate to use short-term models to predict volatility in these two of the three real estate markets.
Diagnostic tests for residuals indicate that skewness is negative and kurtosis is larger than the value of 3 for Hong Kong and Italy. Thus, t-student distribution could be possible as well with serial correlation being stronger in France and Hong Kong and less effective in Italy. In particular, the Ljung-Box statistic is important and significant for both, simple and squared residuals for France and Hong Kong and not for Italy. However, the simple and squared residuals of serial correlation are quite larger for France and Hong Kong.

Negative Feedback Trading (NFT) and FIGARCH Results
The cases of Australia, Germany, Japan,andSweden

In these markets, there is a negative feedback trading ($\beta_3>0$) which results in positively autocorrelated returns ($\beta_2<0$). Sentana and Wadhwani (1992) assumed that this phenomenon occurs at low volatility levels as β_2 dominates to $\beta_3\sigma_t^2$. From the above, it can be deduced that the **negative feedback trading explains the positive autocorrelation in daily stock returns**. A similar explanation could stem from non-synchronous trading. Our results for the Australia real estate market suggest that the coefficient of (β_2) is negative and becomes positivewhen we consider the (β_3)coefficientranging from -0.016 to 0.015. The sign of β_2 is negative, indicating that non-synchronous trading or inefficiencies might be the cause of positive autocorrelation in return series. Positive autocorrelation is increased from the coefficient β_2 to the coefficient β_3 and, as a result, the market is influenced the most by feedback traders' strategies. Thus, this market should attract more opportunistic investors as feedback trading strategies are not limited and autocorrelation of returns is positive.
Our results for the Australia market suggest that returns exhibit a positive serial correlation. This finding could be attributed to the negative feedback trading, as the degree of positive feedback trading is not enough to offset this effect. Thus, negative feedback traders are more prevalent than positive. Similarly, we can interpret the results for the markets of Germany, Japan and Sweden as investors follow **negative feedback trading strategies with positive autocorrelation of returns**.
The result for Germany is **partly** in agreement with the results of (see Bohl and Reitz (2004))who found that during periods of high volatility **negative return autocorrelation due to negative feedback trading is generated**.
In terms of volatility persistence, this term is significant in the Australia real estate market and equals to 0.39. This means that this market is long-term reverting. The degree of fractional integration among the markets of Australia, Germany, Japan, and Sweden is in the range between 0.23 and 0.42 with the FIGARCH model, supporting long-term effects.In these markets, the long-term effect is found to play an important role, which means that the effects of shocks on volatility could die away in the long run rather than in the short-run.Thus, this result reveals that a FARMA model could be used for forecasting volatility, as long-memory models are more appropriate in these markets. The long-term volatility dependence shows that a forecasting model, which accounts for lower volatility persistence can be used.

Skewness is negative for all the real estate markets except for Japan and kurtosis is smaller than 3 for Australia and Japan. However, it is larger than 3 for the real estate markets of Germany and Sweden. This means that in the first two markets normal distribution best describes the behavior of returns except for volatility, however, in the latter two markets alternative statistical distributions are possible to be undertaken. In terms of returns' autocorrelation, in Australia only the Ljung-Box statistic for the standardized residuals is statistically significant at the 5% level. In addition, there is a full impact on standardized and squared standardized residuals as far as the serial correlation for the market of the Sweden real estate is concerned.Moreover,in Japan only the Ljung-Box statistic for the squared standardized residuals is statistically significant at the 5% level. Furthermore, the Ljung-Box statistic is not significant either for standardized or for squared standardized residuals for the real estate market of Germany.

The case of the UK

In this market, there is a negative feedback trading ($\beta_3>0$) which results in positively autocorrelated returns ($\beta_2<0$). Sentana and Wadhwani (1992) assumed that this phenomenon occurs at low volatility levels as β_2 dominates to $\beta_3\sigma_t^2$. From the above, it can be deduced that the **negative feedback trading explains the positive autocorrelation in daily stock returns**. A similar explanation could stem from non-synchronous trading. Our results for the UK real estate market are not similar to Sentana and Wadhwani (1992)'s results for the same stock market. They found that the coefficient of (β_2) is positive and becomes negative during the crash week ranging from 0.12 to -0.05. In our case, the coefficient varies from 0.004 to 0.009. The sign of β_2 is positive, indicating that non-synchronous trading or inefficiencies might be the cause of positive autocorrelation in return series. Positive autocorrelation is increased from the coefficient β_2 to the coefficient β_3 and, as a result, the market is influenced the most by feedback traders' strategies. Thus, this market should attract more risky investors as feedback trading strategies are not limited and autocorrelation of returns increases from coefficient β_2 to coefficient β_3. Our results for the UK market suggest that returns exhibit a positive serial correlation. This finding could be attributed to the negative feedback trading, as the degree of positive feedback trading is not enough to offset this effect. Thus, negative feedback traders are more prevalent than positive.

In light of volatility persistence, volatility memory is not limited, which indicates that the market is mean reverting, with an important degree of fractional integration, being equal to d=0.58.

Diagnostic tests for standardized residuals indicate that normality is present in the series and there is partial evidence of serial correlation in the series of standardized residuals. This is not however, the case for the squared standardized residuals. In addition, skewness is negative, which means that a negative autocorrelation in return series or residuals is feasible as well.

Does the long-term volatility in the real estate markets correlate negatively with the Feedback trading?

The results of long-term volatility are mixed, supporting that the stationarity of volatility memory for the markets of Hong Kong and UK is due to the feedback trading strategies. For the rest of the markets, for instance **Japan, Australia, Germany, France, Italy and Sweden** the **long-term** volatility memory is influenced by feedback trading strategies. Regardless of the market volatilities being **long-term or stationary**, there seems to be evidence of **negative or positive** feedback trading strategies. In addition, in seven out of the eight real estate markets, the sign is reversed, which shows that there is a link between long-term volatility and autocorrelation of real estate returns, being negative or positive. The exception is the **UK** real estate market.

V. Cumulative VAR Impulse Response Function for the real estate markets' volatility of the FIGARCH approach

Based on previous work by Conrad and Karanasos (2006) and Brunetti and Gilbert (2000) and Baillie et al. (1996), we state the cumulative impulse response coefficient λ of the FIGARCH (1,d,1) modelas:

$$\lambda(L) = 1 - \{[e(L)(1-L)^d]/[1-\beta(\mathrm{L})]\} \tag{3}$$

With the above in mind, the conditional variance of the FIGARCH (1,d,1) process could be written as:

$$h_t = \frac{c}{1-\beta(1)} + \lambda(\mathrm{L})\varepsilon_{\mathrm{t}}^2 \tag{4}$$

where, e(L) = 1-eL and β(L) = 1-βL. (5)

In the Appendix, Figures 1-8, feature the cumulative impulse response functions of the parameter estimates for the FT-FIGARCH(1,d,1) model with β, e , and d set to the values found by the models presented at Table 1-3 of the Appendix. It is worth mentioning that a shock of the past conditional variance to the future dies away at an exponential rate in the ARCH type models as opposed to a slow hyperbolic rate found in the FIGARCH model.

VI. Conclusions and Implications for Investors

The conducted empirical analysis suggests that volatility is negatively linked to returns' autocorrelation in the real estate markets of France, Hong Kong and Italy and positively to the real estate markets of Australia, Germany, Japan, Sweden and UK however, with unlimited negative trading strategies in the latter markets**.** The results are consistent with traders following feedback strategies with the possibility that non-synchronous trading gives rise to serial correlation in real estate returns. As long-term volatility increases, for instance in Germany and France, there are both significant negative and positive feedback trading with long-term reverting effects, respectively. One would expect an inverse relationship between returns' serial correlation and long-term volatility; our findings highlight such a straightforward situation in the series of real estate returns. This homogeneity, except for UK,is generated by the fact that positive feedback trading is followed by rising prices and negative feedback trading is induced by falling prices.

Summarizing our findings we provide supporting evidence to the hypothesis that autocorrelation persists for significant time-intervals and thus volatility dies away at a slow hyperbolic rate. A plausible explanation is rooted in the existence of risk aversion traders who interact with feedback traders in real estate markets and, if theyget anxious, they sell after price drops and volatility spikes. Further research should emphasize on the importance of non-synchronous trading in order to reveal additional effects arising from the impact of feedback trading on volatility.

Our analysis entails significant implications for the real estate markets under examination and investors therein. While negative feedback trading helps make markets less volatile, positive feedback trading is a source of market volatility. In particular, when a cycle of positive feedback continues for too long, it can create an asset bubble or a market crash as investors seem to speculate on the shorter term and avoid longer term investments. Therefore, market regulators should be aware of the existence of positive feedback trading in order to diminish the possibility of price distortion and escalating market volatility. Finally, for portfolio considerations investors should make their investment decisions based on the profitable feedback strategies available in real estate markets. In particular, when there is a negative (or positive) serial correlation between portfolio volatility and real estate return, the decision whether this asset should be included in an investor's portfolio depends on the feedback trading strategy that investors wish to follow.

References

Alkali, M., Sipan, I., NajibRazali, M., 2020.The effect of negative information on the volatility of real estate residential prices in Abuja, Nigeria. International Journal of Housing Markets and Analysis, Vol. 13 No. 2, pp. 267-280

Antoniou, A., Koutmos, G., Pericli, A., 2005. Index futures and positive feedback trading: evidence from major stock exchanges Journal of Empirical Finance, 12, 219- 238.

Baillie, R.T., Bollerslev, T., Mikkelsen, H.O., 1996. Fractionally integrated generalized autoregressive conditional heteroskedasticity. Journal of Econometrics 74, 3 – 30

Bohl, M. T., Siklos, P. L., 2008. Empirical evidence on feedback trading in mature and emerging stock market. Applied Financial Economics, 18, 1379-1389

Bohl, M. T., and Reitz, S., 2004. The influence of positive feedback trading on return autocorrelation: Evidence for the German stock market. Conference paper.

Brunetti, C. and Gilbert, C.L., 2000. Bivariate FIGARCH and Fractional Cointegration. Journal of Empirical Finance 7, 509-530.

Campbell, J. Y., Lo, A. W., &Mackinlay, A. C. 1997.The econometric of financial markets. Princeton University Press, Princeton.

Chau, F., Jing-Ming Kuo, Yukun Shi, 2015. Arbitrage Opportunities and Feedback Trading in Emissions and Energy Markets. Journal of International Financial Markets, Institutions and Money 36,130-147

Chau,F.,Deesomsak,R.,Lau,M.C.K.,2011.Investor sentiment and feedback trading: Evidence from the exchange-traded fund markets. International Review of Financial Analysis 20, 5, 292-305.

Chau, F., Deesomasak, R., 2015, Business cycle variation in positive feedback trading: evidence from the G-7 economies. Journal of International Financial Markets, Institutions and Money 35, 147-159.

Cheng, P. K. & Kim, Y.S. 2017. Speculative bubbles and crashes : Fundamentalists and positive-feedback trading, Cogent Economics & Finance, 5:1, 1381370.

Cifarelli, G., Paladino, G., 2010. Oil price dynamics and speculation: A multivariate financial approach. Energy Economics 32, 363-372.

Conrad, C., and Karanasos, M. 2006. ''The Impulse Response Function of the Long Memory GARCH Process.'' Economics Letters 90, 34–41.

Cotter, J. and Stevenson, S. 2008.Modeling long memory in REITs. Real Estate Economics 36, 533-554.

Davis, P., Zhu, H., 2009. Commercial property prices and bank performance.The Quarterly Review of Economics and Finance, 49, Issue 4,pp.1341-1359.

DeLong, B. J., Shleifer, A., Summers L. H. and Waldmann R. J. 1990. Noise Trader Risk in Financial Markets.Journal of Political Economy 98, 703 – 38.

Ding, Z., Granger C.W.J., and Engle, R.F. 1993. A long memory property of stock market returns and a new model, Journal of Empirical Finance I, 83-106.

Dolde, W., Tirtiroglu, D., 2002. Housing Price Volatility Changesand Their Effects. Real Estate Economics,30,1, pp. 41-66.

Engsted, T. and Pedersen, T.Q., 2014. Housing market volatility in the OECD area: Evidence from VAR based return decompositions, Journal of Macroeconomics 42, 91-103.

Faff, R.W., Hillier, D., McKenzie, M.D., 2005. An investigation of conditional autocorrelation in emerging markets. Review of Pacific Basin Financial Markets Policy 8, 467-499.

Heidi, F. and Saija, T., 2010. International Articles: Effects of international investments on the Finnish commercial real estate market. Journal of Real Estate Literature 18 (2).

Koulakiotis, A., &Kiohos,A. (2016) Positive feedback trading and long-term volatility links: evidence from real estate markets of USA, Be/Lux and Switzerland, Applied Economics Letters, 23:2, 97-100, DOI: 10.1080/13504851.2015.1054061

Koutmos, G. 1997. Feedback Trading and the Autocorrelation Pattern in Stock Returns: Further Empirical Evidence", Journal of International Money and Finance 16, 625 – 36.

Koutmos, D., 2012. An intertemporal capital asset pricing model with heterogeneous expectations. Journal of International Financial Markets, Institutions and Money 22, 1176-1187.

Kroencke, T.A., Schindler, F. 2012. International diversification with securitized real estate and the veiling glare from currency risk Journal of International Money and Finance 31, 1851–1866

Kyrkilis, D, Koulakiotis, A., Babalos, V., Kyriakou, M.,2018. Feedback trading and short-term return dynamics in Athens Stock Exchange Novel evidence and the role of size. International Journal of Managerial Finance Vol. 14 No. 5, pp. 574-590

Laopodis, N., 2005. Feedback trading and autocorrelation interactions in the foreign exchange market: further evidence. Economic Modelling, 22, 811-827.

Lee, C.L., 2009. Housing price volatility and its Determinants. International Journal of Housing Markets and Analysis Vol. 2 No. 3,pp. 293-308.

Liow, K. H., 2009. Long-term memory in Volatility: Some evidence from International Securitized Real Estate Markets. Journal of Real Estate Financial Economics 39, 415-438.

Nofsinger, J.R., Sias, R.W., 1999. Herding and feedback trading by institutional and individual investors. Journal of Finance, 54, 2263-2295.

Pearson N, Yang Z, Zhang Q. 2017. Evidence about bubble mechanisms: precipitating event, feedback trading, and social contagion. Work.Pap., Univ. Illinois, Urbana-Champaign

Qureshi,F., Kutan, A.M., Ismail, I., Gee, C.S. 2017. Mutual funds and stock market volatility: An empirical analysis of Asian emerging markets. Emerging Markets Review 31, 176–192

Salm, C.A., Schuppli, M., 2010. Positive feedback trading in stock index futures: international evidence. International Review of Financial Analysis, 19, 313-322.

Sentana, E. and S. Wadhwani (1992).Feedback Traders and Stock Return Autocorrelations: Evidence from a Century of Daily Data“, The Economic Journal 102, 415 – 25.

Shiller, R. J., 1990. Market volatility and investor association, The American Economic Review 80 , 58-62.

Stevenson, S. 2002. Momentum effects and mean reversion in real estate securities. Journal of Real Estate Research, 23(1/2), 47–64.

Taylor, S., 1986, Modelling financial time series (Wiley, Chichester).

Appendix

Table 1: PFT-FIGARCH(1,d,1) results for France, Hong Kong and Italy

$$r_t = \beta_0 + \beta_1\sigma_t^2 + (\beta_2 + \beta_3\sigma_t^2)r_{t-1} + \varepsilon_t$$

$$\sigma_t^2 = c + \beta\sigma_{t-1}^2 + [1 - \beta L - (1 - eL)(1 - L)^d]\varepsilon_t^2$$

Variables	France	Hong Kong	Italy
β_0	0.019 (0.001)*	0.005 (0.001)*	-0.002 (0.001)*
β_1	-0.009 (0.001)*	-0.033 (0.001)*	0.013 (0.001)*
β_2	0.005 (0.001)*	0.071 (0.001)*	0.083 (0.001)*
β_3	-0.014 (0.001)*	-0.003 (0.001)*	-0.010 (0.001)*
C	1.401 (0.001)*	0.508 (0.001)*	0.138 (0.001)*
B	0.046 (0.001)*	0.280 (0.001)*	0.054 (0.001)*
E	0.223 (0.001)*	0.147 (0.001)*	0.141 (0.001)*
D	0.461 (0.001)*	0.606 (0.001)*	0.309 (0.001)*

Log-likelihood	-12617.430	-13674.924	-14577.840
Skewness	-0.027	-0.216	-0.444
Kurtosis	2.671	3.261	5.364
LB(20)	50.520*	66.050*	26.662
LB^2 (20)	728.651*	56.325*	24.267

Notes: Table reports estimation results of Equation (1) and (2) for real estate markets of France, Hong Kong and Italy.(*)(**)(***) indicate significance at the (1%)(5%)(10%) level.

Table 2: NFT-FIGARCH(1,d,1) results for Australia, Germany, Japan and Sweden

$$r_t = \beta_0 + \beta_1\sigma_t^2 + (\beta_2 + \beta_3\sigma_t^2)r_{t-1} + \varepsilon_t$$

$$\sigma_t^2 = c + \beta\sigma_{t-1}^2 + [1 - \beta L - (1 - eL)(1 - L)^d]\varepsilon_t^2$$

Variables	**Australia**	**Germany**	**Japan**	**Sweden**
β_0	0.007 (0.001)*	0.030 (0.001)*	0.001 (0.001)*	0.003 (0.001)*
β_1	-0.025 (0.001)*	-0.004 (0.001)*	-0.024 (0.001)*	0.011 (0.001)*
β_2	-0.016 (0.001)*	-0.012 (0.001)*	-0.032 (0.001)*	-0.006 (0.001)*
β_3	0.015 (0.001)*	0.004 (0.001)*	0.016 (0.001)*	0.046 (0.001)*
c	0.099 (0.001)*	0.007 (0.001)*	0.083 (0.001)*	-0.913 (0.001)*
β	0.289 (0.001)*	0.032 (0.001)*	0.306 (0.001)*	0.054 (0.001)*
e	0.118 (0.001)*	0.058 (0.001)*	0.042 (0.001)*	0.054 (0.001)*
d	0.398 (0.001)*	0.230 (0.001)*	0.423 (0.001)*	0.086 (0.001)*
Log-likelihood	-11556.872	-13192.357	-14832.409	-14185.598
Skewness	-0.155	-0.737	0.615	-0.436
Kurtosis	1.414	14.230	1.524	5.088
LB(20)	32.365**	23.127	25.648	65.986*
LB^2 (20)	24.833	13.092	34.995**	462.779*

Notes: Table reports estimation results of Equation (1)and (2) for real estate markets of Australia, Germany, Japan and Sweden. (*)(**)(***) indicate significance at the (1%)(5%)(10%) level.

Table 3: NFT-FIGARCH(1,d,1) results for the UK

$$r_t = \beta_0 + \beta_1\sigma_t^2 + (\beta_2 + \beta_3\sigma_t^2)r_{t-1} + \varepsilon_t$$

$$\sigma_t^2 = c + \beta\sigma_{t-1}^2 + [1 - \beta L - (1 - eL)(1 - L)^d]\varepsilon_t^2$$

Variables	**UK**
β_0	-0.001 (0.001)
β_1	0.018 (0.001)*
β_2	0.004 (0.001)*
β_3	0.009 (0.001)*
C	0.112 (0.001)*
B	0.490 (0.001)*
E	0.088 (0.001)*
D	0.584 (0.001)*
Log-likelihood	-11546.943
Skewness	-0.130
Kurtosis	2.862
LB(20)	35.642**
LB^2 (20)	13.918

Notes: Table reports estimation results of Equation (1) and (2) for real estate market of UK. (*)(**)(***) indicate significance at the (1%)(5%)(10%) level.

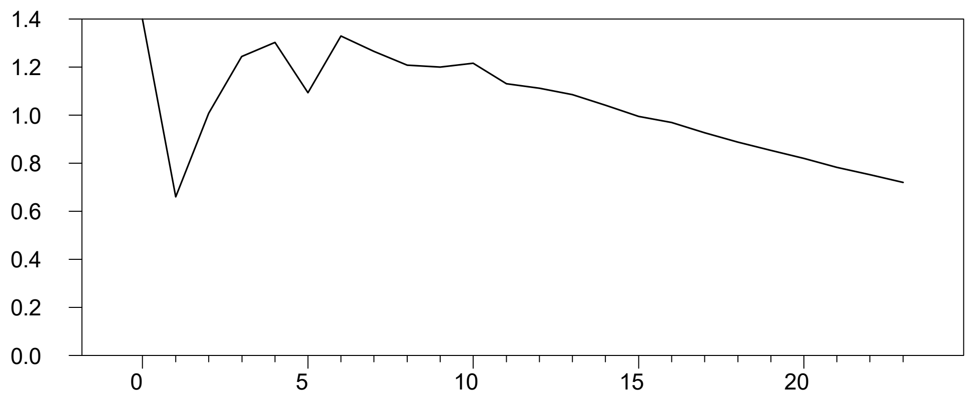

Figure 1: Cumulative Impulse Response Function for Australia

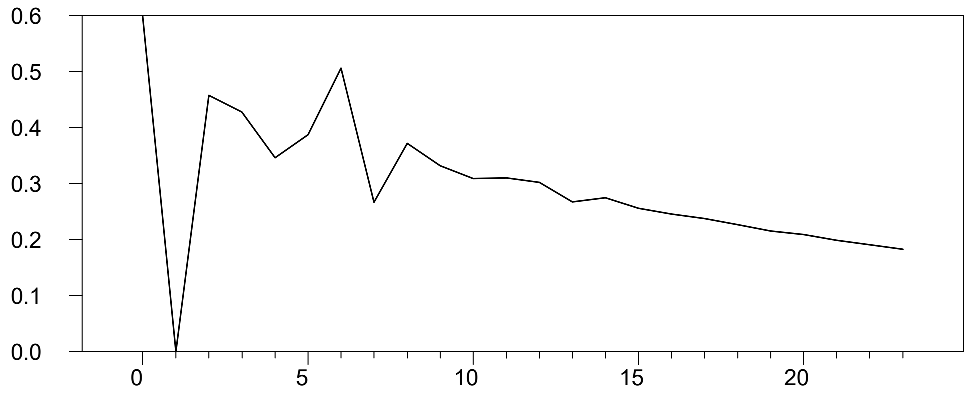

Figure 2: Cumulative Impulse Response Function for France

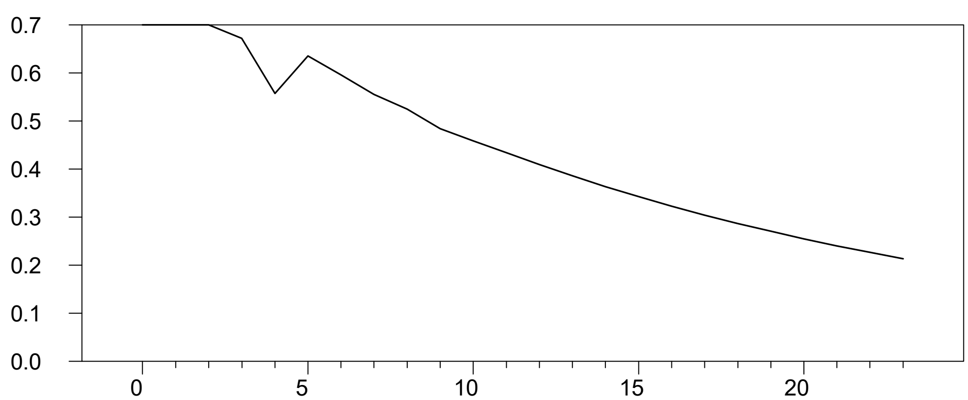

Figure 3: Cumulative Impulse Response Function for Germany

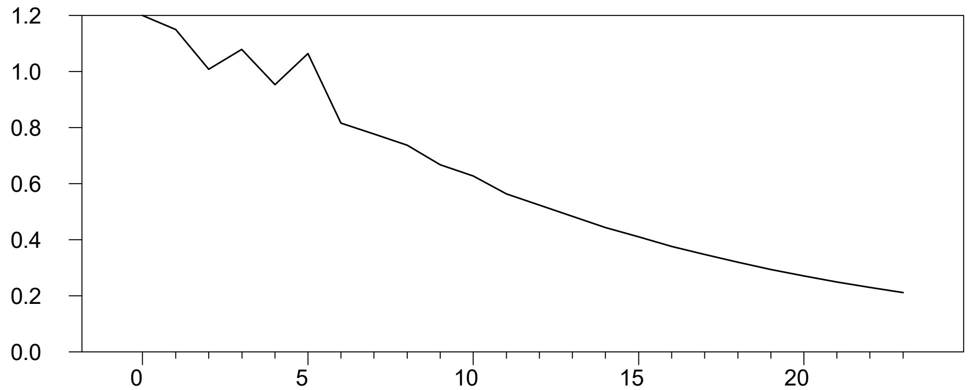

Figure 4: Cumulative Impulse Response Function for Hong Kong

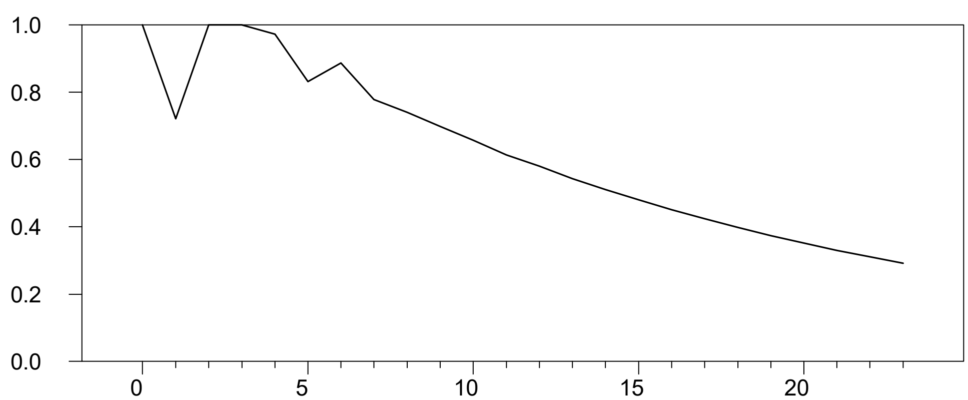

Figure 5: Cumulative Impulse Response Function for Italy

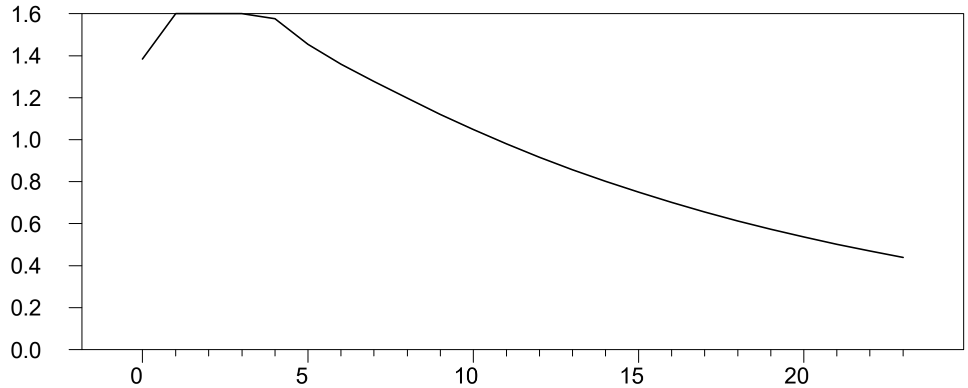

Figure 6: Cumulative Impulse Response Function for Japan

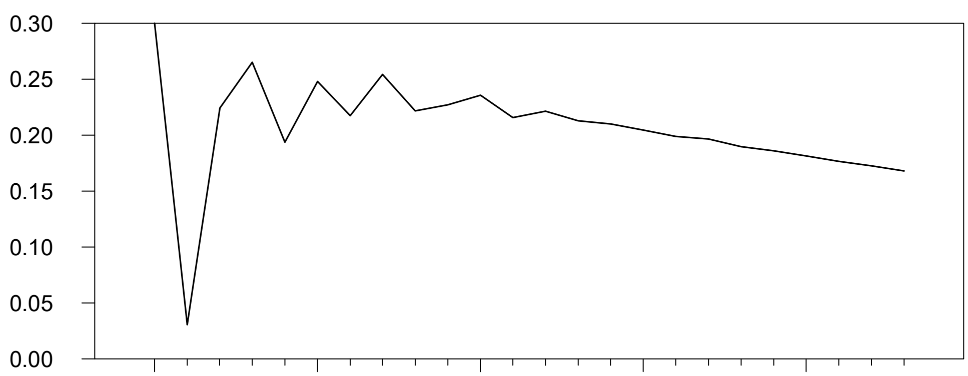

Figure 7: Cumulative Impulse Response Function for Sweden

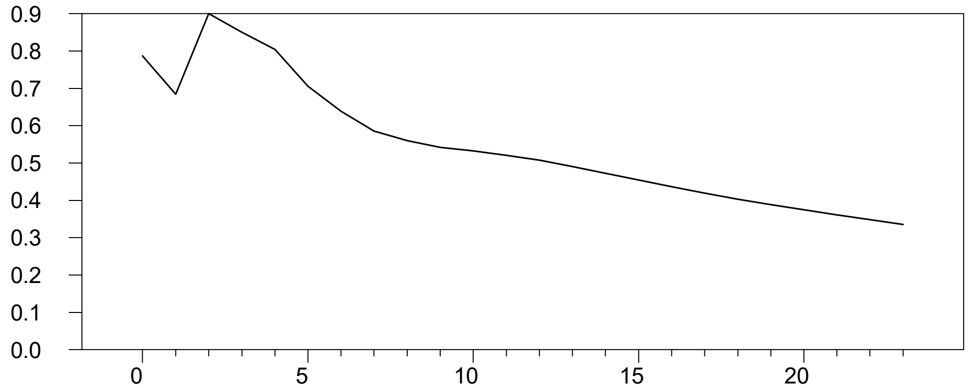

Figure 8: Cumulative Impulse Response Function for the UK