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The Impact of the US Real Estate Market on Other Major Markets During Normal and Crisis Periods

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Abstract

This paper utilizes a new contagion test based on case-resampling bootstrap technique to investigate whether there is any contagion effect in the interaction of the US real estate market with those of Australia, Japan and the UK arising out of the recent US real estate crisis or subprime crisis. Contrary to expectations, it is found that the relationship of the US market with the other markets following the US real estate market crisis cannot be characterized as one with contagion effect. Its relationship with the other markets is rather characterized by dependency behavior that prevails regardless whether the markets are under distress or not.

Running title: Testing for US Real Estate Market Contagion Effect

JEL Classifications: F36, G15, C22

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1. Introduction

The importance of the underlying relationship between variables during a period of crisis is paramount. Investors and policymakers pay attention to the issue of whether there are spill-over dynamics originating from one market to another for the duration of such a period. As a result of globalisation and increased integration among financial markets worldwide, this subject has increasingly become the centre of attention. These spill-over effects could simply be the result of the "normal" course of market interactions driven by the changes in fundamentals that govern the regular relationship between these markets. Spill-overs or co-movements during a non-crisis period reflect economic and financial interdependencies, such as trade linkages, systematic capital flows and banking linkages. However, these spill-over effects may go beyond the normal interactions as a result of the reaction of markets to non-fundamental news which drives markets to exhibit herding behaviour. In this situation, the spill-overs can then be characterised as one of contagion effect.

In this paper, we investigate the existence of international contagion effects in real estate markets. Knowledge of real estate markets contagion is highly valuable to property investors in their quest for diversification. The existence of contagion provides them with more motivation to diversify their real estate portfolios. The study of contagion has also important implications for the efficiency of real estate markets. The efficient market hypothesis implies that markets react instantaneously and properly to unanticipated information relative to economic fundamentals. Contagion is an evidence for market inefficiency as it emerges in situations where investors overreact to unanticipated external information without high quality fundamental analysis. Furthermore, knowledge of real estate markets contagion is also very valuable to regulators as this will allow them to develop policies that can contain or limit the effects of unwanted contagion, particularly since real estate is one of the most important sectors in a country's economy. The recent US sub-prime crisis where the real estate crisis spilled over into other sectors of the economy bears testimony to this scenario.

Specifically, in this study, we examine the extent by which the recent US real estate crisis or sub-prime crisis led into contagion in the real estate markets of other countries – in this case, the UK, Japan and Australia. Examining real estate market contagion with a focus on the US market is highly important and very topical. First, the recent US real estate market crisis has precipitated the still on-going global financial and economic crisis. Second, the US real estate market is the largest in the whole world and as will be explained in the next section, is highly globalised. Given the severity of the crisis and the great publicity it attracted worldwide, one would expect that the US market contagion effect on other real estate markets would have been very significant. One would think that the crisis would have driven investors away from the real estate markets in other countries for fear that what has happened in the US real estate market could happen to them. We therefore investigate the extent of contagion by the US real estate market crisis on the real estate markets of other countries. To what extent, therefore, did the US real estate market crisis trigger herd behaviour in the UK, Japanese and Australian real estate markets?

In our investigation, we make use of a new contagion test based on case-resampling bootstrap technique developed by Hacker and Hatemi-J (2005) that performs accurately when the financial markets are under distress and the standard assumption of normal distribution and constant variance is not fulfilled. We utilize this bootstrap test to both estimate the underlying parameters and to test their statistical significance. A more detailed discussion is provided later in the paper – in Section 3, with regards to the merits and details of this test vis-à-vis existing contagion tests.

The rest of the paper is organised in the following manner. The next section provides a discussion of contagion as it relates to real estate markets. Section 3 describes the test for contagion used in this paper. Section 4 discusses the data and presents the empirical results. The summary and conclusions are provided in the last section.

2. Contagion and Real Estate Markets

Conceptually, contagion is defined as spill-over effects that are caused by non-fundamental factors. There are a number of different explanations as to why contagion occurs. These explanations generally relate to information cascade as well as herd behaviour. The crisis in one market may trigger a domino effect when investors sell off similar assets in other markets. Knowledge about a crisis in one market may also lead to a general shift in sentiment regarding growth and earnings expectations in other markets (see Masson ,1999 as well as Kaminsky and Schmukler, 1999 for a further discussion). Thus, in these explanations, the reactions of other markets to a crisis in a certain market are not simply due to the changes that occur in the fundamentals that are shared between these markets. If the market reactions are simply due to changes in shared fundamentals, then this would just result in a high degree of co-movement during non-crisis and crisis periods. For example, as pointed by Glick and Rose (1999), shocks can be transmitted from one market to another because these markets are economically linked by trade. In this case, the increased co-movement is not considered to be contagion but rather simply as interdependence.

Theoretical models, therefore, often explain contagion through the role of an additional agent – essentially, global investors. These investor-related models include those based on herding behaviour, information correlation (King and Wadwhani, 1990), asymmetries or cascades (Calvo and Mendoza, 2000, and Yuan, 2005), portfolio re-balancing (Kodres and Pritsker, 2002), wealth constraints (Kyle and Xiong, 2001 and Yuan, 2005) and borrowing constraints (Boyer, Kumagai and Yuan, 2006). These models provide an explanation of how markets which are seemingly unrelated become linked when a crisis occurs in the context of international finance (Baur and Fry, 2008).

The liquidity-constraint models posit that when investors need to liquidate some of their holdings to raise cash which may be a result of margin calls, they may choose to liquidate their investments in other markets and in so-doing they therefore transmit the shock to these other markets (Calvo, 1999; Yuan, 2000). Banks can also serve as the transmission agents. When faced with problems in their loans in a country, they may attempt to protect their overall loan portfolio from deteriorating by decreasing their exposure in risky investments – which could be those located in other markets. The need for liquidity and protection of loan portfolios arising from a crisis in one market can therefore lead investors and bank to transmit the crisis into other markets.

Contagion can also be transmitted to other markets through the cross-market rebalancing action of investors based on the model of Kodres and Pritsker (2002). When a crisis occurs in a certain market, and the value of the investors assets in that market decrease, investors portfolios become overweight in that market. They may therefore act to re-balance their portfolios by decreasing their investments in other markets, and through this action, they therefore spill-over the crisis to other markets. Investors may be motivated to undertake this rebalancing as portfolio performance and incentive structures could be tied to certain benchmarks which require the maintenance of fixed weights for asset classes. Thus, if a huge group of investors are guided by these considerations, then there will be more cross-market rebalancing actions which will then result in greater contagion effects.

Under the information-based models of contagion, information pertaining to price changes in one market is perceived to have effects on the valuation of assets in other markets which therefore lead to price changes (King and Wadwhani, 1990). Information asymmetries and imperfect information may lead investors to conclude that the crisis in one market could also occur in other markets particularly the ones that share similarities with the crisis market. When a crisis occurs in one market and cross-market rebalancing is undertaken, this may lead to high volume of investment liquidation in other markets and therefore exacerbate the price changes in other markets (Calvo and Mendoza, 2000, and Yuan, 2005). This can happen when the cross-market rebalancing is done between markets with information asymmetries as the action may be interpreted by investors as information-based. Romer (1993) and Hong and Stein (1999) further argue that small price changes in a market can reveal substantial information to partially informed investors, which may lead them to rebalance their portfolios in other markets, thereby causing contagion (Jokipii and Lucey, 2007)[1].

1 There are still other channels of contagion which we do not discuss here further. Wealth constraints are one of them. Xiong (2001) studies wealth constraint as an amplification mechanism, while Kyle and Xiong (2001) study it as a spillover mechanism. Also, Gromb and Vayanos (2002) develop an equilibrium model of arbitrage trading with margin constraints to explain contagion. Contagion may be due to wealth effects.

It is claimed that real estate markets may be highly susceptible to contagion as these markets, particularly the US market, have become globalised over the past decade (Bardhan and Kroll, 2007). This globalisation has been mainly driven by the globalisation of real estate investments which has been facilitated by the rise of common real estate investment vehicles Eichholtz and Kok, 2007). For example, from 2001-2006, cross-border investments have tripled to a level of US$ 116 billion, which amounts to 20 percent of all property investment worldwide (Hobbs, Chin and Topintzi, 2007). Foreign capital inflows into a country can now easily find their way into the real estate market. In addition to globalisation of investment, other factors that have significantly contributed to the globalisation of real estate markets are the internationalisation of real estate service providers, the development of more transparent international benchmarks or standards in real estate across the globe such as the recently published Real Estate Transparency Index of Jones Lang LaSalle (JLL, 2008), the reduction of political barriers, and the liberalisation of capital markets which also give rise to new financial instruments which allow foreign investors similar or almost equal footing with local real estate investors (Eicholtz, et al, 2009). These developments lead into what La Porta, et al (2000) call as functional convergence of markets.

The globalisation and internationalisation of real estate markets will lead to increasing integration. This integration among markets can arbitrage away excess returns between markets and therefore convergence in returns among real estate markets worldwide after adjusting for risk, including country and currency risks, as markets become more efficient due to the availability of more global information that allow investors to make better informed decisions. It is also expected that this integration will lead to more co-movement of prices among real estate markets worldwide. However, the fact that real estate is “non-tradeable’ may moderate this co-movement between markets. As a result of this non-tradability, Bardhan et al (2007) show that real estate markets do not respond rapidly to international shocks as the effect of these shocks would have to go indirectly through local domestic variables rather than directly to real estate markets.

Real estate markets are therefore becoming globalised and integrated and therefore, it is expected that international contagion will occur in these markets. However, since real estate is non-tradeable, contagion in real estate markets will have to arise through the other channels which have been discussed earlier, such as in terms of investors liquidity, portfolio rebalancing and information channel. As also stated previously, real estate markets have been found not to respond rapidly to international shocks (Bardhan et al 2007). Hence, it is not clear to what extent would international contagion affect real estate markets.

Very few papers have investigated the issue of contagion among real estate markets globally, particularly in relation to the recent US real estate market crisis. This limited number of studies has come up with mixed results. Fry et al (2008) investigated, among others, contagion among the real estate markets of the US, the UK, Australia, Germany, Japan and Hong Kong using a contagion test that relies on changes in higher moments. The study found no evidence of contagion among the markets. Bond et al (2006) investigated the extent of contagion among the real estate markets of Australia, Hong Kong, Japan, Singapore and the US. Using a multivariate latent factor model, contrary to Fry, et al (2008), the study found existence of contagion among the markets. Mun (2005) investigated the extent of contagion among real estate markets of the Pacific Rim countries during four financial crises – Mexican, Asian, Russian and Brazilian. The study also found evidence of contagion effects among the markets. Wilson and Zurbruegg (2004) examined contagion of the Thailand real estate market on the markets of Australia, Hong Kong, Malaysia and Singapore but found little evidence for market contagion arising out of the 1997 Asian crisis. Both Mun (2005) and Wilson and Zurbruegg (2004) used the Forbes and Rigobon methodology to estimate contagion.

Thus, there is scope for the current study. The focus of our paper is the contagion effect of the US real estate market on those of the UK, Japan and Australia. As mentioned previously, we make use of a new contagion test developed by Hacker and Hatemi-J (2005) which is based on a pairwise bootstrap technique. This technique overcomes problems of non-normality and change in volatility that characterize financial data especially during crisis periods. We utilize this bootstrap test to both estimate the underlying parameters and to test their statistical significance. None of the existing papers on real estate market contagion has used this methodology.

3. Contagion Test

In terms of an operational definition of contagion, there is no general agreement within the literature. However, one that is highly used refers to contagion as "a significant increase in cross-market linkages after a shock to one country (or group of countries)" (Forbes and Rigobon, 2002). Based on this definition, a number of studies have been conducted that estimate the correlation coefficients between different markets (see for example, King and Wadhwani, 1990; Lee and Kim, 1993; Calvo and Reinhart, 1996; Forbes and Rigobon, 2002, Hon, Strauss and Yong, 2004; and Pretorius and Beer, 2004). Other commonly used methods for testing contagion include: (1) the use of the variance-covariance matrixes in an ARCH or GARCH context to investigate spill-overs between markets (see for example Hamao, Masulis, and Ng, 1990), (2) the examination of changes in a cointegrating vector between countries (see for example Longin and Solnik, 1995, and Granger, Huang, and Yang, 2000), and (3) the investigation of the determinants of different markets' susceptibility to financial crises (see for example Eichengreen, Rose, and Wyplosz, 1996; and Forbes, 2004).[2]

[2] Forbes and Rigobon (2002) provide a review of contagion tests based on cross-correlation coefficients and other methods which are used in some of the articles mentioned here. Still another empirical approach in testing for contagion is to examine whether Granger causality changes during the crisis period, as used for example in Granger, Huang, and Yang (2000) and Hatemi-J and Roca (2005).

Although contagion tests based on the changes in correlation coefficients seem straightforward, Forbes and Rigobon (2002) pointed out that the increase in correlation between markets after the crisis could be biased if the volatilities also increased. They therefore calculated correlation coefficients that are adjusted for the changes in volatilities. Based on asymptotic t-distribution, they then tested whether the increase in adjusted correlations after the crisis are statistically significant. Their results show that, contrary to the results of many previous studies, in a number of crises, the increase in adjusted correlations were not statistically significant, and thus, contagion effects were not present.

Forbes and Rigobon (2002) therefore adjust the correlation coefficients to remove the bias created by the change in volatility between periods when there is no change in the true regression slope coefficient.[3] Hatemi-J and Hacker (2005) suggest being more direct by concentrating on the estimated slope coefficient in a regression of a financial variable in one market versus a financial variable in another instead of on the correlation coefficient between these variables. The authors develop a case-resampling bootstrap test for contagion that performs accurately when the financial markets are under distress and the standard assumption of normal distribution and constant variance is not fulfilled. A statistical software component that is developed by Hacker and Hatemi-J (2009) is used to do the calculations. To test for the contagion effect we make use of the following regression:

$$R_{i,t} = a_1 + a_2 D_t + b_1 R_{US,t} + b_2 D_t R_{US,t} + u_t, \qquad (1)$$

The denotations are defined as the following:

$R_{i,t}$ is the continuous return of the real estate market for Australia, Japan or the UK at time *t*. $R_{US,t}$ is the continuous return for of US real estate market. D_t is an binary indicator variable that has a value equal to zero for the period before crisis and it has a value equal to one for each observation during the period after the crisis. The break period is $t \geq 2007:08:01$. The stochastic error term is denoted by u_t. This error term does not have to be necessarily normally distributed with constant variance because the method that we are applying does not require these assumptions. If the parameter b_2 is statically significant it means that the contagion effect prevails.

A new bootstrap approach that performs accurately when the data is non-normal with time varying volatility has been developed by Hatemi-J and Hacker (2005). This method is used to estimate and test the statistical significance of the parameters a_1, a_2, b_1 and b_2 in model (1). In order to describe the method compactly we express equation (1) in matrix format as

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[3] Forbes and Rigobon (2002) show that their adjustment is algebraically equivalent to one suggested by Boyer, Gibson, and Loretan (1999) and Loretan and English (2000).

$$Y = BX + u \tag{2}$$

where

$$Y = \begin{bmatrix} R_{i,1} \\ R_{i,2} \\ \vdots \\ R_{i,T} \end{bmatrix} \text{ a } (T \times 1) \text{ vector, } X = \begin{bmatrix} 1 & R_{US,1} & D_1 & D_1 R_{US,1} \\ 1 & R_{US,2} & D_2 & D_2 R_{US,2} \\ \vdots & \vdots & \vdots & \vdots \\ 1 & R_{US,T} & D_T & D_T R_{US,T} \end{bmatrix} \text{ a } (T \times 4)$$

matrix,

$$B = \begin{bmatrix} a_1 & a_2 & b_1 & b_2 \end{bmatrix} \text{ a } (4 \times 1) \text{ vector, and } u = \begin{bmatrix} u_1 \\ u_2 \\ \vdots \\ u_T \end{bmatrix} \text{ a } (T \times 1) \text{ vector.}$$

The ordinary least squares estimator for the parameter vector is provided by

$$\hat{B} = \left(X'X \right)^{-1} X'Y . \tag{3}$$

The pairwise bootstrap approach is implemented via the following steps:

1. First, create the variables *Y* and *X* by means of resampling with replacement (indicated as Y^* and X^*) , i.e. produce:

   $Y^* = \{Y_1^*, Y_2^*, \cdots, Y_T^*\}, \quad Y_i^* \in Y \; \forall \, i.$ Where $i = 1, \cdots, T.$ Where *T* is the size of the bootstrap sample. Likewise

   $X^* = \{X_1^*, X_2^*, \cdots, X_T^*\}, \; X_i^* \in X \; \forall \, i.$ Where $i = 1, \cdots, T.$

2. Second, we estimate the parameters ($\hat{B}$) using Y^* and X^*. That is , we estimate

   $$\hat{B} = \left(X^{*'} X^* \right)^{-1} X^{*'} Y^* .$$

3. Third, we repeat the two above steps *N* times. We repeat the simulations *N* =10000 times.

4. Finally, we acquire the casewise bootstrap coefficient vector ($\hat{B}^*$) by taking the median. The median is used instead of the mean value because the mean value is sensitive to the extreme values.

We apply the bootstrap method to test the statistical significance of each element in $\hat{B}^*$. In particular, we perform the following procedures to obtain the casewise bootstrap p-value that corresponds to the hypothesis $H_0 : rB = 0$, where *r* is a four by one vector that identifies the restrictions. For instance, if the null hypothesis $a_1 = 0$ is tested, then $r = [a_1 \quad 0 \quad 0 \quad 0]$.

As a first step in deriving the bootstrap p-value for rB, we rank the calculated values for $\hat{B}^*$. If the estimated value of the median for rB^* is greater than zero, then the p-value is equal to the proportion of elements in the bootstrap distribution for rB^* that are negative plus those that are greater than twice the median. On the other hand, if the estimated median for rB^* is less than zero, then the p-value is the proportion of elements in the bootstrap distribution for rB^* that are positive plus the proportion of elements in rB^* that are less than twice the median. P-values that are analogous to those associated with symmetric two-sided tests in traditional hypothesis testing are generated by the cut-off point of twice the median of rB^*, as explained in Hatemi-J and Hacker (2005).

4. Data and Empirical Results

In this paper we test for contagion effect from the US real estate market to Australia, Japan and the UK real estate markets. As stated earlier, it is not clear theoretically as well as from the literature as to the extent by which contagion effects can characterise the interaction in real estate markets. In this section, we present the empirical results derived from the application of the Hatemi-J and Hacker (2005) contagion test.

4.1 Data

For purposes of diversification, real estate serves as an important component of investors' portfolios due to its many attractive characteristics such as its stable and predictable increase in value over time, its strong performance yet low correlation vis-a-vis such traditional asset classes as stocks and bonds domestically and across countries, and , especially, for its ability to act as an inflation hedge which has been documented, for instance, by Hudson et al (2003) among others (Yunus, 2009 and Bond et al 2006). However, physical real estate has the drawback of being "lumpy" and "relatively illiquid". The processing of transactions relating to investment in physical properties may drag on for six months to even one year (Bond and Hwang, 2004).

An alternative method for investing in real estate that overcomes these disadvantages of physical real estate is investing through real estate securities. As pointed out by Yunus (2009), since the advent of securitization in the early 1960s and especially over the last decade, REITs (real estate investment trusts), REOCs (real estate operating companies) and private indirect vehicles have emerged as viable alternatives to domestic commercial real estate ownership, making real estate available, albeit indirectly, to a wide audience. With institutional investors' increased demand for these securities, countries other than the US have also started to introduce tax-transparent REITs or REIT-like structures throughout the world, thereby fostering the growth and indirectly promoting the transparency of the global real estate securities market. This growth is evidenced by the fact that, according to NAREIT, the global market capitalization of publicly traded property securities has grown 170% from approximately $350 billion to $945 billion over the 7-year period beginning January 2000 and ending March 2007.[4]

In this paper, we therefore focus on the securitised (equities) segment of the real estate market. By doing so, we are able to use higher frequency data than what can be obtained from the direct real estate market. This is advantageous in the investigation of contagion since contagion is often transmitted between markets in short time horizons. The data employed in this study consist of publicly traded real estate stock price indices, quoted on a weekly basis, from Datastream for the four real estate markets under study, namely the United States, United Kingdom, Japan and Australia — over the period 2005 to 2009. "Datastream's Real Estate Index aims to represent securitized real estate markets. The Thomson Datastream database constitutes the universe from which the index is drawn. Companies included in the index represent around 75-80% of the total market capitalization. Suitability for inclusion in the index is determined by market value and availability of the data. There are no liquidity requirements as well as no adjustments for non-public holdings of shares or for cross-holdings. The index constituents are reviewed at a quarterly basis and re-set to represent the new top group of stocks by market value" (Serrano and Hoesli, 2009).

The period of the structural break is chosen to be at August 1, 2007 because this was when the real estate problem developed into a crisis (Kiff and Mills, 2008 and Dell'Ariccia, et al, 2008 and Frank and Hesse, 2009). We provide a brief account, in the subsequent paragraphs, as to how the crisis US real crisis eventuated in the summer of 2007. The beginnings of the crisis can actually be traced back to the middle of 2005 when home repayment delinquency rates actually started to pick up which then continued to increase in 2006 (Federal Reserve Bank of San Francisco 2008). By the middle of 2006, housing prices in the US began to decline and sub-prime mortgage foreclosures started to increase (OFHEO 2008a). Mortgage lenders with re-purchase provisions for their loans were called upon to undertake repurchases in the fourth quarter of 2006 (Krinsman 2007) but at the same time,

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[4] In terms of absolute value, Wilson and Zurbruegg (2003) report that the US has the largest securitised property market (known as Real Estate Investment Trusts or REITs), although, proportionately, the US securitised sector is smaller than some of the securitised property markets of Asia or Europe. For instance, about 55% of all institutional grade real estate recorded in the Australian Property Council's database is listed, compared with similar listings for the US of 18%, the United Kingdom of 17% and Japan of 10%, as pointed out by Steinert and Crowe (2001).

investment banks started shutting down credit lines to independent mortgage lenders (Tavakoli 2008). This therefore resulted in a funding difficulty for those lenders who were undertaking repurchases of delinquent mortgages (Greenlaw et al. 2008).

It was not, however, until the summer of 2007 that this situation developed into a full-blown crisis. This was precipitated by deteriorating quality of U.S. subprime mortgages, a credit, rather than a liquidity event. Increased delinquencies on subprime mortgages, driven by rising interest rates for refinancing and falling house prices, resulted in uncertainty surrounding the value of a number of structured credit products which had these assets in their underlying portfolios. As a result, rating agencies downgraded many of the related securities and announced changes in their methodologies for rating such products. This rapidly propagated across different asset classes and financial markets. The rating agencies began issuing warnings about subprime real estate mortgage backed securities and collateralised debt obligations (CDOs) in the spring of 2007. By April, New Century Financial Corporation, the second-largest subprime lender in 2006, succumbed to borrower defaults—one of many such lenders to disappear. In June, two Bear Stearns hedge funds failed, brought down by their investments in subprime CDOs—especially toxic waste tranches; one of the funds was leveraged by more than 21-to-1 (Kelly and Ng 2007). In July, the credit-rating agencies downgraded hundreds of subprime tranches. The German bank IKB took a substantial hit on U.S. subprime mortgage investments and required an emergency infusion of funds from shareholders and the German government. In August, the French bank BNP Paribas was forced to halt redemptions from three funds that could not be valued because their subprime holdings had become so illiquid. During the summer of 2007, liquidity therefore evaporated in the credit markets for short-term papers with mortgages representing the single largest type of collateral and with holders of short-term papers not knowing how much of these backed up by sub-prime mortgages (Criado and Van Rixtel 2008). The US real estate and sub-prime crisis had indeed truly arrived in the summer of 2007.

4.2 Diagnostic Test Results

The continuous return of each variable is used. The data were tested for normality and ARCH effects. As can be seen from Table 1, the null hypotheses of normality and no ARCH effects were strongly rejected. Thus, the standard methods might not function well in this case.

Table 1: Descriptive statistics and diagnostic tests.

Country	Mean	SD	Max	Min	P-value of Normality Test	P-value of ARCH test
Entire Sample Period						
US	-0.11109	2.3043	12.3395	-11.0562	0.00001	0.00001
Japan	-0.0605	2.4195	5.83110	-8.07671	0.00452	0.00001
UK	-0.1471	2.0654	7.44810	-8.74501	0.00001	0.00001
Australia	-0.1577	1.8988	8.18784	-9.08277	0.00001	0.00800
Before the Crisis						
US	0.08534	1.08320	2.5185	-3.7819	0.00001	0.68050
Japan	0.22751	1.71917	5.36459	-5.1819	0.06032	0.00300
UK	0.07290	2.06540	4.42530	-3.7498	0.00019	0.00290
Australia	0.06775	0.89626	2.57460	-3.3271	0.02348	0.53330

After the Crisis						
US	-0.40272	3.37551	12.33951	-11.0562	0.000017	0.01730
Japan	-0.46877	3.15830	5.83110	-8.07671	0.66077	0.01080
UK	-0.46877	2.88460	7.44810	-8.74501	0.21713	0.0288
Australia	-0.50981	2.76395	8.18784	-9.08277	0.09946	0.58650

Note: The Jarque-Bera test for normality is used. Engle's LM test is used to test for ARCH effects.

The return for each market is reduced for the period after the crisis compared to the period before the crisis. Further, the volatility has increased for each market. The tests show that the data set is non-normal and ARCH effects prevail, especially for the entire sample. These diagnostic tests point to the fact that the standard methods based on the assumption of normality with constant volatility would not perform accurately. Thus, the application of the pairwise bootstrap approach is of paramount importance in this case in order to be able to draw valid empirical inference.

We have also tested for unit roots in order to avoid spurious results. The test results that are presented in Table 2 indicate that the null hypothesis of one unit root can be rejected for each individual returns as well as the series within a panel as a group.

Table 2: Unit root test results.

Variable	H_0: I(1), H_1: I(0)
US	0.00001
Japan	0.00001
UK	0.00001
Australia	0.04302
Panel	0.00000

Note: The Phillips-Perron test was used for testing the null hypothesis of one unit root in each individual series. Im, Peseran and Shin test was used to test for the panel unit root. The p-values are presented.

4.3 Results of Contagion Test

We apply therefore the Hatemi-J and Hacker (2005) contagion test to circumvent these statistical problems. The empirical results are presented in Table 3. Based on these results we can deduce that the relationship between the US real estate market and other three markets cannot be characterised by contagion but rather dependency that prevails regardless of which state (normal or distress) that the markets are in. This is based on the fact that the negative change in the slope is not statistically significant in any case. It should be mentioned that the intercept, which can be considered as a measure of risk premium for investing in the US real estate market is not statistically significant in any of the cases investigated. This seems to be true in the sub-periods before as well as after the crisis.

Table 3. The results based on case-resampling bootstrap method.

Country	Intercept (a_1)	Change in Intercept (a_2)	Slope (b_1)	Change in Slope (b_2)
Australia	0.0588 (0.4209)	-0.3528 (0.1415)	0.3021 (0.0003)	-0.0329 (0.8257)
Japan	0.1686 (0.2304)	-0.4695 (0.1035)	0.5651 (0.0001)	-0.2651 (0.1446)
UK	0.0397 (0.6737)	-0.2139 (0.3229)	0.5833 (<0.0001)	-0.0424 (0.7398)

Notes:

The parameters are estimated by case-resampling bootstrap method. Median values are presented.

The p-values based on the casewise bootstrap approach are presented in the parentheses.

Thus, in spite of the great publicity and the panic in financial markets and the economic crisis that ensued, our analysis based on a new contagion test developed by Hacker and Hatemi-J (2005), shows that the US real estate market crisis did not bring contagion effects on the real estate markets of other countries. Our results are in line with the recent study of Fry, et al (2008).

5. Conclusions

In this paper, we apply a new contagion test to investigate whether there is any contagion effect between the US real estate market with those of Australia, Japan and the UK. This new contagion test is based on a case-resampling bootstrap approach that performs accurately during a crisis period in which the assumptions of normality and constant variance are not fulfilled. Inspite of the severity of the US real estate crisis, we find that the relationship of the US real estate market with the other markets is not characterized by contagion effects but by simply a dependency behavior that prevails whether the markets are under distress or not. Thus, even with the globalization of real estate markets, it appears that these are less susceptible to contagion effects arising from international shocks. This indicates that real estate markets' interaction is guided more by fundamentals rather than by non-fundamentals that create herding behavior. These results also imply that real estate markets are efficient in processing information from each other. Our finding also support the desirability of real estate as a component of investment portfolios since the absence of contagion effects can lead to more stable correlations. Given that the real estate industry is a major cornerstone of major economies, our finding also provides positive news for economic regulators and policymakers.

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