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Stock Prices and House Prices: Which one affects the other?

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Abstract:
Stock and house are two major assets which play important roles in the balance sheet of Iranian households. Changes in the two markets have a large influence on wealth and the general economy. The purpose of this study is to examine the relationship between stock and house prices over a thirty-year period using vector auto-regression (VAR). Using yearly data for the period from 1985 to 2013, we conducted a Granger-causality test and Impulse response functions (IRF). The causality test is performed with control variables and the results supply evidence on the bidirectional relationship between house price and stock price. Impulse response function is estimated in order to investigate the size and timing of the causality. The IRF concludes that, when the impulse is stock price, every response of house price is most positive and the values fluctuate around the line zero at each time period.

JEL classification**:** C22, G10, R30

Keywords: *House prices, Stock prices, VAR, Causality, Impulse response functions, Variance decomposition, Iran*

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1. Introduction

In the majority of worldwide countries, changes in the real estate market are large and significant parts of the future trend of the overall economic activities. The number as well as the quality of investments in the real estate market, tends to affect development of the entire economy. Therefore, a rising crisis in the real estate market would be very critical for the future of the economy, in terms of productivity growth, employment and income growth. At the same time, unforeseen capital gains arising in the stock market lead to higher consumption spending, due to the presence of the wealth effect, and, in turn, to higher income and employment (Apergis and Lambrinidis, 2011). However, these two markets have different characteristics; they have intrigued homebuyers and investors since both offer investment opportunity and influence future wealth of households. Stock market as a convenient investment means with low transaction cost is more volatile and more liquid, whereas, real estate is heterogeneous with high transaction cost and low liquidity. As Lin and Fuerst (2014) stated, the distinctive asset characteristics have made the two assets potential risk diversifiers for each other in portfolio management.

The relationship between these two markets became the focal point of interests among researcher. Apergis and Lambrinidis (2011) specified that the issue of the relation between the two markets is of great significance because it also implies the presence of non-periodic investment cycles that could affect investor’s asset allocation strategies in various maturities. Andersson (2014) stated that understanding the relationship thoroughly is necessary for restricting large fluctuations of wealth. These fluctuations may also affect the wellbeing of the general economy. Moreover, it is crucial from the perspective of a policymaker to clearly understand how a potential relationship between the two markets works. Lin and Fuerst (2014) argued that identifying such an integrative relationship provides insights for portfolio management and government policy. If real estate markets are found to be segmented from stock markets, this would allow investors to have a better diversified portfolio and lower systematic risk. The joint effect of such portfolio strategies can affect their overall wealth, consumption behaviours, aggregate demand and employment in one country. Li *et al.*, (2015) suggested in the U.S. economy, house ownership and stockholding comprise the two largest and principal components of wealth. Movements in their market values can dramatically affect the economic condition of families and businesses and, hence, affect the overall growth of the U.S. economy. Booms and busts in housing and stock markets have always played an important role in U.S. business cycle history. Also, Yuan *et al.*, (2014) cited the potential dynamic relationship between house and stock prices has been the subject of substantial debate in both academic and practitioner literature. Pinpointing the relationship between stock and house markets is essential to explain the housing price dynamics of an economy, since it is one of the leading indicators of real economic activity, inflation or both and hence serves as indicator to where the real economy is heading to. Hence, the linkage between real estate and financial assets is important to investigate in order to assess the transmission mechanisms between these two asset classes and develop a more comprehensive understanding of the role that each asset has in portfolio diversification. This requires an understanding of the directions and magnitude of relationships between these two markets.

Most empirical studies on the relationship between house prices and stock prices were conducted in the context of developed countries and few studies investigated this relation in developing countries. For instance, in U.S and U.K many studies focused on this relation and found negative correlation between housing and stock returns (see Ibbotson and Siegel, (1984), Hartzell (1986), Gyourko and Keim (1992), Worzala and Vandell (1993), Eichholtz and Hartzell (1996), Bonnie (1998)). Sim and Chang (2006) by using VAR model found that house and land prices influence stock prices in Korea. Hoesli and Hamelink (1997) who studied this issue in Switzerland and Eng (1994) in

Singapore point to the integration between the two markets. Fu *et al.,* (1994) and Oliver (1993) and Wilson *et al.,* (1996) support the existence of segmentation between the two markets in Hong Kong and Australia respectively. To the best of our knowledge, no empirical study has been carried out to give a complete picture of the relationship between the two before mentioned markets in Iran and this paper is the first attempt to introduce this subject. In doing so, we aim at exploring the linkage between stock market and house market in Iran by using yearly data from 1985 to 2013. The hypotheses are to examine the relationship and causality between these two markets by using VAR regression.

The outline of this article is as follows: Section 2 as usual presents the relevant literature. Section 3 describes wealth and price effects. Section 4 investigates the market segmentation or integration analysis. The model specification is supplied in section 5. Section 6 explains the econometric results and their significance. Section 7 concludes.

2. Literature review

Since the late 20th century the relationship between stock prices and house prices has got a lot of attention in both academic and practitioner literatures. Economists and interested researchers have been discussing this relation from several aspects and using different methods of analyses, whether in developed countries or the more advanced Asian countries (Batayneh and Al-Malki, 2015). Some authors investigate the relationship in the framework of market segmentation/integration theory, some focus on the wealth/price effect, and others investigate the causality between the two markets.

The first group concentrates on the presence of integration or segmentation in the stock market and real estate market. Understanding market integration/segmentation across an economy is important, since disturbances in one market's fundamentals can drive capital movements of the relevant market. If stock and direct real estate markets are well integrated, then it implies that the two assets are good substitutes in investment allocations, such substitution having a significant influence on price fluctuations in the related market. Conversely, if the two markets are segmented, then this has significant implications for investment strategy that two assets can be included in a portfolio as means of risk reduction (Lin and Fuerst, 2014). The literature on this subject leads to ambiguous results. Some studies provide evidence in favour of segmentation, like Schnare and Struyk (1976), Goodman (1978, 1981), Grissom *et al.,* (1987), Kuhle (1987), Geltner (1990), Wilson and Okunev (1996), He (1998), and Ling and Naranjo (1999). On the contrary, some point to the close link between these two markets. Newell and Chau (1996) by using a simple correlation indicated the existence of a positive correlation between the stock and real estate markets. Ge and Lam (2002) built house price forecasting models for Hong Kong using quarterly time series data and suggested that stock index is one of the important variables in determining house prices. Also, Mei and Lee (1994), Li and Wang (1995), Oppenheimer and Grissom (1998), Ling and Naranjo (1999), Ambrose *et al.,* (2007), Zeckhauser and Silverman (1983), Miles *et al.,* (1990), Ross and Zisler (1991), Ambrose *et al.,* (1992), and Koh and Ng (1994) support the presence of an integration between the two asset markets.

The second group focuses on the wealth/price effect. Case *et al.,* (2005) examined wealth effect by using a panel of 14 industrial countries and a panel of U.S. states during 1980s and 1990s. They found weak evidence of stock market wealth effect and strong evidence that variations in housing market wealth have important effects upon consumption. Kapopoulos and Siokis (2005), in their study of house and stock price interaction in Greece, also found evidence of a wealth effect in Athens, in which there is a lot of investment in real estate, while other urban areas in Greece exhibited a credit-price effect. There are other studies like Chen (2001) in Taiwan, Jud and Winkler (2002) in U.S and Kakes and van den End (2004) in Netherlands.

The third group tries to examine this relation by the causality test. Kapopoulos and Siokis (2005) by using Granger causality scrutinized the relationship between real estate prices and stock prices in Greece. The results indicated that for Athens, stock prices cause real estate prices. Anderson (2014) investigated the relationship between the stock market and the house market in the U.S from 1987 to 2013. A bivariate correlation analysis and the Granger causality test, based on a vector auto-regressive model were applied. The bivariate correlation analysis concluded that a large and positive correlation exists between the two markets. All causality tests indicated a unidirectional causality running from the stock market to the house market. The results of a study in Thailand by Ibrahim (2010) indicated that housing prices and stock prices are co-integrated and that the stock market leads the housing market. Table 1 reports a summary on previous literature.

Table 1: Summery of previous researches

Authors	Methodology	Case study	Conclusion
Gyourko and Keim, (1992)	OLS	U.S	Lagged values of traded real estate portfolio returns can predict returns on the appraisal-based index after controlling for persistence in the appraisal series. The stock market reflects information about real estate markets.
Eng (1994)	VAR	Singapore	There exists a contemporaneous long-term relationship between property stock price index, real estate price index and three-month Treasury bill interest rate.
Wilson *et al.*, (1996)	Granger causality test and co-integration	Australia	Market integration between the real estate and securities markets is verified.
Quan and Titman (1999)	Cross sectional and fixed effect regression	Sample of 17 countries	With the exception of Japan, the contemporaneous relation between yearly real estate price changes and stock returns is not statistically significant.
Okunev *et al.*, (2000)	Linear and nonlinear causality test	U.S	Unidirectional causality running from the stock market to the real estate market.
Tse (2001)	VAR	Hong Kong	Changes in stock prices tend to move with residential and office property prices in the long run.
Green (2002)	Granger causality test	California	Evidence is consistent with the notion that stock values influence housing consumption in Northern California.
Kakes and van den End (2004)	VAR	Netherland	Stock price fluctuations have distributional effects across different segments of the Dutch housing market.
Yang and Ye (2010)	Pearson Correlation	China	Monthly returns on Chinese real estate and stock markets are not correlated.
Su (2011)	Threshold error correction model	Western European countries	Existence of long-run unidirectional and bidirectional causality between the real estate market and the stock market is confirmed.
Aye *et al.*, (2011)	Linear and non-parametric co-integration/ Granger causality test	South Africa	The nonparametric co-integration test revealed a long-run one-to-one relationship between the two series (house and stock), with the nonparametric Granger causality test indicating a bi-directional causality.
Shirvani *et al.*, (2012)	Granger causality test	U.S	The presence of bilateral causality between stock prices and home prices and between stock prices and consumer spending have been approved. The results also show unilateral causality from home prices to consumer spending.

3. Wealth and price effect

The interpretation of causality between real estate market (house) and stock market facilitates the duty of policymakers and investors to predict future performance from one market to the other through various mechanisms. Lean and Smith (2014) enumerated five channels in order to explain the potential dynamic interaction between house and stock prices.

The first mechanism is wealth effect. Price fluctuations, particularly those in housing prices, have been much emphasized in recent literature. More specifically, in light of recurring financial crises in many parts of the world, emphasis has been placed on the role played by stock price fluctuations in housing price dynamics. It is generally argued that, being both investment and consumer goods, housing prices may be affected by stock market fluctuations through the well-known wealth effect (Ibrahim, 2010). Wealth effect assumes that houses are investment and consumer goods. Therefore, as a result of the rise in the value of stock portfolio due to escalating stock prices, investors will feel more comfortable about their wealth which may motivate them to increase their demand for housing and shift the demand curve upward, causing real estate prices to rise (Batayneh and Al-Malki 2015). Many authors studied wealth effect such as Abelson *et al.,* (2005) for Australia, Kapopoulos and Siokis (2005) for Greece, Kakes and van den End (2004) for Netherlands, Chen (2001) for Taiwan, Ibrahim (2010) for Thailand. Also, Jud and Winkler (2002) and Benjamin *et al.,* (2004) studied the wealth effect of both housing and stock on consumption.

The second channel to explain the relationship between stock and house prices is the well-known credit price effect. In contrast, a credit effect implies the causal relationship running from house prices to stock prices. Here rising house prices (and more widely all real estate) can act as a form of collateral to credit constrained household and firms. This can lead to an increase in consumption from households and an increase in investment from firms. Both the increase in consumption and the increase in investment may ultimately lead to an increase in stock prices (through increasing expected future earnings from greater demand and firm efficiency). This therefore, in turn can fuel a round of wealth effects arising from higher stock prices and an upwards price spiral for both stocks and housing could occur (McMillan, 2012). Sim and Chang (2006) investigated the credit price effect in Korea.

Stock prices may have an impact on house prices through channels other than wealth exposures and price effect. Stock prices are likely to reflect firms' profitability and profit-related remuneration of employees, such as bonuses. Hence, an increase in stock prices will generate an increase in the demand for housing as both consumption and investment goods, which will, in turn, results in higher housing prices.

The fourth mechanism is composition risk, which relates changes in asset prices to changes in expenditure share. Piazzesi *et al.,* (2007) presented a model of composition risk in which changes in the expenditure share on housing drives asset prices and the expenditure share on housing forecasts excess stock returns. Investors concern with consumption risk, which relates changes in aggregate consumption growth to asset prices, implies that stock prices move with the business cycle. During downturns in the business cycle, as investors expect higher future consumption, they sell stocks to increase current consumption, which drives stock prices down. In Piazzesi *et al*.'s (2007) model, inter-temporal substitution in consumption increases the downward pressure on stock prices when the share of housing consumption is low. However, an increase in composition risk; i.e., fluctuations in the relative share of housing in one's consumption basket, strengthens investors' precautionary savings motive. For risk-free assets, precautionary savings mitigate downward pressure on stock prices generated by the inter-temporal substitution mechanism.

Fifth, sluggish and auto-correlated adjustment of housing prices to shocks in the fundamentals is likely to create lead-lag relations between stock and housing price movements. Because housing prices are slower than stock prices to adjust to shocks in the economic fundamentals, the lead-lag relations identified by Granger causality can be due simply to the slow adjustment of the housing market. To put it differently, while economic fundamentals are important factors responsible for movements in housing prices, housing prices might react slowly to shocks in the fundamentals (see e.g. Clayton, 1996 and Himmelberg *et al.*, 2005).

In addition to these channels, a theory has been proposed by Markowitz (1952). It is based on the expected risk and expected return of a portfolio. The main purpose is to maximize the expected return or reduce the variance. The risk or return of assets contributed in the portfolio must be evaluated (by investors) together rather than individually. By looking at the overall contribution, it is possible to control for a desirable level of expected return and expected variance. To achieve this, the investor puts different weights to the assets in the portfolio depending on the objective (Elton *et al.*, 2010). If the value of stocks or houses changes, the weights in the portfolio shift. Hence, the expected return and variance is affected. If the holder of the portfolio is unhappy with this new distribution, they need to rebalance the portfolio which is achieved by selling/purchasing assets. To simplify the analysis, it is assumed that the household’s portfolio consists of only stocks and houses and the only way to shift weights is to increase/decrease the holdings of these two assets. It is also assumed that the holder´s objective is to keep weights constant. In other words, the holder of the portfolio wants a constant risk and return distribution. An increase in stock prices increases the value of stocks in the portfolio which disturbs the weights. To rebalance the portfolio and to keep weights constant, the portfolio manager must decrease the holdings of stocks and increase the holdings of houses. The demand for houses increases and thus the price should increase. According to the reasoning above, the two markets do affect each other (Andersson, 2014).

4. Market integration/segmentation analysis

Another approach to study the relationships is to answer the question of market segmentation (integration) across real estate and stocks, which would contain direct ramifications for practitioners. Generally speaking, two approaches have been adopted to determine whether real estate and stock markets are integrated or segmented (Wilson *et al.*, 1998). The first kind of approach is based on asset pricing model characterized by identifying the fundamental macroeconomic factors determining the returns of real estate and stocks. The second kind of approach centers on forming the behavioral features of stock and real estate prices over the long horizon without considering the underlying macroeconomic variables.

(a) Asset-pricing model

Within the asset pricing framework, property market is generally found to be segmented with the stock market when un-securitized appraisal-based data are used as a proxy for the property market. The opposite results would be presented if the securitized data serves as a proxy for the property market. Table 2 summarizes the empirical findings on the issue of market integration under an asset-pricing framework.

Liu *et al.,* (1990), for the first time, explicitly examined the extent of segmentation between the real estate and stock markets using a capital asset pricing model. These authors found conflicting evidence on whether the real estate market and the stock market are segmented. The results of their analysis are contingent on whether real estate returns are computed from appraisal values or from imputed sales values. The stock and real estate markets are found to be segmented when un-securitized appraisal-based (FRC) data is used in the analysis, although they are unable to discern the market segmentation when ACLI data is evaluated. On the other hand, the two markets are found to be integrated when real estate investment trust (REIT) data is used in place of the appraisal-based data.

In a later study, Liu and Mei (1992), examined the predictability of equity REITs returns and the relationship between the market for equity REITs and stock markets. By using a multi-factor latent variable model, it is found that conditions in the direct real estate markets represented by cap rates seem to impact the returns of both EREITs and small-cap stocks. Furthermore, the returns of equity REITs move much more closely with small cap stocks and much less with those of bonds, even though the cash flow portion of EREITs resembles interest payments on bonds. Mei and Lee (1994) revealed that market segmentation found in Liu *et al.*, (1990) disappears in a more general asset pricing model in which they allow for three factors (stocks, bonds, and real estate) other than the traditional two market factors (stocks and bonds) to affect asset returns. Specifically, they found that risk premium on all assets are determined by same systematic factors.

Table 2: Summary of studies on the integration between real estate and stock markets with asset-pricing framework

Study	Sample period	Findings
Liu *et al.*, (1990)	1978-1986	The stock and REITs markets are integrated. There is no evidence of integration between the commercial real estate market and the stock market due to indirect barriers such as cost and differences in information availability.
Liu and Mei (1992)	1971-1989	Conditions in the direct real estate markets represented by cap rates seem to impact the returns of both EREITs and small-cap stocks. Returns of EREITs move more closely with small-cap stocks than with large-cap stocks.
Mei and Lee (1994)	1978-1989	A systematic real estate risk premium exists in REIT pricing in addition to a stock- and bond- market factor. Market segmentation disappears after other factors affecting the REIT returns are considered.
Li and Wang (1995)	1971-1991	Pricing in the indirect real estate and stock markets is very similar. Returns of REITs are no more predictable than returns of the stock market.
Jud and Winkler (1995)	1985-1992	Cap rates are determined, with significant adjustment lags, by required return in the debt and stock markets.

Li and Wang (1995) also found similar predictability for equity REIT returns and other assets, using a two-factor (stocks and bonds) model. They interpreted this as further evidence that REIT stocks are integrated with the general stock market. In an examination of the relationship between the cap rate of direct commercial properties and market returns, Jud and Winkler (1995) found cap rates responded with significant adjustment lags to changes in capital market spreads, i.e., default premium and market excess return, and interpreted it as evidence of information inefficiency and segmentation from the stock market for direct real estate market.

(b) Relationship between real estate and stock prices

Other than determining the fundamental variables that explain movements in stock and real estate returns, another approach to measure the degree of market integration is to model the behavioral characteristics of stock prices and real estate prices. The evidence for market segmentation using this approach seems to be more mixed than that obtained from adoption of asset pricing model. Under this approach, indirect real estate data (transaction-based) is used in most of the studies. Table 3 summarizes the empirical finding on the relations of behavioral features between the real estate price and stock price.

Wilson and Okunev (1996), using a linear co-integration analysis, found evidence from the US, the UK and Australia to suggest domestic market segmentation across indirect real estate and stocks. Wilson *et al.*, (1998) then extended their earlier study by using the same co-integration test taking into account structural breaks in various data series. Specifically, the techniques of Perron (1989), Zivot and Andrews (1992), and Perron and Vogelsang (1992) were adopted. Their results from the three different techniques generally supported the notion of market segmentation across indirect real estate and stocks.

Table 3: Summary of studies on the integration between real estate and stock markets by forming the relations between asset prices

Study	Sample period	Findings
Ambrose *et al.*, (1992)	1962-1989	Both REITs returns and stock market returns display random walk. REITs may not be a good proxy for returns for direct real estate investment.
Wilson and Okunev (1996)	1980-1993	Long-run equilibrium relationship between domestic equity and indirect property markets is absent.
Okunev and Wilson (1997)	1979-1993	Indirect property market is nonlinearly related to the stock market, but the extent of mean reversion between the two markets is quite slow.
Wilson *et al.*, (1998)	1980-1993	There is no co-integration between the domestic indirect property market and the stock market in the presence of structural breaks.
Chaudhry *et al.*, (1999)	1978-1996	Long-run relationship is found between direct real

		estate and financial asset markets covering stocks, bonds and Treasury bills.
Wu and Duan (2012).	1998-2010	Real estate and stock markets have a certain degree influence upon each other in short term.
Liow and Lee (2013)	1995-2011	The results show that the extreme dependence patterns of real estate-stock markets are similar for many of the Asia-Pacific economies.
Su *et al.*, (2016)	1990-2010	From the frequency domain, output and stock, house prices correlate with each other across different frequencies

Chaudhry *et al.*, (1999) examined the properties of several time series representing the performance of direct commercial real estate and several classes of financial assets in the US, including common stocks, bonds and Treasury bills. A long-run relationship, found among various assets, is an indication of market integration between direct real estate and other financial assets under a broader capital market framework. It was also found that different direct real estate types are co-integrated while properties across regions are not.

In contrast with the assumed linear relationships between real estate and stocks, Ambrose *et al.*, (1992) used tests of non-linear dependency to explore the market integration. With REITs as a proxy for real estate investment, they found that mortgage and equity REITs display similar return generating characteristics to the stock market. This led them to conclude that real estate and stock markets were integrated. More recently, Okunev and Wilson (1997) proposed an alternative non-linear test, which allows for a stochastic trend term, as opposed to a deterministic drift term, to test whether the indirect real estate and the stock markets are co-integrated. The evidence supports the view that the two markets are fractionally integrated, but the extent of mean reversion is quite slow and deviations between the two markets could be prolonged.

5. Model specification

In the analysis, there are several factors that affect both house price and stock price; factors such as interest rate, national income, exchange rate and inflation (or consumer price index). In any case, the structures of these two markets determine which factors are more relevant. If these factors are determined in a false way, the results are ineffective and lead policymakers to erroneous policies. In this part, we try to introduce those factors which are more relevant in explaining the behaviour of stock and house price. We cast the analysis in a VAR framework. The VAR framework has distinct advantages in that it allows variables to be potentially endogenous and imposes minimal restrictions on the ways in which the variables interact. In this way, it enables the evaluation of the variables' causal interactions. This is appealing because from an economic point of view, it is readily acceptable that the concerned variables may be linked through various causal patterns (Ibrahim *et al.*, 2009). The model can be specified as follow:

$$Y_t = \alpha_1 + \sum_{i=1}^{n} \beta_{1i} Y_{t-i} + \sum_{j=1}^{n} \gamma_{1j} X_{t-j} + \sum_{k=1}^{2} \delta_{1k} Z_k + \varepsilon_{1t} \quad (1)$$

$$X_t = \alpha_2 + \sum_{i=1}^{n} \beta_{2i} X_{t-i} + \sum_{j=1}^{n} \gamma_{2j} Y_{t-j} + \sum_{k=1}^{2} \delta_{2k} Z_k + \varepsilon_{2t} \quad (2)$$

Where Y and X represent stock prices and house prices, respectively. Z introduces control variables, GDP growth rate, interest rate, exchange rate and inflation rate. α_1 And α_2 are constants. ε_{1t} And ε_{2t} are vectors of error terms.

Investments, such as stocks and houses, are highly affected by the interest rate. The risk-free rate is often the benchmark for returns of riskier investments. The level of interest does also affect the present value and it is therefore important to be taken into consideration before making any investment decisions (Andersson, 2014). There are two perspectives for investigating the relationship between interest rate, house price and stock price. According to user costs of housing and rents theory, which has been proposed by Nakajima (2011), interest rates and house prices have a negative relationship. There are many studies, like Harris (1989), Peek and Wilcox (1991), Sutton (2002), that support this hypothesis and show a negative relationship between interest rates and house prices. On the other hand, Alam and Uddin (2009) found a significant negative relationship between interest rates and stock prices in 15 countries. Also, Hsing (2004) and Uddin and Alam (2007), concluded that this negative correlation could not be ignored. The second perspective is built on the capital asset pricing model which accentuates the positive side of this relation. In this model, investors hold risky assets (such as houses and stocks) and riskless assets. The investors assemble these two assets in order to get the appropriate distribution of risk return. In equilibrium, the return on an efficient portfolio is determined by the market price of time and the market price of risk multiplied by the exposure to the risk (Elton *et al.,* 2010). The return on an individual security is as follow:

$$\overline{R_i} = R_F + \beta_i\,(\overline{R_M} - R_F) \tag{3}$$

Where symbols are $\overline{R_i}$ for expected return on security *i*, R_F for risk free rate, β_i for beta of security *i*, and $\overline{R_M}$ for expected return on market. The first component of the equation is the risk-free rate. If the risk-free rate increases, the return on the security should also increase. Hence, house prices and stocks should both be positively related to the interest rate. Due to data scarcity, we use interest rates on deposits of state-owned bank accounts as a proxy for interest rate.

In addition to interest rate, we include national income as an explanatory variable due to the important role of real income in affecting housing demand and supply. GDP can influence both the house market and the stock market. Undoubtedly, income growth determines changes in house prices. Sutton (2002) found that equity prices predict national income which is an indirect channel in affecting house price. Englund and Ioannides (1997) obtained result in support of significant and positive effect of GDP growth on house price. Case and Shiller (2003) documented that growth in national income is positively related to changes in house prices. Also, national income influences stock market prices. A change in the national income affects individuals' income and their consumption. Changes in consumption are closely related to a firm´s revenue and cash flow. Thus national income and stock prices should be positively related (Andersson, 2014). Levine and Zervos (1996) and Mohtadi and Agarwal (2001) concluded a significant positive relationship between national income and stock prices.

We use Iran annual data from 1985 to 2013 on the real house and stock prices that comes from Central Bank of Iran and Tehran stock Exchange. The data on gross domestic production in constant 2005 dollars and interest rate come from World Bank Indicators and Statistical Centre of Iran.

6. Econometric results

Unit root test

Most economic variables that are used for policy analysis and forecasting are characterized by high persistence and possibly non-stationary behaviour. It is common practice in applied work to subject these series to pre-tests for unit roots and co-integration prior to the vector autoregressive (VAR) analysis to determine the appropriate transformations that render the data stationary (Gospodinov *et al.*, 2013).

Testing for the presence of a unit root has become a problem of great concern to economists. Theoretical advances by, among others, Dickey and Fuller (1979, 1981), Said and Dickey (1984) and Phillips (1987) have permitted the development and applications of formal tests of this hypothesis. Useful reviews and applications of these procedures can be found in the work of Dickey *et al.*, (1986) and Perron (1988). The unit-root hypothesis in a time series of data has indeed far-reaching implications with respect to economic theory and the interpretation of empirical evidence (Perron, 1990). This is because a unit root is often a theoretical implication of models, which postulate the rational use of information that is available to economic agents (Phillips and Perron, 1988). Pre-testing for unit roots is often a first step in modeling the above-mentioned relationship. An important econometric task is determining the most appropriate test. In this paper, the so-called Augmented Dickey-Fuller unit-root test has been employed for that purpose.

The results of Dickey–Fuller unit-root test have been summarized in Table 4. The test provides strong evidence in support of the four series having a unit root and all the variables are integrated of order one.

Table 4: Results of ADF unit root test

Variables	ADF	Critical values		
	I(1)	%1 critical values	%5 critical values	%10 critical values
Stock price	-4.137 (0.003)	-3.670	-2.963	-2.621
House price	-8.967 (0.000)	-3.689	-2.960	-2.619
Interest rate	-5.681 (0.000)	-3.886	-3.052	-2.666
GDP growth	-3.810 (0.015)	-4.057	-3.119	-2.701
Exchange rate	-5.365 (0.0002)	-3.699	-2.976	-2.627
Inflation rate	-5.437 (0.0001)	-3.699	-2.976	-2.627

Source: Own calculation

* The optimal lag structure is determined by Schwartz Bayesian Criterion

** The p-values are in parentheses

Lag length selection

An important aspect of empirical research in the specification of the VAR models is the determination of the lag order of the autoregressive, since all inference in the VAR model depends on the correct model specification. In several contributions, the effect of lag length selection has been demonstrated: Lutkepohl (1993) indicated that selecting a higher order lag length than the true lag length causes an increase in the mean square forecast errors of the VAR and that under fitting the lag length often generates auto-correlated errors (Gutierrez *et al.*, 2007). The literature has shown how to select an adequate lag order of a VAR model but this lag length is frequently selected using an explicit statistical criterion such as the *Akaike Information Criterion* (AIC) or Schwarz' Bayesian Information Criterion (SIC). The results of lag selection have been summarized in table 5. Based on AIC and SIC, the optimal lag length is 3.

Table 5: Results of determining lag length selection

Lag	AIC	SIC
1	93.02	95.00
2	90.99	94.70
3	86.00*	91.47*
4	87.32	92.36

Source: Own calculation
* Indicates lag order selected by the criterion

Testing for co-integration

Once variables have been classified as integrated of order, I(0), I(1), I(2) etc. are possible to set up models that lead to stationary relations among the variables, and where standard inference is possible. The necessary criterion for stationary among non-stationary variables is called co-integration (Johansen and Juselius, 1990). Testing for co-integration is the necessary step to check if your model is empirically meaningful. If variables have different trend processes, they cannot stay in fixed long-run relation to each other, implying that you cannot model the long-run, and there is usually no valid base for inference based on standard distributions (Sjo, 2008).

Incorporating information about the integration and co-integration properties of the data in VAR models reduces the estimation uncertainty and the degree of small-sample bias of impulse response estimates (Gospodinov *et al.*, 2013). The appropriate test for co-integration is Johansen's test which has desirable statistical properties.

The Johansen's co-integration tests were performed by allowing three lags length, which is based on AIC and SIC. Results of co-integration tests have been presented in Table 6. As can be seen, both tests (trace and max-eigenvalue) indicate that four and two co-integrations exist among the variables included in the system at 5 percent level of significance.

In the comparison, no major differences between corresponding maximum eigenvalue and trace tests are detected. In a small sample simulation comparison it is found, however, that in some situations trace tests tend to have more heavily distorted sizes whereas their power performance is superior to that of the maximum eigenvalue competitors. In particular, the trace tests are advantageous if there are at least two more co-integrating relations in the process than specified under the null hypothesis (Lutkepohl *et al.,* 2000). Based on our analysis we have a performance for the trace tests.

Table 6: Results of Johansen counteraction test with optimal lag length of three

Hypothesized No. of CE(s)	Trace Statistic	5% Critical Value	Prob
R=0	173.2*	95.75	0.0000
R≤1	92.24*	69.81	0.0003
R≤2	56.49*	47.85	0.0063
R≤3	31.04*	29.79	0.0357
R≤4	12.339	15.49	0.1414
Hypothesized No. of CE(s)	Max-Eigen Statistic	5% Critical Value	Prob
R=0	80.98*	40.07	0.0000
R≤1	35.74*	33.87	0.0296
R≤2	25.44	27.58	0.0916

Source: Own calculation

Note. * Trace and Max-eigenvalue tests indicate 4 counteraction equations and 2 counteraction equations at 0.05 level of significance, respectively.

VAR estimation

This section reports results of the variables' dynamic interactions via Granger causality tests, Impulse Response Functions and variance decomposition.

VAR Causality Test

The VAR can be considered as a means of conducting causality tests, or more specifically Granger causality tests. Granger causality really implies a correlation between the current value of one variable and the past values of others. It does not mean changes in one variable cause changes in another. Based on Granger (1988), the direction of causality between house prices and stock prices is determined by means of standard F test, or Wald type Granger Causality test.

Table 7 shows the results of Granger causality test. Results of short-run Granger causality can be summarized as follows:

- There are significant direct relationships from house price and GDP growth to stock price.
- There exists statistically significant direct causal relationship running from interest rate, stock price and GDP growth to house price.
- There is no statistically significant direct causal relationship running from house price, stock price and real GDP to interest rate.
- There are statistically significant direct causal relationships that run from interest rate, stock price, exchange rate, inflation rate and house price to the GDP growth.

Table 7: Wald Granger causality test with optimal lag length of three

Dependent variable: GDP growth			
Excluded	Chi square	df	Probability value
Stock price	14.54	3	0.0022
House price	11.70	3	0.0085
Interest rate	11.67	3	0.0086
Exchange rate	11.32	3	0.0000
Inflation rate	11.97	3	0.0003
Dependent variable: Interest rate			
Excluded	Chi square	df	Probability value
GDP growth	4.26	3	0.2347
Stock price	6.40	3	0.0936
House price	5.01	3	0.1710
Exchange rate	1.36	3	0.1548
Inflation rate	2.54	3	0.9876
Dependent variable: Stock price			
Excluded	Chi square	df	Probability value
GDP growth	26.16	3	0.0000
Interest rate	2.45	3	0.4843
House price	21.25	3	0.0001
Exchange rate	2.32	3	0.7895
Inflation rate	12.3	3	0.0000
Dependent variable: House price			
Excluded	Chi Square	df	Probability value
GDP growth	33.36	3	0.0000
Interest rate	17.77	3	0.0005
Stock price	10.19	3	0.0169
Exchange rate	32.21	3	0.0002
Inflation rate	25.36	3	0.0000
Dependent variable: Exchange rate			

Excluded	Chi Square	df	Probability value
GDP growth	7.27	3	0.0987
Interest rate	2.31	3	0.7856
Stock price	8.69	3	0.0014
House price	9.65	3	0.0036
Inflation rate	7.14	3	0.0007
Dependent variable: Inflation rate			
Excluded	Chi Square	df	Probability value
GDP growth	15.36	3	0.0000
Interest rate	11.87	3	0.0009
Stock price	12.36	3	0.0078
House price	18.71	3	0.0000
Exchange rate	2.52	3	0.2587

Source: Own calculation

Impulse Response Function

The Granger causality test provides information regarding the direction of a potential causality among the variables. The test investigates if lagged values of a variable have a statistical impact on the future values of the other variables. The test does not provide information about the size or timing of the influence on the other variables. The impulse response function is a complement to the Granger causality test. Impulse responses trace out the response of current and future values of each of the variables to a one-unit increase (or to a one-standard deviation increase, when the scale matters) in the current value of one of the VAR errors, assuming that this error returns to zero in subsequent periods and that all other errors are equal to zero.

As our VAR model, we have six variables. We can work the response between these variables. In order to analyze dynamic effects of the system when the model receives the impulse, we plot the chart as figures 1 to 6.

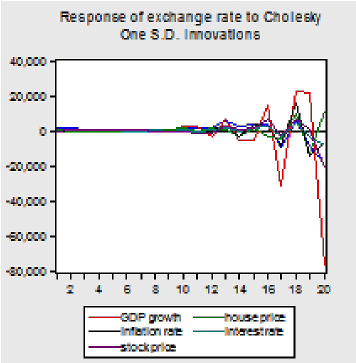

Figure 1: Impulse response functions to a shock to exchange rate

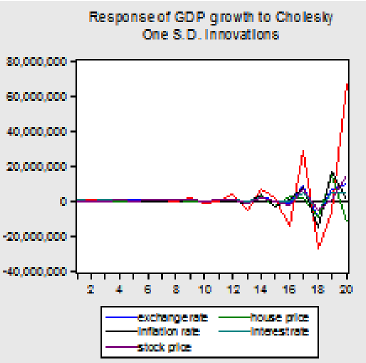

Figure 2: Impulse response functions to a shock to GDP growth

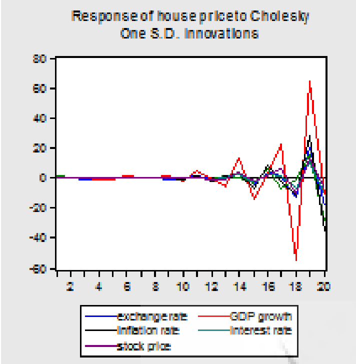

Figure 3: Impulse response functions to a shock to house price

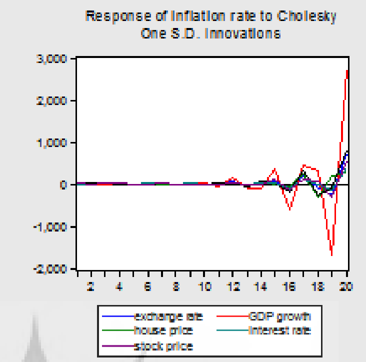

Figure 4: Impulse response functions to a shock to inflation rate

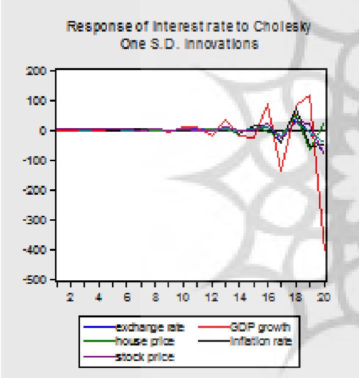

Figure 5: Impulse response functions to a shock to interest rate

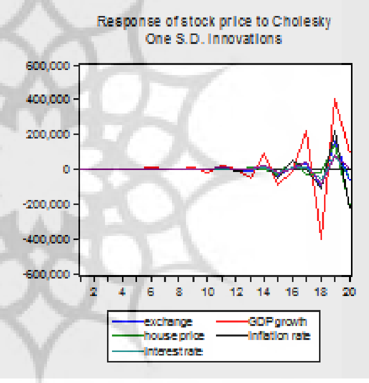

Figure 6: Impulse response functions to a shock to stock price

Figure 6 plots the impulse response of stock price to interest rate, house price, GDP growth rate, exchange rate and inflation rate. When the impulse is stock price, every response of house price is most positive and the values fluctuate around the line zero at each time period. Most responses of interest rate are also positive except for two durations.

The third figure is the impulse response of house price to interest rate, GDP growth rate, stock price, and exchange rate and inflation rate. When the impulse is house price, the response of the GDP growth rate has an obvious fluctuation at the end of the period. Responses of interest rate are mostly positive and near zero. The response of stock price has a smooth fluctuation and shows negative relationship in two periods.

Variance decomposition

An alternative of impulse response, to receive a compact overview of the dynamic structures of a VAR Model, is variance decomposition sequences. Impulse response functions let us report how y responds to changes in u. Another question we might ask is: how important is variation in u for explaining variation in y? This question is addressed by reporting variance-decompositions. This method is also based on a vector moving average model and orthogonal error terms. In contrast to impulse response, the task of variance decomposition is to achieve information about the forecast ability[3]. The idea is that even a perfect model involves ambiguity about the realization of y, because the error terms associate uncertainty. According to the interactions between the equations, the uncertainty is transformed to all equations. The aim of the decomposition is to reduce the uncertainty in one equation to the variance of error terms in all equations. The results of variance decompositions are illustrated in table 8 and 9. According to table 8, in the first period, 94 percent of variation in house price is due to its fluctuations and stock price has no significant effect in explaining house price, however, this effect increases in the next periods. Also, regarding to table 9, in first period house price can explain 6.14 percent of the variations in stock price.

[3] One way to determine how important the different exogenous shocks are in explaining the dependent variables is to calculate the fractions of the forecast error variance of these variables attributable to the respective orthogonal shocks.

Table 8: Variance decomposition of house price

Period	S.E.	Stock price	Interest rate	House price	Inflation rate	GDP growth	Exchange rate
1	1342.505	0.000000	0.000000	94.04715	3.345305	0.419735	2.187811
2	1794.995	1.578714	0.010301	84.61847	3.575818	2.494278	7.722417
3	1940.586	1.408837	0.061754	51.66468	3.029475	19.51298	24.32228
4	2128.658	1.226011	0.396225	39.90814	3.183398	31.71464	23.57158
5	2277.128	1.036459	0.342526	33.54837	2.983643	41.07032	21.01868
6	2376.304	2.153096	0.865997	22.05939	2.057512	50.42673	22.43728
7	2387.297	2.769109	2.848144	24.48797	6.074711	44.19507	19.62499
8	2549.921	4.736817	2.759094	22.74922	7.234616	43.73538	18.78487
9	2854.306	3.946752	2.749532	18.32795	5.761564	47.98677	21.22744
10	4475.927	3.643245	1.763832	9.401205	5.854063	67.77523	11.56243
11	5359.698	1.736076	0.773942	4.178362	3.697517	79.61761	9.996488
12	6879.174	3.227522	1.796624	12.22566	8.326951	65.09858	9.324659
13	11567.00	2.174727	1.088136	10.27104	5.652199	76.08309	4.730808
14	13723.85	4.962307	1.715687	3.207024	4.035272	79.01205	7.067661
15	15755.29	3.806447	2.365688	6.320931	8.875769	72.18721	6.443957
16	23369.73	3.324855	2.710943	13.80115	14.28804	59.18960	6.685416
17	41655.28	4.228811	1.720437	11.40971	7.985706	70.81177	3.843567
18	51509.78	3.353283	1.376731	3.169613	4.672099	82.86762	4.560650
19	59933.63	3.166033	1.727785	5.231773	7.907051	76.08692	5.880442
20	103392.7	2.821065	2.248005	13.51396	12.95213	61.18274	7.282093

Source: Own calculation

Table 9: Variance decomposition of stock price

Period	S.E.	Stock price	Interest rate	House price	Inflation rate	GDP growth	Exchange rate
1	680.5043	62.70689	18.26409	6.145905	6.211647	0.062200	6.609268
2	1813.815	14.76039	2.570926	9.193994	0.993592	32.97564	39.50546
3	2798.280	7.663060	1.099604	7.464626	1.800645	51.05528	30.91679
4	3200.336	6.809823	1.355282	15.53582	3.016671	39.12068	34.16172
5	4142.984	4.904004	1.011308	12.34129	2.524248	48.03669	31.18246
6	7537.589	2.584800	0.789267	4.228455	1.427843	80.47257	10.49707
7	9162.039	7.201969	3.209231	5.798982	10.63064	63.74744	9.411733
8	10472.53	6.330347	2.952523	15.83818	13.93526	48.96095	11.98273
9	15271.08	4.789765	2.328495	8.377485	6.912524	64.69726	12.89447
10	26056.35	3.147938	1.344067	3.427429	4.977250	82.57954	4.523776
11	37658.29	4.111879	2.265787	5.379637	9.347732	68.10172	10.79325
12	41327.64	3.626147	2.080407	15.75706	12.17471	56.76556	9.596108
13	66306.47	1.941857	0.842022	7.695958	4.756040	80.22380	4.540326
14	120740.5	4.171295	1.352875	2.684918	4.643559	82.48250	4.664857
15	168635.5	3.636748	2.196122	6.615386	9.381356	70.59650	7.573889

16	185436.2	3.012078	2.230997	15.99973	13.18337	58.76859	6.805236
17	296288.2	2.803309	1.079812	7.670305	5.183924	79.73455	3.528102
18	537290.2	3.975640	1.545134	2.874766	5.251387	81.61615	4.736924
19	748338.9	3.241502	2.061665	7.098460	9.521119	71.13456	6.942695
20	821387.0	2.693610	2.123738	15.54192	13.01243	60.18809	6.440214

Source: Own calculation

7. Conclusion

The direction and magnitude of the relationship between stock market and property market have important implications for both practitioners and policy makers. On the one hand, real estate market is believed to provide diverse benefits to stock-holders as a good alternative, given the abnormal returns and high volatility in share market, implying an adverse relation between the prices. On the other hand, although housing prices and stock prices might be driven individually by specific economic or financial factors, investors having earned a handsome profit from stock market during its boom may in general be induced to turn to the perhaps still attractive property market. Such wealth effect is especially prominent in countries with limited investment vehicles. Hence, wealth effect arising from the stock market might lead two prices to move in the long-run.

This study aimed to provide an alternative perspective on the dynamic relationship between stock prices and house prices in Iran economy. The issue is crucial to be highlighted since these two assets are large components of the wealth of Iranian households. For this purpose, we use yearly data for the period from 1985 to 2013 and conducted a Granger-causality test and Impulse response functions (IRF). The econometric results provide three major conclusions: The Granger causality test, based on a vector autoregressive model, indicated a bidirectional causality running from the stock market to the house market and vice versa. The GDP and the interest rate were included as control variables and the direction of the causality did not change. To investigate the timing and the size of the causality, an Impulse response function was estimated. The IRF concludes that when the impulse is stock price, every response of house price is most positive and the values fluctuate around the line zero at each time period and when the impulse is house price, the response of stock price has smooth fluctuations and shows negative relationship in the two periods. Our research has provided valuable evidence regarding the long-term relationship between stock and house markets and is useful to institutional investors in mixed asset allocation.

It is clear that stability in the real estate market is critical for stability in the stock market and vice versa. Hence, Iranian policymakers need to be cautious in implementing policies so that instabilities are not generated in either markets, since stability in the financial markets is expected to increase household welfare, reduce poverty, increase investment in portfolio assets, and promote economic growth. Overall, our results call for more careful attention in forming time series data, as linear models could lead to misspecification in the true nature of relationships, thus leading to wrong policy recommendations.

To conclude, our comprehensive results provide useful information and advice to international investors and risk management personnel in tactical asset allocation so as to manage the extreme dependence between real estate and stock markets. More quantitative studies of the extreme dependence of financial markets should receive greater attention.

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