Inflation and Residential Property Markets: A Bounds Testing Approach

Koon Nam Henry Lee

Abstract—**Using classical regression and cointegration approach, this study investigates the short-term and long-term inflation hedging effectiveness of residential property in Hong Kong over the period 1980-2011.The cointegration test used is the Autoregressive distributed lagged bounds testing approach of Pesaran *et al.* (2001) - [Pesaran, M.H., Y. Shin and R. J. Smith, "Bounds testing approaches to the analysis of level relationships", Journal of Applied Econometrics, vol. 16, pp. 289–326, May, 2001] that based on the estimation of an unrestricted error correction model. This paper addresses one of the major problems of how to use a relatively small sample to estimate the long term relationships between variables that faced by many researchers in economic modeling. The results of actual inflation model show that the Hong Kong small and medium size residential property provides an effective short-term hedge against actual inflation. The ARDL bounds testing results provide strong evidence to support the hypothesis that residential properties (all categories) and common stock provide effective long-term hedge against inflation. This study concludes that small and medium size residential property in Hong Kong are better short term and long term inflation hedge than large and luxury residential property, common stock and time deposit.**

Index Terms—**Bounds testing, inflation hedging, residential property, Hong Kong.**

I. Introduction

The impact of inflation on real estate return has long been a primary financial concern of investors since the outbreak of global inflation in the early 1970s. While inflation may have slowed in the 1990s, the global financial crisis in the 2008 and recent anxiety of global inflation provide an opportunity to re-examine the relationship between inflation and residential real estate return. The effectiveness of real estate and financial assets as an inflation hedge has been studied since 1970s. In a pioneer study, Fama and Schwert [1] examined inflation hedging ability of residential properties, government bonds and common stock in the US between 1953 and 1971 using classical regression models. The authors concluded that only residential real estate was a complete hedge against expected and unexpected inflation. However, those regression results are not sufficient as a basis for concluding that the assets have been hedged against inflation even Fama and Schwert [1] had tried to apply a 'differenced variable' approach instead of the 'level variable' to tackle the spurious regression problem as indicated by Granger and Newbold [2]. While the method of 'differencing' satisfies the stationary condition, the economic inferences derived from such estimated parameters have limited significance in the short-run. The criticism of spurious regression is valid if the regression model's underlying variables exhibit a long-run equilibrium relationship. To tackle this problem, Ganesan and Chiang [3] employed Engle-Granger [4] cointegration approach to investigate inflation hedging ability of real estate assets. Ganesan and Chiang [3] found conflicting results between regression and cointegration approach. They concluded that residential properties is a good hedge against inflation in the short-term but fail to provide a long-term inflation hedge in Hong Kong over the period 1984-1994. In a more recent study, Li and Ge (2008) [5] found that residential properties in Shanghai do not provide an adequate hedge against inflation in the short-run based on regression results. However, the cointegration results suggest the Chinese real estate properties provide an effective hedge against inflation. Our review of empirical literature indicates that while property is likely to be a hedge against inflation, definitive details concerning whether property is an inflation hedge are still unclear [1], [3], [5]-[10].

Due to the statistical uncertainties of previous results, this research aims to re-examine the short and long-term inflation-hedging characteristics of residential properties (four categories) and two major alternative financial assets (common stock and fixed deposit) in Hong Kong over the period of 1980-2011. The main purpose of this research is to compare and contrast the short-term and long-term inflation hedging ability of residential real estate and financial asset based on the empirical results of classical regression models and Pesaran bounds testing cointegration models. The contribution of this research is twofold. First, the results of the Autoregressive distributed lagged (ARDL) cointegration approach is the first bounds testing study to provide additional evidence for the empirical literature of inflation hedging effectiveness of Hong Kong residential real estate assets. Second, quantitative findings in this research provide a source of relevant information for the investment fund industry and government bodies to assess the effects of a variety of business and public policy options, and assists in managing their investment portfolios. The Hong Kong residential property markets is selected as Hong Kong has been one of the most dynamic markets in the World.

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K. N. H. Lee is with the City University of Hong Kong, Kowloon Tong, Hong Kong, China (e-mail: cmhenry@cityu.edu.hk).

The residential property price in general increase eleven-fold over the bull market period from 1984 to 1997 and follow by a decrease by more than 65% over the bear market from 1998 to 2003. The residential property price rebounds by 200% from the period from 2004 to 2011.

II. Research Methods and Data

A. The Data

The annual data series on inflation rate, common stock price, and time deposit rate were extracted from the Hong Kong monthly digest of statistics, while the data series of various residential real estate returns were collected from the Hong Kong property review. The estimation period covers a period of 32 years from 1980 to 2011. As Fama and Schwert (1977) concluded that the consumer price index (CPI) is an acceptable proxy for the price levels an investor faces, the consumer price index A (CPIA) will be employed as a reliably accepted measure of actual inflation because it consists of the smallest weight of private housing cost among all series of Hong Kong CPI. The four categories of private residential units are classified according to sizes; representing floor areas of 39.9 square meters (m^2) and below (U40), 40.0 to 69.9 m^2 (U69), 70.0 to 99.9 m^2 (U99) and 100 m^2 and over (O100). Given the disaggregated data set, it is possible for us to perform submarket tests across the different size categories

B. Actual Inflation Model

As shown in equation one, the first model is designed to test whether the various residential real estate and financial asset are effective hedges against actual inflation. This is equivalent to assume that the expected inflation is forecasted by Naive model as suggested by Gultekin [11], and it provides perfect forecasts of inflation.

$$\Delta REit = a_0 + b_i \Delta INFit + eit \quad (1)$$

where $\Delta REit$ = return on residential real estate and financial assets and $\Delta INFi\,t$ = actual rate of inflation. While the intercept a_0 can be interpreted as representing the real rate of return, the beta coefficient on $bi\Delta INFit$ shows the impact of the asset returns on changes in the actual change in inflation.

C. Selection of Pesaran ARDL Cointegration Approach

Although the classical Engle-Granger approach and Johansen[12] cointegration approach had been applied by Gransen and Chiang [3] and Stevenson [8] to test for the existence of long-term relationships between inflation and real estate return in Hong Kong and United Kingdom, there are several disadvantages to those approaches. Firstly, the Engle-Granger [4] and Johansen [12] approaches, for example, required that all the underlying variables be integrated with the same order. The premodeling test for the integration order is technically the first essential step required to determine long-run cointegration relationships. However, it is found that in our premodelling analysis that the traditional Engle-Granger approach and Johansen cointegration approach will be unable to apply in this study because the unit root test results, discussed in section III.A., indicate that all the underlying variables are either I(0) or I(1) variable and not integrated with same order. Secondly, Johansen [12] cointegration approach based on maximum likelihood method is an asymptotical efficient estimator. It implies that when the Johansen procedures are applied to small sample, such as annual real estate return data in this study, the parameter estimates will be subject to small sample bias. As the availability of the annual residential real estate return data is limited to 32, it is on the main concern about this small sample bias problem. Hence, there should be a strong motive to search for alternative cointegration approaches that is applicable for small sample size for further investigations. The problems associated with unit root tests and the limited sample size of annual data in this study support the use of the Pesaran et al. [13] bounds testing approach, which is applicable irrespective of whether the underlying variables are I(0) or I(1) and applicable for small sample size estimation.

D. Pesaran ARDL Bounds Testing (Cointegartion) Model

In contrast to the traditional Engle-Granger approach and Johansen cointegration approach which are widely applied in the empirical literature, the Pesaran et al. (2001) approach has not been employed in any inflation and asset return study for Hong Kong.

$$DY_t = a_0 + a_1 time + \sum_{i=1}^{K} b_i DY_{t-i} + \sum_{i=0}^{K} d_i DX_{1t-i} + + g_1 Y_{t-1} + g_2 X_{1t-1} + \mu_t \quad (2)$$

An unrestricted error correction model (UECM) is constructed to test for the existence of a long-run relationship in equation 2, where Y is the dependent variable (asset return), the X is the independent variable (inflation) and all variables in logarithm, K is the number of lags, and D represents the differences. The intercept and time trend may be added based on the empirical results in equation 2. Following Stevenson [12], only actual inflation is examined for the cointegration analysis. This is justified on the basis that the purpose of the cointegration analysis is to test for evidence of a long-run relationship, and therefore it is legitimate to assume that actual and expected rates of inflation are equal. The maximum number of lags is 3 due to the limited sample size of 32 in this study. We then use bounds testing approach to examine for the presence of a long-run relationship between inflation and asset return using two separate statistics. Firstly, we use the F-statistics to determine the significance of the lagged levels of the included variables in the underlying autoregressive distributed lag model in Equation 2. The Pesaran

approach gives two sets of critical values, one set assuming that all the underlying variables are I(0), and the second set assuming that all underlying variables are either I(0), or I(1). For each application, this provides a band covering all the possible classifications of the variables into I(0) and I(1). According to Pesaran, if the computed F-statistics falls within the critical bound of the value band, a conclusive inference is inconclusive, and depends on whether the underlying variables are I(1) or I(0). The second test is a t-test on the lagged level dependent variable in equation 2. The t statistics have a non-standard distribution and depend on whether the variables are individually I(0) or I(1). The values of the F and t tests statistics will indicate the existence of the long-term relationships between the underlying variables in the inflation and asset return models.

III. Empirical Results

A. Regression Results

The results of actual inflation model (equation one) in Table I show that the general residential property (overall), small size property (U40) and medium size property (U69) reports significant and positive beta coefficients at 95% level, while the large residential property (U99) is significant at 90% level. However, the beta coefficients of the actual inflation variables in the luxury residential property (O100), time deposit and stock equation are non-significant positive even at 90% level. The regression results suggest that there is only evidence of short-term inflation-hedging ability for small and medium size residential real estate in the Hong Kong market.

TABLE I: Results of Actual Inflation Model (Annual Data)

Variables/ Annual Data	*a*	*b*
Residential property (overall index)	-0.004	1.386**
Small size apartment (U40)	-0.002	1.404**
Medium size apartment (U69)	0.001	1.451**
Large size apartment (U99)	0.013	1.281*
Luxury size apartment (O100)	0.078	0.063
Time Deposit[1]	0.037**	-0.003
Stock	0.086	-0.10

Notes 1/. In the presence of autocorrelation problem in the time deposit regression, the Cochrane–Orcutt procedures are employed to adjust for serial correlation in the error term and only the regression results adjusted by Cochrane–Orcutt procedure are reported in Table 1. , 2/. U40, U69, U99 represent the apartment size under 40, 69 and 99 square meters. 3/. O100 represents the apartment size over 100 square meters and 4/. **/* indicate the significance at the 5% and 10% level.

B. ARDL Cointegration Results

Before conducting the ARDL cointegration tests, the conventional Augmented Dickey and Fuller (ADF) unit root tests are carried out to determine the order of integration of the variables. While the inflation variable are I(0) variable, all the asset return variables under investigation are I(1) variables at 95% level. The unit root results necessitated the applications of the ARDL approach to cointegration. When the causal relationship is assumed to run from inflation to asset return, the results in Table II indicates that the F-statistics and t-statistics of general residential property, small, medium, large, luxury size of residential properties and stock are higher than their respective upper bound critical values of 5.73 (F-statistics) and 3.22 (t-statistics) at 95% level, respectively. The results demonstrate that the small, medium, large and luxury residential real estate (U40, U69, U99 and O100), common stock and general residential property provide long-term effective inflation hedge over the period 1980-2011. However, time deposit failed to provide inflation hedge for the long-term investor for Hong Kong investor. The ARDL cointegration results are consistent with Anari and Kolari [6] but contradict to Zhou and Clementa [9]. Alternatively, if the causal relationship is assumed to run from asset return to inflation, the results of F- and t-statistics in Table II indicate the cointegration results are rather mixed. It indicates that the small, medium and large size residential properties are cointegrated with inflation but the luxury property, stock and time deposit are not cointegrated with inflation at the 95% level. In summary, the regression and cointegration results suggest that the small and medium size residential property are providing a better short-term and long-term hedge than large, luxury property, stock and time deposit against inflation in Hong Kong

TABLE II: Results of ARDL Cointegration Tests

Asset Type	Inflation- to Asset return		Asset return to Inflation	
	F-Statistics	t- Statistics	F-Statistics	t- Statistics
Residential property (oversll)	11.782(1)**	-4.781(1) **	7.855 (1) **	-3.692(1) **
Small size apartment (U40)	8.730(1)**	-4.12(1) **	5.95(1) **	-3.22(3) **
Medium size apartment (U69)	14.299(1) **	-5.264(1) **	6.698(1) **	-3.361(1)**
Large size apartment (U99)	12.25(2) **	-4.927(2) **	11.097(1) **	-4.459(1) **
Luxury size apartment (O100)	7.599(1) **	-3.69(1)**	4.859(1) *	-2.59(1)
Time Deposit	3.427(2)	-2.56(2)	2.363(2)	-0.734(2)
Stock	9.405(1) **	-4.328(1) **	4.77(2)	-2.994(2) *

Notes: The upper bound limit of the critical value for the F-test is 5.73 (5%) and 4.78 (10%). 2. The upper bound limit of the critical value for the t-test is 3.22 (5%) and 2.91 (10%) and the critical values of F-test and t-test are obtained from Pesaran et al. (2001) and 3. ** /* indicates the significance at the 5% and 10% level.

IV. Conclusion and Implications

Using ARDL cointegration approach and classical regression approaches, this paper investigated the nature of the inflation hedging effectiveness of residential properties (four categories), common stock and time deposits for Hong Kong. The ARDL cointegration results

suggest that all size of residential real estate and common stock provide a better long-term inflation hedge than time deposit, but only the small and medium size properties provide a short-term inflation hedge based on the regression results. The regression and cointegration results demonstrate that small and medium size real estate assets are the most effective investment vehicle for short and long term inflation hedge. It therefore implies that investors wishing to safeguard the value of purchasing power should reallocate their time deposit assets to the small and medium size residential property during the period of high inflation. During the low inflation and deflation period, the results suggest the investor should shift their investment away from all categories of residential properties to time deposits. Overall, this study concludes that the small and medium size properties provide a better short-term and long-term hedge against inflation than large, luxury apartments and financial assets in Hong Kong. The cointegration results is contradict to the findings of Ganesan and Chiang [3], Chu and Sing [7] and Zhou and Clementa [9] but comply with Anari and Kolari [6] and Li and Ge [5] and Daniel and Kurzrock [10]. Further research should be considered for the cointegration and causality analysis of the nature of the inflation hedging effectiveness of business real estate, such as offices, shops, factory and hotel and the directions of causality between inflation and residential and business real estate returns.

REFERENCES

[1] E. F. Fama and G. W. Schwert, "Asset returns and inflation," *Journal of Financial Economics,* vol. 5, pp.115-46, November, 1977.

[2] C. W. J. Granger and P. Newbold, "Spurious Regression in Econometrics," *Journal of Econometrics,* vol.2, pp. 111-120, July, 1974.

[3] S. Ganesan and Y. H. Chiang, "The inflation-hedging characteristics of real and financial assets in Hong Kong," *Journal of Real Estate Portfolio Management,* vol. 4, no.1, pp. 55-67, July, 1998.

[4] R. F. Engle and C. W. J. Granger, "Co-integration and Error Correction: Representation, Estimation and Testing," *Econometrica,* vol.55, no.2, pp.251-276, March, 1987.

[5] L. H. Li and C. L. Ge, "Inflation and housing market in Shanghai," *Property Management,* vol. 26, no.4, pp.273-28, September, 2008.

[6] A. Anari and J. Kolari, "House prices and inflation," *Real Estate Economics,* vol. 30, no. 1, pp. 67-84, Spring, 2002.

[7] Y. Q. Chu and T. F. Sing, "Inflation hedging characteristics of the Chinese real estate market," *Journal of Real Estate Portfolio Management,* vol. 210, no. 2, pp. 145-54, June, 2004.

[8] S. Stevenson, "A long term analysis of regional housing markets and inflation," *Journal of Housing Economics,* vol. 9, pp.24-39, March, 2000.

[9] X. Zhou and S. Clementa, "The inflation-hedging ability of real estate in China," *Journal of Real Estate Portfolio Management,* vol.16, no.3, pp. 267-77, September, 2010.

[10] O. Daniel and B. M. Kurzrock, "Inflation-hedging properties of indirect real estate investments in Germany," *Journal of Property Investment & Finance,* vol.30, no. 3, pp. 218-240, April, 2012.

[11] N. B. Gultekin, "Stock Market Returns and Inflation: Evidence from Other Countries," *Journal of Finance,* vol.38, no.1, pp. 49-65, March, 1983.

[12] S. Johansen, "Statistical Analysis of Cointegrating Vectors," *Journal of Economic Dynamics and Control,* vol. 12, no.1, pp.231-254, 1988.

[13] M. H. Pesaran, Y. Shin and R. J. Smith, "Bounds testing approaches to the analysis of level relationships," *Journal of Applied Econometrics,* vol. 16, pp. 289–326, May, 2001