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A Panel Cointegration Analysis for Macroeconomic Determinants of International Housing Market

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***Abstract*—**The main purpose of this paper is to investigate the long-run equilibrium and short-run dynamics of international housing prices when macroeconomic variables change. We apply the Pedroni's, panel cointegration, using the unbalanced panel data analysis of 33 countries over the period from 1980Q1 to 2013Q1, to examine the relationships among house prices and macroeconomic variables. Our empirical results of panel data cointegration tests support the existence of a cointegration among these macroeconomic variables and house prices. Besides, the empirical results of panel DOLS further present that a 1% increase in economic activity, long-term interest rates, and construction costs cause house prices to respectively change 2.16%, -0.04%, and 0.22% in the long run. Furthermore, the increasing economic activity and the construction cost would cause stronger impacts on the house prices for lower income countries than higher income countries. The results lead to the conclusion that policy of house prices growth can be regarded as economic growth for lower income countries. Finally, in America region, the coefficient of economic activity is the highest, which displays that increasing economic activity causes a faster rise in house prices there than in other regions. There are some special cases whereby the coefficients of interest rates are significantly positive in America and Asia regions.

***Keywords*—**House prices, Macroeconomic Variables, Panel cointegration, Dynamic OLS.

I. Introduction

AS the development of technology and information increase, global implications of housing market have become more critical. House price estimation is a very main issue for consumers, investors, and the banking industry. Therefore, there are many past relative papers to discuss the relationships between house price and economic variables. Considering the non-stationarity of many economic time series, there are some past empirical papers to investigate the relationships between macroeconomic variables and house prices applying the conventional cointegration techniques, such as the Engle–Granger or the Johansen approach which are restricted to a high availability of long time series of housing market data. However, an increasing number of recent studies have been chosen panel data methodology to analysis for improving several of the shortcomings of individual time series methods, which is fully expressed in the information of the data and solves many problems of the individual time series. Besides, the methodology of panel data also has caused that the focus of methodology analysis has shifted from individual country to international housing market in recent years for housing studies.

In housing literature, it has been suggested that house price and fundamental economy should have long-run equilibrium relationship, from these articles [1]-[3] [1]. Recently, new research studies have appeared that tackle the issue of global housing market, i.e. [4]-[6]. The aim of this paper is to discuss the relationship between house price and macroeconomic variables. We choose the macroeconomic variables which could affect house price are chosen based on m the model of the DiPasquale and Wheaton (see [7]). As to the methodology, considering the housing market data often including shorter time period, hence, this paper will apply the Pedroni's panel cointegration (see [8], [9]) to examine the relationships among house prices and macroeconomic variables from 33 countries. Theory based on this method suggests that *T* observations of a time series of an individual country over all *N* countries so that in effect *N*T* observations are available for estimation. Viewed in this light, it can be regarded as good evidence to support higher robustness of the estimation process.

For the objectives to be achieved, the paper is structured as follows. The next section describes the choice of economic variables for estimating house prices, is based on the model of DiPasquale and Wheaton (see [9]). Sections III presents research methodology and procedures for the collection of data. Results are then presented in Sections IV. Finally, summarizes our findings and suggestions are made for further research.

II. Literature

The house prices experienced substantial fluctuations in many countries in past decade, which caused a voluminous amount of literature examining the relationship between house price changes and macroeconomic conditions. House prices play an important role in national economies and financial markets. We find that house prices across countries have inter-linkages between house price change and macroeconomic conditions. The relationships of housing, financial and economic activities could influence the performance of the economy as a whole (see [10]).

Being different from the reaction of other capital market assets, the announcing of economic news could not

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[1]Reference [2] analyzed housing prices in Dublin into fundamental and non-fundamental components. Here one gets house prices in Dublin are driven by market fundamentals and the key to increase the prices by speculative bubble. Reference [3] shows construction cost in a city-level for 62 Metropolitan Statistical Areas (MSA) in the US, using panel data analysis.

immediately change house prices which generally exhibit low price fluctuation.(see [11]) Because of homeowners wouldn't like to sell their house below a certain price in the period of recessions, which makes house prices often have strong decreasingly sticky prices. Besides, house price's sluggishness also causes, irrational exuberance bubbles in the house market during the economic booms period.

Recently, some studies, such as [12], [13], have investigated the transmission when house prices are affected by the macroeconomic shocks, which discuss, for instance, unexpected changes of some macroeconomic variables, such as money supply, industrial production or interest rate, how to affect house price with a lag depending on the speed of the transmission mechanism. The speed of transmission depends on the efficiency of the institutional framework which includes the speed of administrative processes, land availability, credit supply, transaction costs, mortgage product innovations, and so on.

Conversely, there is also a feedback reaction from housing prices to the macroeconomic. Increasing house prices also causes wealth effect which will raise consumption, while decreasing house prices might shrink the consumption (see [14])[2].There are some empirical research has examined the wealth effect of house prices on consumption. According to the empirical results of [12], in the U.S., two-thirds of dwellers are owner-occupants, which cause a strong impact of the wealth effect on consumer spending. There are many results of other papers to confirm meaningful housing wealth effects in many countries (see [15]-[21]). Several studies (see [19], [21]) have indicated that increasing housing wealth influenced consumer boom during the 1980s in the UK. In Singapore, reference [22] confirms that the residential property prices are correlated with changes in private consumption, while it is not enough effective to change the relationship in Singapore.

Another line of relative literature has studied global macroeconomic effects on house price, such as [6], [12], [23]-[25], and so on. However, many previous studies (see [1], [5], [12], [26]-[29]) show that a long-run equilibrium exists between house prices and macroeconomic variables, such as income, construction costs, stock index, employment rate, mortgage rates, and so on. Being concerned with the non-stationarity of macroeconomic time series, these studies investigate the relationships between macroeconomic variables and house prices applying the conventional cointegration techniques, such as the Engle–Granger or the Johansen approach which are restricted to a high availability of long time series of housing market data.

Using the full information of the data to improve several shortcomings of individual time series methods, an increasing number of recent studies apply panel data methodology. Using the panel unit root test, [30] investigates the long-term relationship between house prices and income in the US. Appling residual-based conintegration test of [8], the empirical results of [31] do not reject the hypothesis of no cointegration between house prices and income.

Besides, there are some other studies using U.S. housing market panel data to analyze house prices, include [32]-[34]. Reference [32], same as [31], adopts income and rent as the main factor affecting the house prices, the empirical results could not explain the dynamics of house prices. For improving the empirical results, [33] and [34] consider other fundamental variables to examine the long run determinants of house prices at the national and at the regional level. Using U.S. housing market panel data of 22 metropolitan statistical areas over 28 years, [34] considers more fundamental variables into their model, which includes real house rent, mortgage rate, personal income, building cost, stock market wealth, and population. Comparing with univariate time series tests, the empirical results of [33] of panel data analysis are more powerful, and the results of [33] show that house prices do not reflect influences of fundamental factors.

Reference [34] also adopts the U.S. data over two periods, from 1975Q1 to 1995Q4 and 1996Q1 to 2005Q2, to observe the U.S. housing price bubble. Being consistent with testing the "cointegrating regression model " of a financial bubble, the empirical results of [34] show that there are no cointegrating relationships between house prices and any fundamental economic variables, which confirms the existence of a U.S. house price bubble for this period.

For highlighting the differences between countries in an integrated long-run equilibrium framework, some literature using cross-border house markets to analysis it. Reference [11] uses a panel analysis of the 15 countries from 1975Q1 to 2007Q2 to examine the long-term impact and short-term dynamics of the macroeconomic on house prices. The empirical results of [11] show that construction costs and long-term interest rate change as house prices adjust upwards or downwards, and only nine countries present a similar long-term response to macroeconomic changes. Besides, the results of [11] indicate that a dynamic adjustment process would spend 14 years, which means that the time of full recovery may be much slower than earlier research.

Most of the above relative literature just focuses on individual country to investigate the relationship between macroeconomic variables on house prices. However, there are some evidences to show highly correlations between cross-border house markets. Even houses are immovable goods and cross-broader houses are not substitute for each other, some fundamental variables, such as GDP, can change the cross-border house markets at the same time, which could cause them be internationally correlated. Most of past relative papers, except for [11], [25], [35], have not covered the effect of cross-border house. Hence, following the line of [11], [25] and [35], the aim of this paper is to discuss the relationships between international house prices and macroeconomic variables. We apply the Pedroni's, panel cointegration, using the unbalanced panel data analysis of 33 countries over the period from 1980Q1 to 2013Q1, to examine the relationships among house prices and macroeconomic variables.

[2]There is another explanation about the transmission of real house prices to the macroeconomic, which is the changes in the interest rate of higher mortgage debt, means higher leverage can influence consumer spending.

III. Methodology

For testing for cointegration of the macroeconomic and housing market variables, a panel cointegration test of Pedroni (see [9]) for heterogeneous panels with multiple regressorsis used in this paper. Pedroni (see [36]) considers the following time series panel regression:

$$y_{it}=\alpha_i+\delta_i t+x_{it}\gamma_i+e_{it} \quad (1)$$

wherey_{it} and x_{it} are the observable variables with dimension of $(N*T) \times 1$ and $(N*T) \times m$,$\alpha_i$are individual fixed effect and$\delta_i t$ are individual time trends to be country-specific deterministic trend effects. The vector of slope coefficients, γ_i, is also allowed to vary by countries, ande_{it} is an error term. The null hypothesis of Pedroni's test is no cointegration, and the test allows for unbalanced panels, including heterogeneity in both the long-term cointegration vectors. Pedrone (see [8]) derives the asymptotic distributions and computes critical values for panel cointegration tests. There are seven panel cointegration statistics, first part is based on the within dimension approach, including the panel *v* statisic, the Panel *rho* Statistic, the Panel *PP* Statistic and the Panel *ADF* Statistic; the second part is based on the between-dimension approach, including the Group *rho* Statistic, the Group *PP* Statistic and the Group *ADF* Statistic. The panel *v* statisic is related to a one-sided test where large positive values reject the null hypothesis of no cointegration. Kao (see [37]) offered two types of test to examine panel cointegration, which includes the Dickey Fuller (DF) and the augmented Dickey Fuller (ADF) tests. Besides, another one uses the Fisher type test to aggregate the p values of the individual Johansen maximum likelihood cointegration test statistics (see [38], [39]).

Because the OLS which is used to estimate the panel cointegration vectors is a biased and inconsistent estimator, hence, the Panel Dynamic Ordinary Least Squares (DOLS) estimator is introduced by [9], [40], which is allowed to take serial correlation and endogeneity of the regressors into the conventional OLS estimator. The model of the DOLS is as the following:

$$y_{it}=\alpha_i+x_{it}\beta_i+u^{*}_{it} \quad (2)$$

$$x_{it} = x_{it-1} + v_{it} \quad (3)$$

With the regressors y_{it} is the house prices of country i, x_{it} is 3×1 vector of economic activity, long-term interest rate, and construction costs of country *i* at time *t*, and being integrated of order 1, then cointegrated with slopes β_i. We also employ the panel FMOLS (Fully Modified OLS) tests estimator from [9]. FMOLS is popular in conventional time series econometrics, in order to eliminate endogencity in the regressors and serial correlation in the errors.

TABLE I
Panel Unit Root Results

Method	HP	EA	I	Cc
LLC (2000)				
Level	-1.41 (0.07)	8.45 (1.00)	-1.17 (0.11)	0.83 (0.79)
First difference	-8.90** (0.00)	-23.21** (0.00)	-40.27** (0.00)	-15.56** (0.00)
Breitung(2000) t-stat				
Level	2.49 (0.99)	6.84 (1.00)	-3.33** (0.00)	-0.36 (0.35)
First difference	-3.75** (0.00)	7.70 (1.00)	-26.51** (0.00)	-4.42** (0.00)
IPS (2003) W-stat				
Level	2.61 (0.99)	2.84 (0.99)	-4.37** (0.00)	2.61 (0.99)
First difference	-14.29** (0.00)	-37.07** (0.00)	-39.20** (0.00)	-20.25** (0.00)
ADF – Fisher Chi-square				
Level	52.10 (0.89)	46.69 (0.96)	125.45** (0.00)	63.66 (0.55)
First difference	370.99** (0.00)	1224.32** (0.00)	1149.9** (0.00)	560.76** (0.00)
PP – Fisher Chi-square				
Level	68.83 (0.38)	229.29** (0.00)	215.63** (0.00)	218.54** (0.00)
First difference	1062.64** (0.00)	2080.03** (0.00)	1374.31** (0.00)	1371.08** (0.00)

Notes The null hypothesis is that the variable follows a unit root process. The lag length is selected using the Modified Schwarz Information Criteria. ** indicates that the estimated parameters are significant at the 5% level.

IV. Data and Empirical Results

A. The Data and Results of the Unit-Root Tests

The quarterly data used in this research cover the period from 1980Q1 to 2013Q2 for the following 33 countries: United States (U.S.), Brazil, Canada, Mexico, Australia, New Zealand, United Kingdom (U.K.), Austria, Germany, Spain, Netherlands, Norway, Italy, Ireland, Russia, Romania, Sweden, Switzerland, Czech Republic, China, Japan, Malaysia, Korea, H.K., Taiwan, Singapore, Indonesia, Thailand, South Africa. The house prices data were provided by the Bank for International Settlements (BIS). The independent variables as macroeconomic factors including money supply, consumption, industrial production, GDP and employment, we follow [11] using first principal component to combine the five measures of economic activity. [3] Both long-term interest rates [4] and construction cost are independent variables, empirical data come from the Data stream. All results in this research were generated using 'Eviews' econometric software and 'MATLAB' high-level technical computing language.

It has been suggested that one feasible way to increase power when testing for a unit root is to use panel data. The incentive behind this is to use more observations and exploit the cross-country variations of the data in estimation, which can have higher test power than standard unit root tests based on individual time series. Table I reports the findings from five alternative methods, namely, LLC, Breitung, IPS (see

[3] The variable economic activity is created by the real variables and adjusted by dividing by CPI.

[4] 10-year government bonds yield is regard as the standard indicator of long-term interest rates.

[41]-[43]), ADF- Fisher chi-square and PP- Fisher chi-square tests. All of these five tests were described earlier as well as [44] who assumes a null hypothesis of joint stationarity against the null that all series are non-stationary. Under cross-sectional independence, each of these statistics is distributed as standard normal as both *N* and *T* increasing.

Table I presents the results of the panel unit root tests with intercept and trend, the results of these five tests show that all variables are stationary at the 5% significance level of the first difference. There is only one exception, the Breitung's *t-Statistic* of the variable economic activity does not reject the null hypothesis of a unit root in both levels and first differences. However, we assume all variables follow I (1) processes because almost all statistics confirmed that the variables are I(1).

B. The Results of Panel Cointegration Test

According to the results of Table I, we confirm all variables are I(1), then we use (4) to start the long-run analysis, that is to use panel cointegration tests examining the relationship among the four variables. Besides, considering the analysis of sensitivity and robustness, we employ three kinds of panel cointegration tests, that is Pedroni's(see [36]), Kao's (see [37]) and Johansen's Fisher panel cointegration tests.

$$hp_{it} = \alpha_i + \beta_{2i} EA_{it} - \beta_{3i} I_{it} + \beta_{4i} Cc_{it} \qquad (4)$$

For starting to discuss the long-run relationship, we have calculated the Kao's tests for the homogeneous panel, where the null hypothesis is the absence of cointegration.

Table II reports the results of Kao's residual panel cointegration tests, which rejected the null hypothesis of no cointegration for the house prices and other variables at the 1% significance level, so that there is existence of cointegration.

Table III shows the results of all these panel conitegration tests when the dependent variable is *HP* (House Price).There are two parts in Table III, the first four test statistics are computed by the "within" dimension (panelstatistics). If the null is rejected, then house prices are cointegrated for all variables. The last three test statistics are computed by the "between" dimension (group statistics). In Table III, most of the estimate results of the Pedroni's heterogenous panel cointegration tests indicate that the null of no cointegration can be rejected at the 5% significant level. This displays that the changes of house prices in these 33 countries are connected with other macroeconomic variables. However, the results in Table III are in consistent; some statistics are significant, but there are some exceptional results, such as the panel and group versions of *ADF*-statistic and the group *rho*-statistic. Because the data applied in this paper are panel data, the varied results can be caused by the different relationships between house price and other macroeconomic variables in these 33 countries.

The result of the Johansen's Fisher panel cointegration test summarizes in Table IV, are fairly conclusive: Fisher's tests, no matter with the Trace test statistics or Max-eigen test statistics, support the presence of a cointegrated relation among the four variables at the 1% significant level. We can conclude from those results of panel cointegration tests, there is a panel long-run equilibrium relationship among the house price, economic activity, long-term interest rates and construction cost move together in the long run.

TABLE II
KAO'S RESIDUAL COINTEGRATION TEST RESULTS

	t-Statistic	Prob.
ADF	-4.01***	0.00

Notes: The ADF is the residual-based ADF statistic (see [42]). The null hypothesis is no cointegration. *** Indicate that the estimated parameters are significant at the 1% level.

TABLE III
PEDORNI'S RESIDUAL COINTEGRATION TEST RESULTS

	t-Statistic	Prob.
Within group		
Panel *v*-Statistic	2.07***	0.01
Panel *rho*-Statistic	-2.88***	0.00
Panel *PP*-Statistic	-4.70***	0.00
Panel *ADF*-Statistic	4.54	1.00
Between group		
Group *rho*-Statistic	0.83	0.79
Group *PP*-Statistic	-1.96**	0.02
Group *ADF*-Statistic	0.85	0.80

Notes: The null hypothesis is that the variable are not cointegrated. Under the null hypothesis, all the statistics are distributed as normal distributions. The variance ratio test is right-sided, while the others are left-sided. ** and *** indicate that the estimated parameters are rejects the null hypothesis of no cointegration at the 5% and 1% levels. Newey-West bandwidth selection using Bartlett Kemel Cross Method Statistic Prob.

TABLE IV
FISHIER-TYPE TEST RESULTS

Model	Fisher statistic (from Trace test)	Prob.	Fisher statistic (from Max-eigen test)	Prob.
None	524.0***	0.00	734.4***	0.00
At most 1	157.4***	0.00	131.0***	0.00
At most 2	71.81	0.29	66.77	0.45
At most 3	41.27	0.99	41.27	0.99

Notes: Asymptotic *p*-values are computed using a Chi-square distribution. *** indicate that the test statistics are significant at the 1% level. Fisher's test applies regardless of the dependent variable.

The panel cointegration analysis of long-run cointegrating relationships is modern time series analysis. Therefore, considering various forms of the residual-based panel Fully Modified OLS (FMOLS) and Dynamic OLS (DOLS) (see [9], [45]-[46]); show that it generally outperforms single-equation estimation techniques.

Table V presents the estimates of the cointegration vectors and t-statistics for (4). We conclude some points from the results. First, the average cointegration coefficient of economic activity in the 33 economies is 2.16 and it is significant at the 1% level, which means that a 1% increase in economic activity leads on average to a 2.16% increase of international house prices in the long run. The average cointegration coefficient of the long-term interest rate is -0.04 and is significant at the 1% significant level, hence meaning that a 1% increase in long-term interest rates will decrease international house prices by 0.04% in the long run. The average cointegration coefficient of construction cost is significantly positive, 0.22, at the 1%

significant level, which also displays that construction cost increasing 1%, will raise international house prices by 0.22% in the long run. The above results, as [11] observed, strongly confirm the theoretical implications of the DW model. Second, the coefficient for economic activity varies between -51.38 for Mexico and +75.33 in the case of the Australia, which shows that the raising effect of increasing economic activity on house prices is not uncertain in each economy. Third, let's focus on the coefficients of interest rates for individual counties. The coefficients of interest rate in most of countries are negative, just as theoretical expectation; the coefficient varies between -9.45 for Romania and +2.15 for Australia. There are some special case whose coefficients of interest rates are positive, such as 2.15 for Austria and 1.2 for China. The coefficients of these two countries are higher than other countries, which imply that higher interest rate significantly causes higher house prices instead of lower house prices.

In short, the coefficients of three variables in (4) for individual counties, two of these three coefficients in 11 countries have wrong sign, which shows that these 11 countries, including Brazil, Mexico, Australia, the UK, Austria, Finland, Germany, Netherlands, Czech, China and Indonesia, do not match the as the theoretical implications of the DW model. However, there are 7 countries where all coefficients of (4) have right sign, in other words, using the DW model to analysis the house markets of these 7 counties, including Norway, Switzerland, China, South Africa and "four Asian Tigers", will get better inferences.

As we now know, the DOLS estimate performs better than the FMOLS method. Table V also presents the results of FMOLS, which show that there is a positive effect on economic activity and construction cost at the 1% significance level. As for the size of these two coefficients, a 1% increase in economic activity raises house prices 2.18%, and a 1% increase in construction cost lifts house prices 0.23% higher. However, the panel long-term interest rate is -0.02, which is not significant at the 1% significance level.

C. More Discussions

Table V's results capture which economies have similar economic behaviors and developing paths. Therefore, to compare for similar or different relationships between high and low developing *economies*, this paper classifies the 33 *economies* into high and low income groups according to the World Bank income classifications in 2013 by GNI (gross national income) per capita. The World Bank classifications are shown as follows. Based on the standard of classification by the World Bank, a country with GNI per capita higher than US$12,616 belongs to the high income group, with all others put into the lower income group. There are 7 countries, including Brazil, Indonesia, Mexico, Romania, Malaysia, Thailand, and South Africa, in the group of lower income, and others are in the group of higher income.

TABLE V
THE RESULTS OF DYNAMIC OLS AND FMOL

	DOLS			FMOLS		
Country	Log (EA)	Log (I)	Log (CC)	Log (EA)	Log (I)	Log (CC)
US	15.87***	0.53**	3.23***	-0.59***	0.06	0.56***
	[3.87]	[2.95]	[7.73]	[-3.13]	[1.42]	[5.54]
Brazil	30.06***	0.12**	-0.87***	32.58***	0.04	-0.91***
	[10.39]	[2.95]	[-5.26]	[15.11]	[1.41]	[-6.75]
Canada	-19.08***	-0.13	1.48***	-15.40***	-0.05	1.26***
	[-7.44]	[-1.78]	[14.17]	[-7.97]	[-1.03]	[11.67]
Mexico	-51.38**	-0.25**	4.43**	10.67***	-0.04*	0.20***
	[-4.46]	[-5.07]	[4.37]	[8.29]	[-2.21]	[3.68]
UK	26.07***	0.18**	-5.49***	16.97***	0.41***	-2.62**
	[8.71]	[2.12]	[-6.76]	[3.66]	[3.02]	[-2.04]
Austria	-6.21***	0.24**	2.33***	-6.52***	0.21**	2.35***
	[-3.82]	[2.30]	[8.99]	[-4.78]	[2.65]	[9.56]
Belgium	18.73***	0.63***	0.61**	13.93***	0.07**	0.08*
	[15.37]	[5.92]	[3.94]	[26.02]	[2.39]	[2.04]
Denmark	6.94**	-0.79***	-1.12**	23.74***	-0.36	-3.81***
	[2.89]	[-3.93]	[-2.10]	[3.34]	[-1.15]	[-3.45]
France	35.23**	-0.43	-3.11**	4.20	0.29*	0.77
	[2.87]	[-1.40]	[-2.89]	[0.42]	[1.89]	[0.82]
Finland	-7.42**	0.36***	1.74***	-3.70	0.41***	1.44***
	[-2.62]	[6.08]	[4.28]	[-1.34]	[7.41]	[3.84]
Germany	11.37***	0.17**	-1.00**	12.43***	0.18***	-1.19***
	[6.26]	[2.46]	[-2.56]	[9.18]	[3.12]	[-3.77]
Spain	17.63***	-0.11*	-2.19***	18.95***	-0.29***	-2.98**
	[7.61]	[-1.77]	[-4.07]	[3.79]	[-3.45]	[-2.67]
Netherlands	-7.42**	0.36***	1.74***	-3.50	0.41***	1.40***
	[-2.63]	[6.08]	[4.28]	[-1.45]	[8.18]	[4.18]
Norway	4.97***	-0.09**	0.62***	6.57***	-0.09**	0.42**
	[3.95]	[-2.16]	[3.22]	[5.53]	[-2.11]	[2.36]
Italy	7.66**	0.12**	0.29	14.45**	0.34***	-0.10
	[2.13]	[2.05]	[1.05]	[2.20]	[2.57]	[-0.24]
Ireland	-29.52***	-0.78**	2.96***	-21.10***	-0.97***	2.33***
	[-6.71]	[-2.55]	[9.20]	[-3.51]	[-3.05]	[5.48]
Russia	-29.52***	-0.79**	2.96***	-21.10***	-0.97***	2.33***
	[-6.71]	[-2.55]	[9.20]	[-3.50]	[-3.05]	[5.48]
Romania	-7.33***	-9.45***	7.23***	-34.72**	0.29	8.82***
	[-20.66]	[-19.52]	[22.19]	[-3.14]	[0.43]	[4.29]
Sweden	-0.55***	-0.42***	0.86***	0.39*	-0.06	0.67***
	[-4.54]	[-6.01]	[10.25]	[1.77]	[-0.83]	[4.52]
Switzerland	1.15**	-0.08***	0.47***	0.80	-0.08***	0.56***
	[2.13]	[-3.92]	[11.37]	[1.32]	[-3.95]	[11.05]
Czech Republic	32.64***	0.48**	-2.12**	15.00***	0.19***	-0.18**
	[4.04]	[3.15]	[-2.76]	[16.04]	[6.53]	[-2.54]
China	15.81**	1.20**	-1.04**	14.03***	0.11***	-0.81***
	[3.68]	[4.14]	[-3.79]	[51.38]	[13.99]	[-51.88]
Japan	9.65	0.16*	0.48	5.54	0.16**	1.51**
	[1.43]	[1.69]	[1.05]	[1.08]	[2.00]	[2.51]
Malaysia	15.44***	-0.11**	-0.32**	9.78***	-0.11***	-0.06
	[47.15]	[-14.90]	[-15.65]	[14.50]	[-3.90]	[-1.59]
Korea	6.30***	-0.14***	0.46***	4.10***	-0.07**	0.16***
	[8.62]	[-3.23]	[5.24]	[8.54]	[-2.25]	[4.83]
H.K.	12.57***	-0.63***	0.06**	10.71***	0.03	0.09***
	[7.59]	[-6.27]	[3.24]	[6.35]	[0.26]	[4.51]
Taiwan	7.46*	-0.05	0.64**	5.09**	-0.01	0.68***
	[1.74]	[-0.05]	[2.17]	[2.49]	[-0.36]	[4.34]
Singapore	1.25**	-0.20**	0.35**	1.79***	-0.01	0.41***
	[2.56]	[-3.11]	[3.40]	[3.02]	[-0.32]	[4.58]
Indonesia	-1.95*	-0.39**	-0.22**	-4.70***	0.02	-0.04**
	[-2.29]	[-5.31]	[-5.08]	[-12.88]	[1.48]	[-2.17]
Thailand	4.14**	0.39*	3.22**	-0.42	0.02	-2.15***
	[2.84]	[2.11]	[4.99]	[-1.28]	[1.23]	[-67.67]
Australia	75.33**	2.15**	-5.18**	15.79***	0.08	-0.65***
	[2.87]	[2.80]	[-2.40]	[8.44]	[1.38]	[-3.82]
New Zealand	-10.49***	-0.69***	1.64***	21.45***	1.05***	-0.46***
	[-8.87]	[-5.11]	[20.52]	[11.84]	[7.06]	[-3.62]
South Africa	5.15**	-0.58***	0.40***	3.57**	-0.76***	0.34***
	[2.75]	[-3.59]	[5.64]	[2.74]	[-6.55]	[5.59]
Panel Group	2.16***	-0.04*	0.22***	2.18***	-0.02	0.23***
	[9.30]	[-1.63]	[8.17]	[9.59]	[-0.98]	[9.47]

TABLE VI
DOLS RESULTS OF HIGHER AND LOWER INCOME GROUP

	DOLS		
	Log (EA)	Log (I)	Log (CC)
Panel Group	2.16***	-0.04*	0.22***
	[9.30]	[-1.63]	[8.17]
HigherIncome Group	2.05***	-0.06**	0.18***
	[10.17]	[-2.51]	[7.48]
Lower Income Group	5.22**	-0.07	0.33**
	[2.24]	[-0.66]	[2.10]

Notes: *, **and *** indicates that the test statistics are significant at the 10%, 5% and 1% levels.

TABLE VII
DOLS RESULTS OF DIFFERENT REGIONS

Regions	DOLS		
	Log (EA)	Log (I)	Log (CC)
Panel Group	2.16***	-0.04*	0.22***
	[9.30]	[-1.63]	[8.17]
America	4.37*	0.33***	0.52***
	[1.86]	[8.34]	[3.09]
Europe	0.43**	0.66*	1.10***
	[2.07]	[1.92]	[17.25]
Asia	2.92***	0.19***	0.03*
	[4.36]	[5.56]	[1.72]
Other	3.88**	-0.21*	0.53***
	[2.01]	[-1.92]	[4.47]

The DOLS empirical results for the higher income group and lower income group are shown in Table VI. As shown in Table VI, we may analysis the results of Table VI as the following: First, for lower income countries, the coefficient of the economic activity, 5.22, is significantly positive, which shows a clear and strong relationship between economic activity and the house prices. Comparing with the he coefficients of the economic activity, 2.05, for higher income countries, the increasing economic activity could cause higher house prices in lower income countries. Second, the results of DOLS revealed that there were group differences on the long-term interest rate variable. The result of higher income countries is significantly negative coefficient, while the coefficient of the lower income countries is statistically insignificant. In other words, the long-term interest rate has a very significantly negative effect on the house prices for higher income countries, but it doesn't for lower income Group. The construction cost coefficient of the higher income group is 0.18, which is smaller than the coefficient for the lower income group, 0.33. The effects of the construction cost have more significant impacts on the house prices for higher income countries than for lower income economies.

Furthermore, in light of the results individual counties in Table VII, individual coefficients vary among regions and we note several findings as follows. First, the coefficients of economic activity in most countries are positive as expected. For instance, the coefficient for economic activity varies between +4.37 for America region and +0.43 in the case of Europe region. If we compare the coefficients of economic activity in different regions, then the coefficients of Asia region are +2.92, and all coefficients of individual economic activity are positive. Second, in America region, the coefficient of economic activity is the highest, +4.37, which displays that increasing economic activity causes a faster rise in house prices there than in other regions.

We now take a look at the coefficients of interest rates for individual regions. The coefficients for the interest rate in other countries are negative, along with theoretical expectation, and the coefficients of interest rates are -0.21. There are some special cases whereby the coefficients of interest rates are significantly positive at 5% significant level, such as 0.33 for America, and 0.19 for Asia, which implies that higher interest rates significantly cause higher house prices instead of lower house prices in America and Asia. The reason behind this result could be that higher interest rates may lead to higher expected returns from house investments, raising house prices further by stimulating the demand for houses. Finally, the coefficients of construction cost in all regions are positive, just as theoretically expected.

V. CONCLUSION

This paper employs the panel cointegration tests to analyse the long run relationships between macroeconomic variables and house prices, using data of 33 countries from 1980Q1 to 2013Q1, and the panel DOLS are applied to deal with the problem of serial correlation and endogeneity of the repressors. Our main findings are as follows.

First, the results of panel unit root test indicate that house prices, economic activity, long-term interest rates and construction cost are non-stationary. The results of the Johansen's Fisher panel cointegration tests support that there is a panel long-run equilibrium relationship among the house price, economic activity, long-term interest rates and construction cost move together in the long run. Second, the results of panel DOLS show that a 1% increase of economic activity, long-term interest rates and the construction costs will cause house prices respectively change 2.16%, -0.04% and 0.22% in the long run.

Third, the increasing economic activity and the construction cost would cause stronger impacts on the house prices for lower income countries than higher income countries. The results lead to the conclusion that policy of house prices growth can be regarded as economic growth for developing countries. Viewed in this light, policy makers and governments should act more quickly to intervene with policies to help the house markets for developing countries.

Finally, in light of the results in different regions, in America region, the coefficient of economic activity is the highest, which displays that increasing economic activity causes a faster rise in house prices there than in other regions. There are some special cases whereby the coefficients of interest rates are significantly positive at 5% level, such as 0.33 for America, and 0.19 for Asia, the reason behind this result could be that higher interest rates may lead to higher expected returns from house investments, raising house prices further by stimulating the demand for houses..

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