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Assessment of Potential Housing Price Bubbles in Hong Kong and Shanghai - An Eclectic Approach

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Housing prices in China have risen considerably over the past decade and many observers fear that a housing price bubble could burst with very negative consequences for the Asian economies as well as for the world economy as a whole. The problem with "bubble statements" is that no one is able to specify what a bubble really is. In this paper an eclectic approach based on a simple discounted cash flow model, a multiple regression equation and a test for cointegration of the selected variables is used not only to determine the potential degree of overvaluation but also to analyze the characteristics of the bubble. These characteristics such as the degree of autocorrelation of housing prices and the deviation from a specified fundamental value have been compared with those of previous bubbles. The analysis has been done for the markets in Hong Kong and Shanghai.

JEL Codes: C22, G02, and G17

1. Introduction

Housing prices in Hong Kong and Shanghai have risen sharply over the past decade. According to the most recent Global Property Guide, property prices in Hong Kong and Shanghai ranked third and 19th amongst the most expensive property markets in the world. Many observers and housing analysts have expressed their concern that housing price bubbles could have emerged and that a burst of these bubbles could have dramatic consequences not only for Asian economies but for the world economy as a whole. The problem of such statements is, however, that no one is able to concretely specify what an asset price bubble really means and how it can be distinguished from just rising fundamental values, or a normal overvaluation that can be corrected without severe economic consequences.

The objective of this paper is to provide a methodology that allows to assess whether an asset price bubble has occurred. Recent data has been used so that the study provides an actual statement on this issue. The methodology is based upon an eclectic approach of three at least partially different valuation models and was tested for the housing markets in Hong Kong and Shanghai. It starts with a simple discounted cash flow model to calculate the fundamental value of the two housing price markets. Secondly, an autoregressive distributed lag model for cointegration has been estimated to test for cointegration between housing prices and several macroeconomic as well as housing variables. The resulting long-term variation coefficients have been used to calculate a second kind of fundamental value. The deviations of market prices from this fundamental value and from the one of the discounted cash flow model provide two independent assessments whether the housing market in Hong Kong and Shanghai could be overvalued. As a third approach a multiple regression model is used including macroeconomic variables as well as terms for autocorrelation and reaction patterns of past price deviations from fundamental values. These characteristics describe to what extent these price movements have been driven by herding behavior (autocorrelation) or by rational investing (corrections of deviations from the fundamental value). If both components have a high impact on housing prices then

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there is a strong likelihood that a price bubbles has been formed. In this regard the values for these two components have been also compared to the ones of former housing price bubbles. By combining these three different methodologies at the end of the analysis it is aimed to form a common conclusion that gives a relatively reliable assessment whether the housing markets in Hong Kong and Shanghai have formed a price bubble.

The remaining of this paper is organized in four sections. The second section contains a literature review of housing price bubbles. In the third one the quantitative methodologies and the used data are described in detail. The fourth section shows the results of the discounted cash flow model and the two econometric models. In the last section the most important findings are explained.

2. Determinants of Housing Prices – A Literature Review

Before a review of housing price determinants begins, the term “asset price bubble” shall be discussed. An asset price bubble can only be defined in terms of a deviation from a fundamental value that it is extraordinary large. The fundamental value can be explained by the present value method or by macroeconomic or housing variables that form a long-run stable relationship with the market under investigation. The price bubble may be a result of a whole range of factors. Irving Fisher and Knut Wicksell in the early 1910s and the late 1890s respectively both asserted that the common cause of asset price bubble was low real rate of interest in combination with an economic boom. Many other researchers echoed this view as low real rate of interest indeed leads to credit and asset price booms (Helbing 2003). Case and Shiller (2003) mentioned that the cause of a bubble was mainly due to people’s expectation of future price increases. Both studies explained that the essential ingredient of a bubble was people’s attitude of treating housing rather as an investment and not as a consumption good. During a bubble, investors are willing to purchase even overpriced properties based on their beliefs that the price would go up further and ignore the risk that prices are elevated due to the market’s excessive and overwhelming expectations. In this regard often behavioral aspects such as herding behavior, over-confidence, over-optimism and similar psychological traps are reinforcing the rising price trend (Shiller 1998).

The difference between an overvalued market and a bubble leaves a lot of room for individual judgment. In the course of this work, the deviation will be quantified in percentage terms and an assessment will be based upon historical comparisons. Another problem is to determine the “right” fundamental value. Since fundamental values of financial or real estate assets contain forward-looking expectations, the calculation of a fundamental value is always linked to a lot of uncertainty. To overcome that problem at least to some degree, different methods to determine the fundamental value can be applied and compared with each other. The most straight-forward method is to discount the future cash flows of an asset by a discount rate. In the case of a real estate market, the cash flows are the rents to be achieved and the discount rate could be reflected by a representative mortgage rate. Since the amounts of rents of a house are not limited by some time horizon one has to approximate the calculation by a perpetual annuity including a reasonable growth rate for the future rents. Another way to estimate the fundamental value of a housing price is to link it with macroeconomic variables that show a stable econometric relationship to housing and that economically would make sense. The cointegration analysis is a particularly useful method to test for such stable relationships. For example, Kim and Lee (2000), Hui and Yue (2006) or Craig and Hua (2011) have used the cointegration method to check for housing price bubbles in Korea and Hong Kong, Beijing as well as Shanghai. Macroeconomic variables that can be considered in

this regard are GDP, stock prices, and interest rates (Hong Kong Monetary Authority 2002 and Chen and Partel 1998). The path of GDP growth is representing the income development of an economy that is driving the demand side of the housing market. Stock prices reflect the overall prosperity of an economy and can be interpreted in similar manner. Interest rates as well as building construction costs represent the cost side of the housing market and can be a price driver from the supply side. Demographics may also play an important role as the number of households in an economy can be an important demand side factor. Governmental policies may also be regarded as the size of available building land often is largely a political variable as well as subsidized home ownership schemes. (Craig and Hua 2011). All these factors will have to be tested and if some of them form a stable relationship with the price of the housing market under investigation then an econometrically based fundamental value for housing can be found.

In contrast to the mentioned studies in this section a unique combination of valuation tools has been used in this paper that may extend the toolkit of market researchers. In addition, this study provides an actual valuation assessment for the housing markets in Hong Kong and Shanghai.

3. Data and Methodology*

3.1 The Data

For Hong Kong, the quarterly data from Q1 1990 to Q3 2011 was analysed. This timeframe was chosen to include the maximum amount of available data into the analysis. The choice of variables was based upon well known macroeconomic relationships as described in section 2. All data was transformed into logarithms except real interest rates. The variables were differentiated on a quarter-on-quarter basis. This differentiation is the most suitable one for long-term relationships between variables and for a data basis reaching back just a little more than twenty years.

RGHPI (Real Housing Prices): The Hong Kong house price index for all classes of properties is used – quarter-on-quarter change in the composite CPI. (published by the Hong Kong Rating and Valuation Department)

RIR (Real Interest Rates): Real interest rate = 1-year Exchange Fund Bill – year-on-year change in the composite CPI (published by Hong Kong's Monetary Authority)
GDP (Real GDP) GDP in chained dollars 2008; seasonally adjusted. (published by the Census and Statistics Department)

RHSI (Real Stock Prices): Hang Seng Index average from monthly data – quarter-on-quarter change in the composite CPI. (data was provided by Datastream)

RRENTS (Real Rents): Hong Kong Rental Index for private domestic premises – quarter -on-quarter change in the composite CPI. (published by the Census and Statistics Department)

RM3 (Real Money Supply): M3 Money supply – quarter-on-quarter change in the composite CPI. (published by the Hong Kong Monetary Authority)

CPI (Consumer Price Index): Seasonally adjusted change in Consumer Price Composite Index including all types of goods; average from monthly data. (published by the Census and Statistics Department)

HHRP (No. of households owning residential properties): Number of domestic household * proportion of owner occupiers. (published by the Census and Statistics Department)

For Shanghai, the quarterly data from Q1 1997 to Q3 2011 was analysed. Again, the timeframe was chosen to include the maximum amount of data available for the investigated variables. All data was transformed into logarithms except real interest rates and differentiated on a quarter-on-quarter basis:

RIR (Real Interest Rates): Real interest rate = People's Bank of China benchmark lending rate – year-on-year change in the composite CPI (published by the People's Bank of China and Shanghai Statistical Information Net)

GDP (Real GDP): GDP in chained dollars 2008; seasonally adjusted. (published by Shanghai Statistical Information Net)

RSHSI (Real Stock Prices): Real Shanghai Stock market Index average from monthly data – quarter-on-quarter change in the composite CPI. (data was provided by Datastream)

RRENTS (Real Rents): Shanghai Rental Index for the private residential market – quarter -on-quarter change in the composite CPI . (published by CB Richard Ellis)

RM1 (Real Money Supply): M1 Money supply - on-quarter change in the composite CPI. (published by the People's Bank of China)

CPI (Consumer Price Index): Seasonally adjusted change in Consumer Price Composite Index including all types of goods; average from monthly data. (published by Shanghai Statistical Information Net)

RBMCOST (Real Building Material Costs): Building Material Costs in Shanghai (NADJ) - on-quarter change in the composite CPI. (published by Shanghai Statistical Information Net)

3.2 Methodologies

Three at least partially independent valuation approaches will be used to combine them at the end to a common assessment with regard to a potential price bubble in the housing markets of Hong Kong and Shanghai. These are a simple discounted cash flow model, an autoregressive-distributed lag model for cointegration and an arbitrage price theory (APT) model including a bubble builder and a bubble burster term. The reasons for the choice of these three methodologies will be discussed in each section of them.

3.2.1 The Discounted Cash Flow Model for Housing

The value of real estate can be estimated by discounting the future expected rents. Since the time horizon of a real estate investment has theoretically no time limit one would have to consider an infinitive amount of future rents. To avoid that problem one can approximate the estimation by using the perpetual annuity: $P_h = \frac{\mathrm{Re}\,nts}{i-g}$

Ph stands for the estimated fundamental value of a house, i – the discount rate - for some representative mortgage rates and g is the expected growth rate of rents. While rents and mortgage rates are known one has to run a reasonable estimate for g. In this paper g was calculated as the observable long-term historical growth rate of rents in the past. Ph of course can be aggregated to the overall housing market as it was done in this study. In economic literature, we also find cointegration based present value estimates by testing for long-run stable relationships between housing prices, rents and interest rates as costs of capital (Campell and Shiller 1987). In this paper, the standard DCF approach was preferred because it provides a more independent outcome from the procedures that follow and in addition it can be easily used to quantify the size of a possible overvaluation in percentage terms.

3.2.2 Autoregressive Distributed Lad Model for Cointegration

The aim of this methodology is to find macroeconomic variables that form a long-term equilibrium path with housing prices and to derive a long-term variation coefficient for the selected explanatory variables. That path can be used to calculate another fundamental value for housing prices. Several cointegration approaches could be applied such as the one of Engle and Granger (1987), and Johansen (1988) as well as his maximum likelihood procedures (1995). Previous studies, however, have shown that testing for cointegration using the Johansen methods often failed to find long-run stable relationships between housing prices and macroeconomic demand and supply factors (Hong Kong Monetary Authority 2002). Furthermore, the variables that can be tested for cointegration have to have the same order of integration. If one takes a closer look at the variables that could potentially be included in a model for the housing market then one finds that stationary variables as well as non-stationary variables have to be considered. This could limit the quality of this analysis substantially. Therefore, an alternative cointegrating technique is used - the autoregressive distributed lag (ARDL) approach. This approach does not require distinguishing the variables according to their order of integration (Pesaran and Shin 1999). The distribution of F-statistics is non-standard irrespective of the integration order of the included variables. Two sets of critical values are provided, one in which all variables are assumed to be integration order one (or two) and another in which all variables are assumed to be of zero (or one) order. These two sets form a band covering all possible classifications of the variables in terms of their integration order. If the computed F-statistic falls outside this band, the analysis can continue without knowing the order of integration of the underlying variables. If it falls within the band than a distinction of the variables becomes necessary. The ARDL approach provides a linear error-correction model to test the significance of the underlying variables and their cointegration. In addition, long-run coefficients based on ARDL models selected by AIC and SBC criteria can be estimated to use them for the calculation of a macroeconomic based fundamental value for housing prices.

For Hong Kong econometric pretesting delivered the results that rents, GDP growth and real interest rates are significant variables that could be cointegrated with housing prices based on an integration order of one. The function for housing prices in Hong Kong takes the following form:

$$RGHPI = \alpha_o + \alpha_1 GDP + \alpha_2 RRENTS + \alpha_3 RIR + \mu_t \quad (1)$$

The error correction version of the ARDL model is as follows:

$$\Delta RGHPI_t = \alpha_o + \sum_{i=1}^{n} \alpha_{1i} \Delta GDP_{t-i} + \sum_{i=1}^{n} \alpha_{1i} \Delta RRENTS_{t-i} + + \sum_{i=1}^{n} \alpha_{3i} \Delta RIR_{t-i} + \alpha_{4i} GDP_{t-1} + \alpha_{5i} RRENTS_{t-1} + \alpha_{6i} RIR_{t-1} + \mu_t \quad (2)$$

For Shanghai econometric pretesting delivered the results that rents, money supply growth and building material costs are significant variables that could be cointegrated with housing prices based on an integration order of one. The function for housing prices in Shanghai takes the following form:

$$RSHHPI = \alpha_o + \alpha_1 RRENTS + \alpha_2 RM1 + \alpha_3 RBMCOST + \mu_t \quad (3)$$

The error correction version of the ARDL model is as follows:

$$\Delta RSHHPI_t = \alpha_o + \sum_{i=1}^{n} \alpha_{1i} \Delta RRENTS_{t-i} + \sum_{i=1}^{n} \alpha_{1i} \Delta RM1_{t-i} + + \sum_{i=1}^{n} \alpha_{3i} \Delta RBMCOST_{t-i} + \alpha_{4i} RRENTS_{t-1} + \alpha_{5i} RM1_{t-1} + \alpha_{6i} RBMCOST_{t-1} + \mu_t \quad (4)$$

The null of no cointegration defined by H0 = aginst H1 = will be tested. The relevant statistic is the F-statistic for the joint significance of the parameters as described above.

3.2.3 An APT Model with Bubble Builder and Burster Terms

An alternative econometric model is explaining housing prices by macroeconomic variables (an application of the arbitrate price theory for housing prices) and combine it with a bubble builder and a bubble burster term (Abraham and Henedershott 1996). The last two terms are of behavioural nature and shall describe to what extent the investigated price path is driven by herding behaviour (bubble builder or autocorrelation term) and by arbitrage trading (bubble burster) where rational investors try to profit from a market price that is far above the fundamental value by selling the asset. The equation to be tested has the following form for Hong Kong and Shanghai:

$$RGHPI = \alpha_o + \alpha_1 GDP + \alpha_2 RRENTS + \alpha_3 RIR + \lambda_1 RGHPI_{t-1} + \lambda_2 (RGHPI_{t-1} - RGHPI^*_{t-1}) + \mu_t \quad (5)$$

$$RSHHPI = \alpha_o + \alpha_1 RRENTS + \alpha_2 RM1 + \alpha_3 RBMCOST + \lambda_1 RSHHPI_{t-1} + \lambda_2 (RSHHPI_{t-1} - RSHHPI^*_{t-1}) + \mu_t \quad (6)$$

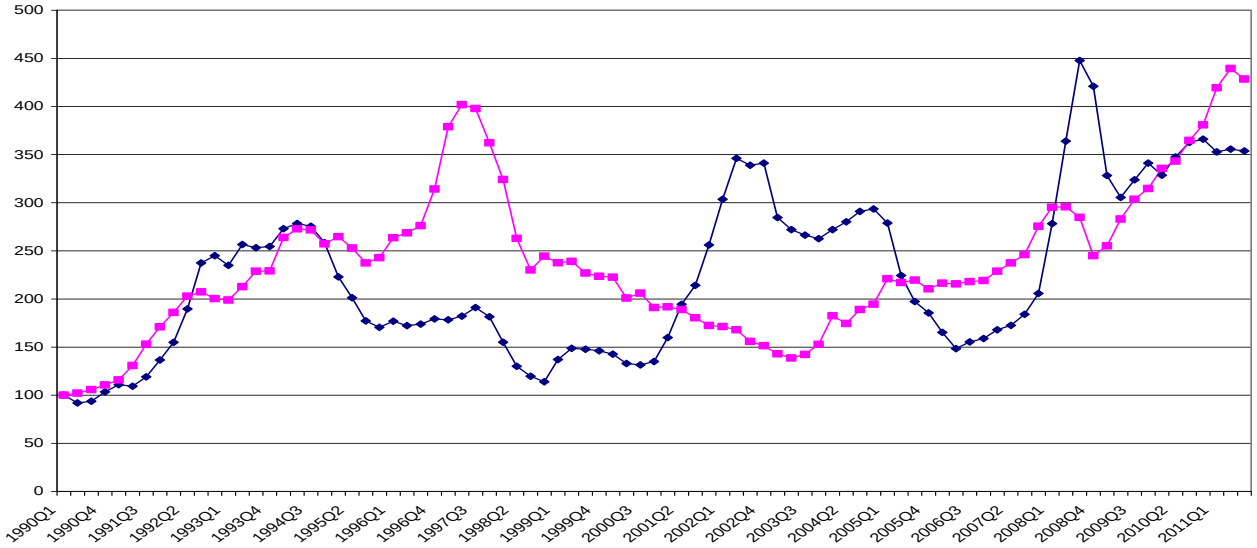
In the original approach of Abraham and Hendershott equations 5 and 6 had been tested first without the bubble builder and burster terms to calculate a fundamental value in line with a classical APT approach. In a second step, the fundamental value (RGHPI* and RSHHPI* for Hong Kong and Shanghai) has been used to introduce the bubble burster term. The important advantage of this procedure is that behavioural and market efficiency characteristics can be linked with macroeconomic variables to extend the analysis of the price path of the housing market. If the variation coefficient for the bubble builder term is high and statistically significant then it becomes probable that the investigated market has been a subject to speculation. If, however, the variation coefficient and the statistical significance of the bubble burster term are high, one may conclude that an arbitrage process has set in because more and more market participants have recognised that the market is overvalued. In this case the end of the bubble and the beginning of a crash is near. So the higher the coefficient and statistical significance of the bubble builder and bubble burster term the larger the likelihood that bubble is about to burst. In contrast to the work of Abraham and Hendershott, the fundamental value here was not taken from an

APT equation but from the above described present value model. This has been done for two reasons: First, the amount of available data particularly for Shanghai was too small to run such a two step equation approach. Secondly, the aim of this paper is to combine three different approaches to derive a common conclusion out of them and to diversify the risk of research mistakes. Calculating a fundamental value by using the described APT approach would have had too many similarities with procedures in 4.2. - causing the risk that the results of 4.2. and 4.3. would have become more correlated.

4. Results

4.1 The Discounted Cash Flow Model for Housing

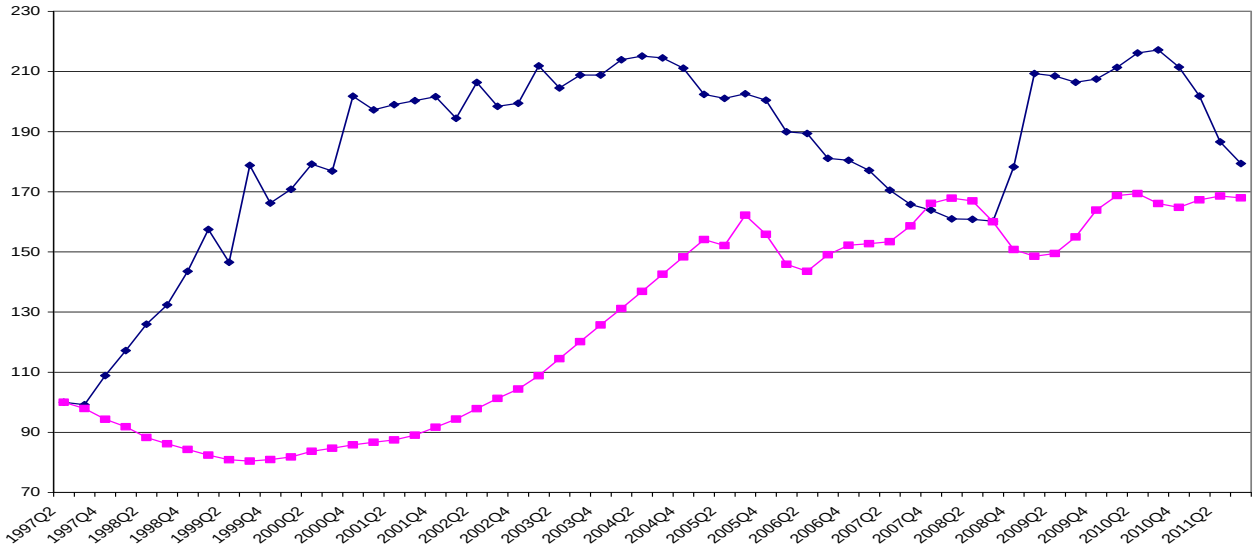
Figure 1: House Price Index and DCF-model results for Hong Kong



The violet line represent the model results and the blue one the actual housing price index level. The DCF model nicely shows the bubble in 1997 when the Hong Kong housing market was highly overvalued and crashed in the years to come. The Hong Kong Monetary Authority reacted to this crash by lowering interest rates substantially. This is why the model results moved up in the years 2001 to 2003 while the market was still in a correction mood, providing an excellent investment opportunity. From 2004 on, market prices rose again very much in line with the DCF results that were driven by falling mortgage rates and rising rents. At the last data point of this investigation – in the third quarter of 2011 – the Hong Market was overvalued by around 20% according to these calculations. This does not look like a real price bubble but rather like an overvaluation. In 1997 for example, the market was overvalued by around 100% before a several years lasting crash took place.

The discounted cash flow model for housing in Shanghai delivered the following results:

Figure 2: House Price Index and DCF-model results for Shanghai



The violet line represent the model results and the blue one the actual housing price index level. The DCF model rose sharply in late nineties mainly driven by falling mortgage rates in Shanghai. The market reacted to that fundamentally improved environment only with some time delay and was finally catching up in 2006. In 2007 the DCF model was driven down by rising mortgage rates before it moved up again supported by monetary easing in the aftermath of the world financial crisis. Lately, interest rates went up again so that in the third quarter of 2011 the Shanghai housing market was overvalued by around 17%. According to the DCF calculations the current market in Shanghai seems to be overvalued but one could not name that a price bubble.

4.2 The ARDL Model and its Long-Run Coefficients

In econometrical pretesting for Hong Kong, the following variables out of the set of variables that has been presented in section 3 turned out to be significant: Real rents, GDP, and real interest rates. The ARDL estimates brought the following results for the error correction version of the model whereas d stands for the differentiation of the variable.

Table 1: ARDL (2,0,1,0) Error Correction Presentation for Hong Kong

Est. Variable	0.463* dRGHPI$_{t-1}$	0.827* dRRENTS	0.119* dGDP	-0.0049* dRIR	0.00017* TREND	–0.4604* ec1 $_{t-1}$
STDE	0.121	0.4742	0.0351	0.00131	0.000062	0.102
T-R.	(3.81)	(1.75)	(3.39)	(-3.74)	2.77	(-4.51)
Prob.	(0.00)	(0.086)	(0.001)	(0.00)	(0.007)	(0.00)

Table 2: Estimation & Diagnostics Statistics

R-Squared = 0.469	R-Bar-Squared = 0.414
F-Statistics = 10.0033 (0,00)	DW-Statistics = 2.134

Testing for existence of a level relationship among the variables in the ARDL model:

F-statistic	95% Lower Bound	95% Upper Bound	90% Lower Bound	90% Upper Bound
7.9374	4.2407	5.3187	3.6132	4.6177

As can be seen from Table 1 all included variables were statistically significant according to their t-ratios although some doubts have to be referred with regard to rents. All three variables had the theoretically expected sign. This was also true for the error correction term that was highly significant and had a negative sign. Its variation coefficient was close to 0.5 suggesting that half of the deviation from equilibrium that may result from a shock will disappear after a year. The statistical significance and the sign of the error correction term were indicating that the included variables were cointegrated with housing prices. This indication was also supported by the F-statistic that showed a value of 7.9374 - clearly above the critical 95% and 90% upper bound level. The R-Squared and the Durbin Watson test for residual autocorrelation did not indicate greater distortions.

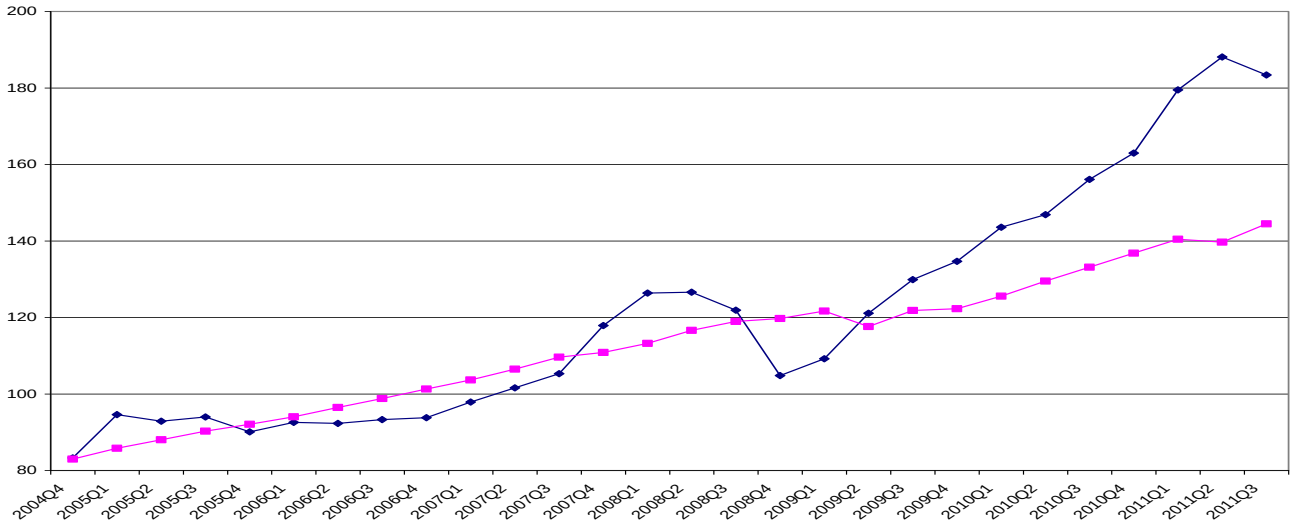
The next step is to calculate the long run coefficients of this ARDL model:

Table 3: Long-run coefficient estimates and diagnostics

CONSTANT	RRENTS	GDP	RIR	TREND
-0.012006	1.7957	0.11111	-0.010695	-0.00037
(-1.85)	(1.49)	(1.34)	(-2.74)	(2.80)

The upper row shows the results for the long-term variation coefficients of the included variables. The values in brackets are the corresponding t-statistics. All variables have again the expected signs and seem to be statistically significant albeit to a lower extent than in the error-correction version. These values can now be used to calculate a macroeconomic and cointegration based fundamental value for the housing market.

Figure 3: House Price Index & ARDL long-run coefficients estimates for Hong Kong



The violet line represents again the model results and the blue one the actual housing price index level. As a starting point the fourth quarter of 2004 was chosen when both time series had reached the same level in the very long-run comparison. The ARDL long-run coefficient estimates point towards a relatively steadily increasing fundamental value of the Hong Kong housing market while real house price index was much more volatile. The recent strong upward movement of housing prices seems to outpace macroeconomic fundamentals. However, the degree of the overvaluation in the third quarter of 2011 has been slightly above 20% confirming the results of the former DCF-approach. The housing

market in Hong Kong is overvalued but not to an extent that could lead to real crash such as in 1997.

In econometrical pretesting out of the set of variables in section 3, the following variables for Shanghai had been significant: Real rents, real money supply (M1) and real building material costs. The ARDL estimates brought the following results for the error correction version of the model:

Table 4: ARDL (2,0,1,0) Error Correction Presentation for Shanghai

Variable	0.0678* dRRENTS	0.8828* dRM1	0.0019* dRBMCOST	–0.4986* $ec1_{t-1}$
STDE	0.0624	0.0704	0.00119	0.1103
T-R.	(1.85)	(12.62)	(1.59)	(-4.52)
Prob.	(0.083)	(0.00)	(0.119)	(0.00)

Table 5: Estimation & Diagnostics Statistics

R-Squared = 0.964	R-Bar-Squared = 0.961
F-Statistics = 334.108 (0,00)	DW-Statistics = 2.0745

Testing for existence of a level relationship among the variables in the ARDL model:

F-statistic	95% Lower Bound	95%Upper Bound	90% Lower Bound	90% Upper Bound
4.666	3.4861	4.6051	2.8616	3.9271

Table 4 shows that all included variables were statistically significant according to their t-ratios although some doubts arise with regard to real rents and building material costs. All three variables had the theoretically expected sign. This was also true for the error correction term that was highly significant and had a negative sign. Its variation coefficient was again close to 0.5 suggesting that half of the deviation from equilibrium that may result from a shock will disappear after a year. The statistical significance and the sign of the error correction term were indicating that the included variables have a stable long-term relationship. This result was also supported by the F-statistic that showed a value of 4.666 and was above the critical 95% and 90% upper bound level. The R-Squared was very high and the Durbin Watson test did not indicate serial correlation of the residuals.

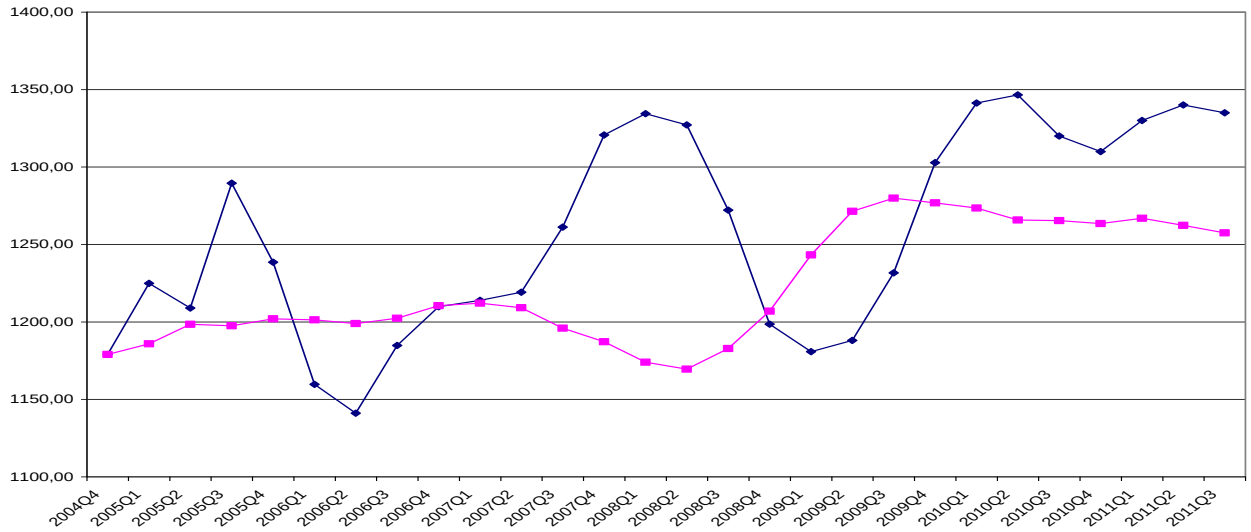
The next step is to derive the long run coefficients out of this ARDL model as presented in Table 6:

Table 6: Long-run coefficient estimates and diagnostics

CONSTANT	RRENTS	RM 1	RBMCOST
-0.00213	0.1359	0.77768	-0.03777
(-1.95)	(1.51)	(5.20)	(1.57)

The upper row shows the results for the long-term variation coefficients of the included variables. The values in brackets are the corresponding t-statistics. All variables have again the expected signs and seem to be statistically significant. Again these values can be used to calculate a macroeconomic and cointegration based fundamental value for the housing market in Shanghai.

Figure 4: House Price Index and ARDL long-run coefficients estimates for Shanghai



The violet line represents again the model results and the blue one the actual housing price index level. As a starting point the fourth quarter of 2004 was chosen when the both time series had reached the same level in the very long-run comparison. The ARDL long-run coefficient estimates was somewhat more volatile compared to the one for Hong Kong but al least from a longer term prospective it showed as well a moderately and steadily rising trend. The recent upward movement of housing prices that started in early 2009 seems to outpace macroeconomic fundamentals somewhat but is not very concerning. The moderate decline in fundamental value that could have been observed over the same time horizon was mainly driven by a more restrictive monetary policy. The degree of overvaluation in the third quarter of 2011 was only around 7% and showed an even more moderate picture than the DCF-approach. The housing market in Shanghai seems to be just moderately overvalued and should not give major concerns for a potential crash at this stage.

4.3 The APT Model Results with Bubble Builder and Burster Term

The APT model contained the same variables as the former ARDL model for Hong Kong and for Shanghai. In addition, a bubble builder and a bubble burster term were included and the estimation was based on an OLS multiple regression procedure.

For Hong Kong, the following results have been achieved:

Table 7: Ordinary Least Square Estimation for Hong Kong

Est. Variable	-0.00373 Constant	0.7077* $RGHPI_{t-1}$	1.1503* RRENTS	0.0663* GDP	-0.0037* RIR	0.00372* BBT^{i}	0.0012* TREND
STDE	0.00302	0.1038	0.5074	0.0351	0.00138	0.06761	0.00061
T-R.	(-1.24)	(6.82)	(2.27)	(1.89)	(-2.68)	0.06	1.99
Prob.	(0.22)	(0.00)	(0.026)	(0.063)	(0.009)	(0.956)	(0.050)

Table 8: Estimation & Diagnostics Statistics

R-Squared = 0.49	R-Bar-Squared = 0.446
F-Statistics = 11.35 (0,00)	DW-Statistics = 1.60
Lagrange Multiplier Test of residual serial correlation CHSQ (12) = 18.08 (0.01)	
Test for Heteroscedasticity based on squared residuals CHSQ (1) = 2.71 (0.099)	

All macroeconomic explanatory variables were statistically significant as can be seen from the t-statistics and all of them had the expected signs. The R 2 is of similar magnitude as in the ARDL version. However, the model seems to suffer somewhat from serial correlation as indicated by the lagrange multiplier and the Durbin Watson test. However, the degree of serial correlation was not high enough to question the overall validity of the model. Of particular interest were now the results of the bubble builder and the bubble burster term. The bubble builder term (RGHPIt-1) was highly significant and had a variation coefficient of around 0.7. These estimates suggested that property prices in Hong Kong were likely subject to speculation. This level is considerably higher than the 0.3 found by the IMF (Kaira, Mihaljek, and Duenwald 2000) and Abraham/Hendershott for US cities as an indication for a potential bubble. On the other hand, the bubble burster term (BBT) was not significant with a very low variation coefficient. This means there is no pressure measureable that market prices could move back to the estimated fundamental values (based on the DCF approach). The major finding of that model is that the housing market in Hong Kong is a target for speculation but at current terms the speculation had not been large enough to cause a reversal in the current trend. This result is fairly supported by the findings in 4.1 and 4.2..

The estimates for Shanghai had the following results:

Table 9: Ordinary Least Square Estimation for Shanghai

Variable	-0.00305 Constant	0.01622* $RSHHPII_{t-1}$	0.03283* RRENTS	0.00232* RBMCOST	0.9476* RM1	0.17213* BBT
STDE	0.00613	0.03642	0.07238	0.00135	0.0835	0.0467
T-R.	(-4.97)	(0.45)	(1.35)	(1.72)	(11.35)	(3.68)
Prob.	(0.00)	(0.658)	(0.11)	(0.091)	(0.00)	(0.001)

Table 10: Estimation & Diagnostics Statistics

R-Squared = 0.943	R-Bar-Squared = 0.937
F-Statistics = 169,35 (0,00)	DW-Statistics = 1.40
Lagrange Multiplier Test of residual serial correlation CHSQ (12) = 9.4649 (0.05)	
Test for Heteroscedasticity based on squared residuals CHSQ (1) = 1.0223 (0.312)	

All macroeconomic explanatory variables were statistically significant as can be seen from the t-statistics and all of them had the expected signs. The R 2 was once again quite high. While the lagrange multiplier looked quite good, the Durbin Watson test was less convincing and pointing towards a distortion of the results from serial correlation. Since all other statistics were within expected ranges a high degree of validity of the model can still be assumed. Of particular interest were now the results of the bubble builder and the bubble burster term. The bubble builder term (RSHHPIt-1) was not significant at all and had a very low variation coefficient. These estimates suggested that property prices in Shanghai had not been affected by bubble building resulting from herding behavior or other behavioral reasons. The bubble burster term (BBT) was highly significant and had a higher variation coefficient found in the studies from the IMF and Abraham/Hendershott. This means that market participants seem to be quite sensitive to overvaluations and ready to correct larger mispricing in the market. This finding supports the results from the

DCF and the ARDL approach that the housing market in Shanghai is far from being in a bubble.

5. Summary and Conclusions

A lot of financial market participants and financial scientists have expressed their concern that Asian housing prices could have formed a price bubble that threatens the economic prospective for the region. The aim of this paper was to investigate these concerns for Hong Kong and Shanghai by using an eclectic approach of three at least partially independent methodologies. A classical discounted cash flow model, a cointegration based APT model and a regression analysis including a bubble builder and a bubble burster term were tested. For both markets, the three methodologies have produced similar results. The housing market in Hong Kong seemed to be overvalued and contained a lot of speculative characteristics but was far away from a price bubble seen in 1997. The overvaluation was assessed to be in a range of 20%. For Shanghai, the results were even more moderate. The market seemed to be overvalued between 7% and 17% - depending on the applied methodology. In addition, bubble building processes were not found but a relatively high tendency to move back to a fundamentally based equilibrium. The fact that all three methodologies provide similar and conclusive results for two different markets over two different time horizons shows that they can be bundled into one eclectic approach that diversifies the risk for a researcher of getting methodology biased results. However, the analysis also has its limitations. It would have been desirable to run it for a longer period to receive more reliable results. This is particularly true for the analysis of Shanghai where the minimum amount of required degrees of freedom was given – but not more. Unfortunately, longer time series for the tested variables were not available. In addition, the validity of that approach could be assured by back-testing it to former historical price bubbles.

Endnotes

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[i] BBT stands for the bubble burster term

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