What Can China Learn about the Way Property Price Bubbles Affect GDP Growth? A Bubble Economics Perspective

Bryane Michael, University of Oxford
and Simon Zhao, University of Hong Kong

Contents

Abstract

How far do China's property prices need to drop in order to trigger a GDP reaction that looks like a price bubble bursting? What does this question tell us about the way Bubble Economies work? In this paper, argue for a separate analysis of 'Bubble Economics' – as the non-linear and often "systemic" (in the mathematical sense of the word) forces which cause significant misallocations of resources. Even the term Bubble Economics can help us keep in mind that when we look at such events, we are witnessing discontinuous jumps representing the radical change in underlying economic structures and fundamentals -- if even for a limited time.

Keywords: China recession, bubble economics, non-linear dynamics, asset bubbles, bubble economics.
JEL Codes: D58, N15, L85, G01
Interests: We have no personal, pecuniary or other interests in this research.
Data Statement: Al data come from popular, publicly available sources.

We gratefully acknowledge support from the Lincoln Institute of Land Policy. Naturally, the opinions expressed in this study remain our own – and should not be attributed to institutions to which we affiliate.

What Can China Learn about the Way Property Price Bubbles Affect GDP Growth? A Bubble Economics Perspective

Bryane Michael, University of Oxford
and Simon Zhao, University of Hong Kong

Introduction

What would happen if China experienced a US-style real estate price/demand collapse similar to the one the US experienced in 2008 and 2009 – or worse? The worse studies like Xiao and Tan (2007) and later Yiu *et al.* (2013) -- simply treat prices as signals, ignoring the structures driving them. The better ones try to assess whether real estate prices exceed their stable long-run market-clearing equilibrium levels, like Hui and Gu (2010) attempt (thought not in typical supply and demand terms). These studies use the classical tools of economics we all learn in school. They use smooth, twice differentiable supply, demand and other curves. They look at the consequences of non-linear change, after it occurs (Slettvag, 2015). Or they throw their hands up - saying that we don't know even how to define such bubbles (Mayer, 2011). They do not deal well with sudden regime change… making predictions about any price collapse difficult to make. What does the inside of the proverbial black hole look like?

In this article, we argue for a Bubble Economics, a set of principles driving bubble economies during the period of a property price/GDP growth collapse. In effect, describing the inside of this data and modelling black hole. During these crises, economic fundamentals in a range of markets change - and most supply and demand elasticities change, either temporarily or permanently.

We organise our paper as follows. The first section looks at the problems in using existing models to predict such property price collapses. These previous studies make crazy predictions - ignoring the specialness of correlations, elasticities and causations in/during the bubble -- as many studies wrongly predict that a 10% change in property prices causes a 1% fall in GDP growth. The second section argues for a more complete analysis of markets in disequilibrium. Risk measures try to get at these underlying economics - but largely avoid talking about the forces leading to the sudden correction. Third, we discuss structural change - and the crises that trigger them (and visa versa). The fourth section analyses the co-determining link between banking/financial crises and/or sovereign debt crises and property prices - noting that disequilibria in one market tells us something about disequilibria in the other. In the middle of the crisis (transition), we observe jumps in data which we plot as smooth lines - rather than the jumpy leaps they are. The final concludes – arguing for economics and social scientists to rethink the rules of economic analysis once inside the black hole of an on-going recessionary property price crisis.

We have numerous caveats to bring to the reader's attention before we begin. First, due to data limitation, we try to talk about the real estate sector as a whole – focusing on both residential and commercial property in all market segments (quality, geographical and so

forth). We will often refer to housing, real estate and property markets interchangeably. Thus, we beg the readers' forgiveness if we treat this highly diverse sector with broad brushstrokes – in order to focus on the bigger picture (a general, correlated collapse in property prices). Second, we purposely omit any discussion of cross-border impacts, monetary policy, exchange rates and sudden stops elsewhere in the economy (Arellano and Mendoza, 2002). China represents one of the most important traders and investors in the global economy. Yet, to keep our modelling simple, we assume China - and the other comparator economies we discuss - exists in a vacuum. Third, we also organise our paper differently than usual. We present the literature during the course of our argument, judging studies as we go along. By adopting such an approach, we hope to arbitrate in some of the long-standing debates in the field – rather than just adding yet another model to the pile.

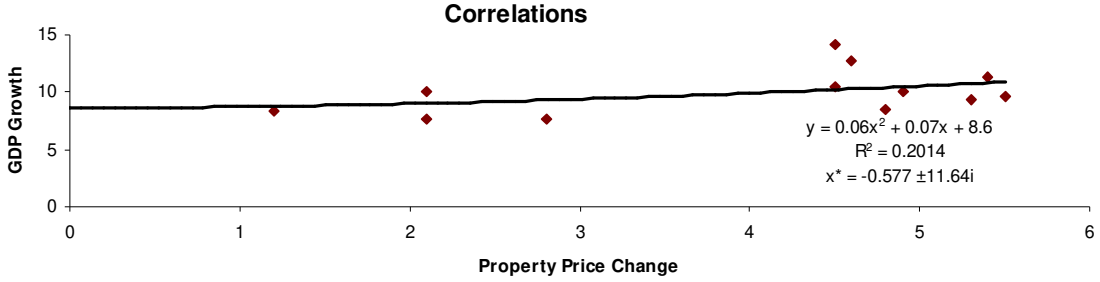
We also make some assumptions worth noting at the start. First, we acknowledge that shocks may come from outside the system, and may even fail to cause a price collapse, as the global financial crisis failed to set off a domestic property price collapse in China (Kang and Liu, 2014). Second, we talk about Bubble Economics right at the start of our paper. We only clarify the term as we go along though. Part of this reflects a rhetorical device, tying the piece into a single story. Part also reflects our ignorance - as what happens in the proverbial black hole -- where prices drop discontinuously - differs for every crisis. If economists and modellers treat these intermission periods as periods worth modelling and studying in their own right…we will have succeeded.

Existing Models Fail to Provide the Basis for Prediction

Literally hundreds of analysts have described the reasons for China's supposed upcoming real estate-led economic and financial crisis. Yet, past performance provides poor grounds for guessing how far property prices need to fall in order to send a country's GDP into recession, like China's. Any simple correlation between property price changes and GDP growth would not yield any sensible results – as China's recent experience only shows the two growth rates moving upward together. Figure 1 shows the relationship between Chinese property price change and GDP growth. In theory, one can just follow the regression line to zero. Yet, it never intersects zero. Thus, the only solution requires a slight decline in property prices of about half a percentage point – and 11 units of another unknown variable![1]

[1] In more mathematical language, only solutions involving imaginary numbers exist for the equation we show in the figure (for GDP growth rates equal zero). Such imaginary numbers simply represent adding another dimension (in our case an unknown variable) which solves the equation.

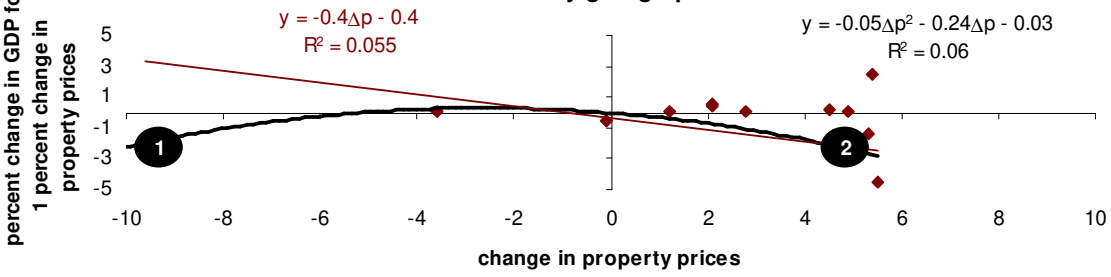
Figure 1: Impossible to Reach Zero Growth from Previous Property Price/Output Correlations



The figure shows the relationship between Chinese GDP change and property price changes from 2000 to 2013. Besides the model fitting very badly (as shown by the low R-squared), GDP growth does not equal zero for any value of property price change. We must resort to an outside variable (in the imaginary dimension) to get zero GDP growth.
Source: authors (with data from the Chinese National Bureau of Statistics).

Yet, most people understand that the GDP/property price nexus is probably non-linear. Figure 2 shows a slightly more nuanced view of such GDP and property prices. Even before applying fancy statistical analysis to get rid of the effects of extraneous variables (like money supply, government policy and so forth) we see that the data reflect the past. If we just draw a line through the data in this figure, at a 10% drop in property prices, we already observe GDP falling 3% for every further 1% drop in property prices. If we fit a non-linear relationship to the data, rapidly falling property prices correspond with rapidly rising GDP. So do rapidly rising property prices. GDP falls only between a -1% and -4% fall in property prices. Point 1 and Point 2 on the figure correspond to the same change in GDP – even though property prices are doing radically different things. Such non-linearities conform to our intuitions – that deep underlying structures probably change when we witness a property price drop of significant magnitudes.

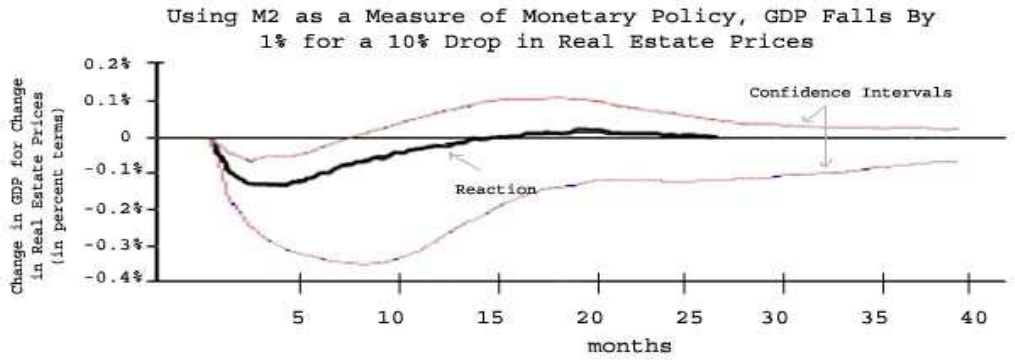
Figure 2: No matter what property prices do, Chinese historical data show GDP only going up



The figure shows what economists refer to as the elasticity of Chinese GDP with respect to property prices from 2000 to 2014. We put this change with the change in property prices, to see how this elasticity changes as property markets heat up (or down!). The highly flawed statistics behind this chart nevertheless confirm the common sense result that rapid rises or drops in property prices correspond to rapidly changing GDP.
Source: authors, with data from the World Bank and the China Statistical Office.

Such a failure to take structure changes into account results in serious errors with all kinds of models of the Chinese economy. Figures 3 shows the expected decrease in GDP as housing prices fall – after taking into account the interaction between GDP, consumer prices, money supply, and housing prices.[2] Each of these figures look at a different way of estimating the effects of changing property prices (or the price of borrowing money for property) on GDP. The top panel uses the amount of money as a way of measuring Chinese monetary policy, whereas the bottom panel uses lending interest rates as the measure of changes in China's monetary policy. Using either measure of monetary policy yields roughly the same result. In general, property prices have about a 1-to-10 effect on GDP. Namely, a 10% fall in property prices leads to about a 1% decrease in GDP levels in the short-term (1-2 quarters). Reflecting the self-correcting nature of a "normal" economy, GDP levels end up rising around 15 months after the crisis – until finally settling at their pre-shock levels. Assuming the Chinese economy operates the same way as before a huge shock, an 80% reduction in real estate prices would been needed to throw China into recession.[3] Yet, we know that the Chinese economy wouldn't operate as before – our models can not take the structural changes of such an economy -- a Bubble Economy -- into account.

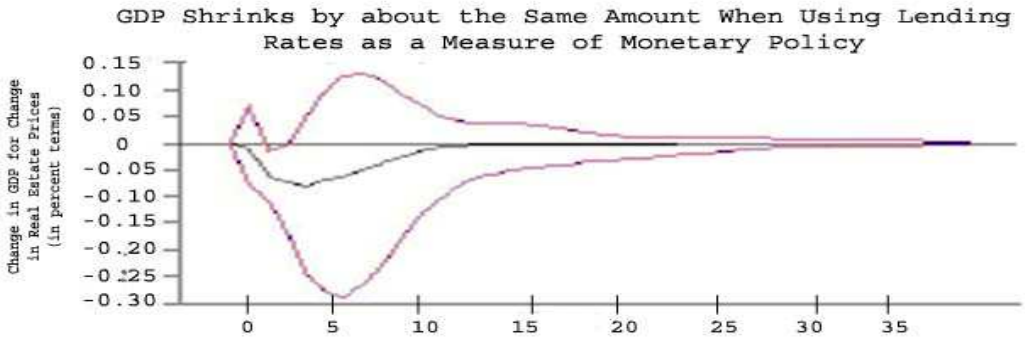
Figures 3: Real Estate Prices Would Need to Halve In Order to Knock GDP Growth Into Negative Territory



[2] The study shown in the Figure focuses mostly on monetary policy – estimating the effect of housing price changes on GDP as one in a series of variables. Other authors like Ma (2010) have reached similar estimates of the effect of housing price changes on GDP of around 0.1 and provide strong evidence that past price changes drive future price changes.

[3] If recession is defined as a decrease in GDP for at least 2 consecutive quarters, and if we assume that China's GDP will grow by 7.7%, then the relationship in Figure 2 shows that we need a decrease in real estate prices of 80% to decrease GDP by 8% -- basically erasing the growth driven by other parts of the economy. The figure also shows that decline continues for about 3.5 quarters – which also exceeds the definition of recession lasting 2 quarters.

Figure 3 continued



The figure shows the effect on Chinese GDP of a property price fall using vector autoregression (VAR) methods. The solid black line shows the estimated response (per month) for a 1% change in property prices. The red lines show confidence intervals. The main effect appears in about 3-4 months (with downside predictions placing the maximum effect at about 8-9 months). We flipped the original source graph along the x-axis in order to show a decrease in property prices.
Source: Tan and Chen (2013).

Part of the problem lies in the way past decisions to make and buy real estate and property reflect on today's decisions. Authors like Nie and Cao (2014) show that real estate comprises roughly 20%-ish of China's GDP – and probably directly contributes about 2% to China's GDP growth.[4] Yet, housing and other types of real estate investment drive GDP growth in other ways. Figure 4 shows the linkages between housing and non-housing investment in China in the early part of the post-2000 period. As shown, a 1% increase in housing investment drives about 0.14% increase in GDP – confirming previous studies. A 1% bump-up in housing investment yesterday also drives a 1.5% increase in housing investment today. These data show that property prices influence investment decisions and consumption decisions – which drive GDP growth. Again, like with the previous studies – yesterday's investment and output levels best explain the future...until they don't.[5]

[4] The authors' estimate refers to the "authors' calculations" of "real estate investment" without further information on the techniques they used or the exact definition of such investment. Even taking the authors at their word, such a measurement would exclude expensed (rather than capital deductible) spending/production on the existing stock of properties and other economically productive activity. As we describe in Figure 4, real estate investment drags along other investment and consumption which counts toward GDP.

[5] In other words, like most time series data, lagged variables often provide better predictors than other independent variables. As we describe in our own modelling, the rate of change of housing (real estate) depends on the level of such a stock. Mathematically inclined readers will recognise this as a differential equation.

Figure 4: GDP Depends on Housing Investment and a Bunch of Unknown Factors

Dependent variables ---> / Independent variables	GDP today	Housing Investment today	Non-housing Investment
Noise	**0.13**	**0.84**	**1.2**
GDP yesterday	0.38	-2.0	-0.21
Housing investment yesterday	**0.14**	**1.5**	
Non-housing investment yesterday	0.1		**0.9**
Equal to zero?	**4.1**	1.6	0.02

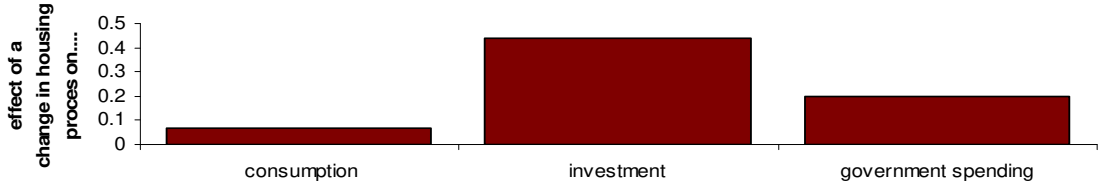
Cells marked in black are statistically significant at the 5% level.
Source: Liu et al. (2002).

The method used to model Chinese GDP growth clearly impacts in way we guess about the effect of property price changes. Another approach looks at the way property price changes might affect the major expenditure categories of GDP growth. Figure 5 shows how a change in Chinese property prices has traditionally filtered through to changes in various types of national expenditure. Property prices have unsurprisingly had the biggest impact on investment – with a 1% change in property prices correlating with a 0.4% change in investment. In line with our description of the effect on households and local governments, property price changes also encourage consumption and government spending. A sudden decline in property prices by 10% would thus lead to a total change in expenditure of around 7% (if the effects shown in Figure 5 work together).[6]

This study highlights three problems with current methods to model China as a Bubble Economy. First, such an estimate varies wildly from the previous one by one order of magnitude! As such, we can not rely on these classes of models to provide consistent results. Second, these models can not show the combined effect on GDP. We have no idea what happens when consumption and investment shocks operate together. Third, we do not know what happens when large, rather than small, changes occur in property prices. Figure 5 shows marginal (or small) effects. We can not simply add up these small effects to get a large effect.

[6] The exact effect of change a change on total expenditure depends on the interaction between consumption, investment and government spending. In theory, the authors' results take into account changes in the other variables. However, in practice, we would want to see a study of these interactions before telling something more definitive.

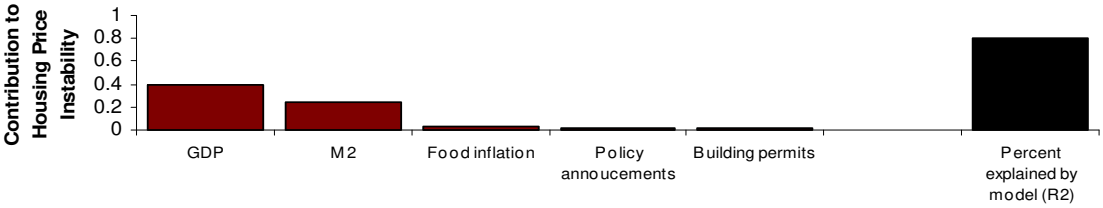
Figure 5: Estimated Impacts of Changes in Chinese Property Prices on Various Aspects of Aggregate Demand



The figure shows the effect of a 1% change in property prices on various elements of Chinese aggregate demand - using special assumptions made by the authors (and in some cases our own interpretation). See paper for more.
Source: Ahuja *et al*. (2010).

Could the "feedback" between changes of GDP growth and real estate prices -- through other variables like the money supply or consumer prices -- distort or amplify the way property price markets impact GDP?[7] Figure 6 shows the contribution of various macroeconomic factors to housing price instability in China. At first glance, changes in GDP seem to explain changes in Chinese property prices better than any other variable. While the money supply also explains these movements, other factors like food price inflation and real sector policies have far less explanatory power. Seemingly, these results support more rigorous studies like Chen and Zhu (2008) – who show bidirectional Granger causality between housing investment (and thus presumably housing prices) and changes in GDP growth.[8] Ostensibly, changes in GDP affect housing/property prices.

Figure 6: Changes to GDP and Monetary Policy Contribute Most to Housing Price Instability



The figure shows the results of the completely mis-specified regression looking at the way GDP instability (and other factors) affect Chinese housing prices. We report on this regression to highlight the need for better (non simple OLS) studies and the likely endogeneity problem extant in our research problem. Housing price stability refers to the residual values obtained from regression real estate prices today on yesterday's real estate prices only.
Source: Wang (2014).

Yet, first impressions lie – and GDP probably has little role to play in property price changes...even during non-bubble times. Figure 7 shows the factors contributing to property price changes over time in China. In recent years, housing preferences, excess

[7] In economic terms, we want to know whether an economically significant endogenous relationship exists between property price growth and GDP growth. In a macroeconomy, everything affects everything else. Yet, by focusing on large effects, we can keep from getting lost in details and complexity.
[8] Granger causality refers to a statistical technique in which (very roughly translated into English) the analyst sees whether today's changes in property prices explain the previous quarter's or year's changes in GDP better than the converse (today's changes in GDP explains yesterday's changes in property prices better).

savings and productivity gains explain rising property prices. Changes in aggregate production/expenditure just don't seem to drive property prices. Figure 8 tackles the problem from a different angle. Let's suppose that the Chinese government instituted a "affording housing" policy (which generated sudden large demand for housing). Such a sudden expansion of GDP in the areas specifically focused on housing should lead to price changes. Yet, the simulation and regression analysis shows that prices actually fall by a very, very small amount. A shock in government investment in housing causes a -.0001 change in housing prices. If such effects even exist, they are too small to seriously worry about. Models like Sinclair and Sun (2014) produce similarly tiny effects. Changes in Chinese GDP do not cause changes in property prices.

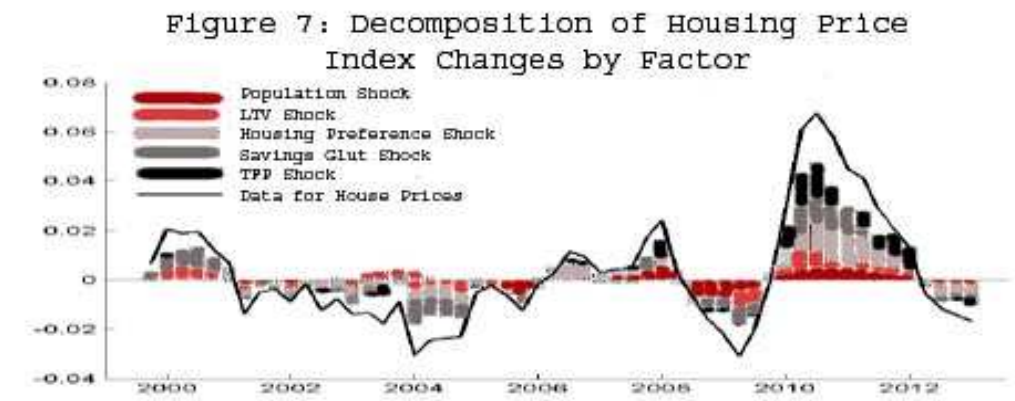


Figure 8: Another Model Produces Microscopic Shocks of "Affording Housing" Shock
(effect at peak)

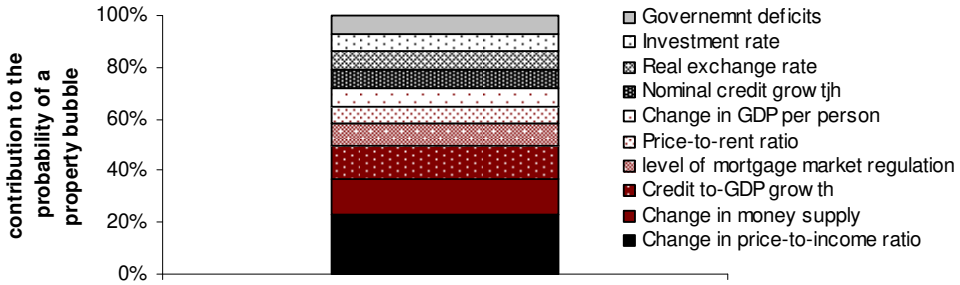
Variable	extent of effect	Variable	extent of effect
Consumption	-0.00013	**Output consumption**	0.0008
Output housing	0.07	**Housing prices**	-0.0015
Labour housing	0.005	**Labour consumption**	0.0012
inflation	0.000075	**Total investment**	0.00045
interest	-0.00018		

The figure shows the response of each variable shown to an "affording housing" policy shock. The shock considers the effect of big bang Chinese government investment in housing. We show the level at the height of its effect (using between 3-6 periods). See source for definition of the shock, the model and other particulars.
Source: Zhou and Jariyapan (2013) at Figure 1.

As if to belabour the point, changes in GDP do not seem to directly impact on property (real estate) price change. Figure 9 shows the probability of a property bubble (from a range of countries). If China follows these other countries, price changes affect the real economy far more than the real economy affects property price changes. As shown, the endogeneity problem seems at first glance minor. Thus, property price changes reflect excessive momentum in pricing – suggesting that serious misalignment can occur. More

fundamental to our paper**,** the failure of the literature to draw conclusions about even basic questions – like whether an endogenous relationship exists between property price changes and GDP changes – highlights the need for our study.[9] Yet, to the extent we can draw conclusions; we know that something other than the underlying fundamentals reflected in GDP drive property prices in China and elsewhere.

Figure 9: Probability of Property Bubble Due to Prices and Credit



The figure show s the extent to w hich the factors show n in the figure contribute to property price bubbles across countries. Clearly, price-to-income, rent-to-income, loan-to-value and other factors represent the best indicators.
Source: Dreger and Kholodilin (2011).

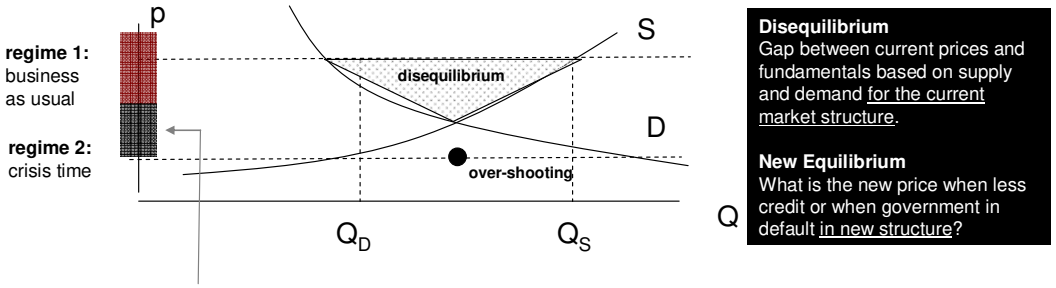
The Need for a Disequilibrium View of China's Real Estate Markets

The lack of property prices' response to economic fundamentals points to potential distortions in property markets which keep prices out-of-equilibrium. Figure 10 shows the standard economic analysis of property markets. The existence of high real estate prices, significant over-supply (particularly in China's supposed ghost cities) and significantly high demand reflects artificially high prices for reasons which we will not discuss at length in this paper.[10] We will discuss the resulting disequilibrium though. As illustrated in the figure by the "short-side rule," a gap appears between a low quantity of property demanded at high prices, very high demand at lower prices -- and high levels of supply based on artificially high prices.

[9] The patchy quality of the statistical analysis conducted in many of these studies represents a far worse problem than the lack of models themselves. Many Chinese authors – having access to statistical software – performed time series analyses on a number of variables and reported on all the statistics the software provided. We thus try to report their findings when applicable, often corroborating or interpreting their studies with our own analysis of data similar to those these authors used. Unfortunately, because of the Chinese distain for criticism/critique, these studies go unchallenged and represent a serious danger to our project/profession!

[10] Even the Australian documentary *Living in a Bubble* highlights the reasons for artificially high prices (reflecting high savings-fuelled demand, low interest rates, and local government development policies). Our paper's goal consists of modelling these effects without dwelling on their particularities in the Chinese context. See Shepard (2015) for more.

Figure 10: Any Housing Price Effect on GDP Needs to Consider the Extent of Current Misalignment, Responses to Post-Crash New Economic Structures and the Way Prices Can Take on a Life of their Own for a While



In a crisis, prices either "overshoot" (because it pays to sell before everyone else sells) or partially adjust to new inchoate market. The former case represents the case of dynamic disequilibrium whereas the later represents probability-adjusted optimal equilibrium.

The bursting of the putative property price bubble will incentivize Chinese authorities to remove the distortions keeping prices about equilibrium. The removal of the part of the figure we have labelled as "disequilibrium" will result in – ironically more actual property coming onto the market at lower prices. Thus, we need to know how high these prices are in order to estimate the effect on GDP growth rates. The figure also refers to price points below equilibrium which result from the general crisis. We know from other countries' experiences that the entire property model changes (at least in the medium-run). Thus, we can not even use existing supply and demand curves to talk about the way property price changes affect GDP. To model the Bubble Economy, we need to know how removing the existing disequilibrium will affect prices and lastly how the ensuing crisis will affect prices and GDP.

Existing studies do not agree about whether Chinese property prices exceed their equilibrium values. Figure 11 shows the results of many of the key studies, which either look at the extent to which property prices exhibit temporal serial correlation or the extent to which variables grow over time with other variables like the availability of bank credit.[11] The current literature suffers from a number of flaws which serious jeopardizes its ability to predict China's (and other Bubble Economies') next crisis. First, while the theoretical literature models property prices "taking on a life of their own" – empirical work fails to use these insights to determine how far property price misalignment could go.[12] Many of these studies establish both unit roots and co-integration in the data.[13] Yet, they do not actually use the parameter estimates to predict (and test their predictions) what will happen to Chinese GDP and property prices.

[11] In other words, these authors use either time series analysis or vector autoregression (and in some cases error correction models).
[12] "Taking on a life of their own" means that property-related physical and financial asset buyers and sellers may engage in herding (buying and selling based on the actions of other traders) instead of focusing on the intrinsic value of the asset(s) as determined by discounted cash flows, supply and demand.
[13] In plain English, "unit roots" refer to a statistical value which shows the tendency of yesterday's prices (or other economic variables) to completely and totally determine today's prices. "Cointegration" refers a relationship in data which grows or shrinks over time.

Figure 11: Previous Studies about Chinese Real Estate Prices

author(s)	Results	Bubble?
Xu (2014)	**Focus:** Looks at whether real estate bubble has formed **Findings:** Finds that property prices take on a life of their own. Economic fundamentals do not explain property prices.	**Yes**
Ma (2010)	**Focus:** Do bubbles affect China's housing market **Findings:** The author erroneously claims that housing prices depend on their previous values – so they "bubble."	**Yes**
Huang et al (2015)	**Focus:** Looks at effect of credit expansion and local amenities on housing prices **Findings:** Availability of credit drives up house prices and develops markets for amenities.	**Yes**
Ahuja et al. (2010)	**Focus:** As above. **Findings:** Housing prices are NOT over-valued, except in big cities, selected markets and in luxury segment.	**Yes**
Bian and Gete (2015)	**Focus:** Look at the extent to which fundamental factors drive housing prices **Findings:** property prices rise due to fundamental factors like population rising, easier credit, more demand for housing, higher savings rates, and or most importantly a change in productivity (technical progress).	**No**
Fang et al. (2015)	**Focus:** Looks at the comparability of returns in housing to other types of financial products. **Findings:** Housing prices inertial and purchasing by lower income-to-rent ratio clients worrying.	**No**
Ren et al. (2011)	**Focus:** Looks at streaks of housing price increases to decide if "rational expectations bubbles" form over time. **Findings:** No streaks of price rises provide encouragement for gambling investors. Thus, no bubbles appear to have formed. Housing is an investment good which doesn't depend on the local economy.	**No**
Lan (2014)	**Focus:** Looks at whether monetary policy and other factors influence property prices **Findings:** No evidence of price bubbles (as other factors besides property price's own momentum drive prices).	**No**
Deng et al. (2012)	**Focus:** Looks at whether land prices drive real estate price changes **Findings:** Land prices and other factors drive property prices. Because prices exhibit "mean reversion" no bubble or long-term disequilibrium likely exists.	**No**

Source: authors (reviewing other sources).

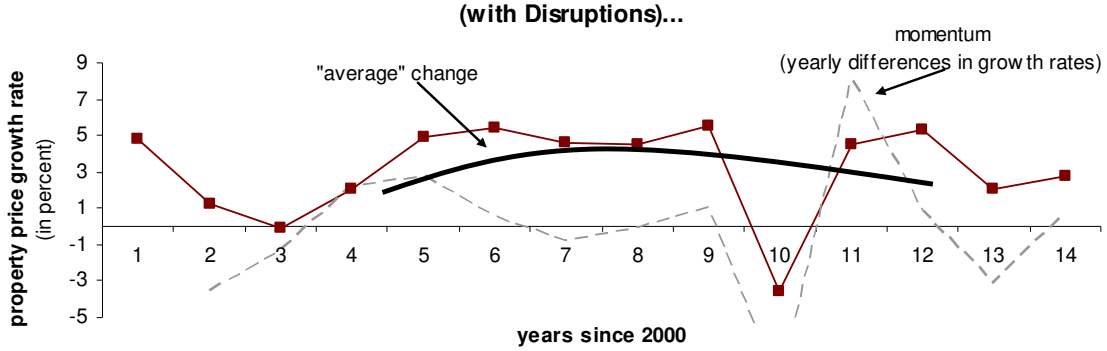
Citing another flaw, these studies fail to establish the conditions for market clearing in the real estate sector and use that yardstick as a measure for price disequilibria. Most studies attribute changes in property prices to changes in variables like credit, under the assumption that these changes reflect changes in demand (or supply if credit goes to construction companies). The observation of large amounts of unused real estate, high prices, and attendant regulations like the Hukou system obviously imply some degree of disequilibrium.[14] For studies that do find disequilibria pricing, they fail to provide testable explanations which result in predictions about when disequilibria grow or change. These studies use past property prices to predict disequilibria in current prices. Yet, they do not use past or current disequilibria (and the misallocation of resources) to explain

[14] Indeed, no reasonable economist would ever claim markets always operate in equilibrium. Accepting some disequilibrium and then trying to assign parts of that disequilibrium to various factors like fast credit expansion serves as a more credible method of analysing Chinese property markets than just wishing these disequlibria away. Hukou refers to the permits Chinese citizens need to live in a particular city.

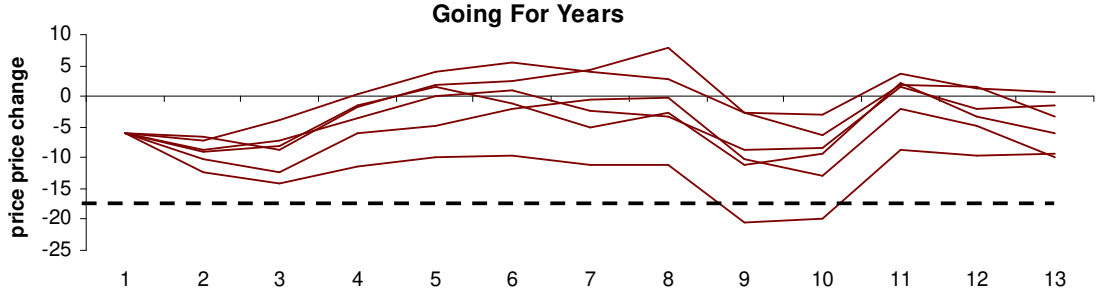
future (predicted) disequilibrium pricing. Distorted markets create distorted price-based incentives.

Most tragically, these studies can not explain sudden momentum in property prices or the way output might respond to property prices. Property prices can change sharply and suddenly. None of these models explain the spurts or times of sudden intense activity. Let's illustrate the problem with this literature by looking at the extent to autocorrelation (memory) in property prices. Figure 12 illustrates the memory in Chinese property prices and the effect such memory would have in the case of a large shock. The upper part of the figure shows way that property prices in any year reflect prices from the previous year. In contrast, momentum (or the difference between this year's price change and last year's price change) has no memory.

Figure 12: Even Property Growth Rates in China Seem to Have a Memory (with Disruptions)...



...and even Using Current Parameters, a Sudden Crash in Property Properties Keeps Going For Years



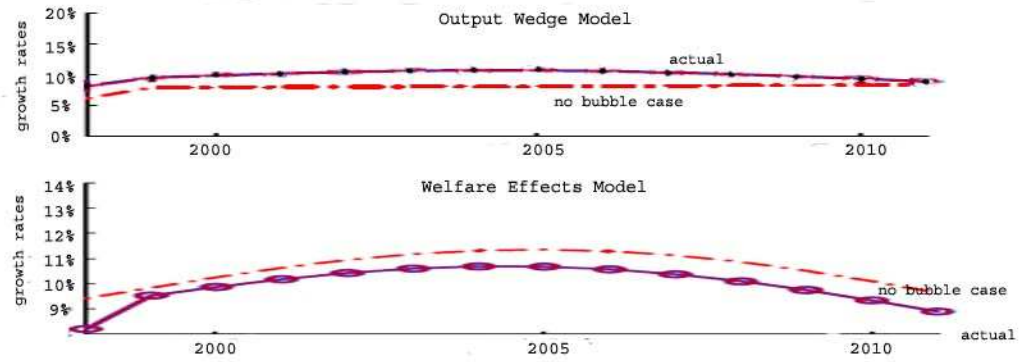
The figure on the top shows the way that Chinese property prices moved over time (and the "stationary" difference in those growth rates). We show the extent to autocorrelation as as traciing out the one-year lag term on the autoregressive (AR1) process. The bottom part shows the simulated time-series structure of China's property price data (basically the second difference of the data which has no memory and a moving average component of 0.76). We kept the moving average, adjusting by the standard deviation of the price data from 2000 to 2014 and basically integrated up to arrive at the price change simulations you see.
Source: authors, using data from the Chinese Statistics Office.

Such momentum shows why prices exhibit a 'jumpiness' that most models can not handle/explain. Again referring to Figure 12, momentum spikes hard in some years (like in 2011) and remains quiet in other years (like 2007). Some event embodied in this momentum statistic (like government policy or even sunspots) could "naturally" knock

property price growth rates well into negative territory.[15] As shown in the bottom part of the figure, when prices suddenly move (thanks to their momentum), they may stay negative for a long time. As shown by these simulations, Chinese prices – if they operated under the rules that currently drive them – would stay negative in most scenarios and for many years. Current models fail to build-in such jumpiness into Chinese prices (and model the way output reacts during the jumpy periods).

Even if we do model such jumpiness at the sector level, failing to look at the economy as a whole can lead to serious problems. Existing models tracing through the impacts of property price disequilibria on output highlight the differences between a sector-based rather than whole-of-the-economy based view.[16] Indeed, we know that wringing disequilibria out of Chinese property markets can actually increase GDP growth – by removing existing distortions. Figure 13 shows the estimated effect of removing the output wedges caused by excessively high property prices. While property price bubbles have resulted in shortages in property markets themselves (in partial equilibrium), they have led to out-of-equilibrium output growth rates (in general equilibrium).[17] High property prices affected employment and the use of capital – and even encouraged higher total factor productivity until around 2009. The net gain in GDP growth from hyper-growth versus the loss from resource misallocation has come to about 2%. These results suggest that any property price correction of around 10%-20% would likely knock off 2% of "bad" GDP growth, raising welfare. More generally, any analysis of China's (or any Bubble Economy's) changing property prices must look at the whole economy.

Figure 13: Distorted Property Prices Lead to Excess Output and Less Welfare



The figures show the growth rate in aggregate output in China (actual) and estimated assuming that a housing price bubble didn't exist at the time. The top figure shows the difference between actual output and the output China would have had without a housing price bubble. The bottom figure shows the welfare effects in both cases -- with welfare being higher without a bubble. Source: Chen and Wen (2014).

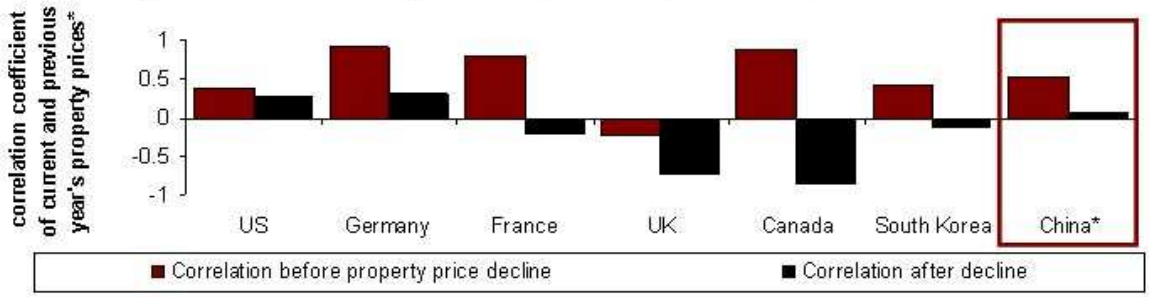
[15] "Sunspots" refer to rational and normal large changes in prices which other economists have observed for no underlying economic reason. Some event (like a solar flair) causes actors to react in the same way for irrational reasons. Yet, these sunspots have very real economic effects. We rely on these sunspots in our modelling later in the paper when talking about a very large price change, explicitly to abstract away from the reasons that prices might change.

[16] Economists refer to this as taking partial equilibrium, rather than a general equilibrium, perspective. Economists are famous for showing counter-intuitive results when looking at the economy as a whole.

[17] Numerous studies show how rapidly rising property prices can create real estate shortages, yet generate temporarily higher incomes for investors and builders who create bustling economic activity around empty neighbourhoods and business centres.

We know that GDP growth rates react very differently to changes in property prices during and after a banking, financial and/or sovereign debt crisis than before.
China probably has yet to experience its cycle of debt-price increases-bubble. Figure 14 shows – for several large OECD economies which we compare with China throughout this paper – the correlation in property prices before and after crisis. For the UK and Canada, property price correlation increases in volatility after a period of property price contraction (such that the following year's prices tend to go in the opposite direction more strongly). For countries like the US and Germany, periods of negative property price growth seem to dampen prices. After China's brief property price decline in 2009, property prices seem to have shorter-worse memories. Again, to belabour the point, Figure 15 shows – after removing the noise – the cycles present in property prices in China and the US.[18] Because the US has already had its regime shifting structural change after its Great Recession in 2008-9, we observe a longer 14 year cycle in the data while we do not observe in the Chinese price data. We need better tools to detect the aspects of the Bubble Economy which we already observe in the US data, but we can only hope to predict in the Chinese property price data.

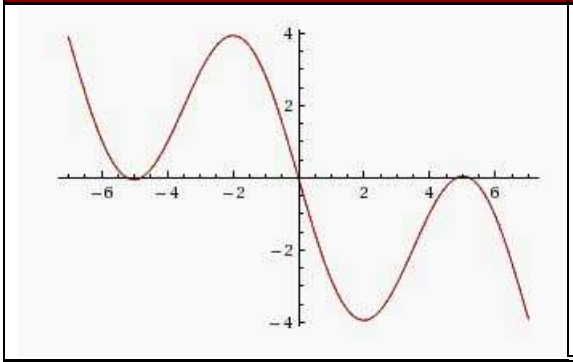
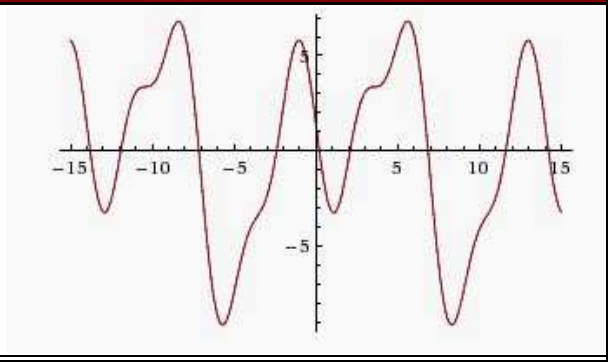
Figure 14: Crisis Change the Way Property Prices Depend on their Past



The figure shows the correlation between property price growth before each country's property price decline (going back until the last crisis or a maximum of 10 years) and the correlation after the price decline. We do not show t-values for these coefficients (to test for similarity) or use time series methods in order to provide the reader with the necessary intuitions without going (yet) into alot of complexity.
Source: authors, with data provided by the OECD and China Statistics Bureau.

[18] No credible economist since the 1940s would argue that period cycles exist in these type of data. However, the idea of cycles remains entrenched in the popular psyche. So we use these data to illustrate poignantly our point about "structure change" in a way a non-PhD would understand.

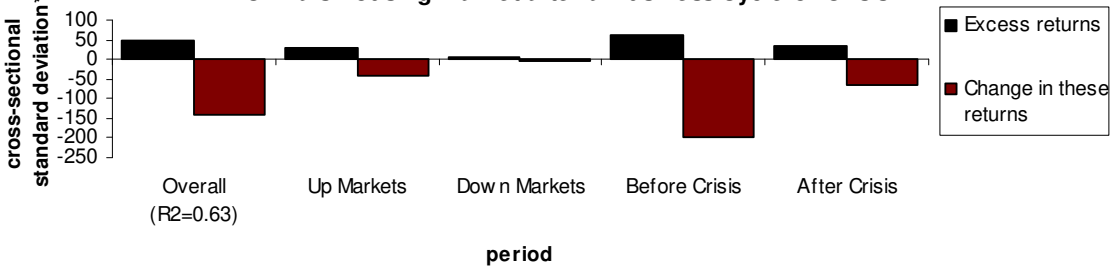
Figure 15: Different "Cycles" Suggest that Forces Have Played Out in the US that Have Yet to Play Out in China

China	USA
	
$p_t=2.5\cos(2\pi/3.5)\ p_{t-1} - 2.9\sin(2\pi/7\ p_{t-1})$	$p_t = 1.43\cos(\pi/7\ p_{t-1})+3.35\sin(\pi/7\ p_{t-1})-5\sin(2\pi/7\ p_{t-1})-2.1\sin(2\pi/3.5\ p_{t-1})-1.66\cos(2\pi/2.8\ p_{t-1})-1.33\cos(2\pi/2.3\ p_{t-1})$

The figure shows a Fourier (spectral) analysis. Such analysis fits sin and cosine curves to data to try and detect underlying cyclical nature in data. We allude to periodicity only to highlight the argument that a deeper cycle has probably already played out in the US, UK and other economies with more experience with property-based lending. Source: authors, based on data from the China Statistical Bureau and the OECD.

Even if herding occurs, we need a way of understanding the ways that structural changes affect such herding. Figure 16 shows a rather pedestrian – and probably wrong – model of herding among Chinese property buyers. While the methodology may confound, the results accidently tell us something about the way crises and other "structural breaks" affect disequilibria property pricing. In theory, everyone should pay what property is worth – sending its rates of return to the market level (even after accounting for differences in the types, quality and other attributes of such property). Yet, we see these differences magnify in certain types of markets. In times of rising prices, we observe "herding" (or at least increased differences in pricing) much more than in down markets. After a significant fall in prices, we observe less variation. A type of shock absorber seems to dampen downward prices movements – either meaning that prices adjust much less to negative events, or will really slide during those rare large crises.

Figure 16: Unusual Reseach Suggests "Herding" Changes Nature in China's Housing Market after a Business Cycle or Crisis

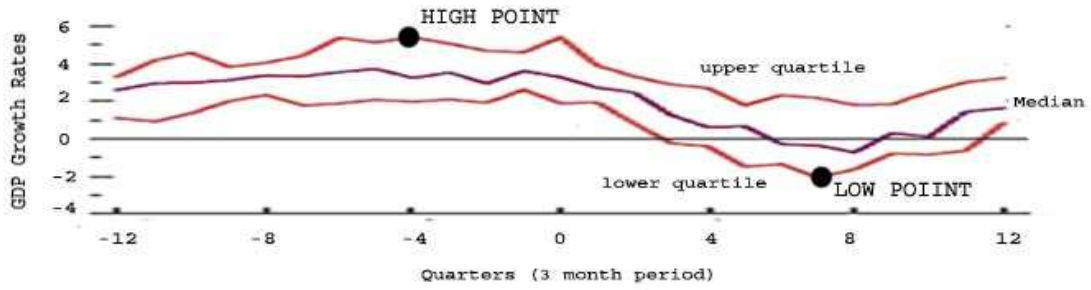


The figure shows the extent to which a one percent increase in housing returns (above the market rate) lead to increased dispersion in different property holders' returns. The authors refer to a "cross sectional standard deviation" as a measure of the extent to which groups "pull away" from the market and each other. Ignoring the indeciperable y-values for a moment, we see increased momentum in up (rather than down) markets and before - rather than after -- crises. Market structures, and thus structural parameters, obviously change in a crisis. Any model must anticipate these changes when making predictions.
Source: Lan (2014).

Thinking about Structural Change in Times of Crisis

What effect would a very large crisis have on Chinese GDP growth and property prices? We know we can not use historical data to estimate these effects – as China has not witnessed a serious recession since 1973. What do large economies' own experiences with Bubble Economics teach us about the way their structures changed and adapted to rapid property price declines? How might their GDP contractions parallel China's future? Figure 17 shows the way that GDP growth rates have varied across time before rapid property price decline. In theory, even if China's experience follows other countries', China could experience a recession. We have labelled as "high point" the GDP growth rate exhibited by upper quartile countries in the IMF's study, and "low point" as the sharpest decline in its lower quartile countries. If China exhibits the best and worst growth shown by other countries, the difference could come to around 7%. But why do these authors assume a continuous relationship exists? Could the economy not jump from one 'state' to another?

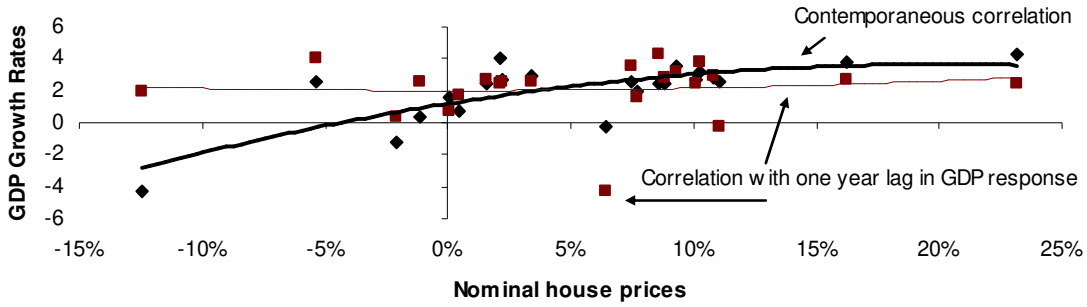
Figure 17: Typical Change in GDP as Housing Price "Busts" Before the Global Economic Crisis



The figure shows the extent to which GDP growth changes before, during and after a housing price "bust." See original source for definition of a bust. IMF (2003).

These other countries did not have the GDP growth rates that China has. As such, we can not directly use these growth rates (even at their apogee) to figure out how far property prices must fall. Instead, we need a way of guessing how far property prices would have collapsed if OECD countries had had growth rates similar to China's. Figure 18 tries to show the intuition behind this calculation. Once growth rates in real estate decelerate to about 5%, we notice a significantly different relationship between property prices and GDP. **Such a non-linearity almost represents a type of structural break – whereby GDP growth acts differently than it did before.**[19] These data suggest that if the UK had China's growth rates, a 30% or more drop in real estate prices would have to occur before any significant GDP growth impact. We also show the relation between housing prices and the next year's GDP growth (on the assumption that maybe property price impacts need time before they affect the real economy). Even simple analysis suggests that the economy feels property price changes very quickly.

Figure 18: If China Were the UK (and Holding Everything Else Equal), Real Estate Prices Would Need to Fall by 5% to Throw into Recession



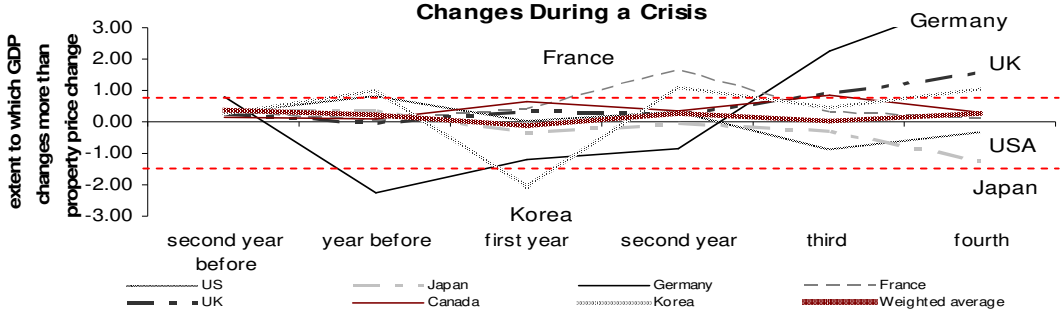
The figure shows the relationship between nominal housing price growth in the UK from 1990 to 2014 and GDP growth. The "bend" in the black line shows that one needed (holding other factors constant) to change housing prices a whole lot at the beginng to start seeing GDP slowing down.

How do price changes affect GDP growth during the pre-crisis and post-crisis period? Figure 19 shows the percent change in GDP growth for changes in property prices. Numbers greater than one mean property price changes more (proportionally) than property prices. Numbers between zero and one mean GDP responds less than property prices. Negative numbers mean decreases in property prices actual lead to more GDP growth (or visa versa). As shown, each country's economy has its own way of responding. The German economy grew more than proportionately with rapidly falling property prices, then shrank rapidly four years later. The US and Japan experienced a period of recovering GDP relative to property prices three and four years after the Global Financial Crisis. China's reaction to a property price slide will depend on whether it is a US-Japan style country or other-style country. Figure 20 (basically an easier to read form of the

[19] The economists in the audience will disapprove strongly of this statement. Technically a "structural break" refers to any discontinuity – and the non-linear line of best fit in the figure clearly shows a continuous function. We wanted to give the non-technical reader an intuition for the way that the relationship between two variables can shift quite suddenly, misusing language that has become itself misused in popular discourse.

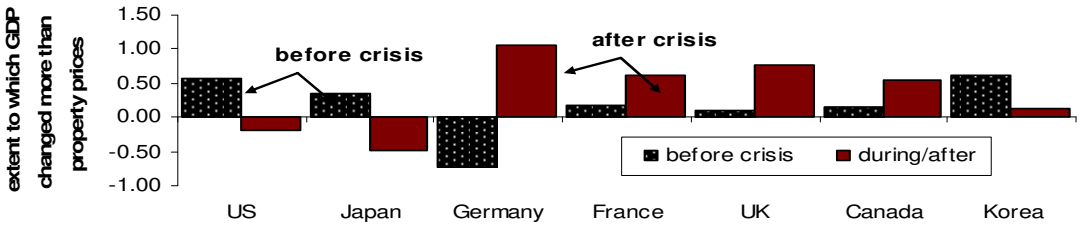
previous figure) shows the average way that GDP growth responded to property price change before and after their property crises. Even for average changes of 0.50, such elasticities imply that a 30% property price change would reflect into a 15% GDP change. Yet, the US and Japanese data also suggest that a large recovery in property prices (after a crisis) translate in a very limited way into GDP recovery.

Figure 19: Elasticity of GDP Growth to Property Price Growth Radically Changes During a Crisis



The figure shows the way that GDP growth rates change relative to property price changes for the two years before the major property price decline, and up to four years after. As shown, some countries like Germany or France can witness periods of amplifying impacts of property prices on GDP. Others like Korea and Japan in the later years of the crisis can see strongly dampening effects. Source: authors.

Figure 20: The Way GDP Changed Relative to Property Prices Differed Radically After the Property Price Bubble Burst

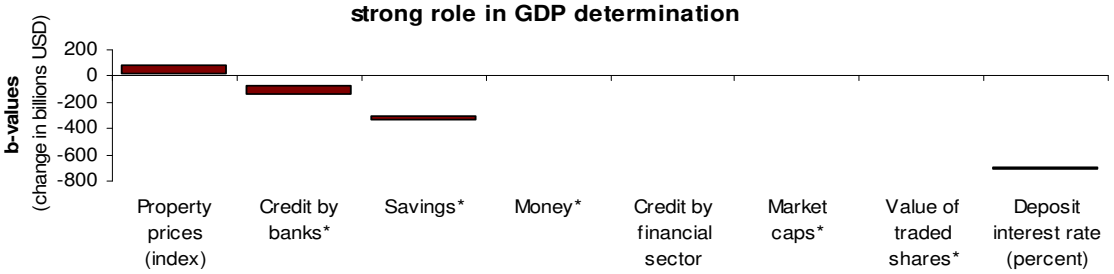


The figure shows the average elasticity of GDP growth with respect to property price growth for the countries shown in the figure from selected dates between 2000 to 2014. We looked at the previous two years before each country's most important property price decline, and the four years after. Source: authors, based on data from OECD.

How does GDP respond to property price movements, when we control for other extraneous factors? We know that factors like the availability of credit, profits coming from the stock market and other factors affect GDP. They also affect property prices – which in turn affect GDP. Figure 21 shows the way that property prices correlate with GDP growth after controlling for some of the most important factors driving GDP. As shown, even after removing the effects of several macroeconomic variables, a 1% increase in property prices correlates with a $52 billion bump in GDP. Once we "cook" the effects of the crisis into our "pure" property price variable, we see any effect of the crisis in our main regression disappear.[20]

[20] "Cooking" means to include a dummy variable in the first regression whose residuals we used to obtain an estimate of the part of property price movements not related to credit, interest rates, money supply, savings, and stock market capitalization. These residuals account for the different means in property prices in the pre-crisis as opposed to post-crisis period. Thus, we would not expect the crisis variable to again show a statistically significant relationship in the main (and highly misspecified) regression on levels of

Figure 21: After removing effects of other stuff, PURE property price still plays a strong role in GDP determination



Dependent variable: Levels of GDP (billions USD).
Other non-significant variables: lending interest rate, central government debt and inflation.
The figure shows the effect of changes in "pure" property prices on the level of GDP (our series are unusally normal and stationary making this a rare exercise). Property price changes of 1% reflect into about 5% change in GDP, after removing the linear effects of other variables (even though this relationship is highly non-linear). We found pure property price effects by first regressing property prices on savings, money supply, credit by the financial sector, and market capitalization and real interest rates and taking the residuals from that regression as the "pure" property price effect.
* variables in percent of GDP except as noted.
Source: authors, based on World Bank and OECD.

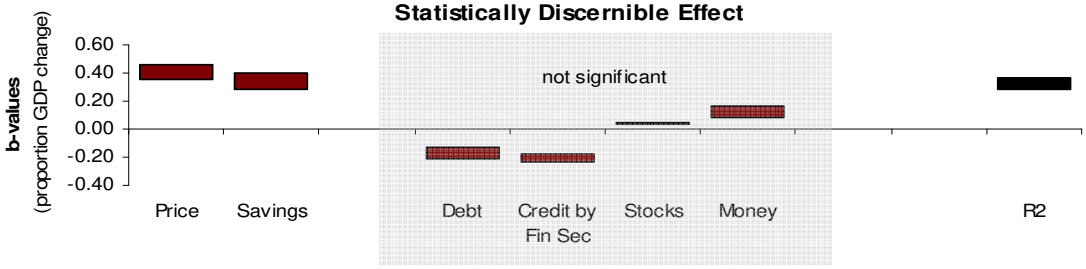
When we look at the data using more conventional methods, we see that "true" property prices remain a key factor in explaining GDP change.[21] Figure 22 shows the relationships we described previously – the extent to which GDP growth in our OECD comparator countries changes as property prices change – while controlling for other factors. We see that GDP grows (or falls) roughly 40% as much as each percent change in property prices after controlling for the feedback of other variables (including GDP) into property price change. Household savings represent the only other significant variable coming out of this analysis once we take into account the differing way these variables behave during a crisis.[22] The relationship in the way money, credit, central government debt and other factors do not remain consistent over time – leading to a loss of explanatory power in these variables as a determinant of changes in GDP.

GDP. We discuss in the Appendix why we should use this regression for illustrative purposes only (namely the regression fails to include a lag, making this a difference equation).

[21] "True" property prices refer to estimated property prices from a procedure known as instrumental variables estimation. We differentiate "true" from "pure" property prices (which use two stages least squares estimation) in order to highlight the different technique used and explain it in a way the average reader can understand. As we describe in the Appendix, both the estimation method (using levels of GDP for example) we use and the statistical procedures we use (instrumental variables for example) do not matter much – as we use math to manipulate the expressions we obtain to triangle believable relationships in the data.

[22] The analysis shown in the figure includes a dummy variable for the year in which each country's property prices declined. Thus, the figure shows the way that these variables relate to each other in a crisis.

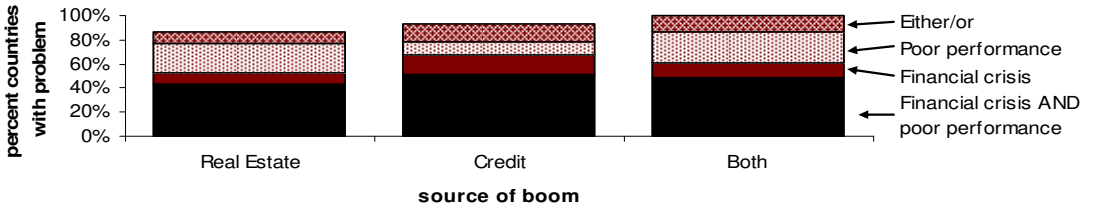
Figure 22: Looking Specifically at Elasticities, Only "True" Price and Savings Have a Statistically Discernible Effect



The figure shows the elasticity of GDP growth change for a proportional change in each of the variables. To achieve this, we used a technique of taking the difference of the natural logs of each variable for 2000 to 2014. Regressing the difference of these logs results in elasticities (which we report above). "True price" refers to property price data obtained by instrumental variables (with tax revenue as a percent of GDP as the instrument).
Source: authors, with data provided by the World Bank and OECD.

One obvious structural change which could occur consists of a banking/financial crisis for very sharp declines in property prices. Obviously, the way GDP reacts to the money supply, government debt, property prices and other factors changes in times of crisis (and probably thereafter). How likely are the structure changes concomitant with rapidly rising property prices? Figure 23 shows the extent to which countries experiencing a real estate boom (and credit boom or both) experienced a sharp decline in GDP as the result of a crisis or "poor performance" (a less dramatic decline in GDP growth). As shown, for real estate booms alone, we over 80% of countries experiencing such a real estate boom subsequently experienced either poor performance or a financial crisis – with the GDP-related problems attendant with such crises. If other countries' experience serves as a guide, China has a high probability of experiencing structural changes attendant with a financial (or other) crisis.

Figure 23: If Other Countries Serve as a Guide, China has a 91% Change of Experiencing a Financial Crisis or GDP growth slow down



The figure shows the extent to which financial crisis and "poor performance" (as measured by a decline in GDP growth by 1% or more). See original for definitions of real estate and credit boom.
Source: Crowe et al. (2011).

If other countries' experience serves as a guide, China can expect to lose up to 1%-2% of GDP per year in case of a banking crisis. Dell'Ariccia and colleagues (2008) found that a banking crisis – and the sudden cut off from finance – causes higher value adding industries to forego investment of roughly -5% of growth of value added.[23] While output

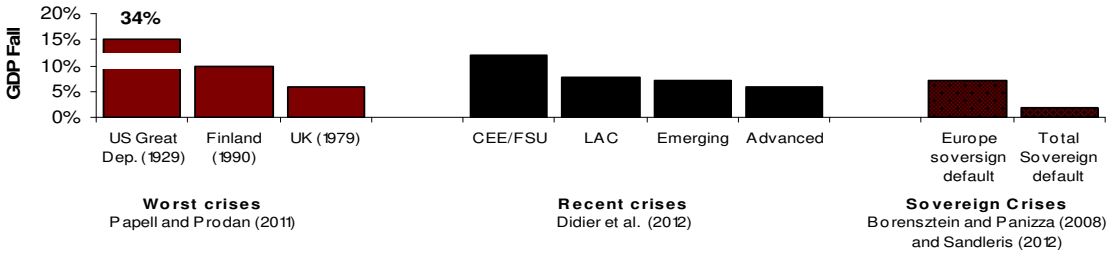
[23] This includes the effect of the crisis of -2.74 on sectors more heavily reliant on external finance and another -2.44 for more important sectors (as reported in Table 1). As a cross-check, a simple skim of Table 7's "Cost of Crisis from Bank Lending Channel" shows that these declines do not defy common sense. Also, simply adding the difference in annual growth rates between crisis and non-crisis years across time

shocks can range up to 30% of GDP, most economies similar in size and scale to China's (like OECD economies) exhibit GDP declines of only around 3%-5% at the most in recent years. Studies like Berkman *et al.* (2009) show that leverage and credit growth speeds help explain the extent to which a financial crisis affects GDP. As such, even an extreme events analysis – using past data as a guide – suggest that a severe banking crisis caused by freezing up real estate markets would shave at most 5% off of Chinese GDP growth.[24]

What Do We Know about Debt Crises and the Way Property Prices Contribute to Them?

If the Chinese government(s) and households deplete their resources (including possibility of borrowing) as property prices fall, how would this affect Chinese GDP growth? We know that the most severe crises occur when governments (including local government) no longer have the ability to engage in expansionary fiscal and/or monetary policy. Figure 24 shows the estimated fall in GDP during crises in various countries. Outside of the Great Depression, Finland and several countries in Eastern Europe and the Former Soviet Union experienced GDP contraction of 10% -- certainly enough to throw China into recession. Looking specifically at crises resulting from sovereign defaults, GDP shrank by about 3%. However, as shown in Figure 25, the mean conceals far more than it reveals. At the extreme – using other countries as an example – GDP could easily fall by 40% or more if China represented the fastest grower before-crisis and the worst grower after-crisis. With total government debt (edging toward 300% of GDP) as one of the highest historically known world-wide, China inches ever-closer toward potential sovereign crisis.

Figure 24: History Shows Recessionary Burst Scenario Possible and Even Probable for China if Sovereign Default

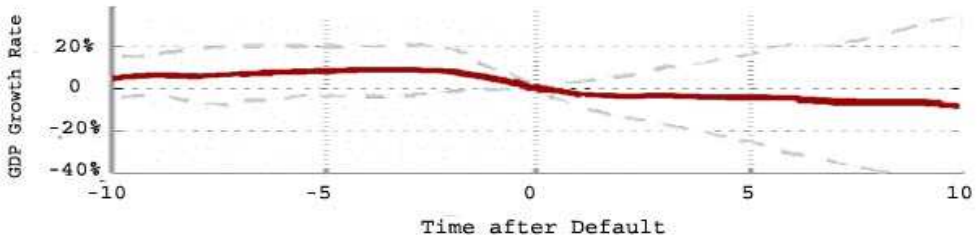


The figure shows the extent of severe GDP declines in various countries (or groups of countries) duirng recessions or other extraordinary shocks. In general, GDP declines remained small and short-lived. Yet, when mixed (or caused by) a sovereign default -- such recessions can become severe.
Sources: See figure for sources.

gives roughly the same result. With the exception of the US's 1980 crisis, few of the countries reported have the same economic scale as China.

[24] As an aside, the 2013 Financial Stability Report also places the maximum decline in GDP from the most extreme banking crisis at around a 4%-5% reduction in GDP (page 162). Le et al.'s (2013) place the effect at closer to 9% because of an expected tightening of monetary policy by the People's Bank of China., which we do not assume (p. 18).

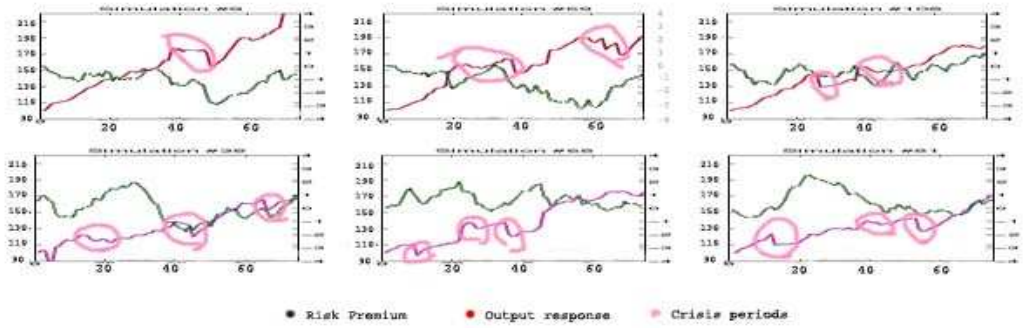
Figure 25: GDP Shrinks By About 5% -- But Can Shrink Up to 20% or More After Sovereign Default



The figure shows the extent of GDP growth rate changes after various financial crises. We have relabelled the y-axis (which originally represented the difference in log values of GDP). Source: Gornemann (2014) at Figure 10.

How likely is such sovereign default in China specifically? China has very different political and economic structures to the emerging markets we have previously discussed. Thus, we can not use historical data. Nevertheless, Figure 26 shows the results of econometric modelling looking at that question for China. According to Le and co-authors (2013) results, a recessionary crisis has a 2.9% probability of occurring every year! They show that for a range of plausible model parameterizations, GDP falls abruptly. The longer the time period, the higher the risk of sudden GDP collapse. Even without changing the structural parameters of their model (as we argue should be done) and without simulating the effects of extreme events and shocks (as we also argue), their model generates rather large GDP drops. Such modelling reflects the non-linear dynamics most closely related to our own work – showing how Bubble Economics has the roots in intrinsic instability which must enter our macro models.

Figure 26: Economic Crisis Comes to China Infrequently -- Yet Inevitably Even With Previous Structural Variables



The figure shows six demonstrative simulations of the evolution of GDP and risk premia from the authors' model of the Chinese economy, using past data to calibrate the model.
Source: Le et al. (2013)

Even the way we plot these variables gives the false impression that prices and other variables change more continuously than they really do. At the places circled, the authors could have chosen to draw them discontinually (or with discrete, unconnected jumps). They did not. The way we model, plot our data and discuss economic events assumes far more continuity than we actually observe. Bubble economics - and the bubble economies

they apply to -- change non-linearly and in fits-and-bursts. Yet, until we acknowledge these discontinuities, our models and even our illustrations will continue to ignore the economic reality the phrase bubble economics seeks to capture. Markets enter into fitful periods which we should analyse, and even plot, differently than in more normal times.

Conclusions

Words affect the way we see the world. Bubble economics refers to the economics of markets during periods of discontinuous jumps in the data and profound change in underlying economic structures. Whether one observes a different economy during these periods of discontinuity represents a metaphysical question more than an economic one. Yet, these economies exhibit different graphs and functions than the smooth ones we think of during normal times.

What if we turn the problem on its head? Instead of looking at the surrounding periods to understand crises and bubbles -- what if we look at these first (and directly)? What if the years around these crises represented the extra bits of economic and econometric analysis - rather than the main bit?[25] All the studies we looked at point to deep, structural changes that happen during a crisis. Yet, none of them analysed the actual discontinuity (crisis) itself, only comparing the crisis period to what came before and after. Instead the 'black hole' of the discontinuity -- where continuous lines should be represented by jumps instead -- serves as our main view of the disequilibrium response for the crash. We need to model and graph with fewer lines, and model the blank places instead. Such a Bubble Economics may teach us something new about our profession.

If economists and modellers treat these intermission periods -- these Bubble Economies -- as periods worth modelling and studying in their own right…we will have succeeded.

Bibliography

Ahuja, Ashvin, Lillian Cheung, Gaofeng Han, Nathan Porter, and Wenlang Zhang. (2010). Are House Prices Rising Too Fast in China? IMF Working Paper 10/274.

Arellano, Cristina and Enrique Mendoza. (2002). Credit Frictions and 'Sudden Stops' In Small Open Economies: An Equilibrium Business Cycle Framework for Emerging Markets Crises. *NBER Working Paper 8880.*

Bryson, Jay. (2014). Implications of a House Price Collapse in China. *Wells Fargo Securities Special Commentary 28 August*.

Chen, Jie and Aiyong Zhu. (2008). The Relationship between Housing Investment and Economic Growth in China: A Panel Analysis Using Quarterly Provincial Data. *Uppsala University Department of Economics 2008:17*.

[25] Even Monte Carlo analysis Follain and Giertz (2013) uses the economics of normal periods to simulate what abnormal periods may arise.

China Statistics Office. Available at: http://data.stats.gov.cn/english/easyquery.htm?cn=A01

Crowe, Christopher, Giovanni Dell'Ariccia, Deniz Igan, and Pau Rabanal. (2011). How to Deal with Real Estate Booms: Lessons from Country Experiences.

Dell'Ariccia, Giovanni, Enrica Detragiache, and Raghuram Rajan. (2008). The Real Effect of Banking Crises. Journal of Financial Intermediation 17(1): 89–112.

Deng, Yong-heng, Joseph Gyourko and Jing Wu. (2012). RBA Land and Housing Price Measurement in China Conferences.

Follain, James and Seth Giertz. (2012). Predicting House Price Bubbles and Busts with Econometric Models: What We've Learned. What We Still Don't Know. *Lincoln Institute of Land Policy Working Paper WP12JF1*.

Gornemann, Nils. (2014). Sovereign Default, Private Investment, and Economic Growth. Sovereign Default, Private Investment, and Economic Growth. Available at: https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=NASM2014&paper_id=878

Huang, Daisy, Charles Leung and Bao-zhi Qu. (xxxx). Do Bank Loans and Local Amenities Explain Chinese Urban House Prices? *Federal Reserve Bank of Dallas Globalization and Monetary Policy Institute Working Paper No. 230*.

Hui, Chi-Man and Qi Gu. (2009). Study of Guangzhou House Price Bubble Based on [a] State-Space Model. *International Journal of Strategic Property Management 13*(4): 287-298.

Kang, Hsin-Hong and Shu-Bing Liu. (2014). The Impact of the 2008 Financial Crisis on Housing Prices in China and Taiwan: A Quantile Regression Analysis. *Economic Modelling 42*(1): 356–362.

Lan, Ting. (2014). House Price Bubbles in China. *Research in Applied Economics 6*(1).

Le, Vo, Kent Matthews, David Meenagh, Patrick Minford and Zhigui Xiao. (2013). Banking and the Macroeconomy in China: A Banking Crisis Deferred? *Cardiff Business School Working Paper No. E2013/5*.

Liu, Crocker Adam Nowak and Stuart Rosenthal. (2014). Bubbles, Post-Crash Dynamics, and the Housing Market.

Ma, Qing-Ping. (2010). Housing market in China's growth recovery and house price determination. Paper presented at the 21st CEA(UK) and 2nd CEA(Europe) Annual Conference Global Economic Recovery: The Role of China and Other Emerging Economies. 12-13 July 2010 University of Oxford, UK.

Mayer, Christopher. (2011). Housing Bubbles: A Survey. *Annual Review of Economics 3*:559-577.

Mees, Helen and Raman Ahmed. (2012). Why Do Chinese Households Save So Much?

Nie, Jun and Guangye Cao.(2014). China's Slowing Housing Market and GDP Growth. *Federal Reserve Bank of Kansas City Macro Bulletin Aug 25*.

Shepard, Wade. (2015). Ghost Cities of China: The Story of Cities Without People in the World's Most Populous Country. Zed Books.

Sinclair, Peter and Lixn Sun. (2014). A DSGE Model for China's Monetary and Macroprudential Policies.

Slettvag, Bjornar. (2014). Consequences of an Abrupt Slowdown in China's Property Market. *Bank of Norway Economic Commentaries 5/2014*.

Tan, Zheng-Xun and Ming Chen. (2013). House Prices as Indicators of Monetary Policy: Evidence from China. Stanford Centre for International Development Working Paper 488.

Wang, Tao. (2014). Measuring Property Bubble in China. UBS Investment Research Macro Keys. Available at: https://wikileaks.org/gifiles/attach/101/101347_MacroKeys220311.pdf

Wang, Xin and Yi Wen. (2012). Housing Prices and the High Chinese Saving Rate Puzzle. *St Louis Federal Reserve Bank Working Paper 2012-038A*. Available at: http://research.stlouisfed.org/wp/2012/2012-038.pdf

Xiao, Qin and Gee-Kwang Tan. (2007). Signal Extraction with Kalman Filter: A Study of the Hong Kong Property Price Bubbles. *Urban Studies 44*(4): 865-888.

Xu, Xiaoqing and Tao Chen. (2010). The Effect of Monetary Policy on Real Estate Price Growth in China

Yiu, Matthew, Jun Yu and Lu Jin. (2013). Detecting Bubbles in Hong Kong Residential Property Market. *Journal of Asian Economics 28*: 115-124.

Zhou, Zhicheng and Prapatchon Jariyapan. (2013). The Impact of Macroeconomic Policies to Real Estate Market in People's Republic of China. *Empirical Econometrics and Quantitative Economics Letters 2*(3): 75 - 92.