A comparison of two housing markets
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China is experiencing rapid increases in house prices similar in magnitude to that observed in the US housing market bubble. We use a simple vector autoregression model (VAR) to compare housing market dynamics in these two countries. We find that the US housing market responds very strongly to interest rate shocks and very little to money supply shocks. In contrast, the Chinese housing market responds strongly to both interest rate and money supply shocks. An inflation shock produces a larger response of house prices in China than in the US, and changes in house prices have a much stronger wealth effect in China than in the US. A major decline of house prices in China is likely to have a much bigger impact on the Chinese economy. Monetary policy in China needs to rely on both interest rate and quantitative measures to curb unsustainable increases in house prices.

Keywords: housing market; monetary policy; VAR; wealth effect

JEL Classification: E44; E52; R31

I. Introduction

In the aftermath of the US housing market bubble, many commentators and economists have turned their attention to a similar, if not more, rapid increase in house prices in China. As shown in Fig. 1, the national house price index in China has increased by about 100% from 1997 to 2011. By comparison, the Case–Shiller home price index had increased by about 130% since 1997, before the housing market bubble in the US burst in 2007. Table 1 shows the summary statistics of house prices in the US and China. The average growth rate of the Case–Shiller index during the 10 years between 1997 and 2006 was about 9.49%, with a SD of 3.57% and an autocorrelation coefficient of 0.91. The average growth rate of the Chinese house price index during the 10 years between 2002 and 2011 was 6.97%, with a SD of 3.42% and an autocorrelation coefficient of 0.74. For the whole sample period between 1997 and 2011, the Chinese house price index had an average growth rate of 5.08%, with a SD of 3.45% and an autocorrelation coefficient of 0.86. The increase in house prices in some major cities in China is probably much bigger than that of the national average. For example, Wu et al. (2010) estimate that the real house price had increased by about 225% over the past decade in major cities after controlling for quality changes in the underlying samples of newly-built, private homes in China. And Fawley and Wen (2013) point out that in large cities such as Beijing and Shanghai, house prices are roughly 23 times the annual income. By comparison, the house price in the US was about 5–6 times the income when the housing market peaked in 2006.

This Chinese housing boom ignites the fear of another real estate bubble in a large economy and the potential impact, once the bubble bursts, on the fragile world economy that is slowly recovering from
a deep recession. While there are still some debates on whether or not China is experiencing a housing market bubble (see, for example, Roach, 2012), the goal of this article is to compare the stylized facts of the US and Chinese housing markets. We are particularly interested in the macroeconomic underpinnings of the housing market movements and the impact of house price changes on the aggregate economy. We use a simple vector autoregression (VAR) model to parsimoniously summarize the dynamic relation between house price and other macroeconomic variables without explicitly specifying a structural model for the economy, except for a few identifying restrictions. We apply the same VAR model to the data from the US and China in order to highlight the key differences between the US and Chinese housing markets.

II. The Model

The VAR model first advocated by Sims (1980, 1986) has become a widely used tool in empirical macroeconomic analysis. Canova (1995) and Christiano et al. (1999) provided excellent surveys of the literature. Recent applications of the model to housing markets include Goodhart and Hofmann (2008), Bjørnland and Jacobsen (2010) and Musso et al. (2011) among others. Goodhart and Hofmann (2008) estimate a panel VAR for 17 countries and use the model to examine the dynamic relations between money, credit, house prices and economic activity. Bjørnland and Jacobsen (2010) use a structural VAR to examine the role of house prices in the monetary transmission mechanism. Musso et al. (2011) use a VAR to compare the US and Euro area housing markets.
In general, a VAR model has the following form:

\[ Y_t = B_0 + B(L)Y_{t-1} + A\varepsilon_t \]  

(1)

where \( Y_t \) is an \( n \times 1 \) vector of economic variables, \( B_0 \) is a \( n \times 1 \) constant of intercept term, \( B(L) \) is a polynomial in the lag operator, \( A \) is an \( n \times n \) matrix and \( \varepsilon_t \) is a \( n \times 1 \) vector of structural shocks with a multivariate standard normal distribution \( \mathcal{N}(0, I) \).

The variables we include in the current article and their orders in the VAR are consumer price index (CPI), real consumption, real interest rate, money supply (M2) and a house price index. All variables except the interest rates are annual growth rates. The first two variables are intended to capture aggregate demand and supply shocks. The interest rate and money growth rate are intended to capture exogenous monetary policy shocks. The house price index is intended to capture exogenous shocks to the housing market. We assume that matrix \( A \) in Equation 1 is lower triangular as in Musso et al. (2011). Such a recursive identification scheme can be justified by the assumptions that monetary shocks do not have contemporaneous effects on inflation and consumption and that the monetary policy does not respond to changes in house prices contemporaneously. For robustness, we also estimated the model using nominal interest rate, instead of the real interest rate, and with different VAR orders (e.g. money growth rate is put before the interest rate). In all these different specifications, we obtained very similar results.

We estimate the model using data from China and the US. The lag length of the estimated VAR is determined by AIC information criteria. All data are obtained quarterly and are from 1997 to 2011. The US macroeconomic variables are from the Federal Reserve Bank at St Louis. The house price is Case–Shiller index for 30 cities in the US. The Chinese macroeconomic variables are from National Bureau of Statistics. The real interest rate is obtained by subtracting Chinese CPI inflation rate from the nominal bank loan rate with duration of 6 months or less. The Chinese house price is the national average price of new constructions quoted in per square metre of living space. This price index is from Wind Information Co. Ltd, a leading service provider of financial data in China. In both countries, real consumption growth rates are obtained by subtracting CPI inflation rates from the growth rates of total nominal consumption expenditures. Summary statistics of the macroeconomic variables are included in Table 2. The statistics clearly reflect the rapid economic growth China has been experiencing since the 1990s. Both consumption and money supply had growth in double digits during the sample period between 1997 and 2011. China also had a much higher real interest rate than the US did during the same period (3.75% versus 0.15%). The low average real interest rate in the US during the sample period is the result of a stable inflation and a very low nominal interest rate in the periods immediately after the burst of internet bubble in 2000 and the real estate bubble in 2007. On the other hand, China seems to have a more volatile economy than the US. The SDs of inflation and consumption growth are about two times those of the US.

### III. Results

One big difference between the US and Chinese housing markets is how they respond to interest rate and money growth shocks. Figures 2 and 3 include the impulse response functions and their 90% confidence intervals of inflation rate from the 3-month Treasury nominal yield. The house price is Case–Shiller index for 30 cities in the US. The Chinese macroeconomic variables are from National Bureau of Statistics. The real interest rate is obtained by subtracting Chinese CPI inflation rate from the nominal bank loan rate with duration of 6 months or less. The Chinese house price is the national average price of new constructions quoted in per square metre of living space. This price index is from Wind Information Co. Ltd, a leading service provider of financial data in China. In both countries, real consumption growth rates are obtained by subtracting CPI inflation rates from the growth rates of total nominal consumption expenditures. Summary statistics of the macroeconomic variables are included in Table 2. The statistics clearly reflect the rapid economic growth China has been experiencing since the 1990s. Both consumption and money supply had growth in double digits during the sample period between 1997 and 2011. China also had a much higher real interest rate than the US did during the same period (3.75% versus 0.15%). The low average real interest rate in the US during the sample period is the result of a stable inflation and a very low nominal interest rate in the periods immediately after the burst of internet bubble in 2000 and the real estate bubble in 2007. On the other hand, China seems to have a more volatile economy than the US. The SDs of inflation and consumption growth are about two times those of the US.

### Table 2. Summary statistics of the US and Chinese macroeconomic variables

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<tbody>
<tr>
<td></td>
<td>Inflation</td>
<td>Consumption growth</td>
</tr>
<tr>
<td>Average</td>
<td>2.46%</td>
<td>2.68%</td>
</tr>
<tr>
<td>SD</td>
<td>1.26%</td>
<td>2.06%</td>
</tr>
<tr>
<td>Autocorrelation</td>
<td>0.73</td>
<td>0.94</td>
</tr>
</tbody>
</table>

\(^1\) Most other monetary VAR models use real GDP instead of real consumption. We use real consumption because we are particularly interested in measuring the wealth effect of house price increases.

\(^2\) China does not have reliable quarterly consumption data until recent years, and major housing market reforms started in the 1990s.
We obtained almost the same result if we switch the order of interest rate and money growth in the VAR model.

In both countries, a positive interest rate shock leads to decline in house prices and a positive money growth shock leads to increase in house prices as expected. However, the response of house prices to interest rate shocks is much bigger and more persistent in the US than in China. In contrast, the response of house prices to money growth shocks is much more persistent in China than in the US. Table 3 reports the results of variance decomposition from the estimated VAR for the US and China. We can see that while interest rate shocks account for more than 56% of the variance of house prices in the US, they only account for less than 15% of the variance of house prices in China. On the other hand, the fraction of variance of house prices that can be attributed to money growth shocks is about 18% in China and is only 4.8% in the US. The US housing market responds very strongly to interest rate shocks but very little to money supply shocks. In contrast, the Chinese housing market responds strongly to both interest rate and money supply shocks.

These differences between the US and Chinese housing markets reflect different degrees of financial development and different monetary policy tools in these two countries. It is well documented that market-based mortgages, through securitization, have become the main source of real estate financing in the US in recent decades. Housing demand is therefore more sensitive to changes in market interest rate than to money supply, and the short-term interest rate has been the main policy instrument of the Federal Reserve.

Notes: This figure plots the impulse response functions from the VAR estimated using the US data. CPI is the annual percentage change in CPI index. RCONSUME is the annual growth rate of real consumption, RSR is the real interest rate, M2 is the annual growth rate of M2, HP is the annual percentage change in house price index. The order of VAR is CPI, RCONSUME, RSR, M2 and HP. The same notations are used in Fig. 3.
since the 1980s. In contrast, traditional bank loans are still the dominating form of real estate (as well as other business investments) financing in China. More importantly, all the major commercial banks in China are state-owned enterprises. The Chinese central bank, unlike the Federal Reserve of the US, has been relying more on monetary control (and sometimes even credit rationing) to implement its policies. For example, during the monetary tightening between 2006 and 2008, the Chinese central bank raised bank reserve ratio 18 times to lower aggregate money supply. It also limited the size of commercial and business loans. During this whole period of monetary tightening, it only raised interest rate eight times. In contrast, between 2001 and 2003, in response to the burst of internet bubble and the September 11 terrorist attack, the Federal Reserve adjusted the Federal Funds rate consecutively for 13 times and eventually lowered it from 6% to 1%.

The US and Chinese housing markets also respond to inflation shocks differently. As we can see from Figs 2 and 3, house prices in the US respond very little to a positive inflation shock. In China, however, house prices respond very strongly to unexpected changes in inflation. A positive one-standard-deviation inflation shock leads to almost one full percentage increase in house prices in China. In fact, inflation shocks account for almost 30% of the total volatility of house price changes in China. That ratio is less than 15% in the US.

Inflation in the US has been low and stable during the so-called ‘great moderation’ before the 2008 financial crisis. Therefore, hedging against inflation is not a strong motivation for housing market investors. In China, however, inflation is much more volatile than that of the US, even though the average inflation rate is slightly lower. The SD of CPI inflation is 2.59% in China, and it is only 1.26% in the US during the same sample period (see Table 2). In China, there are also much less investment instruments, other than domestic residential housing assets, that are available to the public. Housing asset, hence, has become the major tool for the public to hedge against inflation risk in China. An increase in inflation can

Fig. 3. Impulse response functions for the Chinese housing market
Notes: This figure plots the impulse response functions from the VAR estimated using the Chinese data. The notations are the same as in Fig. 2.
generate a much stronger demand for housing asset as a store of value and hence a bigger house price response.

The last shock in our VAR model is an innovation to house prices. This shock is orthogonal to all other macroeconomic shocks in the model by construction. It should include a nonfundamental or a speculative component of house price changes. In both the US and the Chinese housing markets, this shock is substantial and produces large changes in house prices (see Figs 2 and 3). It accounts for 21% of the total volatility of house price changes in the US and 33.5% of house price volatility in China (see Table 3). A possible reason that this shock accounts for a larger fraction of house price movement in China is that China is going through rapid urbanizations in the past two decades, a process that can produce strong demand for urban housing units in China.

An unsustainable house price increase driven by speculations is harmful to the economy not only because it produces inefficient resource allocations but also because such price movements are prone to sharp reversals and can have large business cycle effects on the economy. One such effect is the wealth effect on household consumption. In Figs 2 and 3, we can see that an exogenous increase in house price indeed leads to increase in real consumption in both the US and China. But, this wealth effect in China is about two times the size of that in the US. Moreover, consumption in China rises much more quickly than it does in the US in response to an exogenous increase in house prices. The sluggish response of the US household consumption to house price shocks is consistent with the result from Musso et al. (2011). Table 3 shows that the exogenous house price shocks account for 21% of the total volatility of consumption growth in China, whereas this ratio is less than 13% in the US.

One reason that house price changes have such a strong effect on household consumption is that housing asset is probably the largest single component of a typical household’s asset portfolio, and this is especially true in China due to its capital control and much underdeveloped capital market. According to Flow of Funds Account of the United States, as of 2009, total household net worth in the US was about $55 trillion and housing asset was about $26.5 trillion. This big difference between the US and Chinese household’s asset portfolios suggests that a sharp decline of house prices is likely to produce a more profound negative impact on the Chinese economy than it does to the US economy.

Table 3. Variance decomposition

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<tr>
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<th>The United States</th>
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<tbody>
<tr>
<td></td>
<td>CPI shock</td>
<td>ΔC shock</td>
<td>r shock</td>
<td>ΔM shock</td>
<td>HP shock</td>
</tr>
<tr>
<td>CPI</td>
<td>47.44</td>
<td>4.93</td>
<td>30.02</td>
<td>8.43</td>
<td>9.19</td>
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<tr>
<td>Consumption</td>
<td>26.56</td>
<td>12.40</td>
<td>37.30</td>
<td>10.81</td>
<td>12.93</td>
</tr>
<tr>
<td>Interest rate</td>
<td>37.43</td>
<td>10.99</td>
<td>33.43</td>
<td>8.62</td>
<td>9.53</td>
</tr>
<tr>
<td>Money growth</td>
<td>18.68</td>
<td>10.06</td>
<td>45.14</td>
<td>19.13</td>
<td>6.98</td>
</tr>
<tr>
<td>House price</td>
<td>14.94</td>
<td>2.87</td>
<td>56.37</td>
<td>4.81</td>
<td>21.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>China</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>CPI shock</td>
<td>ΔC shock</td>
<td>r shock</td>
<td>ΔM shock</td>
<td>HP shock</td>
</tr>
<tr>
<td>CPI</td>
<td>69.97</td>
<td>4.88</td>
<td>4.51</td>
<td>9.99</td>
<td>10.65</td>
</tr>
<tr>
<td>Consumption</td>
<td>17.08</td>
<td>33.63</td>
<td>7.33</td>
<td>20.77</td>
<td>21.19</td>
</tr>
<tr>
<td>Interest rate</td>
<td>64.83</td>
<td>4.04</td>
<td>5.21</td>
<td>16.36</td>
<td>9.56</td>
</tr>
<tr>
<td>Money growth</td>
<td>28.61</td>
<td>6.87</td>
<td>6.10</td>
<td>47.16</td>
<td>11.26</td>
</tr>
<tr>
<td>House price</td>
<td>29.29</td>
<td>4.33</td>
<td>14.79</td>
<td>18.06</td>
<td>33.63</td>
</tr>
</tbody>
</table>

Notes: This table reports the variance decompositions after 20 lags for house price and other macroeconomic variables under shocks to inflation (CPI shocks), shocks to real consumption growth (ΔC shock), shocks to interest rate (r shock), shocks to money growth (ΔM shock) and shocks to house price changes (HP shocks). Each number represents the fraction of the variance of a variable that can be attributed to one particular underlying shock.

4 Of course, this component does not need to be a nonrational house price bubble. For example, time-varying housing market risk premiums due to changes in investor’s preferences can also produce ‘exogenous’ changes in house prices even though the macroeconomic fundamentals remain the same.

5 Since we use a recursive identification scheme in our VAR, this variance decomposition actually gives a conservative estimate of the wealth effect of house prices on consumption.
IV. Conclusion

The rapid and continuing increases in house prices in China has attracted worldwide attentions since the burst of the real estate bubble in the US in 2007. While the increases in house prices in these two countries are similar, there exists some major differences between the US and China in areas such as economic and political systems, monetary and fiscal policies, as well as financial markets and institutions. In this article, we use a simple VAR model to empirically quantify the differences between the Chinese and the US housing markets. These stylized facts may provide disciplines on structural models that aim to gain a deeper understanding of the housing market in China (e.g. Chen and Wen, 2013, among others). By comparing to the US housing market, we are able to obtain a preliminary assessment of the potential impact on the Chinese economy in case of a major house price decline in China. Our results also suggest that while the interest rate can be an effective monetary policy tool in the US, China probably needs both interest rate and quantitative measures to curb excessive increases in house prices in China.

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