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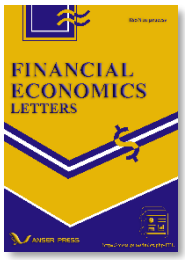

Housing and monetary policy: Fresh evidence from China

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ABSTRACT

We empirically address the effects of monetary policy on the housing market in China using a novel Time-Varying Parameter VARX model. We show that an expansionary monetary has positive effects on the housing market, while during COVID-19, the effects are approaching to zero or even negative. In addition, the effects of the LPR policy are strong and even larger than that of COVID-19. Relative impulse response functions in the shorter and longer time horizons are dynamic and especially during COVID. This paper also contributes to the housing literature to show that COVID-19 can block the transmission of monetary policy.

KEYWORDS

Housing market; Monetary policy; Interest rate

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1. Introduction

Housing market has played an important role in the macroeconomics activities which has obtained widely attention among researchers and policy makers recently (see e.g. Wadud et al., 2012; and Xiao, 2013). There is an increasing number of literature checking the economics questions pertaining to housing market, mortgage debt market and the need to assess the effects of policy in particular monetary policy, on these markets (see e.g. Deng et al., 2011, Geanakoplos et al., 2012 and Sommer &Sullivan, 2018). In addition, the monetary policy can reach the housing market through lens of transmission channels and the housing sectors are sensitivity to this effect vary across time and sectors (Mishkin, 2007 and Feroli et al., 2012). From a textbook treatment we see that a loose monetary policy environment, which feed the demand into housing which further enhance the housing prices. Recently there are some variations in the monetary policy in China, even though all these changes are not closed related to the housing but they will influence the housing market through direct and indirect ways. Around September 2019, most banks ask mortgagee to change the fixed rate mortgage into floating rate mortgage according to Loan Prime Rate (LPR). LPR has a high degree of marketization and can fully reflect the supply and demand of funds in the credit market. Using LPR for loan pricing can promote the formation of market-oriented loan interest rates and improve the efficiency of market interest rates to credit interest rates. During the recent COVID-19 period, LRR 1 year and 5 year are both decreased to simulate the consumption demand and further revive the China's economy.

The housing market is always in the quick development process in China and the housing prices vary severely. For example, recently, the changes in housing prices over the past ten years have been popular. Among the nine biggest cities in China, the fastest rising housing prices in the past ten years is Shenzhen, with an increase of 361%, surpassing other cities such as Beijing, Shanghai and Guangzhou, ranking No. One. However, housing prices in third- and fourth-tier cities have begun to fall, with the highest even reaching 30% and 50%.[1]

In this case the goal of this work is to buy a novel TVP-VARX model to examine the effects of monetary policy on housing market and this method excels at detecting the varying effects across time and quantities in China. In addition, we will plan to not only cares the aggregate situation but also some housing sectors across cites to emphasize the crucial role of heterogeneity in Monetary policy and housing prices for future research. Some interesting results indicate that an expansionary monetary has positive effects on the housing market while during the COVID-19, the effects are approaching to zero or even be negative, which may provide some evidence that a negative external event can weaken the role of monetary policy. In addition, the effects of LPR policy has shown a very strong effects even larger than that in the COVID-19 case and relative impulse response functions in the shorter and longer time horizons are dynamic and especially during the recent COVID-19 period while one particular is that during the COVID-19 period, the effects in the shorter run is lower than that in the longer run.

Related Literature. —The first strand of literature speaks to the monetary policy and asset pricing since the monetary policy works as an important tool to stabilize economic activities. Rigobon & Sack (2004) and Gilchrist & Leahy (2002) are the first few works to discuss the effect of monetary policy on asset prices. Later on there are many studies contributing in this field. Some theory paper like Geromichalos et al. (2007) and Lester et al. (2012), they all construct a model to discuss the transmission of monetary toys on asset prices. Kaplan et al. (2018) use a HANK model to discover the heterogeneous effects of monetary policy on the liquidity and un-liquidity assets. In addition, there has been a plethora of work to provide more empirical evidence. For example, Bernhard & Ebner (2017) use Swiss asset prices as an example to address the un-conventional monetary tool's effects and they show that the estimated effects are bigger after the announcements of the unconventional monetary policy. Miranda-Agrippino & Ricco (2018) develops a new proxy for the monetary policy shocks to detect the information rigidity

[1] Data are extracted from the China Statistical Yearbook.

and they show the tightening policy may determine the asset prices and economic activities. Burlon et al. (2018) use a new two-region model to examine the link of non-standard monetary policy in a monetary union and a case of Eurosystemâs Asset Purchase Program (APP). Jarocinski & Karadi (2020) contributes to the literature by examining the monetary policy announcements shocks on the asset prices.

In particular, housing prices has obtained some special attention. Iacoviello (2005) uses a classical business cycle model to take borrowing constraints into the relationship between housing prices and monetary policy. account. Coincidentally, Taylor (2007) shows that the variation of housing market may cause the economics fluctuation using a simple business cycle model and it is seen that the significant relationship between housing prices and delinquency rates. Some empirical work among them, for example, Fratantoni & Schuh (2003) use a heterogeneous-agent VAR method to document the effects of monetary policy on the housing market and detect some time variation over heterogeneous regions. Vargas-Silva (2008) shows that the contractionary monetary tool may have negative effect on the housing investment and the results are sensitive to the restriction periods. McDonald & Stokes (2013) use a VAR model and Granger causality to investigate the housing bubble- Federal rate nexus. Franz (2019) shows that under the high loan-to-value (LTV) levels, the effects of monetary policy on the housing prices and other assets are are more pronounced. My research contributes to the existing work by exploring some evidence by using a newly developed tool i.e. a TVP-VARX model to imply the dynamic time-varying effects of monetary policy and from different time periods to provide more interesting evidence to consider the boom and recessions.

Relative fewer studies are available to study the Chinese heterogeneous housing prices. Some works focus on the advanced economy, for example, Calza et al. (2013) construct a two sector DSGE model to document the transmission of monetary policy on housing finance and some developed countries' mortgage systems. Musso et al. (2011) use a SVAR model to show a empirical study on the effects of monetary policy on housing market in the US and euro areas. Similarly, Luciani (2015) investigates the Federal Reserve's policy in the housing market in the US and show the separate details during boom and bust periods. The interesting finding reveals that a strict policy can smooth the housing cycle in US. There are also some recent studies to address this issue. Jawadi et al. (2017) address the unconventional monetary effects, similarly, Huber & Punzi (2020) use a set of vector auto-regressive models to address the relationship between unconventional monetary policy and housing market for the USA, the United Kingdom, Japan, and the Euro Area. In addition, some work tries to tell a Chinese story, for example, Gai et al. (2020) examine the role of the housing problem in the business cycle model and provide some evidence from China. This work departs from the extant macro housing-monetary policy literature by trying to buy China's macroeconomic data to address the heterogeneous effects of monetary policy on the housing market and there are some workhorse theoretic model to take the housing sector into account and this work may provide some fresh evidence from empirical perspective.

This empirical try is closely related to some very recent studies, for example, Albuquerque et al. (2020) evaluate monetary policy and US housing expansions. They show the housing prices has declined during the expansionary monetary policy. Agarwal et al. (2019) use a difference-in-difference model to show the housing spending increase a lot after the expansionary monetary policy using the individual panel data. However, my design is different from theirs in that first, I discuss the heterogeneous housing market in China using some macroeconomic time series data; second, I try to discuss two commonly used monetary tools in China to show some heterogeneous effects; third, I consider the some interesting monetary events to document the specific time impulse response analysis.

The rest of this paper proceeds as follows. Section 2 outlines the main methodology i.e. a TVP VARX model used in this work. In section 3, we disclose the data set used here and some basic statistics is shown. Section 4 reports the main empirical results on the effects of monetary policy on the housing market. Section 5 concludes.

2. Methodology

In this part, I follow Paul (2020) to consider the monetary policy as a pre-determined exogenous surprise in the conventional Time-Varying Parameter VAR model (see Cogley & Sargent, 2001; and Primiceri, 2005). I show y_t is an $n \times 1$ vector of endogenous variable, and the reduced form of this model is:

$$y_t = \alpha_{0,t} + \alpha_{1,t} y_{t-1} + \cdots + \alpha_{k,t} y_{t-k} + \beta_t z_t + \varepsilon_t t = 1 \ldots . T \quad (1)$$

where $\alpha_{j,t}$ for $j \in 1, \ldots k$ is an $n \times n$ vector of coefficients, $\alpha_{0,t}$ is a vector of constants, the exogenous variable z_t with an $n \times 1$ vector of time-varying parameter β_t.

The exogenous variable z_t is assumed with a structural shock shown below,

$$z_t = \phi \zeta_{1,t} + \eta_t \quad (2)$$

where $\eta_t \sim N\left(0, \delta_\eta^2\right)$ and it is assumed to be orthogonal to other variables.

Next, for the coefficients α_t, it's assumed to evolve a drift-less random walk:

$$\alpha_t = \alpha_{t-1} + v_t \quad (3)$$

Where $v_t \sim N(0, V)$, $V = Var\begin{pmatrix} \varepsilon_t \\ V_t \end{pmatrix}$.

The following estimation method heavily relies on the work of Paul (2020) and the main idea is that using the Markov Chain Monte Carlo (MCMC) methods to deal with the data Span from January 2010 to September 2020 with 15,000 iterations and the first 5,000 draws works as burn-in process which will be discarded. For the prior, I use the data from January 2001 to December 2009 to work as a training sample which base on a OLS estimation of a constant VAR method.

3. Data

In order to check the effects of monetary policy on the housing market in this work, I employ the macroeconomics variables reported in Table 1, the main exogenous variable is the monetary policy proxy index (Rate) which is the Weighted Inter-bank Offered Rate (7 days). Following some literature (see e.g. Fratantoni & Schuh, 2003; Luciani, 2015; and Jiang et al., 2017), the index of interest reflecting the housing market we used in this research is Real Estate Climate Index[2], in addition, some other control variables used in the TVP-VAR system are inflation (Real Estate Climate Index), GDP index, stock market price (Shanghai Composite Closing Index) and monetary policy uncertainty index. The monthly data spans from January 2001 to September 2020 are bought in this empirical test and all these data can be obtained from Wind database which is the most widely used database in China and the research data on the monetary economic policy uncertainty in China (see Huang & Luk, 2020 for details). Our data is long enough to have an in-depth study on some extreme events in China, such as 15 stock crises in China and the recent COVID-19 which attracts the attentions from all over the world. As in the novel method in Paul (2020), we make use of the data from January 2001 to December 2009 to work as a training sample and the other parts since 2010 will be our experiment subject.[3]

In order to have a clear whole picture on the data that I have used, I plot these variables in Figure 1. we can see that all data show strong fluctuation pattern, and some data tells us an interesting story. For example, Interest rate shows a very strong fluctuation during 2000-2016 while after that, the rate become calm, to some extent which imply the monetary policy attitude in China: With the development of China's economy, the policy makers can try to make the economy into a very stable state which is a good way to make the people have a good expectation for

[2] This index can reflect the general housing situation in China. The index is compiled by the government statistics department which can represent the country's supervision functions. Therefore, it has the characteristics of timeliness, comprehensiveness and authority (source: Wind database).

[3] The data are available at http://www.wind.com/ and https://economicpolicyuncertaintyinchina.weebly.com/. Due to the data limitation, we can not consider a longer data set in this work.

future and also for the housing markets.

Not to mention, the stock market in China fluctuates severely during the 15 stock crisis in China and in particular, over the recent COVID-19 period. Similar pattern can be seen in the housing market which also reveals that the markets show strong fluctuation but one thing to note that it seems that China's housing market is not affected badly by the external COVID-19 event, which indicate that the government has taken some effective measures including monetary policy to make the economy more healthy.

Table 1. Variables adopted in our paper.

Variable	Notation	Definition	Data source
Monetary policy proxy index	Rate	Weighted Inter-bank Offered Rate (7 days)	Wind
Housing price	RECI	Real Estate Climate Index	Wind
Inflation	CPI	Consumer Price Index	Wind
GDP	GDP	Gross Domestic Product Index	Wind
Stock price	Stock price	Shanghai Composite Closing Index	Wind
Monetary policy uncertainty	MPU	China's monetary policy uncertainty	Huang & Luk (2020)

This can be also seen in the Monetary policy uncertainty which is constructed by Huang & Luk (2020) that the index shows a quite stable pattern of interest compared with other figures. Another interesting pattern is shown in CPI and GDP, we see that these years, it's witnessed that China has caught the economy highway trains and the GDP and CPI shows a slow but continuous increasing state. In this case, from some basic fact, we try to detect some general properties of monetary policy on the macroeconomics by using a TVP-VAR approach.

To see the data more closely, we show the summary statistics in the Table 2, from the standard deviation, we see that the monetary policy uncertainty has the relatively small value which echos the results from Figure 1, i.e. the monetary policy shows a quite stable pattern also reflects the healthy economy in the recent China. While for interest rate it shows quite a big standard deviation, that being said, China has try means in the governance of the economy and to make a suitable one therefore after one particular time, the interest rate will come to a relatively stable one. In most cases, the skewness is negative which indicate the variable used in this paper shows a heavy tail type and from the kurtosis data we see the commonly financial time series properties in them that is sharp peak and heavy tail. For some other statistics, we see some variables follow the normal distribution while others do not.

Table 2. Descriptive statistics.

	Rate	Stock Price	RECI	CPI	GDP	MPU
Mean	3.0105	7.9208	4.5963	4.5995	4.8295	12.0476
Median	2.8250	7.9625	4.6092	4.6032	4.8167	12.0534
Max	6.8000	8.4364	4.6624	4.7336	5.8805	12.5215
Min	1.4700	7.5905	4.5265	4.4530	3.8089	11.4768
S.D.	0.8949	0.1799	0.0348	0.0700	0.4142	0.2781
Skew	1.2564	-0.0016	-0.3628	-0.2569	-0.1309	-0.2016
Kurt	5.2567	2.7372	2.0886	2.4086	2.6223	2.0128
J-B	60.8381***	0.3683	7.2378**	3.2734	1.1263	6.0646**

Up to now, we have the detailed data sample of this work and next section, we'll turn our attention to the main empirical results and discuss some policy implication in the next section.

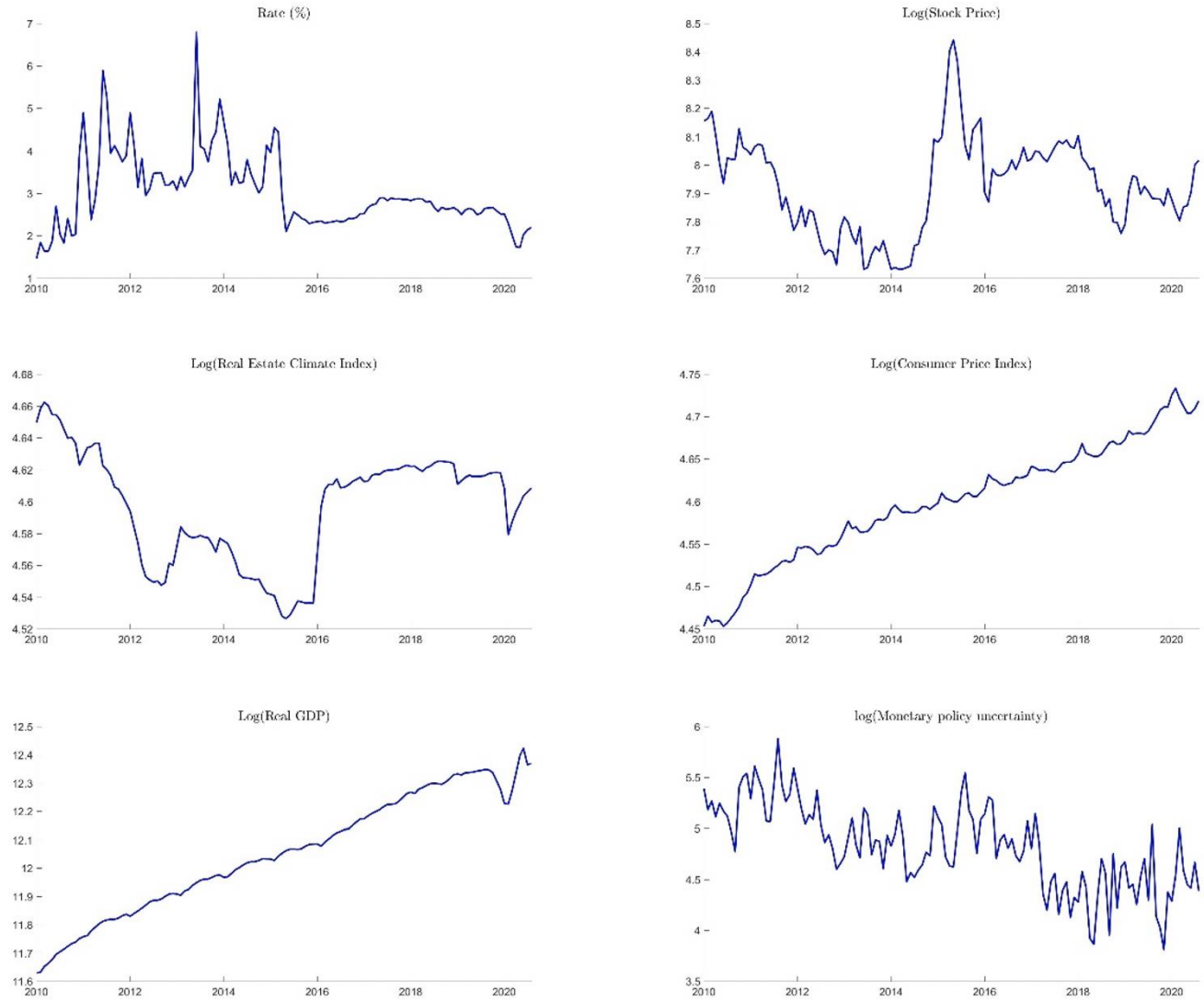

Figure 1. Plot of variables adopted in our paper.

4. Empirical results

4.1. Preliminary results

First of all, I show some estimates for the time-varying impulse response of Housing market reported in Figure 2 from January 2010 to September 2020. With the monetary expansionary shock, we can see the response of the real estate climate index show a varying degree of effects. But in general case, we see the effects are positive while during the recent COVID-19, it's interesting that the effects turn negative. The results are in the contrast with the recent evidence in US as in Paul (2020).

In addition, from the numerical results we see some interesting pattern, for example, the effects are quite stable during the sample period and during the years; which may indicate that the China's housing market is quite stable and independent to some extent. Second, the extremely external events are indeed show some impact, and the COVID-19 has changed the people's expectation which may weaken the role of monetary policy and blocked the transmission channel of monetary policy.

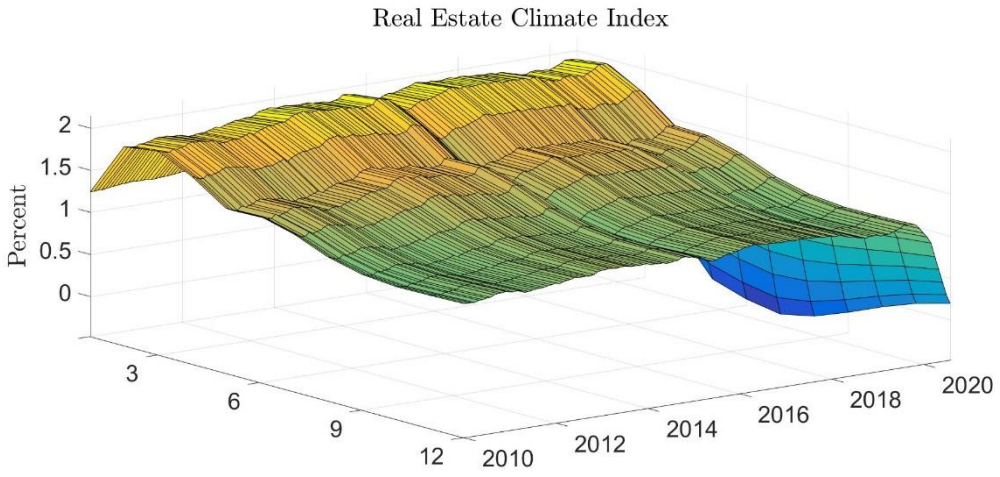

Figure 2. Time-varying impulse response of Housing market.

Notes: The figure shows the cumulative impulse responses to an expansionary monetary and the x-axis is the month, which is also the left horizon, y-axis is the year and z-axis is the percent change. The data span from January 2010 to September 2020.

To make our analysis more comprehensive, we have also shown the estimates for the time-varying impulse response of GDP and stock market in Figures 3 and 4 from January 2010 to September 2020. On the one hand, for GDP, we see that the effects show heterogeneity and asymmetry. To be more specific, the effects vary a lot during the experiment period which is in a strong contrast with the housing case, and you can see in years, the effects also show some varying effects. In addition, the asymmetry property can be seen in this figure, in particular, during the 2012-2016, the effects are mostly positive while after that time period, the effects turn negative and the degree of negative is very strong with a monetary expansionary shock.

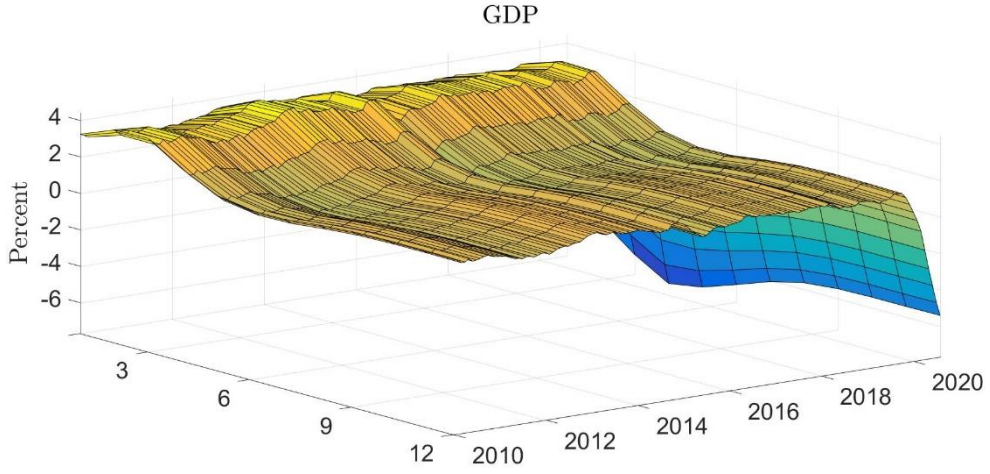

Figure 3. Time-varying impulse response of GDP.

Notes: See the Figure 2.

The results are in a contrast with the recent contribution as in Albuquerque et al. (2020) which is to show the expansionary monetary policy shock can always show a positive effect on the GDP in US. Compared with the developed country, Chins works as one of the biggest emerging economy in the world, it shows some different pattern since it's witnessed that China has caught the economy highway trains and the GDP and CPI shows a slow but continuous increasing state. But for the recent COVID-19, the effects can be negative with the bad expectation

of people.

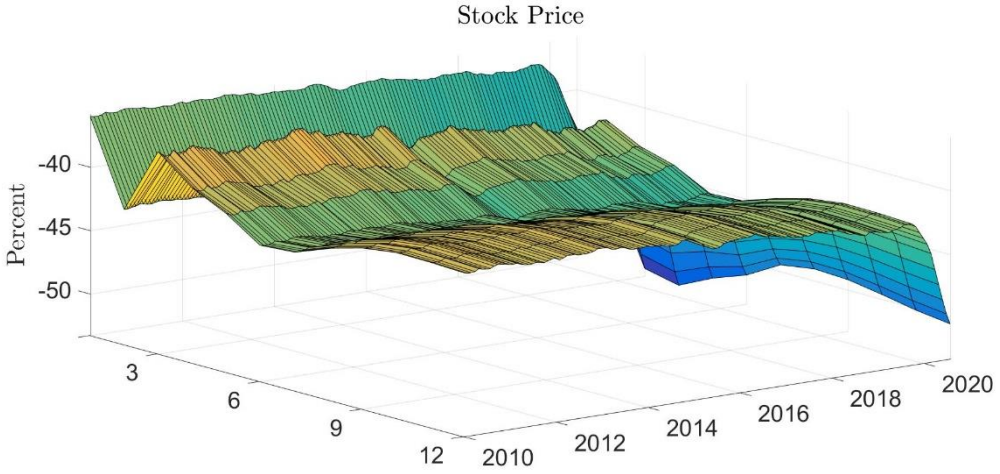

Figure 4. Time-varying impulse response of stock market.

Notes: See the Figure 2.

On the other hand, as for the stock market, it is observed that a very consistent pattern in the Figure 4. The expansionary behaviour of monetary policy shock can have a positive effect on the stock market, similarly, during recent COVID-19, the degree of positive effects becomes severe which shows that this event has weakened the role of monetary policy and blocked the transmission channel of monetary policy. My finding in stock market is lines with Galí (2015). It's shown that the positive effects of expansionary monetary are quite stable.

4.2. Further results

This section I show some interesting results on the effects of monetary policy shock on the housing market. First thing, as mentioned in the introduction part, we know that around September 2019, most banks ask mortgagee to change the fixed rate mortgage into floating rate mortgage according to Loan Prime Rate (LPR). LPR has a high degree of marketization and can fully reflect the supply and demand of funds in the credit market. Using LPR for loan pricing can promote the formation of market-oriented loan interest rates and improve the efficiency of market interest rates to credit interest rates.

In addition, the COVID-19 has received the greatest attention from all over the world (see e.g. Baker et al., 2020; Chetty et al., 2020; Gupta et al., 2020; and Haushofer & Metcalf, 2020) and it starts to break out around China on March 2020 and spreads to the world.

Against this background, I want to see the effects of the two time event on the effect of monetary policy shock on the housing market. The result is reported in Figure 5. This figure shows some information that when shock starts at the specific time and the varying effects after that period. It first comes to our mind that the effects under the two time windows are quite strong and consistently positive, and the main takeaway is that the effect can be larger with time going on but it will diminish over time to a relatively lower state.

To be more specific, for the LPR policy in China, which has aroused people's discussion of real estate policy, especially thinking about their own mortgage. Such a new policy may influence the Chinese people a lot since most people has been used to the conventional tools and policy and may be shocked with such a new policy. That being said, those people want to have some safe asset while it may be impacted a lot with this new policy since they may feel unsafe or do not understand the role of this policy. All these have been reflected in our figure, one can see that the effects of new policy has shown a very strong effects even larger than that in the COVID-19 because that LPR is housing-related policy, as the policy continues to ferment, the effects become stronger and then reduce slowly.

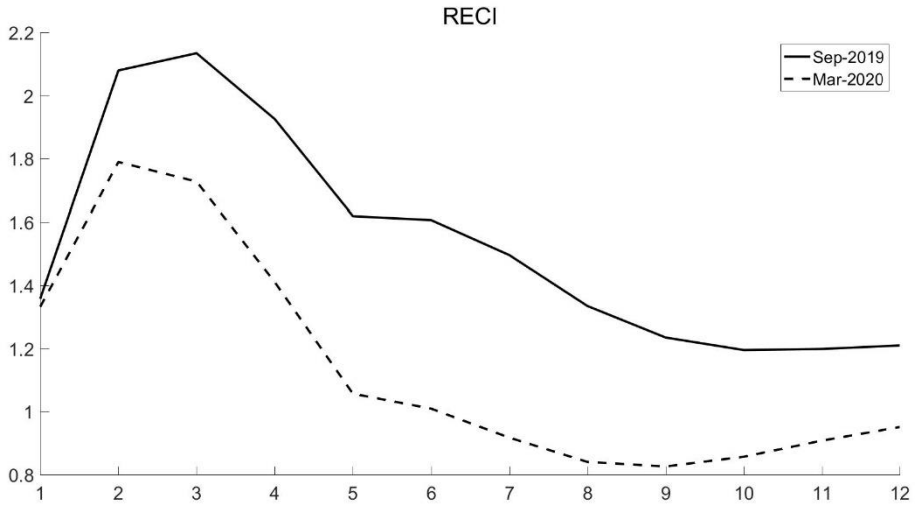

Figure 5. Relative impulse response functions w.r.t time events.

Notes: The figure shows the cumulative impulse responses to a monetary expansionary with some particular external event. September 2019 is time when the most banks ask mortgagee to change the fixed rate mortgage into floating rate mortgage according to Loan Prime Rate (LPR) policy in China and March 2020 is time when the COVID-19 starts to break out around China and spread to the world.

With regard to the COVID-19 time event, the story of our results is very similar to that in LPR policy, while the magnitude is different. Since the housing market in China is relatively independent and the demand for housing in China is stable, we can still see effects of the external negative events, but the magnitude is not so large as in the US study in Albuquerque et al. (2020). The magnitude is also lower than that in the LPR case, the effects can be approaching to 1.8% at most while for LPR policy, the max value is near 2.2%.

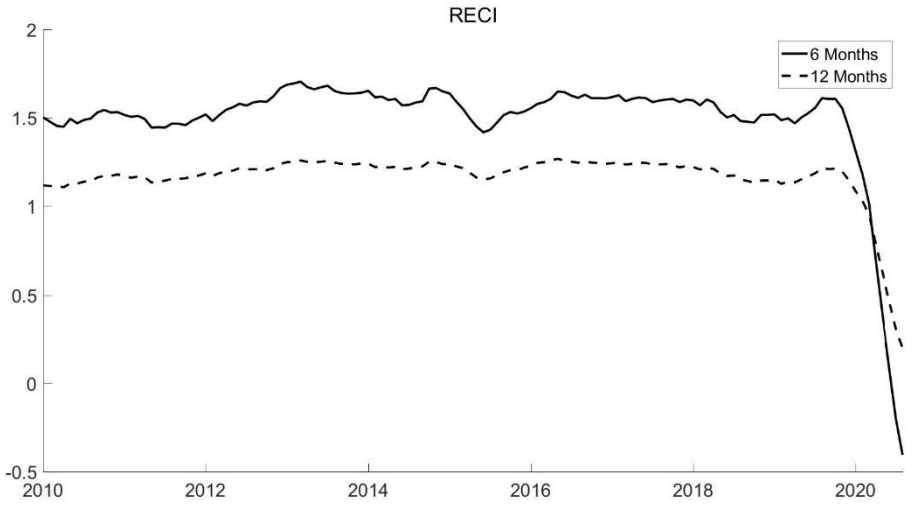

Figure 6. Relative impulse response functions w.r.t time events.

Notes: The figure shows cumulative mean time-varying responses of monetary policy to housing market. Responses for 6 and 12 months after the shock.

From another alternative time window perspective, I show the relative impulse response functions at different

time horizons, i.e. the 6 and 12 months. The main take way from the Figure 6 is that we can gain new insights that the effects are dynamic and especially during the recent COVID-19 period. From different time horizons, the effects of are quite consistent and the negative effects of COVID-19 can be detected.

On the other hand, we see that during the short or middle time horizons, the effects of monetary policy shock has positive effects and stronger effects than that in the longer time horizons (12 months), while one particular is that during the COVID-19 period, the effects in the short run is more negative than that in the longer run, which approaching to -0.5%. It is of note that in the long run, the negative effects of the COVID-19 can be weakened but it still shows that the positive effects can be approaching to zero. All the above results confirm that the expansionary monetary can stimulate the demand of housing market while the COVID-19 working as a negative external event can weaken the role of monetary policy role.

5. Conclusion

In this paper, I empirically address the effects of monetary policy on the housing market in China by using a novel Time-Varying Parameter VARX model proposed by Paul (2020) to consider the monetary policy as a pre-determined exogenous surprise in the conventional VAR system. The monthly data spans from January 2001 to September 2020 are employed in this empirical test.

I show that an expansionary monetary has positive effects on the housing market while during the COVID-19, the effects are approaching to zero or even be negative, which may provide some evidence that a negative external event can weaken the role of monetary policy role. Some similar argument can be found in the GDP and stock markets, while for GDP, the general properties of shock effects show heterogeneity and asymmetry. The effects of stock market are positive but the COVID-19 still can weaken the positive ones.

I have also shown some further results from alternative time event perspective. One can see that the effects of new policy has shown a very strong effects even larger than that in the COVID-19 because that LPR is housing-related policy, as the policy continues to ferment, the effects become stronger and then reduce slowly. The COVID case is similar with LPR case, while the magnitude is lower.

When we talk on the effects from relative impulse response functions from time horizons, it's seen that the effects are dynamic and especially during the recent COVID-19 period. We see that during the short or middle time horizons, the effects of monetary policy shock has positive effects and stronger effects than that in the longer time horizons (12 months), while one particular is that during the COVID-19 period, the effect in the short run is more negative than that in the longer run.

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Declaration of Competing Interest

All the authors claim that the manuscript is completely original. The authors also declare no conflict of interest.

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