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House Prices and China's Birth Rate: A Note

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This study aims to explore whether house prices have an asymmetrical threshold effect on the birth rate in China. We find that house prices have a significant negative impact on the birth rate when it is higher than the threshold value. This result indicates that excessive house prices have reduced the birth rate. Therefore, for areas above the threshold, their housing market should be regulated to alleviate family burden.

I. Introduction

In this paper, we examine how house prices have affected China's birth rate. Our hypothesis is that house prices exert an asymmetric threshold impact on the birth rate. The proposed relationship between house prices and the birth rate is motivated by the standard economic theory of fertility, proposed by Dettling & Kearney (2014) and Lo (2012). Dettling & Kearney (2014) point out that when house prices rise, homeowners may use their increased housing wealth to achieve their reproductive plans because children are normal goods. But Lo (2012) argues that under the limited household budget constraints, high housing prices may delay a family's reproduction behavior.

For the sake of controlling population growth, the Chinese government implemented the one-child policy in the late 1970s. As a basic national policy, this family planning policy had achieved remarkable results in restraining the rapid growth in population. The rapid decline in birth rate provides a sufficient "demographic dividend" for China's economic growth (Gu & Zhao, 2015). However, it projects China into an aging population situation, which has become an obstacle for long-term economic growth. China's housing prices had soared since the late 1990s, particularly in the coastal and urban regions. High house prices changed household budget constraints and led to a decline in the birth rate (Yi & Zhang, 2010). In 2013, the Chinese government changed its fertility policy by stipulating that if either parent is the only child, they are eligible to have two children. In 2015, the government abolished the one-child policy and allowed each family to have two children. However, the effect of these policies was not as significant as expected (Xiong & Xie, 2016). We argue that the reason is that the rapidly rising house prices in recent years has played an important role in the decline of the birth rate. This hypoth-

esis test is important because it can offer suggestions for population growth and housing regulation. If house prices do have an obvious influence on the birth rate, then the population can be adjusted through the housing market.

We employ Chinese provincial level data covering the 1998-2017 period and find that house prices have a single threshold effect on the birth rate. Above the threshold value, house prices have an obvious negative impact on the birth rate. These results pass robustness tests that address issues related to housing price and the birth rate. Our findings contribute to the literature as follows. There is mixed evidence on house prices and the birth rate: Simon & Tamura (2009) reveal that an increase in house prices has a significant negative influence on the birth rate. On the other hand, Lovenheim & Mumford (2013) find a positive relation. Chen (2013) demonstrates that the effect of housing cost on birth rate is more significant in the higher threshold regime than in the lower regime in Taiwan. Therefore, this study intends to examine the possible asymmetric relationship between house prices and the birth rate by applying a panel threshold regression model. This model is applied to take into account structural breaks in the data. There are several approaches to consider structural breaks, such as the wavelet analysis (Su, Khan, et al., 2019; Su, Wang, et al., 2019), and the bootstrap rolling-window method (Su et al., 2020). However, these methods cannot be applied to panel data.

The rest of the paper is organized as follows. The panel threshold regression is introduced in Section II. Data and the results are presented in Section III. Finally, conclusions are given in Section IV.

II. Panel threshold regression

Threshold regression is used to describe the rapid tran-

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sition of time series from one mechanism to another at one point in time. Based on Hansen (1999), using housing prices-to-income ratio as the threshold variable, we propose the following single threshold regression model as following:

$$br_{it} = \begin{cases} \mu_i + \beta_1 PIR_{it} + \alpha' x_{it} + \varepsilon_{it}, & \text{if } PIR \leq \gamma \\ \mu_i + \beta_2 PIR_{it} + \alpha' x_{it} + \varepsilon_{it}, & \text{if } PIR > \gamma \end{cases}$$

$$\alpha = (\alpha_1, \alpha_2, \alpha_3)', x_{it} = (GDP_{it}, FE_{it}, UR_{it}) \quad (1)$$

where br_{it} is the birth rate (our dependent variable); PIR_{it} is the housing price-to-income ratio, which is the independent variable (Pan & Xu, 2012) and also the threshold variable; and x_{it} is a set of control variables, which are expected to influence the birth rate. We use per capita GDP (GDP_{it}), female education level (FE_{it}) and unemployment rate (UR_{it}) as control variables. X. T. Liu et al. (2016) argue that an increase in per capita GDP brings a positive effect on the birth rate. C. H. Liu & Chang (2014) find that female education level is negatively associated with the birth rate. Huang (2003) considers unemployment and find a significant impact on many families' birth decisions. In addition, μ_i is the fixed effect; γ is the value of the threshold; β_1 and β_2 are the coefficients of the threshold; $\alpha = (\alpha_1, \alpha_2, \alpha_3)$ are the estimated coefficients of control variables; subscript i represents different provinces, and t represents different years; and, finally, ε_{it} is the error term, which has zero mean and finite variance.

Equation (1) can also be rewritten as:

$$br_{it} = \mu_i + \beta_1 PIR_{it} I(PIR \leq \gamma) + \beta_2 PIR_{it} I(PIR > \gamma) + \alpha' x_{it} + \varepsilon_{it} \quad (2)$$

where $I(\cdot)$ is an indicator function.

There may be multiple thresholds in the data. This can be depicted using a double threshold model is as follows:

$$br_{it} = \begin{cases} \mu_i + \beta_1 PIR_{it} + \alpha' x_{it} + \varepsilon_{it}, & \text{if } PIR \leq \gamma_1 \\ \mu_i + \beta_2 PIR_{it} + \alpha' x_{it} + \varepsilon_{it}, & \text{if } \gamma_1 < PIR \leq \gamma_2 \\ \mu_i + \beta_3 PIR_{it} + \alpha' x_{it} + \varepsilon_{it}, & \text{if } PIR > \gamma_2 \end{cases} \quad (3)$$

Similarly, this can be extended to multi-threshold models. In this paper, we employ the panel threshold regression method to study whether house prices have a nonlinear effect on China's birth rate.

III. Data and results

A. Data

Our hypothesis test is based on a panel data consisting of 30 provinces over the period 1998 to 2017. Data of the birth rate of 30 provinces¹ come from the National Bureau of Statistics (NBS). Pan & Xu (2012) stress that it is more reasonable to use housing prices-to-income ratio (PIR) to measure the housing purchase burden than to use house prices only. Therefore, we use PIR as the threshold variable. The PIR is calculated as the average residential sales price scaled by the multiple of per capita disposable income of urban resi-

dents and per capita residential building area of urban residents. The average residential sales price is calculated according to the sales amount and area sold of the residential buildings in each province. These data are from the NBS and China Real Estate Statistic Yearbook.

As for the control variables, per capital GDP is obtained from the China Center for Economic Research database. Women's educational attainment is expressed as a proportion of women with senior secondary school or higher-level qualification in the total population. Related data come from the China Population & Employment Statistics Yearbook. Urban registered unemployment rate data is from the NBS.

B. Empirical results

We estimated panel unit root tests based on Levin et al. (2002) and Im et al. (2003). In un-tabulated results, we find that the null hypothesis is rejected for all variables. Therefore, the variables are stable, and we can continue to estimate the panel threshold regression model.

Table 1 reports the results from the three threshold tests between housing prices-to-income ratio and the birth rate. The F -statistic of the single threshold effect in Table 1 is 27.958, which is greater than the 1% critical value of 21.868. However, the F -statistics of double and triple threshold effects are all smaller than the 10% critical value. Table 1 ascertains that housing price-to-income ratio exerts an obvious single threshold effect on China's birth rate. In addition, the threshold value is 8.472, which is a turning point in dividing the two contrasting effects of housing prices-to-income ratio on the birth rate. The regression model with a single threshold effect can be expressed as follows:

$$br_{it} = \mu_i + \beta_1 PIR_{it} I(PIR \leq 8.472) + \beta_2 PIR_{it} I(PIR > 8.472) + \alpha' x_{it} + \varepsilon_{it} \quad (4)$$

Table 2 reports the estimated coefficients for the threshold variable, as well as t -statistics with homoscedasticity and heteroscedasticity standard errors. As shown in Table 2, when housing prices-to-income ratio is below the threshold value of 8.472, the estimated coefficient of $\hat{\beta}_1$ is 0.048, which indicates that a 1% increase in it will increase the birth rate by 0.048%. In addition, the t -statistics under homogeneous and heterogeneous standard errors are both significant. Therefore, housing prices-to-income ratio has a significant and positive influence on the birth rate under this regime. The explanation is related to the high proportion of homeownership in China. This result coincides with those of Dettling & Kearney (2014), who assert that rising house prices promote homeowners to raise their birth rates.

On the other hand, when housing prices-to-income ratio is above the threshold value, the estimated coefficient of $\hat{\beta}_2$ is -0.021, which means that a 1% increase in the housing prices-to-income ratio will decrease the birth rate by 0.021%. The t -statistics under homogeneous and heterogeneous standard errors are both significant. Therefore, when housing prices-to-income ratio exceeds 8.472, there is a re-

1 Tibet data are eliminated due to incomplete data.

Table 1: Tests for threshold effects

Test	Threshold Estimate	F-statistics	Bootstrap p-value	Critical values		
				1%	5%	10%
Single Threshold	8.472	27.958***	0.036	21.868	16.139	10.128
Double Threshold	4.847 8.472	5.243	0.649	15.145	12.818	10.699
Triple Threshold	0.221 4.847 8.472	0.847	0.986	11.127	8.448	7.136

This table reports threshold estimates for single, double, and triple thresholds. The p -value and F -statistics are obtained by repeating the bootstrap procedure 1,000 times for each test. Finally, *** indicates statistical significance at the 5% level.

Table 2: Coefficients of housing prices-to-income ratio and control variables

	Coefficients	OLS se	t_{OLS}	White se	t_{White}
$\hat{\beta}_1$	0.048	0.020	2.400**	0.021	2.285**
$\hat{\beta}_2$	-0.021	0.008	-2.625***	0.009	-2.333**
$\hat{\alpha}_1$	0.943	0.012	78.583***	0.014	67.357***
$\hat{\alpha}_2$	-0.003	0.008	-0.333	0.011	-0.273
$\hat{\alpha}_3$	-0.015	0.006	-2.590***	0.007	-2.143**

This table reports the coefficients of housing prices-to-income ratio determinants based on ordinary least squares where standard errors are White adjusted. $\hat{\beta}_1$ ($\hat{\beta}_2$) indicate that the coefficient estimates are smaller (larger) than the threshold value, and $\hat{\alpha}_1$, $\hat{\alpha}_2$ and $\hat{\alpha}_3$ indicate the coefficient estimates of per capita GDP, female education level and unemployment rate, respectively. Finally, ** and *** indicate statistical significance at the 5% and 1% levels, respectively.

duction in the birth rate. This implies that when house prices are excessive, it has a significant negative effect on the birth rate. This can be seen from the effect of China's fertility policy. In 2015, the Chinese government allowed every household to have two children. However, the birth rate has not increased significantly. In 2017, it was 0.52%, lower than in 2016. X. T. Liu et al. (2016) point out that it is mainly due to high living costs created by high house prices.

We apply three control variables to explore the possible influence of per capita GDP, female education level, and unemployment rate on the birth rate. Table 2 also summarizes the parameter estimates of these variables. Both homogeneity and heterogeneity standard deviations are considered, the coefficients of $\hat{\alpha}_1$ are significant, which imply that per capita GDP has a positive effect on the birth rate. The coefficient $\hat{\alpha}_2$ is negative but insignificant, indicating that female education level does not affect birth rate significantly in China. The coefficient $\hat{\alpha}_3$ is negative and significant, which indicates that the increase in unemployment has reduced birth rate in China.

In order to test the robustness of our empirical results, we estimate the model using residential disposable income

instead of per capital GDP. We find that these changes do not affect the main conclusions we reached earlier, which means the results are not sensitive to the measure of income.

IV. Conclusion

In this study, we test the asymmetric effect of house prices on China's birth rate. Empirical results show that there is a single threshold. When housing prices-to-income ratio is above a threshold value, it has a negative effect on the birth rate. Therefore, the government should: (a) regulate the housing market to lighten the heavy burden of the residents; (b) strengthen the construction of housing security system so that younger people can afford to buy a house; and (c) deepen the reform of income distribution system and promote the growth of residents' income and reduce the unemployment rate.

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