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Why homebuyers have a high housing affordability problem: Quantile regression analysis

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A B S T R A C T

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Previous researchers discussing housing affordability issues have primarily focused on the housing pressure of the whole society, and most papers on this topic have discussed to a degree on the housing affordability situation of individual households. However, housing affordability involves many problems, and cannot be analyzed using only the average or median housing price. To clearly identify the housing affordability situation of individual households, the individual household housing price-to-income ratio (i.e., the micro PIR) is used in this paper.

We used the ordinary least squares model and quantile regression to analyze the micro PIR. The empirical results of this study show that the micro PIR has a right-skewed long-tail distribution. The empirical results revealed that general homebuyers with higher budgets and lower permanent incomes, who have purchased new houses with large amounts of space, located in downtown areas, tend to exhibit relatively higher micro PIR. Moreover, the results suggested that increasing search times or viewing additional houses cannot resolve the housing affordability problem.

The 90th quantile result indicated that homebuyers with high micro PIRs may have high budgets and low incomes, and may be purchasing houses to invest. Thus, high housing PIRs may not indicate housing affordability.

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Introduction

Many Organization for Economic Co-operation and Development (OECD) countries have faced the challenge of sharply rising housing prices since 1990. The housing price of main OECD members rose strongly in the mid-1990s, and the housing price in Asian emerging markets subsequently started to rise.[3] The housing prices in Hong Kong, Shanghai, and Beijing rose considerably from 1990 to 2003. The housing price index in Shanghai rose by 63% from 2001 to 2003 (Hui & Yue, 2006). Park, Bahng, and Park (2010) indicated that the housing price in South Korea continued to climb sharply under the control of the government from 1999 to 2006.

Rising housing prices are also pushing the housing affordability of Asia forward. Mengjie, Reed, and Wu (2008) observed that the housing price-to-income ratio (PIR) in Beijing increased from 6.69 up to 9.12 from 2002 to 2006. The housing PIR in Taiwan[4] increased from 5.1 to 7.1 from 2003 to 2007. Data published by the Demographia International Housing Affordability Survey[5] (2006) show that the housing PIRs of most countries in Europe and America are less than 6. However, most of the housing affordability of Asian countries in 2006 was over 6, even more than 9, showing that housing affordability is heavier in Asia. Based on this boom in housing prices, it is reasonable to expect that the housing affordability in Asia might deteriorate more significantly than that in Europe and the United States. Consequently, the heavy housing affordability in Asia is increasingly deteriorating.

In studying housing affordability, most researchers have focused on the correlation between housing price and income. Gallin (2006) tested the cointegration between the housing price and income in the American local market, showing that housing prices

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[3] Anonymous, Organisation for Economic Cooperation and Development, OECD Economic Outlook, 2005, 78.

[4] Data come from the housing demand survey published by the Taiwanese government.
[5] The internationally housing PIR is published by the Demographia International Housing Affordability Survey (http://www.demographia.com/). There are 227 cities and 41 real estate related organizations involved in this case.

do not appear to have a stable long-run equilibrium relationship with fundamentals such as income. Chen, Tsai, and Chang (2007) used a cointegration model and STOPBREAK test to analyze the housing prices and income in Taiwan. The cointegration result also showed the housing price and income to have no stable relationship. However, the STOPBREAK test shows that the housing price and the income still have a stable relationship in a long-term state. Whereas most of the literature on the relationship of housing price and income treats only cointegration, this study introduces the notion of housing PIR.

The United Nations Human Settlement Programme (UNHSP) and the World Bank have proposed the housing PIR as the best indicator to measure housing affordability. The housing PIR established by the UNHSP is the ratio of the median free-market price of a dwelling unit to the median annual household income. However, Linneman and Megbolugbe (1992) showed that this measure of housing affordability presents many problems. This indicator does not control for changes in the quality of housing, and the relationship between median home prices and median income does not account for actual financial constraints. We also found that the "housing price" in this indicator is the housing price borne by homebuyers, whereas the "income" includes the whole population. In other words, the income includes people who have no ability to purchase a house (e.g., house renters), but the housing price includes only people who purchase a house. Because of this problem of measuring, the housing PIR established by the UNHSP might be inconsistent and overestimated.

Researchers have conducted a number of studies using the mortgage payment rate as a housing affordability measuring indicator. Duca and Rosenthal (1994) showed that the mortgage payment rate can measure the housing affordability of households. However, for some households, such as young people, the pressure of housing affordability might not come from the monthly payment, but from the down payment. Thus, the mortgage payment rate might not consider important factors such as the down payment and loan-to-value ratio.

Considerable research has been conducted in this field to seek for the best indicators to measure housing affordability. Quigley and Raphael (2004) observed that housing affordability involves many aspects, and is difficult to measure. Linneman and Megbolugbe (1992) suggested that housing affordability measures should consider income and price distribution simultaneously. Gan and Hill (2009) accounted for the whole distribution of income and house prices, and their results show that lower-income households may have housing affordability problems. However, research is limited on the housing affordability of individual households.

Although the literature on housing affordability treats only the measuring problem, this study introduces the concept of the individual household affordability problem. As previous studies have shown, most housing affordability research uses qualitative research methods to identify households who might have housing affordability problems. To understand which household may have housing affordability problems, and what types of households with high housing PIR still buy a house, we discuss the household characteristic difference by individual household house PIR (micro PIR). We used quantile regression to analyze different quantiles of households to overcome the problem of measuring the median or mean.

This study presents a conceptual framework for linking individual household PIR and housing affordability. The objective of this study is to understand the individual household housing affordability problem, and whether households with high housing PIR represent the heavy housing affordability problem.

Table 1
The macro PIR and micro PIR of Taiwan and Taipei from 2006 and 2007.

year	Taiwan		Taipei City	
	micro PIR	macro PIR	micro PIR	macro PIR
2006	6.6	9.1	8.8	9.6
2007	6.9	11.0	9.1	12.8

The remainder of this paper is structured as follows: Macro and micro housing price-to-income ratio section presents the concepts of macro PIR and micro PIR and a discussion of the housing affordability in Taiwan and Taipei. The data section provides the data and how we estimated the function of household permanent income. Method section presents the applied method. Empirical results section provides a summary of the empirical result and draws several conclusions.

Macro and micro housing price-to-income ratio

As this review has shown, the housing PIR in Chinese society is higher than that in Europe and America (Malpezzi & Mayo, 1997).[6] This may be the result of the cultural background. In Chinese society, most people are attached to their native land and are unwilling to leave it. Many believe that land is the only thing in the world worth working for. Therefore, the housing affordability problem might be more serious in Chinese society. We used housing PIR data from Taiwan to better understand the housing affordability problem in Chinese society.

The ratio of the median housing price and the median household income is used to establish the housing price-to-income ratio internationally, and we used the ratio of the mean housing price and the mean household income[7] to establish the "macro PIR" (Function 1) in this paper. Following previous research, we used the data of a housing demand survey in Taiwan. This survey provides detailed data of households, such as the housing price, income, and house location. We used each household's housing price and income to establish the micro PIR (Function 2).

$$\text{macro PIR} = HP_m/IN_m \tag{1}$$

$$\text{micro PIR} = HP_i/IN_i \tag{2}$$

where HP_m is the mean housing price in an area, IN_m is the mean household income, HP_i is each household's housing price, and IN_i is each household's income.

To better understand the differences between the macro PIR and micro PIR, Table 1 presents the macro PIR and micro PIR of Taiwan and Taipei from 2006 to 2007. These data show that the macro PIR, which uses the mean of whole society data, might be higher than those of the micro PIR. This table shows that using the mean or median data of an area to measure housing affordability might result in overestimation. To clarify the individual household housing affordability problem, the next part of this analysis uses the micro PIR to represent the housing affordability of each household.

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[6] The World Bank and the UNHSP collected housing indicators from 51 countries in 1993. Malpezzi and Mayo (1997) used the PIR data from these 51 countries to analyze the various countries' housing affordability. This research shows that the housing PIR in Asia (such as Beijing 14.8 and Tokyo 11.6) is much higher than in Europe and America (such as Munich 9.6, Toronto 4.2, and Washington D.C. 3.9).

[7] The mean housing price data were retrieved from the Cathay Real Estate Index Report and Sinyi Real Estate Review, and the mean income data were derived from a survey of family income and expenditures.

Table 2
Household income function.

Variables	Coeff.	Stdev	*t* Value
Years of education	0.060	0.001	60.470
Sex (male = 1)	0.073	0.009	7.820
Occupation (public sector = 1)	0.279	0.013	22.150
Household scale	0.159	0.003	46.170
Couple	0.298	0.015	19.780
Couple with young children	0.371	0.017	22.220
Couple with older children	0.675	0.019	35.600
Couple with parent and children	0.279	0.018	15.520
Taipei City	0.377	0.011	34.160
Taipei County	0.120	0.009	13.520
Intercept	11.975	0.015	809.730
Samples	13,608		
F-test	1988.16		
Adj. *R*-squared	0.59		

Fig. 1. Current income and permanent income (unit: ten thousand NT dollars).

The data

This study uses the data from a housing demand survey filled out by 1715 Taipei City and Taipei County households who purchased a house in 2007. In the past, several studies have noted the income obtained from a household as the current income, and did not consider the household life cycle and income growth. To address this shortcoming, we chose to use the two-stage approach (Miles, 1997). The first stage estimates the function of household permanent income.[8] We used the years of homebuyer education, sex, occupation, household scale, and location to simulate the function of household permanent income. Table 2 presents the model results, and 13,608 samples were obtained for this model. The F test of this model is 1988.16, and the adjusted *R*-square is 0.59. Permanent income was used to conduct the follow-up analysis.

Fig. 1 shows the sample income (current income) and the permanent income decile situation. The sample income is interval data; thus, 10% to 30% of decile household income is NT$360,000, and 40–60% of households is $900,000. This result shows the limit of the sample income, which cannot show the real change in household income in deciles. The permanent income presents a stable change, and overcomes the limit of the income interval. According to a survey on family income and expenditure (SFIE), the average annual household income of Taipei City and Taipei County is between $1.19 million and $1.62 million. In this study, the average current income is $970,000, and it is obvious that the household income is underestimated. Compared with the current income, the average of permanent income ($1.55 million) is much closer to the annual household income.

Method

Dependent variable

The dependent variable of this study is the micro PIR, and it is calculated by dividing the household housing price by the household permanent income. The average micro PIR was 7.76, and standard deviation was 7.8. Fig. 2 shows the micro PIR sample distribution. The micro PIR presents a right-skewed pattern, and approximately 70% of buyers have a housing PIR between 4 and 10, and 10% is less than 4, and above 20% is higher than 10. According to the Demographia International Housing Affordability Survey, the housing affordability crisis is 5.0 (i.e., when the housing PIR is more
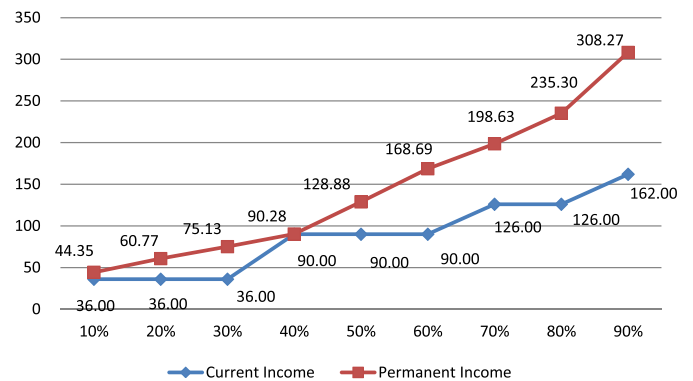
than 5, it means that the area has a serious housing unaffordability problem).

However, most of the housing PIR in Chinese society is over 5, even more than 10 (Malpezzi & Mayo, 1997), and the Taiwan average housing PIR in 2007 is over 7 times. To account for the high housing PIR phenomenon in Chinese society, this study defines a housing affordability crisis as 10. In other words, a household with over 10 micro PIR can be viewed as having a serious housing unaffordability problem.

Based on this distribution of the micro PIR, we identified households that might have a heavy housing affordability problem. The following sections present an analysis of the characteristics of different housing affordability households, and discuss whether these households have a housing affordability problem.

In considering the distribution of the micro PIR as a non-normal distribution, we used the quantile regression method to analyze the characteristics of different housing affordability households. The quantile regression model allows researchers to examine the marginal effects of either ends of the dependent variable without having to impose the strict parametric assumptions associated with segmenting or partitioning data. Quantile regression can be used to explain the determinants of the dependent variable at any point of the distribution (Koenker & Bassett, 1978, 1982; Koenker & Hallock, 2001).

We estimated the following quantile regression model: $Y_t = X'_t \beta_\theta + \varepsilon_{\theta t}$, where θ represents a different point in the distribution, and is between 0 and 1; β_θ represents the parameter vector; and $\varepsilon_{\theta t}$ represents the corresponding error. In this study, Y_t is the micro PIR, and X_t includes household attribute variables, search cost variables, and housing attribute variables.

Fig. 2. Distribution of micro PIR in Taipei City and Taipei County (unit: sample percentage).

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[8] This data is from a survey of family income and expenditures published by the Directorate General of Budget, Accounting, and Statistics in 2007.
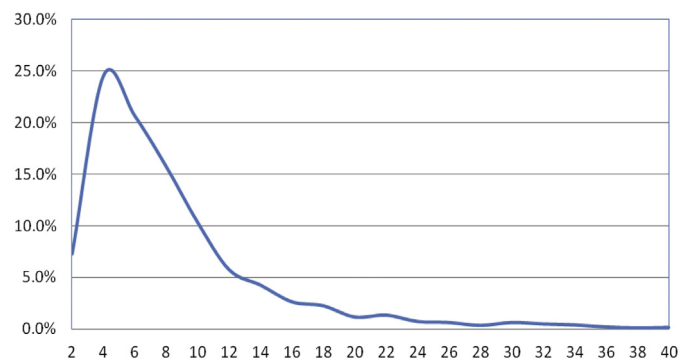
Independent variable

Most housing affordability studies have used qualitative methods to investigate the characteristics of the heavy housing affordability household. Following previous studies, we selected variables that might affect the housing affordability of the household. The independent variables to be addressed in this paper are as follows:

1. Household attribute

Based on previous studies on housing affordability and housing tenure choice (Ahmad, 1994; Cho, 1997; Ihlanfeldt, 1980; Tu & Goldfinch, 1996), we chose important variables of household characteristics, such as budget, age, logarithmic permanent income, and stage of life cycle.

In addition to these variables, we added two variables that have not been discussed before: (a) motive and (b) first-time homebuyer. We added the motive variable because households with different purchasing purposes might have different ideas of housing affordability. Households that purchase a house for consumption often consider the maximum utility of living space and the comfort of long-term residence. In contrast, households that purchase a house for investment may seek the maximum utility of capital gains and the rapidness of transaction (Chou, 2005). Thus, an investment household might have a higher micro PIR than a consumption household.

Mulder and Wagner (1998) indicated that there are many reasons for households to purchase their own house. One reason is that a house is a tangible asset, and owning a house is helpful to asset accumulation. This concept conforms to Chinese people, who think that land is the only thing in the world worth working for. Therefore, a first-time buyer might have a higher micro PIR than other buyers.

2. Search cost

The housing market is characterized by expensiveness, heterogeneity, and non-triability, and consumers need to collect substantial information in making their housing purchase decisions (Chou & Chang, 2005a, 2005b). In a normal market, more information collected indicates a better housing purchase decision. However, not all purchase decisions are the same, and the housing market involves extensive professional laws and regulations. The housing transaction amount is frequently up to millions dollars, and many households lack housing transaction experience. Thus, in the housing market, consumers need to spend more time or search for more houses to reduce transaction risks (Lee, 2009).

Previous research has shown that many variables can be used to measure the search cost of a household, including search time, number of houses seen, and the channels of information used. The search time is the most frequently used variable for search cost (Chou & Chang, 2005a, 2005b; Clark & Flowerdew, 1982; McCathy, 1982; Smith, Clark, Huff, & Shapiro, 1979; Smith & Mertz, 1980). This study uses the search time and the number of houses that have been seen to represent the search cost of a household. We also investigated whether the search cost can effectively reduce the housing affordability of a household.

3. Housing attribute

The heterogeneity of the housing market differentiates from other markets (Tu & Goldfinch, 1996). Therefore, it is essential to control housing characteristics when measuring household characteristics. Thus, the housing attribute variables can be regarded as control variables in this model. This study uses the housing type, meters, and the housing location to control housing heterogeneity.

Table 3 presents the descriptive statistics, and the percentage or mean of each variable. The first part of Table 1 shows that motives include investment and consumption. The investment motive accounts for 20.2% of the sample, whereas other respondents had the consumption motive. First-time buyers accounted for 53.8% of the sample, the average purchase budget is approximately $266.56 thousand, the average purchase age is 37.6 years old, the average logarithmic permanent income is 2.02, and the life cycle stage of households mainly consists of couples and young children (accounting for 35.7%).

The second part of Table 1 shows the search cost, indicating that the average household must spend 5.38 months and see 10.24 houses to find a house. The third part is the housing attribute. The average purchase square of a household is approximately 116.53 m. Results show that 54.0% of households choose existing houses, and 46.0% choose to purchase new houses, including presale houses and newly constructed houses. Results show that 67.5% of households purchase a house in the suburbs (Taipei county), and others purchase a house in the downtown area (Taipei city).

Empirical results

We used the quantile regression model and the least squares regression method to analyze the micro PIR and determine the different housing affordability household characteristics. Table 4 presents the results estimated by the quantile regression and the OLS model. From left to right, these results are estimated by the quantile regression of the 10th, 25th, 50th, 75th, and 90th quantiles. The rightmost row is the result estimated by the OLS model. The bottom column is the R-square of model, the OLS model adjusted R-square is 59.9%, and the Pseudo R-square of the quantile regression is between 40% and 50%. To further investigate the all the independent variable, we calculated the coefficient of the motive variables in Fig. 3.

Table 3
Summary statistics of independent variables.

Variables	Description	Percentage or Mean (std. dev)
Household attributes		
Motive	Consumption (1)	79.8%
	Investment (0)	20.2%
First-time buyer	First-time homebuyer (1)	53.8%
	Not first-time homebuyer (0)	46.2%
Budget	Thousand US dollars	266.56 (714.90)
Age	Years old	37.6 (8.28)
Permanent income (log)	Dollars per year	2.02 (0.242)
Stage in life cycle	Single (1) other (0)	18.8%/81.2%
	Couple (1) other (0)	34.2%/65.8%
	Couple with young children	35.7%
	(1) other (0)	64.3%
	Couple with older children	3.8%
	(1) other (0)	96.2%
Search cost		
Search time	Month	5.38 (5.60)
Search houses	Houses	10.24 (26.06)
House attribute		
Type	Newly constructed houses (1)	46.0%
	Existing houses (0)	54.0%
Square	Meters	116.53 (52.61)
Location	Taipei County (1)	67.5%
	Taipei City (0)	32.5%

Table 4
The results estimated by the quantile regression and the OLS model.

Quntile (PIR)	10% (3.36)		25% (4.63)		50% (6.31)		75% (8.71)		90% (12.03)		OLS	
	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio
Household attribute												
Motive	−0.028	−0.25	−0.005	−0.06	−0.171	−2.10**	−0.355	−2.99***	−1.044	−3.30***	−0.838	−3.70***
First-time buyer	0.107	1.09	−0.044	−0.60	−0.025	−0.37	−0.061	−0.62	−0.126	−0.50	−0.222	−1.17
Budget	0.004	25.43***	0.004	44.91***	0.005	84.80***	0.006	71.72***	0.005	18.13***	0.005	25.51***
Permanent income	−8.208	−34.76***	−10.234	−59.36***	−13.239	−72.80***	−15.862	−45.99***	−19.549	−15.41***	−21.339	−42.16***
Age	−0.006	−0.87	−0.004	−0.81	−0.008	−1.93*	−0.007	−1.20	0.008	0.47	0.016	1.32
Stage in life cycle												
Single	−0.096	−0.51	0.073	0.52	−0.094	−0.72	−0.125	−0.67	−0.211	−0.42	−1.075	−2.95***
Couple	−0.280	−1.48	−0.127	−0.90	−0.097	−0.74	0.051	0.27	0.207	0.41	−0.856	−2.34**
Couple with young children	−0.089	−0.45	−0.031	−0.21	−0.167	−1.21	−0.100	−0.51	−0.272	−0.52	−0.930	−2.40**
Couple with older children	−0.324	−1.11	−0.046	−0.21	−0.264	−1.31	0.251	0.87	0.999	1.31	−0.663	−1.17
Search cost												
Search time	0.014	2.02**	0.017	2.50**	0.015	2.75***	0.036	4.76***	0.036	1.81**	0.010	0.62
Search houses	0.003	4.30***	0.003	5.48***	0.001	2.89***	0.002	2.16**	0.013	5.67***	0.002	0.78
House attribute												
Type	0.271	3.01***	0.248	3.64***	0.254	4.02***	0.226	2.51**	0.799	3.39***	0.547	3.11***
Square	0.025	3.89***	0.039	10.49***	0.055	19.25***	0.066	16.60***	0.132	9.89***	0.085	10.69***
Location	−0.538	−4.93***	−0.688	−8.61***	−0.796	−11.03***	−0.879	−8.39***	−1.393	−4.78***	−1.451	−7.21***
Intercept	18.597	33.09***	22.543	54.01***	28.713	69.31***	34.440	47.43***	42.185	16.35***	46.173	40.09***
R-square	0.402		0.453		0.488		0.498		0.480		0.599	

The results of each quantile regression model consistently show that the budget and square variables are significantly and positively related to micro PIR, whereas permanent income and location variables are significantly and negatively related to micro PIR; that is, a household with a higher budget, lower permanent income, purchasing more space, and purchasing in a downtown area tend to have a higher micro PIR. Regarding the empirical results, the variables are discussed in three dimensions: Household attributes, search costs, and housing attributes. The high micro PIR (90th quantile) characteristics are also discussed.

1. Household attributes

The OLS model results of the motive variable revealed that investors' micro PIR was significantly higher than that of consumers. The quantile regression results revealed no significant difference below the 50th quantile, but above the 50th quantile, the micro PIR of investors was significantly higher than that of consumers.

The motive variable, as shown in Fig. 3, indicated that the marginal effect of the motive variable decreases varied significantly. Thus, homebuyers with higher PIRs tend to be investors, and may explain the existence of high micro PIR homebuyers. Homebuyers purchasing houses as investments may seek maximal capital gain and transactional rapidity (Chou, 2005), and may be relatively unconcerned about housing affordability.

As shown in Fig. 3 first-time buyer, among first-time homebuyers, the trend change in each quantile of the marginal effect was positive only in the 10th quantile, and in other quantiles, was negative. This indicated that the first-time buyer variable was insignificant in the OLS model and in the quantile regression, revealing that housing affordability for first-time homebuyers may not significantly differ from that of other homebuyers.

The purchase budget and household income variables were significant in the OLS model and in the quantile regression. Previous studies have discussed homebuyer activity under budget and income restrictions.

The OLS model showed that homebuyers with high budgets or low incomes have high micro PIRs (housing affordability). These two variables were further examined by calculating the coefficient of the budget and permanent income variables.

As shown in Fig. 3, the coefficient change of the purchase budget variable exhibited a parabolic pattern. The marginal effect increased before the 80th quantile, then decreased. This indicated that, among homebuyers who were and were not purchasing houses for investment, the budget marginal effect may have decreased and increased the micro PIR, respectively.

The marginal effect of the permanent income variable was negative, and the average trend was approximately 8−20%. The permanent income marginal effect declined as the micro PIR increased in conditional quantiles. The decrease of the income marginal effect was clear, as shown in Fig. 3, and the income coefficient in the OLS model described only the coefficient for the 99th quantile. The misalignment of OLS model might be attributed to the right-skewed, long-tailed, non-normal income distribution.

The marginal effect of the age variable was approximately −0.4% to 0.8%, and the age variable was mostly insignificant. The median quantile regression indicated that young homebuyers tend to have high micro PIRs.

The life cycle variables (including single, couple, couple with young children, and couple with grown children) results in the quantile regression were all insignificant. By contrast, the OLS model showed that atypical families had higher micro PIRs. As shown in Fig. 3, the life cycle variables decreased in the 99th quantile, which may explain the insignificance of the life cycle variables in the OLS model were significant. The OLS model results were affected by right-skewed distributions.

2. Search costs

The search cost variable comprised the search time and number of houses viewed; the OLS result revealed that both of these variables were insignificant, and in all quantiles, search time and search houses were positive and significantly correlated.

The coefficient of the search time variable (Fig. 3) showed an increasing trend of change in each quantile. In particular, it marginally affected the purchase budget variable before the 90th quantile before
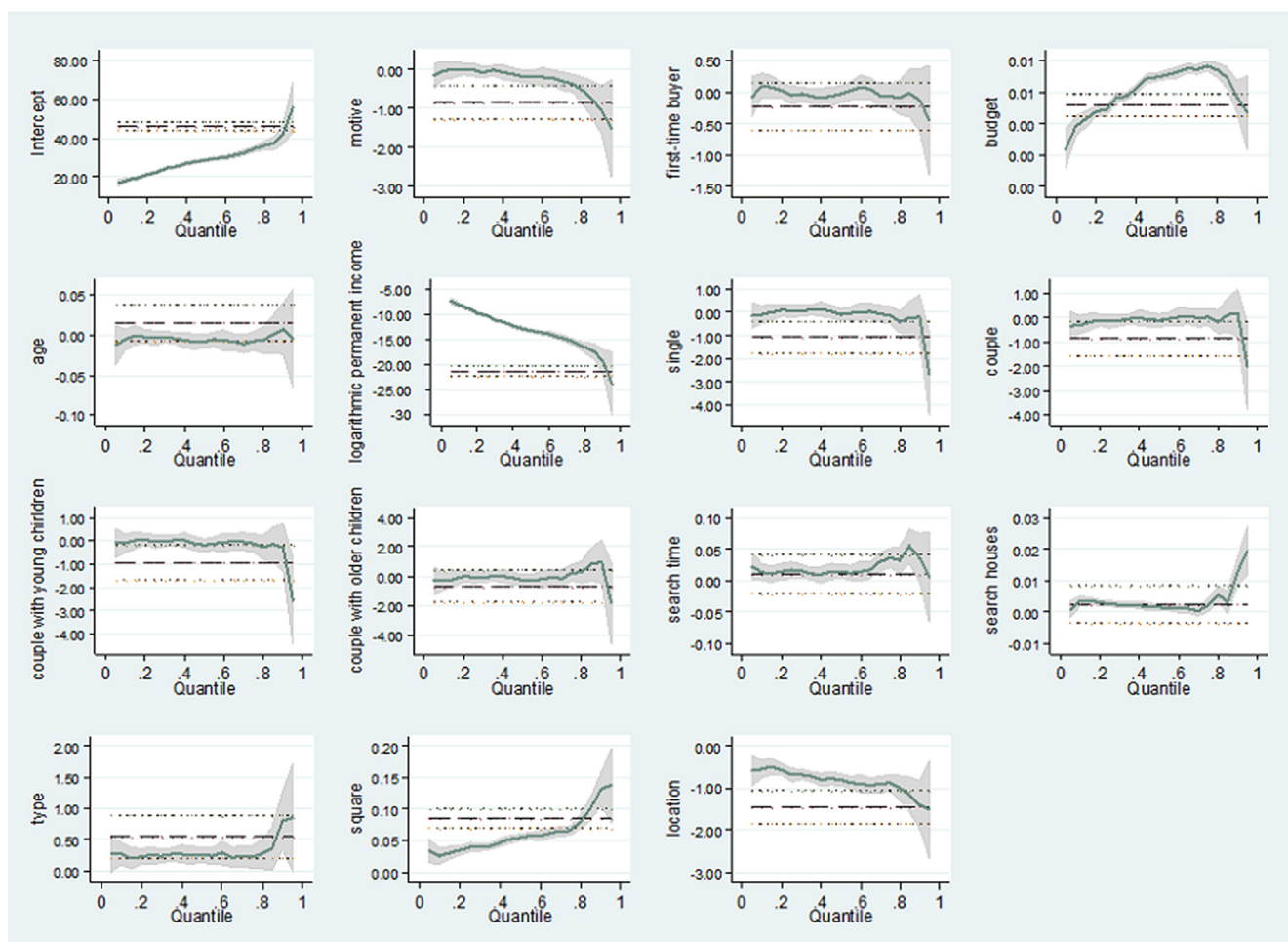
Fig. 3. The coefficient change of all independent variables.

decreasing. Among general homebuyers with comparatively higher micro PIRs (excluding those in the 90th quantile), the search time marginal effect increased. This result indicated that increases in search time may not reduce housing affordability.

The number of houses viewed yielded a marginal positive effect, and excluding the 90th quantile, demonstrated an average trend of approximately 0.1% to 0.3%. The marginal effect of the search houses variable decreased as the micro PIR increased in conditional quantiles. The results indicated viewing additional houses may not affect housing affordability.

In sum, increasing search costs cannot effectively resolve the housing affordability problem. In other words, although spending time viewing additional houses can yield satisfactory purchase decisions, homebuyers willing to spend higher search cost may purchase higher quality, rather than cheaper houses.

3. Housing attributes

The housing attribute variables were type, square, and location. All of the housing attributes were significant in the OLS model and in the quantile regression. The results revealed that the micro PIRs of homebuyers who purchased newly constructed houses was considerably higher than that of homebuyers who purchased previously constructed houses.

The marginal effect of the square variable was positive, and the average trend was approximately 2–7% (excluding 90th quantile

homebuyers). These results indicated that homebuyers who purchased large houses had relatively high micro PIRs, and that homebuyers with high micro PIRs purchased large houses.

The marginal effect of the location variable was negative, and the results indicated that homebuyers purchased houses located downtown (Taipei City) had higher micro PIRs than homebuyers who purchased a houses located in the suburbs (Taipei County). The results also showed a clear negative trend for the marginal effect.

Homebuyers with extremely high micro PIRs were further investigated. At the 90th quantile (representing 12.03 micro PIR), the results showed that homebuyers who purchased houses as investments, with higher budgets and lower permanent incomes, who purchased houses that were newly constructed, larger, and located downtown, had higher micro PIRs. This suggests that homebuyers with high micro PIRs may not represent traditional homebuyers who are purchasing houses as residences. High micro PIR households may purchase houses as investments or as part of asset accumulation, suggesting that a high micro PIR is not necessarily indicative of a housing affordability problem.

Conclusion

Previous studies on the housing PIR have mostly discussed the main or average housing affordability in a particular area. However, research based on the macro PIR has many limitations, such as a measurement bias, the statistical overestimation problem, and the

measurement group inconsistency phenomenon. This study investigates the problem of high housing affordability in Chinese society, and uses data from the Taiwanese micro PIR to represent the housing affordability of each household.

We used a two-stage approach to establish and accurately measure the micro PIR. The first stage involves the function of household permanent income, which can be calibrated as the ratio of current household income to permanent income. We used the least squares method and the quantile regression method to analyze the mean and various quantile household characteristics of the micro PIR in the second stage.

The empirical results of this study showed that micro PIR exhibited a right-skewed, long-tailed, non-normal distribution. Therefore, the least squares method cannot be used to account for the distribution trend of the samples. The quantile regression method was used to analyze the characteristics of various household quantiles.

Homebuyers who purchased houses as investments; had high budgets and low permanent incomes; and purchased houses that were newly constructed, large, or located downtown tended to exhibit relatively high micro PIRs. Increasing search costs cannot effectively resolve the housing affordability problem, because homebuyers who are willing to spend time and view additional houses may purchase higher quality, rather than cheaper, houses.

Last, the high quantile result indicated that homebuyers exhibiting high micro PIRs with higher budgets and lower incomes, may be purchasing houses as investments. This contradicts the finding that a high housing PIR indicates a high level of housing affordability.

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