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Saving and housing of Taiwanese households: New evidence from quantile regression analyses ☆

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Abstract

Considering the possible heterogeneity of saving propensity of the household, this study estimates Taiwan's household saving functions based on quantile regression, focusing on the effects of housing price appreciation in the late 80s on homeowners and renters over past two decades. The empirical results show that evident heterogeneity exists not only in the marginal propensity to save out of income but also in discouragement effect for renters and wealth effect for homeowners across the conditional distribution of savings. Consequently, housing market boom lowers saving propensity for renters in common while homeowners with higher saving rates show larger wealth effect that lead to the redistribution of social welfare eventually. Based on the estimation of quantile regression, this study is a prelude to the estimation of comprehensive conditional household saving functions. Contribution of this study is to provide new evidence on the heterogeneity of household saving propensity that is different from those presented in the existing literature.

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1. Introduction

Wealth is the accumulation of savings through the household's life-cycle and housing equity accounts for a major part of wealth of the household. Volatility of housing prices will alter not only the optimal saving and consumption decisions of the household but also the process of capital formation, and consequently induce the redistribution of social welfare of the entire society. Due to the radical change of housing prices associated with the apparent decline of saving rates in Western developed countries over the 60s and 70s, the possible impact of housing equity on savings and consumption has attracted much attention of economists since the 80s. Focusing on aggregate data, Case et al. (2005), Muellbauer and Murphy (1990) and Peek (1983), among others, consistently suggest that housing equity appreciation leads to significant wealth effect, resulting in higher consumption and lower saving.

The studies based on aggregate data are, however, silent to the varieties of individual and household characteristics, let alone the comparison of saving and consumption propensities among different groups. As an example, renter's saving propensity may be discouraged by housing price soar while this discouragement effect cannot be disentangled from owner's wealth effect in aggregate aspect. Attanasio and Weber (1994) stress the advantages of using micro rather than macro data in the analyses of household consumption behaviors; see also Engelhardt (1996), Chou et al. (2003), Miles (1997) and Ogawa and Wan (2006). For a complete survey of the studies on micro data, we refer to Bostic et al. (2005). A drawback of existing micro studies is that they typically separate homeowners from renters in the discussions of the effects of housing price appreciation (Engelhardt, 1994, 1996; Manchester and Poterba, 1989; Moriizumi, 2003) and hence are subject to possible selectivity. Although Skinner (1991) and Campbell and Cocco (2005) investigate the saving behavior of homeowners and renters at a time, the former does not consider the effect of home equity on saving, and the data in the latter are of synthetic cohort type and thus lose the distinction between homeowner's and renter's saving propensities. Studies that admit both wealth effects for homeowners and discouragement effects for renters are rarely seen.

In terms of methodology, the existing regression analysis of micro data relies on the methods of ordinary least squares (OLS) and least absolute deviations (LAD). It is well known that the OLS (LAD) method estimates the marginal effects of the covariates on the conditional *mean* (*median*) function of household saving. Yet, such estimates may not fully represent the patterns of saving propensity of the covariates in the conditional distribution. For example, Engelhardt (1996) employs both OLS and LAD and obtains divergent saving propensities, showing that the marginal effects of the covariates need not be homogeneous across the conditional quantiles of saving. Understanding the (possible) heterogeneity of household saving behaviors is fundamental to grasp the impacts of capital windfall, and therefore the effectiveness of related housing and tax policies, on higher and lower savers. The issue of divergent saving propensity, however, has not been carefully analysed in the literature. It should be noted that such heterogeneity is different

from that discussed by, e.g., Skinner (1991), Starr-McCluer (1998) and Disney et al. (2002) which focus on the heterogeneous effect of different income groups on saving. It also differs from the heterogeneity discussed in the macroeconomics studies which emphasize on the heterogeneous effects over time or across countries[1]; see Leung (2004) and Ortalo-Magne and Rady (2006) for comprehensive surveys of recent works.

In this paper we employ the method of quantile regression introduced in Koenker and Bassett (1978) to reexamine Taiwanese household saving behavior in response to household characteristics, in particular the change of income and housing prices over the 80s and 90s. We focus not only on the extent to which housing equity appreciation significantly affects homeowner's and renter's saving decisions but also on the heterogeneity of marginal propensity to save. The major contribution of this study is to prelude comprehensive estimates of the household saving function over the entire conditional distribution as pioneer in housing literature.[2] The empirical findings support the premise that household saving propensities are heterogeneous in a broad sense as follows. First, the marginal propensity to save out of permanent income of the household is positively associated with saving rates. For mean and median saver, the marginal propensity to save is around 35%. However, the marginal propensity for higher saver (upper quantile) is as high as 55% while that for lower saver (lower quantile) is as low as 15%. Since saving and income are positively associated as well, it implies that the rich are likely to save more, confirming the findings of Dynan et al. (2004).

Second, we find that homeowners indeed behave statistically different from renters. In addition to the significant housing ownership dummies in saving and consumption functions found by Miles (1997) and Ogawa and Wan (2006), this study demonstrates that, given fixed housing rent, renters with saving rate below the median tend to save more than homeowning counterparts in 1980 and 1990, while the reverse is true for the household in year 2000. The result reflects the possible discouragement effect for low saving renters to give up house purchasing plan after the rapid housing price appreciation. This is consistent with, yet more insightful than, the conclusions of Engelhardt (1994) and Yoshikawa and Ohtake (1989). Finally, in terms of marginal effect of housing price appreciation on saving, 10% increase of the housing price will result in 0.5–1% decrease of saving for renters. The corresponding response for homeowner counterparts is 0.3–1.7% decline of saving. The higher savers, the larger decline of saving, and the negative wealth effect is evidently enlarged after overall housing market boom along with the implementation of national health insurance and financial liberalization. Nevertheless, the wealth effect of the homeowner in Taiwan is smaller (about one-tenth to one-half) than that in the US estimated by Skinner (1989).

The remainder of this paper is as follows. Section 2 provides a brief explanation of quantile regression and its application in the empirical estimation of household saving

[1] For theoretical works, see Alvarez-Pelaez and Diaz (2005), Chatterjee (1994), Chatterjee and Ravikumar (1999), Obiols-Homs and Urrutia (2005), Atkeson and Ogaki (1996), Ortalo-Magne and Rady (1999) and Rebelo (1992). On the empirical side, refer to Atkeson and Ogaki (1996), Chatterjee and Ravikumar (1999), Han and Ogaki (1997), Ogaki and Atkeson (1997).

[2] Chou et al. (2003) estimate household saving function by quantile regressions to check the magnitude of the impact of national health insurance on households of different saving rates. However, housing equity plays no role in Chou et al. (2003) and the estimation of quantile regressions is a subordinate annotation providing only supplementary evidence to that of difference-in-difference model based on mean regression.

function. Section 3 presents some description of Taiwan's economic background with an outline of the data we use and the covariates in the empirical model. Section 4 reports the estimation results. Section 5 summarizes the main conclusions of the paper.

2. Saving function and quantile regression

Although the model setups of household saving function under aggregate and individual data are fairly similar, the components of covariates are actually very different. Specifically, the richness of individual data with regard to household characteristics and backgrounds enables us to investigate the household's optimization behavior in detail that aggregate data can hardly afford. Consider a linear regression specification of household saving under micro data:

$$S_i = X_i'\beta + \varepsilon_i, \quad i = 1, 2, \ldots n, \tag{1}$$

where X is a vector of covariates, β is the vector of parameters, and ε is the error term. The vector X contains the determinants of household saving, including income, change of housing price, and other demographic factors that are relevant in affecting individual household's decision.

First, income is the most important in the determination of saving. According to life-cycle/permanent income hypothesis, it is standard to have two-stage estimates with the first stage fitting a life-time income equation and the second stage, plugging the predicted income in the regressions of saving function (Skinner, 1991; Dynan et al., 2004). Second, changes of the price of housing equity play a crucial role that affects household behavior. Housing equity windfall may induce wealth effect for homeowners to reduce saving (Case et al., 2005), while housing price surge may encourage or discourage the renter's tendency to save (Moriizumi, 2003; Engelhardt, 1994). Third, in addition to income and wealth, impacts of demographic factors, such as head's and spouse's schooling, age distribution of children, household composition, and so on, should be relevant to the consumption and saving decisions (Attanasio and Weber, 1994; Hoynes and McFadden, 1997). It is worth noting that all effects derived from these factors are based on individual observations that reflect the very individualistic saving decision of the household.

Estimating Eq. (1) by the OLS method, it is well known that the estimated regression function $X_i'\hat{\beta}$ is an approximation to the conditional mean of S, and $\hat{\beta}$, the OLS estimate of β, thus characterizes the marginal effect of X on the "averaging" behavior of S. If Eq. (1) is estimated by the LAD method, the estimated regression function is an approximation to the conditional median of S, and the LAD estimate of β is the marginal effect of X on the "center" behavior of S. Although mean and median are two leading location measures of a distribution, they are not able to fully characterize a distribution. In the context of linear regression, the marginal effect of a covariate may be heterogeneous across the conditional distribution of S, so that the OLS and LAD estimates of such effect may not be representative.

Other than the OLS and LAD methods, Eq. (1) can be estimated by the method of quantile regression proposed by Koenker and Bassett (1978). Let θ be a real number in $(0, 1)$. In accordance with Eq. (1), the regression specification of the θth conditional quantile can be expressed as

$$S_i = X_i'\beta_\theta + \varepsilon_{i\theta}, \quad i = 1, 2, \ldots n, \tag{2}$$

where β_θ is the vector of parameters that depend on θ, and ε_θ is the corresponding error. The quantile regression estimate $\hat{\beta}_\theta$ is obtained by minimizing the asymmetric weighted sum of absolute deviation:

$$\min_{\beta \in R^K} \left[\sum_{i:S_i \geqslant X_i'\beta} \theta |S_i - X_i'\beta| + \sum_{i:S_i < X_i'\beta} (1-\theta)|S_i - X_i'\beta| \right], \tag{3}$$

and $X_i'\hat{\beta}_\theta$ is an approximation to the θth conditional quantile of S. When θ is close to zero (one), $X_i'\hat{\beta}_\theta$ characterizes the behavior of S at the left (right) tail of the conditional distribution. When $\theta = 1/2$, Eq. (3) is equivalent to the objective function of LAD estimation, so that $X_i'\hat{\beta}_\theta$ describes a "center" (the median) behavior of S.

The first order condition of (3) is

$$\sum_{i=1}^{n} \left[\theta - \frac{1}{2} + \frac{1}{2} \operatorname{sign}(S_i - X_i'\beta) \right] X_i = 0, \tag{4}$$

where sign $(\lambda) = I(\lambda \geqslant 0) - I(\lambda \leqslant 0)$ with $I(A)$ the indicator function of the event A. Clearly, Eq. (4) is not differentiable at $S_i = X_i'\beta$. Thus, standard numerical optimization algorithms do not work. Koenker and Bassett (1978) and Koenker and d'Orey (1987) propose the use of linear programming to estimate in Eq. (4). Under some regularity conditions, the asymptotic distribution of $\hat{\beta}_\theta$ is

$$\sqrt{n}\left(\hat{\beta}_\theta - \beta_\theta\right) \xrightarrow{A} N(0, \Lambda),$$

where Λ is the asymptotic covariance matrix:

$$\Lambda = \theta(1-\theta)(E[f_{\varepsilon|X,\theta}(0|X_i)X_iX_i'])^{-1}E[X_iX_i'](E[f_{\varepsilon|X,\theta}(0|X_i)X_iX_i'])^{-1},$$

and $f_{\varepsilon|X,\theta}$ is the conditional probability density of the error term; see Koenker (2005) for a comprehensive treatment of quantile regression. A convenient way to estimate is the bootstrap method (Efron, 1982). Specifically, m observations are drawn (with replacement) from the total sample of X and S to constitute a sub-sample of X^* and S^*, and a bootstrap estimate $\hat{\beta}_\theta$ is computed from the sub-sample. This procedure is then repeated B times to yield a collection of bootstrap estimates $\hat{\beta}^*_{\theta j}$, $j = 1, \ldots, B$. The estimator of the asymptotic covariance matrix is then computed as

$$\hat{\Lambda} = m\left\{ \frac{1}{B} \sum_{j=1}^{B} (\hat{\beta}^*_{\theta j} - \hat{\beta}_\theta)(\hat{\beta}^*_{\theta j} - \hat{\beta}_\theta)' \right\}. \tag{5}$$

The bootstrap estimate of the asymptotic covariance matrix is proved to be fairly robust (Buchinsky, 1992). In this paper, we use STATA 8.0 which adopts the algorithm of Armstrong et al. (1979) to compute $\hat{\beta}_\theta$ and the bootstrap method for computing Λ. In our estimation, m in Eq. (5) is set to n and B (the number of bootstrap repetition) is set to 1000.

The quantile regression estimate $\hat{\beta}_\theta$, represents the marginal effects of covariates upon saving, depending on the *location* of the conditional distribution of saving. Such effect may vary across the distribution. If the conditional distribution of saving is not homogenous, the estimated slope coefficients of quantile regressions are expected to

deviate from that of OLS and LAD (Koenker, 2005). Also, the discrepancies of the marginal effects between tail quantiles characterize the heterogeneity of different groups of households. Thus, the economic implications and policy suggestions derived from quantile regressions would be more enriched than that from traditional OLS and LAD regressions.

3. Data and empirical model

Over the past two decades Taiwanese households exhibit extraordinarily high saving rates (Deaton and Paxson, 1994; Gersovitz, 1988) and housing ownership against the backdrop of the soaring housing prices (Lin and Lai, 2003) in the late 80s. These phenomena make Taiwan the best laboratory to study the household's saving behavior with respect to changes of real estate market. According to the National Wealth Statistics of the Directorate-General of Budget, Accounting and Statistics (DGBAS), a central government agency, real estate accounts for 69–74% of national wealth in between 1998 and 2002, thus land and housing weight the largest portion of national wealth (DGBAS, 2005). In year 2003, the total value of housing related assets (including land, housing and construction) of overall sectors is 67,651 billion NT dollars (approximately 2255 billion US dollars), in compared to 90,806 billion NT dollars (approximately 3027 billion US dollars) of financial assets; the former is about 74.5% of the latter. In particular, for the household and non-profit sectors, the announced current value[3] of housing related assets reaches 49,809 billion NT dollars (approximately 1660 billion US dollars) and the financial assets, 38,523 billion NT dollars (approximately 1284 billion US dollars). Obviously, real estate is the largest item of assets held by the household and non-profit sectors in Taiwan. Therefore, changes of real estate price are expected to play a significant role in the determination of intertemporal optimization behavior.

3.1. Economic background over the 80s and 90s

With regards to the fluctuation of real estate market, there is lack of complete housing price survey in Taiwan over the entire 1980–2000 period.[4] Here we use the housing price index of Taipei City derived by Lin et al. (1996) to describe the real estate market boom in Taiwan during the late 1980s and early 1990s. Fig. 1 shows that Taipei City's reselling housing price index (1991 = 100) started to soar since 1985 and stayed high after 1994. Between 1985 and 1994, the price index boosted over 173%. In line with the dramatic appreciation of real estate price, the average cost of a residential unit in Taipei metropolitan rose from a resident's 2 years labor income in early 80s to that of 10 years in early 90s (Lin, 1993). In spite of the sky high housing price, housing ownership in Taiwan keeps increasing over the past two decades, to be one of the highest in the world. As shown in Fig. 2, housing ownership rate increased from 67.4% in 1976 to 86.8% in 2004. Per-household and per-person living space rose as well over the same time. Average housing

[3] Announced current value is the incidence of land tax that is usually understated than market value.

[4] There is a Housing Survey supplementary to the Labor Force Survey in Taiwan, but Housing Survey was conducted between 1980 and 1993 only.

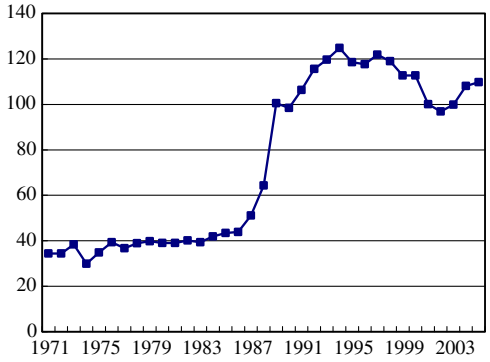

Fig. 1. Price index of used house in Taipei (1990 = 100).

space increased from 23 pins in 1976 to 42 pins in 2004 with per-person space enlarging from 4.4 pins to 12.1 pins.[5]

The largest two expenditure items of Taiwanese households are food and housing (including rent and utility). Due to the rapid economic development, Engel curve of food expenditure drops very fast. Food share declined sharply from 45% in 1976 to 23.7% in 2004. In contrast, share of housing expenditure remained fairly above 20% during the same period. After 1995, expenditure shares of the two items are about the same, which reflects the fact that housing and food are of the similar weights in a high-ownership and high housing price economy like Taiwan. Correspondingly, Chetty and Szeidl (2004) find that the average housing expenditure accounts for 20% while food and clothes account for 15% in the US.

In accordance with the fluctuations of housing price and expenditure shares over the past decades, how do the patterns of saving evolve over time? In terms of aggregate aspect, Fig. 3 shows that national saving rates[6] held steadily high at around 30–34% before the mid-80s, peaked at 38.5% in 1986–1987 and decreased to 30% by 1990, then further dropped to 23.8% in 2001. The movements of national saving rates seem to coincide with the change of housing prices. Lin and Lai (2003) document the wealth effects from macro aspects and conclude that real estate appreciation was responsible for the decline of saving after the 90s. The saving pattern from micro aspect is, however, not quite the same as that from macro aspect in terms of evolving patterns and peak years. As shown in Fig. 4, household saving rates were lower than 20% in early years. Economic growth led to an increase of household saving rate which reached 30% in the early 90s then fell to 25% in 2000. The co-movement between saving rates and housing price in microeconomic data is not apparently true, and the wealth effect on saving remains unsolved.

[5] Pin is a traditional space measurement. One pin is around 3.24 square meters.

[6] Different from the US where business saving is the major component (Frank and Bernanke, 2006), household saving outweigh business and government savings in national saving in Taiwan.

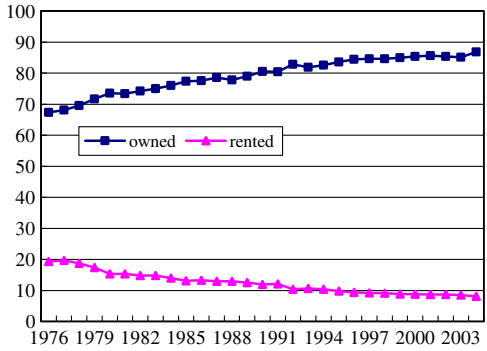

Fig. 2. Housing ownership rates.

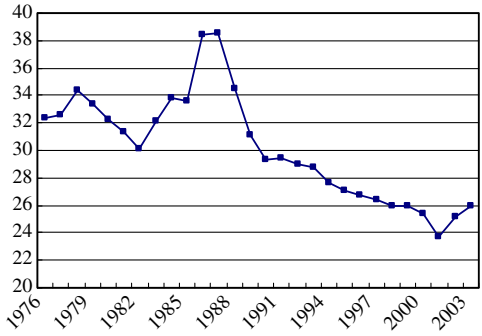

Fig. 3. National saving rates.

3.2. Survey of family income and expenditure

The data used in this study are taken from the Survey of Family Income and Expenditure (SFIE) conducted annually since the early 60s by the DGBAS. The SFIE is not of panel type; a new sample of households is drawn in each wave which collects information on socio-demographic and socio-economic characteristics of all household members along with detailed household expenditures on a broad range of commodities, including actual paid rents of renters and imputed rents for homeowners in particular. In addition to the standard and commonly reported items in most budget surveys, it is relatively rare for household surveys to also obtain detailed information on non-labor income and comprehensive housing attributes. These two key modules of the survey are crucial to improving the estimation of permanent income and the proxy of housing wealth in the following analyses.

Three years of the survey, 1980, 1990, and 2000 of SFIE are used in this study to investigate the responsiveness of household saving behavior before and after the housing market boom.[7] Sampling ratio of SFIE is around 0.2% of the total population, so that about

[7] Since this study is a prelude to use the SFIE in the analysis of saving function, we select specific years of data with fixed time intervals over the past decades, as in Miles (1997). This type of setting inevitably neglects the impacts from aggregate aspect such as business cycle and financial liberalization. See the last section for further discussion of data arrangement in future research.

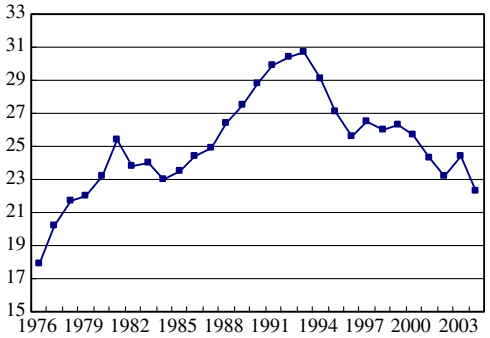

Fig. 4. Household saving rates.

14,000–16,500 households were surveyed in the three waves. We restrict the sample to homeowner and renter households with heads aged 25–64 years old to mitigate headship selectivity (Deaton and Paxson, 1994). Less than 10% in the total sampled households with borrowed or issued residences are also excluded.[8] These restrictions result in samples of around 12,000 households in each wave.

Descriptive statistics are reported in Table 1 with three waves in separate panels. Within each panel, Column 1 is the total sample, and sub-samples of homeowners and renters are in the second and third columns. There are 11,143, 13,899, and 12,251 samples for 1980, 1990, and 2000, with 17.3%, 13%, and 9.5% renter households, respectively. Upper part of the panel contains income and saving of the household. It is clear that average household real income (1990 = 100) doubles every ten year over the past decades. Reversely, saving rate declines from 24.6% to 16.2% over the same period of time. It is worth noting that saving distribution of Taiwanese households is right skewed by 1980 in which median saving is lower than mean and that is similar to the US (Dynan et al., 2004). In 1990 and 2000, however, the distribution of saving alters to be left skewed and it implies that there exist a certain number of low (negative) saving households. Furthermore, homeowners consistently earn more and save more than renters, thus the left skewness of renters in Column 3 is more prevalent than homeowners in Column 2 in recent years.

Lower part of each panel contains household characteristics. It shows that the head's age is increasing while household size is decreasing along with economic development. Heads of renters tend to be younger than those of homeowners. Around 5–8% of the heads are employed in public sector and they are more inclined to be homeowners than their private sector counterparts. The majority (around 50–64%) of the household lives in urban area and around 1/4 lives in suburban area, the remaining in rural. More than 75% of the renters crowd in urban area.

To further understand the distribution of income and saving, we calculate the average income of ten "cells" stratified by the nine deciles. Fig. 5 shows that real income increases substantially over the decades with the upper deciles increase more than the lower deciles, which reflects the fact that income distribution deteriorates continuously since 1981 (DGBAS, 2005). Following the same categories of income, average saving rate of each income "cell" is calculated and as shown in Fig. 6 that saving rate is increasing monoton-

[8] The household may borrow dwelling units from friends or relatives, while the issued housing is provided by the governments to pubic sector employees.

Table 1
General Statistics of Household Income, Savings and Characteristics, SFIE 1980, 1990, and 2000

Year	Item	Total sample		Owners sample		Renters sample	
		Mean	Stdev	Mean	Stdev	Mean	Stdev
1980	*Income and savings*						
	Household real income[a]	259,918	151,797	268,041	157,124	221,102	115,603
	Mean saving rate	0.246	0.199	0.250	0.203	0.229	0.178
	Median saving rate	0.239	—	0.243	—	0.216	—
	Log savinf rate = (ln Y − ln C)	0.314	0.254	0.319	0.253	0.289	0.253
	Permanent income[b]	12.894	0.379	12.922	0.390	12.760	0.287
	Household characteristics						
	Head age	41.348	10.096	42.045	10.019	38.019	9.801
	Household size	5.009	2.003	5.164	2.029	4.269	1.690
	Head public emp. (yes = 1)	0.079	0.270	0.080	0.271	0.075	0.264
	Housing renters (yes = 1)	0.173	0.378	—	—	—	—
	Log estimated payed rent[b]	1.768	3.871	—	—	10.218	0.488
	Log estimated imputed rent[b]	8.357	3.861	10.106	0.594	—	—
	Urban dwellers (yes = 1)	0.488	0.500	0.437	0.496	0.734	0.442
	Suburban dwellers (yes = 1)[c]	0.213	0.409	0.223	0.417	0.160	0.367
	Obs no.	12,251		10,131		2,120	
1990	*Income and savings*						
	Household real income	619,762	386,570	635,800	395,750	512,102	296,588
	Mean saving rate	0.227	0.328	0.228	0.338	0.219	0.252
	Median saving rate	0.244	—	0.247	—	0.227	—
	Log savinf rate = (ln Y − ln C)	0.308	0.310	0.311	0.315	0.284	0.271
	Permanent income	13.443	0.422	13.466	0.431	13.287	0.321
	Household characteristics						
	Head age	41.693	10.289	42.164	10.401	38.528	8.881
	Household size	4.338	1.740	4.388	1.768	4.004	1.498

(*continued on next page*)

Table 1 (*continued*)

Year	Item	Total sample		Owners sample		Renters sample	
		Mean	Stdev	Mean	Stdev	Mean	Stdev
	Head public emp. (yes = 1)	0.079	0.269	0.083	0.276	0.047	0.211
	Housing renters (yes = 1)	0.130	0.336	—	—	—	—
	Log estimated payed rent	1.422	3.688	—	—	10.965	0.494
	Log estimated imputed rent	9.510	3.709	10.927	0.571	—	—
	Urban dwellers (yes = 1)	0.548	0.498	0.517	0.500	0.756	0.430
	Suburban dwellers (yes = 1)	0.286	0.452	0.299	0.458	0.203	0.402
	Obs no.	13,899		12,097		1,802	
2000	*Income and savings*						
	Household real income	1,211,549	720,487	1,239,911	732,450	940,630	521,802
	Mean saving rate	0.162	0.253	0.163	0.248	0.153	0.296
	Median saving rate	0.171	—	0.173	—	0.151	—
	Log savinf rate = $(\ln Y - \ln C)$	0.215	0.278	0.217	0.281	0.200	0.245
	Permanent income	13.855	0.450	13.880	0.452	13.615	0.359
	Household characteristics						
	Head age	43.349	9.732	43.525	9.807	41.668	8.815
	Household size	3.861	1.626	3.892	1.630	3.569	1.556
	Head public emp. (yes = 1)	0.048	0.214	0.052	0.222	0.011	0.106
	Housing renters (yes = 1)	0.095	0.293	—	—	—	—
	Log estimated payed rent	1.342	4.149	—	—	14.162	0.347
	Log estimated imputed rent	12.851	4.176	14.196	0.408	—	—
	Urban dwellers (yes = 1)	0.635	0.481	0.619	0.486	0.784	0.412
	Suburban dwellers (yes = 1)	0.252	0.434	0.259	0.438	0.184	0.387
	Obs no.	11,143		10,087		1,056	

Source: SFIE 1980, 1990, and 2000. Authors calculated.

[a] Real income is defaulted by CPI (2000 = 100).

[b] Estimating details in the text.

[c] Rural dwellers as references.

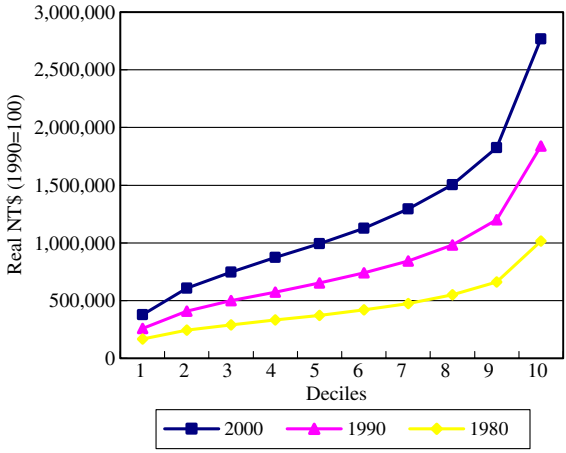

Fig. 5. Distribution of real total household income.

ically with income. Similar to the finding of Dynan et al. (2004) in the US data, there exists strong positive correlation between current income and saving rates over the income distribution in Taiwanese data. It is clear that distributions of saving in 1980 and 1990 stand side by side except for the very bottom cell. Overall decline of saving occurs in 2000 results in parallel down shift of saving across income deciles.

3.3. Empirical model

In empirical study, saving is usually defined as the change of net wealth holding over a period of time (Engelhardt, 1996) in panel data. If panel data are not available or when the data set contains no module of wealth holding, saving is equal to the difference between income and consumption (Dynan et al., 2004). In the estimation of saving function, correct measurement of income and housing equity is crucial. On the one hand, life-cycle hypothesis emphasizes that permanent income, instead of transitory income, is the determinant of household saving (Mayer, 1972). And it is suggested that if saving is defined as income minus consumption, incorrectly measured income will bias toward the same side with savings and result in spurious correlation (Dynan et al., 2004). We therefore estimate

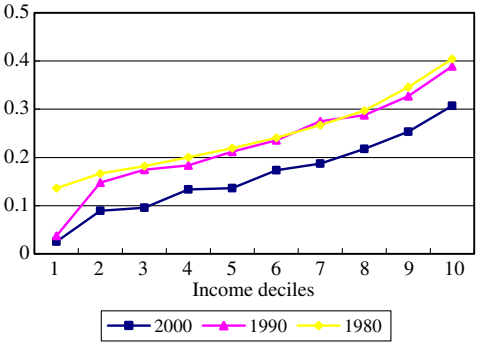

Fig. 6. Distribution of average saving rates across income deciles.

a proxy of permanent income to alleviate the problems of transitoriness and measurement error of current income in saving function.

On the other hand, the correct measure of housing wealth is controversial. Case et al. (2005) and Engelhardt (1996) stress the advantage of using self-reporting housing values because this value reflects the perception of the home owner and should be the "driving force" in consumption and saving decisions. In addition, self-reporting housing value can be used for estimation regardless of geographic location. Although the SFIE collects no information of housing wealth but rent, housing rent is supposedly proportionate to housing equity which could be used as a proxy of housing wealth for homeowners and expected burden for renters with purchasing plan. Lin (1993) concludes that the rent multiplier (the rent-price ratio of housing equity) in Taiwan was as high as 300 in the early 80s, and further increased to over 500 in the late 80s.[9] If housing wealth and saving propensity is negatively correlated, exceptionally high rent multiplier may result in under-estimated marginal propensity to save out of housing wealth owing to lower sensitivity of housing rent relative to that of housing wealth.

The saving function regression in this study is based on a two-stage estimation procedure. In the first stage, permanent income and proxy of housing wealth are estimated separately. In the model of permanent income, dependent variable is the logarithm of total household income and independent variables include household non-labor income and joint income, gender of head, head age and age squared, existence of spouse, educational levels for both head and spouse, number of earners, household size, housing ownership, and urban and suburban dweller dummies. In the model of housing wealth proxy, the logarithm of rent is regressed on a set of covariates which consist of housing attributes including the story level, building types, indoor and outdoor floor space, plus the heads' characteristics and household background, same as that in permanent income model.

Both permanent income regressions and rent regressions are estimated by OLS with Huber/White estimator of variance. The results show that the adjusted R squared in permanent income regressions are around 0.6 and that in rent regressions, 0.5. The problem of weak instruments may not be a concern here (Staiger and Stock, 1994).[10] Averages of the predicted values of permanent income and housing rents are reported in Table 1 in which permanent income increases moderately over time while housing rents in year 2000 are a lot higher than those of past years.

Sheiner (1995) insists the inclusion of the households with positive and negative net worth in analysis, since the household with negative saving may contain as much information about asset accumulation as those with positive assets. To avoid the problem of undefined negative saving in logarithm, we follow Deaton and Paxson (1994) by defining household saving as the difference between the logarithm of income ($\ln Y$) and logarithm of consumption ($\ln C$). This definition is actually an approximation of saving rate, i.e., $(Y - C)/Y$, when saving is low.[11] Table 1 shows that log saving rate ($\ln Y - \ln C$) ranges

[9] Rent multiplier is around 100 in the US (Lin, 1993).

[10] Results of these regression models are available from the authors upon request.

[11] Assume Y, C, and S are income, saving and consumption, respectively. It is simple that $S = Y - C$ so that $C/Y = 1 - s$ where s is saving rate. Hence, $\ln(Y/C) = -\ln(1 - s)$. A Taylor expansion about $s = 0$ yields $\ln(1 - s) \cong -s$, so that $\ln(Y/C) \cong s$. In numerical simulation, if saving rate s is one digit, the deviation of $\ln(Y/C)$ from s is less than 5%. If saving rate is as high as 30%, the deviation is nearly 20%. Authors are grateful to Charles Leung for reminding this point.

between 0.32 and 0.20 that are moderately higher than corresponding saving rates $((Y-C)/Y)$.

The saving function is estimated with the following regression:

$$S_i = \alpha_0^\theta + \alpha_1^\theta \mathrm{Perm}Y_i + \alpha_2^\theta D_{\mathrm{renter},i} + \alpha_3^\theta \mathrm{HW}_i^* D_{\mathrm{renter},i} + \alpha_4^\theta \mathrm{HW}_i^* D_{\mathrm{owner},i} + \beta^\theta X_i + \varepsilon_i^\theta,$$
$$i = 1, 2, \ldots n,$$

where i indexes households, θ indexes quantiles, S_i is the log saving rate ($\ln Y - \ln C$) observed for household i, Perm Y is the estimated permanent income, D_{renter} and D_{owner} are the dummy variables for renters and homeowners, HW is the estimated housing rent, and X is a vector of household characteristics, including head age, age squared, household size, indicator for head employed in public sector, and urban and suburban dweller dummies, and ε is a random error term. Note that the coefficient α_1 measures the marginal propensity to save out of permanent income, α_2 measures the "intercept" propensity difference between renters and homeowners, α_3 represents the marginal discouragement effect on renters and, the wealth effect on homeowners.

4. Empirical results

As noted in the general statistics, saving is proportionate monotonically to income level and the distribution of saving rate is right skewed or left skewed rather than normal. It implies that the unconditional distribution of saving would behave quite differently at tails than at the mean or median. Accordingly, how does the conditional distribution of saving behave? Will the saving propensities vary in accordance with the structure of saving? More specifically, will the marginal propensity to save out of permanent income reveal certain pattern across the entire distribution? Will wealth effect and discouragement effect vary with respect to the level of saving rate of households? All these are empirical questions. Because an OLS regressions may shed no light on the conditional distribution of the dependent variable at various quantiles, this study employs quantile regressions to delineate the conditional distribution of saving in depth. For each wave of the SFIE, we estimate the saving function by conditional quantile regressions at every five percentiles, from the 5th to the 95th and with 19 regressions in total. We select three quartiles (the 25th, the 50th and the 75th quantiles) and the 10th and the 90th quantiles at the lower and upper tails as representatives. The estimated coefficients with test statistics of significance based on the bootstrapped standard errors are presented in Table 2. The results of mean (OLS) regressions are also reported for comparison.

4.1. Marginal propensity to save: OLS results

Table 2 contains three panels for the data waves of SFIE. Column 1 to Column 6 in each panel are the regression results of least squares and the five representative quantiles in order with R-squares and pseudo R-squares statistics below. It shows that almost all of the explanatory variables significantly explain the variation of saving and the signs of the covariates are mostly consistent with the prediction of theory. The OLS results show that marginal propensity to save out of permanent income was 0.349 in 1980. Along with economic development marginal propensity to save decreased moderately to be 0.324 in 1990 and 0.298 in 2000. It suggests that 10% increase of permanent income results in around

Table 2
Quantile regressions of saving function of SFIE 1980, 1990, and 2000

Dep. var: $S = \ln Y - \ln C$	OLS		0.10		0.25		0.50		0.75		0.90	
	Coeff.	t value	Coeff.	t value	Coeff.	t value	Coeff.	t value	Coeff.	t value	Coeff.	t value
Year 1980												
Permanent income	0.349	42.020***	0.177	11.020***	0.268	25.200***	0.380	29.430***	0.456	37.970***	0.509	26.970***
Head age	−0.012	−6.680***	−0.002	−1.300	−0.006	−3.510***	−0.013	−6.250***	−0.019	−7.630***	−0.022	−5.310***
Head age square/100	0.015	6.980***	0.002	1.040	0.006	3.330***	0.016	6.440***	0.023	8.120***	0.028	5.610***
Household size	−0.040	−31.450***	−0.017	−9.190***	−0.028	−19.910***	−0.041	−25.380***	−0.052	−28.280***	−0.062	−24.750***
Head public emp. (yes = 1)	0.013	1.590	0.013	1.900*	0.017	2.650***	0.016	1.530	0.009	0.810	−0.006	−0.410
Housing renters (yes = 1)	0.032	0.230	0.261	2.150**	0.270	2.590***	0.128	0.830	−0.128	−0.600	−0.302	−0.790
Log estimated payed rent	−0.066	−5.970***	−0.054	−5.680***	−0.066	−8.220***	−0.082	−7.330***	−0.069	−3.930***	−0.069	−2.420***
Log estimated imputed rent	−0.066	−10.140***	−0.034	−5.110***	−0.045	−8.960***	−0.073	−8.370***	−0.082	−9.270***	−0.096	−8.090***
Urban dwellers (yes = 1)	−0.086	−10.890***	−0.055	−6.650***	−0.073	−10.990***	−0.082	−8.550***	−0.104	−8.310***	−0.138	−7.230***
Suburban dwellers (yes = 1)	−0.033	−4.820***	−0.016	−2.630***	−0.023	−4.100***	−0.026	−3.320***	−0.040	−4.310***	−0.067	−4.710***
Intercept	−2.692	−25.660***	−1.255	−6.350***	−2.011	−13.890***	−2.847	−15.480***	−3.597	−14.800***	−3.967	−9.900***
Payment rent = imputed rent[1]	0.010	0.935	4.330	0.038**	6.170	0.013***	0.480	0.487	0.570	0.452	0.770	0.380
R^2 and Pseudo R^2	0.147		0.033		0.056		0.087		0.111		0.125	
Year 1990												
Permanent income	0.324	38.360***	0.177	11.530***	0.268	23.630***	0.380	29.350***	0.456	33.410***	0.509	28.170***
Head age	−0.013	−6.150***	−0.002	−1.300	−0.006	−3.550***	−0.013	−5.870***	−0.019	−7.150***	−0.022	−5.150***
Head age square/100	0.016	6.630***	0.002	1.050	0.006	3.410***	0.016	6.030***	0.023	7.540***	0.028	5.460***
Household size	−0.035	−20.050***	−0.017	−9.120***	−0.028	−18.630***	−0.041	−23.900***	−0.052	−28.270***	−0.062	−23.490***
Head public emp. (yes = 1)	0.020	2.170**	0.013	1.850*	0.017	2.580***	0.016	1.540	0.009	0.810	−0.006	−0.400
Housing renters (yes = 1)	0.014	0.070	0.261	2.580***	0.270	2.270**	0.128	0.860	−0.128	−0.630	−0.302	−0.840
Log estimated payed rent	−0.092	−6.340***	−0.054	−5.440***	−0.066	−7.380***	−0.082	−7.540***	−0.069	−4.490***	−0.069	−2.560***
Log estimated imputed rent	−0.094	−12.720***	−0.034	−5.610***	−0.045	−8.070***	−0.073	−8.920***	−0.082	−9.570***	−0.096	−7.930***
Urban dwellers (yes = 1)	−0.097	−9.520***	−0.055	−6.950***	−0.073	−10.580***	−0.082	−8.580***	−0.104	−9.560***	−0.138	−7.130***

Suburban dwellers (yes = 1)	−0.004	−0.510	−0.016	−3.070***	−0.023	−3.860***	−0.026	−3.400***	−0.040	−3.890***	−0.067	−5.100***
Intercept	−6.924	−71.850***	−1.516	−10.560***	−2.281	−17.320***	−2.974	−20.240***	−3.468	−23.100***	−3.665	−13.280***
payment rent = imputed rent[1]	0.030	0.861	1.810	0.179	2.030	0.154	0.010	0.926	0.030	0.857	2.620	0.105
R^2 and Pseudo R^2	0.111		0.028		0.046		0.072		0.091		0.124	
Year 2000												
Permanent income	0.298	36.940***	0.196	12.810***	0.210	18.850***	0.295	31.220***	0.353	27.460***	0.405	20.830***
Head age	−0.022	−10.420***	−0.016	−5.180***	−0.016	−6.380***	−0.021	−7.590***	−0.029	−8.900***	−0.039	−8.220***
Head age square/100	0.026	11.060***	0.017	5.030***	0.017	6.220***	0.026	7.860***	0.035	9.420***	0.049	9.050***
Household size	−0.041	−21.700***	−0.015	−4.790***	−0.022	−9.970***	−0.040	−18.280***	−0.058	−22.400***	−0.073	−19.110***
Head public emp. (yes = 1)	0.099	8.580***	0.102	5.880***	0.103	6.520***	0.086	5.360***	0.086	5.530***	0.094	3.690***
Housing renters (yes = 1)	−0.843	−2.480***	−0.812	−2.260**	−0.800	−3.080***	−0.751	−2.590***	−0.912	−2.100**	1.061	1.440
Log estimated payed rent	−0.075	−3.180***	−0.032	−1.180	−0.048	−2.690***	−0.078	−4.500***	−0.074	−2.550***	−0.093	−1.730*
Log estimated imputed rent	−0.139	−13.770***	−0.097	−5.800***	−0.109	−10.360***	−0.135	−10.570***	−0.142	−9.770***	−0.172	−10.250***
Urban dwellers (yes = 1)	−0.086	−7.880***	−0.062	−3.600***	−0.050	−5.010***	−0.076	−5.850***	−0.115	−7.090***	−0.132	−7.240***
Suburban dwellers (yes = 1)	−0.045	−4.720***	−0.042	−2.670***	−0.022	−2.400**	−0.026	−2.310**	−0.059	−4.040***	−0.080	−5.210***
Intercept	−1.286	−9.420***	−1.766	−4.390***	−1.665	−6.200***	−2.116	−8.010***	−2.565	−6.000***	−2.595	−3.240***
payment rent = imputed rent[1]	7.140	0.076*	6.440	0.011***	11.300	0.001***	7.700	0.006***	4.860	0.028**	2.270	0.132
R^2 and Pseudo R^2	0.136		0.040		0.048		0.073		0.096		0.116	

*Statistically significant at 0.10; **At 0.05 level; ***At 0.01 level.

[1] F statistics and p values in the grids of coefficient and t value for equality tests.

3.0–3.5% increase of saving for mean saver. To some extent, saving propensity of Taiwanese households is much more conservative in response to permanent income than that of developed countries in average (Engelhardt, 1994; Yoshikawa and Ohtake, 1989).

Both Engelhardt (1994) and Yoshikawa and Ohtake (1989) document noticeable discouragement effects in terms of decline of renter's saving for home purchase when housing price is rising. These two studies, however, restrict the observations to renters, as the former looks at the dichotomous decisions to join a favorable saving plan for down payments while the latter investigates difference of saving propensities of renters with and without purchasing plan. The behavioral differences of saving between owner and renter households are in fact ambiguous in the existing literature. This study incorporates both homeowner and renter samples in analysis thus enables us to extend the measurement of discouragement effect to include both "intercept" and "slope" in which "intercept" of discouragement effect is the dichotomous index to control the difference of saving propensity between renter and homeowner (as reference group) given others fixed, while the "slope" effect is the renter's marginal propensity to save (actually, dissave) with respect to housing rent changes.[12] The OLS result shows that given fixed housing rents of mean savers, intercept discouragement effect is not significant by 1990. It implies that in spite of the impact of housing wealth, renters and homeowners shared statistically the same saving propensities during the 80s.[13] After the rise of housing price in the early 90s, ceteris paribus, renter per se saved significantly less than homeowner. As housing ownership rate has reached 90% high by 2000, households without shield are rather selected and their attitudes toward saving may well reflect their special perspectives on housing ownership.

In addition to the difference of intercept propensity between owner and renter, marginal discouragement effect and wealth effect in the sense of saving propensities out of predicted housing rent exist as well. For mean savers in 1980, the marginal effects of paid and imputed rents were both significantly negative in which 10% of housing price increase results in around 0.6% decline of saving for both renter and owner households. It implies that the rise of housing price in primitive housing market brought about small but significant effect on household saving propensities. Based on this magnitude, housing price rose more than 170% will result in two-digit decline of saving. Marginal discouragement effect and wealth effect became larger in 1990 in which 10% of housing price increase results in around 0.9% decline uniformly of saving. In year 2000, the discouragement effect was -0.07, the wealth effect was -0.14, and the former is about half of the latter. The two effects are significantly different from each other on the margin based on F test ($F = 7.14$, p-value $= 0.076$). It is suggested that after housing market boom homeowners become less prudent for precautionary saving (Case et al., 2005) while renters become less aggressive for home buying saving (Engelhardt, 1994). Compared to Skinner (1989) who documents that 10% increase of housing price results in 3% decline in household saving, the wealth effect of mean saver in Taiwan is minor in early age and only about 1/2 of that in the US by year 2000.

[12] Because we include both owner and renter samples in a model, this set-up is by construction.

[13] We did try to interact permanent income with renter's dummy and the result shows that the indicator variable is not significant.

4.2. Heterogeneity of saving propensity: quantile regression results

Other than the saving propensity of the mean savers, we discuss the possible heterogeneity of saving propensity across the conditional distribution of saving based on quantile regression results. Fig. 7 presents a compact summary of the estimation of the marginal propensity to save out of permanent income and the intercept discouragement effect of renter's propensity; Fig. 8 shows the marginal discouragement effect and wealth effect of housing rent. Each plot describes one covariate's coefficient in the regression. The solid

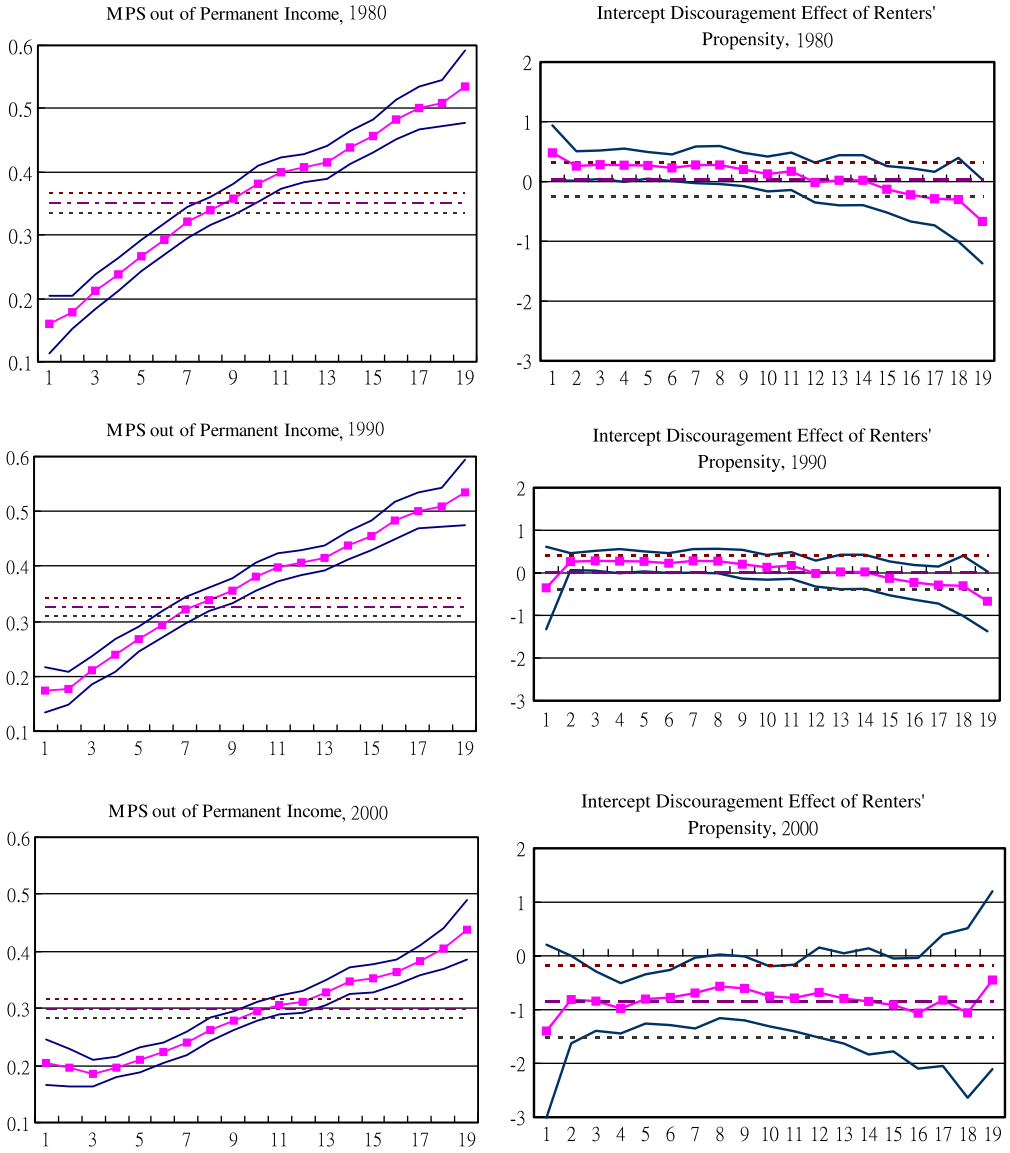

Fig. 7. Quantile regressions for saving propensity and intercept discouragement effect.

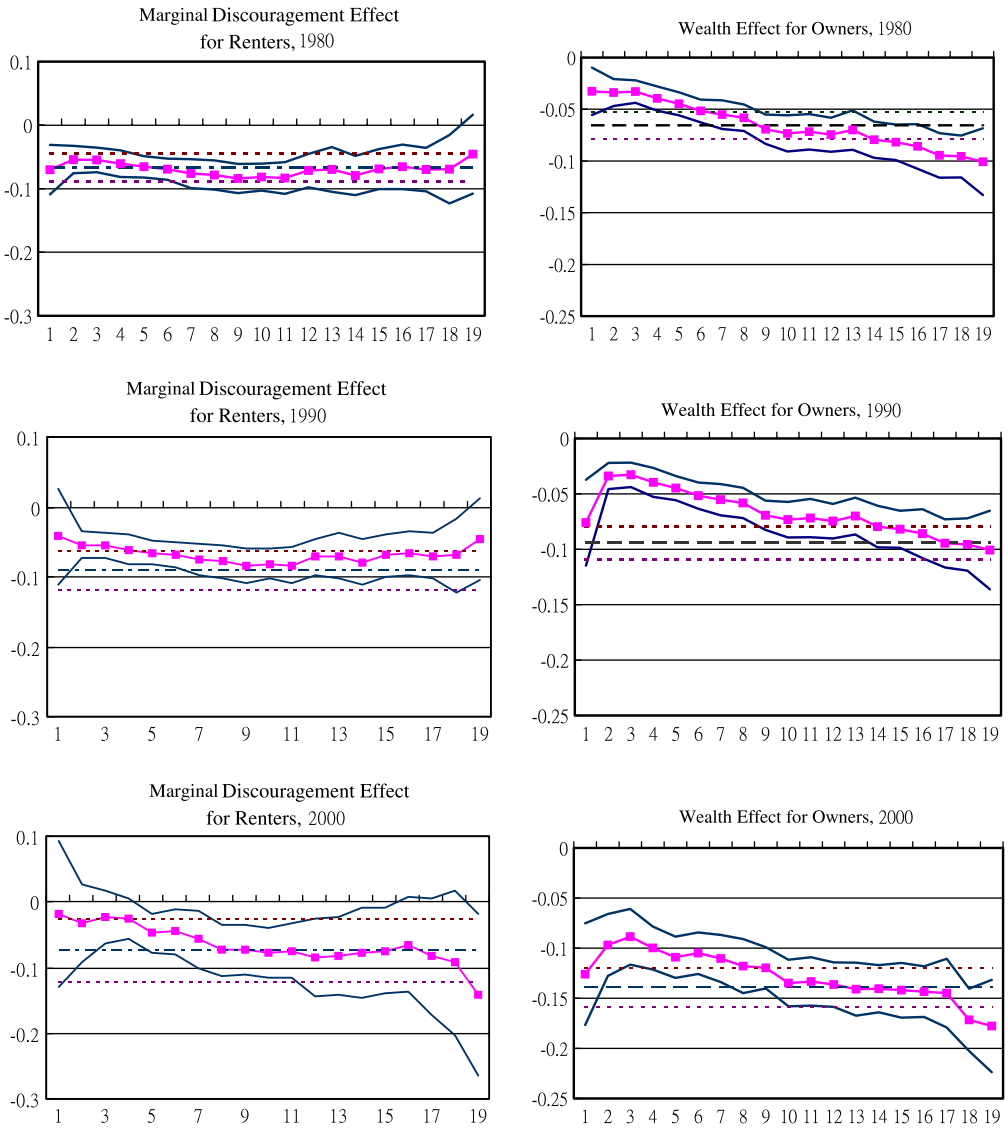

Fig. 8. Quantile regressions for marginal discouragement effect and wealth effect.

line with filled squares depicts the nineteen point estimates over the distribution of every five percentiles with the two solid lines side by side representing the upper and lower bounds of the 95% confidence intervals. The dashed horizontal line is the OLS estimate of the mean saver, and the area between the two dotted lines indicates its 95% confidence interval correspondingly. Statistical tests on the disparity of estimated coefficients between different quantiles are also conducted by inter-quantile regressions with the results reported in Table 3. There are three panels in Table 3, each panel containing four columns from left to right as the disparity between the two tails (0.9–0.1), the right tail and the

Table 3
Inter-quantile regressions of saving function, SFIE 1980, 1990, and 2000

Dep. var: $\ln S = \ln Y - \ln C$	0.9–0.1		0.9–0.5		0.5–0.1		0.75–0.25	
	Coeff.	*t* value	Coeff.	*t* value	Coeff.	*t* value	Coeff.	*t* value
Year 1980								
Permanent income	0.331	15.840***	0.128	6.620***	0.203	13.430***	0.188	13.340***
Head age	−0.020	−4.250***	−0.009	−2.230**	−0.011	−5.210***	−0.013	−5.180***
Head age square/100	0.026	4.660***	0.012	2.570***	0.014	5.610***	0.017	5.700***
Household size	−0.045	−16.640***	−0.020	−8.310***	−0.024	−13.210***	−0.024	−11.760***
Head public emp. (yes = 1)	−0.019	−1.230	−0.021	−1.470	0.003	0.230	−0.009	−0.790
Housing renters (yes = 1)	−0.563	−1.570	−0.430	−1.240	−0.133	−0.820	−0.398	−1.930*
Log estimated payed rent	−0.015	−0.580	0.012	0.470	−0.028	−2.230**	−0.004	−0.230
Log estimated imputed rent	−0.062	−4.680***	−0.022	−1.860*	−0.039	−4.760**	−0.037	−4.440***
Urban dwellers (yes = 1)	−0.082	−4.150***	−0.056	−2.930***	−0.027	−2.920***	−0.030	−2.870***
Suburban dwellers (yes = 1)	−0.051	−3.610***	−0.041	−3.100***	−0.009	−1.190	−0.017	−1.850*
Intercept	−2.149	−7.890***	−0.690	−2.720***	−1.458	−8.970***	−1.188	−7.150***
Pseudo R^2	0.125		0.125		0.087		0.111	
Year 1990								
Permanent income	0.229	11.990***	0.051	3.200***	0.178	13.430***	0.162	10.530***
Head age	−0.020	−4.800***	−0.003	−0.680	−0.018	−5.240***	−0.008	−2.920***
Head age square/100	0.025	5.270***	0.005	1.130	0.020	5.350***	0.011	3.610***
Household size	−0.045	−12.130***	−0.019	−5.670***	−0.026	−9.790***	−0.032	−12.090***
Head public emp. (yes = 1)	−0.028	−1.400	−0.014	−0.850	−0.013	−0.900	−0.022	−1.670*
Housing renters (yes = 1)	0.789	2.050**	0.542	1.520	0.247	1.030	0.157	0.600
Log estimated payed rent	−0.103	−3.680***	−0.056	−2.320**	−0.047	−3.020***	−0.054	−2.870***
Log estimated imputed rent	−0.040	−2.460***	−0.013	−0.860	−0.027	−2.640***	−0.041	−3.610***
Urban dwellers (yes = 1)	−0.087	−3.960***	−0.036	−1.780*	−0.051	−3.820***	−0.059	−3.880***
Suburban dwellers (yes = 1)	−0.022	−1.240	−0.014	−0.890	−0.008	−0.720	−0.011	−0.920
Intercept	0.397	1.820*	0.360	1.820*	0.037	0.300	0.193	1.280
Pseudo R^2	0.095		0.116		0.072		0.091	
Year 2000								
Permanent income	0.209	9.110***	0.110	6.430***	0.099	6.650***	0.143	10.990***
Head age	−0.023	−4.520***	−0.018	−4.460***	−0.005	−1.570	−0.013	−4.090***
Head age square/100	0.031	5.440***	0.023	5.030***	0.008	2.250**	0.018	4.880***
Household size	−0.058	−11.230***	−0.033	−8.950***	−0.024	−7.440***	−0.035	−14.200***
Head public emp. (yes = 1)	−0.009	−0.300	0.008	0.340	−0.017	−0.880	−0.016	−0.970
Housing renters (yes = 1)	−0.249	−0.300	−0.309	−0.420	0.061	0.140	−0.112	−0.260
Log estimated payed rent	−0.061	−1.040	−0.015	−0.290	−0.046	−1.610	−0.027	−0.890
Log estimated imputed rent	−0.075	−3.470***	−0.037	−2.310**	−0.038	−2.140**	−0.033	−2.200**
Urban dwellers (yes = 1)	−0.070	−2.870***	−0.055	−2.840***	−0.015	−0.860	−0.065	−4.190***
Suburban dwellers (yes = 1)	−0.038	−1.730*	−0.054	−3.000***	0.016	0.970	−0.037	−2.600***
Intercept	−0.580	−1.760*	−0.169	−0.600	−0.411	−1.740*	−0.788	−3.890***
Pseudo R^2	0.116		0.116		0.073		0.096	

Note: see Table 2.

median (0.9–0.5), the median and the left tail (0.5–0.1), and the two quartiles (0.75–0.25), respectively. Inter-quantile regression is modeled as higher quantile minus lower quantile, and positive sign implies an ascending pattern of coefficients between the two quantiles while negative sign for descending pattern.

Plots in Column 1 of Fig. 7 are the marginal propensity to save out of permanent income. The coefficients estimated by quantile regressions show evident heterogeneity across the distribution: the marginal propensity to save for upper quantile is as high as 50% while the lower quantile counterpart is less than 20%. Disparities of the confidence intervals between quantile regressions and OLS regressions are apparently visible that mean tendency explains little of the behaviors of the two edge quartiles and tail quantiles. Row 1 of each panel in Table 3 also confirms that heterogeneities in marginal propensity to save out of permanent income are highly significant between the specific quantiles.

It is worth noting that saving propensity of permanent income in year 2000 is lower than before with the lower tail propensity standing still while higher tail propensity shifting down thus the connecting line of marginal propensity to save becomes flatter across the distribution. And for the household with saving rate below left quartile, their saving propensity is steadily low at around 20%. It is suggested that the household became less conservative in recent year, high saving households in particular. Chou et al. (2003) use the SFIE data to emphasize that the national health insurance system started in 1995 is responsible for reduction on precautionary saving and the effect is expected to concentrate on low saving group. Our result of saving propensity of permanent income seems not fit with the prediction of Chou et al. (2003); rather, the fact that financial liberalization makes the wealthier households easier to access financial tools and thus lowers their saving propensity is consistent with our results.[14] Explanation of changes of saving propensities from macroeconomic impacts is beyond the scope of this study and is worth further investigation.

Column 2 of Fig. 7 is the plots of intercept discouragement effect of renter's saving propensity. The mean effects of 1980 and 1990 estimated by OLS are not statistically different from zero. The results of quantile regressions clearly show that renters below the first quartile of the distribution tend to have higher saving propensity than homeowners in 1980, given other things, with the existence of significant disparity between the upper and lower quartiles. In year 2000, renters had consistently lower saving propensity over the entire distribution than owners. The confidence bands of two types of regressions are largely overlapped with the implication that mean propensity explains the conditional distribution of saving propensities fairly well. Plots in Column 1 of Fig. 8 show that marginal discouragement effect out of housing rent for renters were highly significant across all levels of saver in past decades. The heterogeneities in marginal discouragement effects, however, seem not to exist because most of the quantile regressions estimated coefficients are within the confidence band of ordinary least squares. The bottom plot depicts that marginal discouragement effect for low saving renters was not significant in 2000. Due to the deteriorated income distribution with prevalent decline of saving propensities in 2000 for all households, renters in the left tail quantiles may be out of surplus resources to "dissave" in response to the rise of housing price.

Wealth effects of housing equity are negative for homeowners depicted in Column 2 of Fig. 8. The effects are negatively associated with the level of saving as homeowners in the upper quantiles tend to have larger propensity to *dissave* in response to housing wealth appreciation than the lower quantiles counterparts. As shown in Table 2, the magnitudes

[14] During the late 80s and early 90s, several important steps of financial liberalization were undertaken in Taiwan, including the interest rate liberalization in 1986, foreign exchange liberalization in 1988, and the allowance of private banking institutes in 1991.

of discouragement effect and wealth effect are significantly different from each other mostly for the low quantile savers (significant up to 0.02 level) but not for high savers. It is reasonably appealing that low savers of rental households are more restrained to dissave than homeowners in response to housing rent appreciation. Furthermore, magnitude of wealth effects in year 2000 is much larger (more negative) than that in 1980 and 1990. Results of inter-quantile regressions in Table 3 denote that wealth effects present systematic discrepancies in broad defined ranges of quantiles in all years. Segregation of the confidence intervals between two types of regressions indicates that average tendency of homeowner's saving behavior is far from adequate to describe the complete wealth effects across the distribution. The mean tendency of the household's saving propensity out of housing equity merely explains the behavior of middle or high savers in part but sheds no lights on the low savers at all.

Several important issues arise from the patterns of wealth effect of housing equity. First, we find that wealth effect is highly associated with saving distribution; the higher the saving, the larger the wealth effect is. As mentioned above, the existence of heterogeneities of household behavior in terms of wealth accumulation and consumption is derived from the theoretical works such of Chatterjee (1994), Chatterjee and Ravikumar (1999), Ortalo-Magne and Rady (2006), among others, and is supported by empirical works of Atkeson and Ogaki (1996), Han and Ogaki (1997), Ogaki and Atkeson (1997), and so on. Findings of heterogeneous household saving propensity of this study not only justify the predictions of theoretical works but also provide complementary evidence to the empirical literatures.

Second, housing price started soaring in late 80s but the pattern of wealth effect did not shift down until 2000 owing to the possibility that homeowners might not react to the appreciation of housing equity immediately. Case et al. (2005) stress that households are not likely to obtain perfect knowledge of their own housing wealth. Neither would it be easy to spend down the capital gain of house wealth windfall without delay. With the fairly conservative attitude reflecting in very high saving level of the Taiwanese household, it may take longer time for the household to realize and react to the windfall gain. And homeowners do not necessarily access their home equities for consumption; rather, they may just lower down their saving propensity towards precautionary motive.

Furthermore, as stressed by Attanasio and Weber (1994), Chou et al. (2003), Leung and Tse (2001), Miles (1997) and Tse and Leung (2002), macroeconomic impacts such as economic fluctuation and technological advancement, plus institutional changes like financial liberalization and national health insurance, may lead to variations of saving over time as well as across households and regions. Although the influences from aggregate aspects on household saving should not be ignored, these factors cannot be accounted for in the model setting of the current study which employs only three cross-sectional waves of SFIE in analysis. It is possible to take macro impacts into consideration by constructing a cross-sectional time-series data format with all available waves of SFIE to merge with aggregate indexes. Therefore, the experience of data processing in this study serves as a preparatory measure for the burdensome data management in the use of all waves of SFIE for future research.

Based on the findings of quantile regressions, the results of this study explicitly demonstrate that households of various saving levels may have significantly different propensities to save in response to permanent income level and housing equity appreciation at every aspect. The result of OLS regressions is not able to capture the complete picture of the varieties. In sum, it is suggested that marginal propensity to save out of permanent income

is positively associated with saving, and saving propensities of homeowners indeed behave statistically different from renters in general. Given fixed housing rent, low saving (below the median) renters' propensity to save was lower than that of home owners by 1990. In 2000, renter's saving propensity was consistently lower than that of owners except for the very high savers (the 90th quantile).

Consistent with Engelhardt (1994) and Yoshikawa and Ohtake (1989), relinquishment of renter's housing purchase plan after the surge of housing price may hold back their saving propensity. The marginal discouragement effect on renters ranges from −0.03 to −0.10, implying that 10% increase of the housing price result in 0.3–1% decrease of saving. Wealth effect on owners ranges from −0.03 to −0.17, suggesting that 10% of housing equity appreciation results in 0.3–1.7% decline of saving. Due to the housing equity windfall, depression of homeowner's saving is positively associated with saving distribution: higher savers reduced more. Obviously, wealthier households (higher saver) are easier to cash-in as well as to spend down their housing capital gain through the reduction on saving. As the overall wealth effect inflated after housing market boom, housing equity windfall is suggested to play an important role in the reduction of Taiwanese household saving after the 90s.

5. Conclusion

This study attempts to investigate the marginal effects of the household characteristics on saving, income and housing rents in particular. Based on the results of quantile regressions, it is unsurprising to see that saving propensity is not homogenous across the whole range of saving distribution with respect to the set of covariates. It is surprising, however, that exiting literature has paid limited attention to the issue of heterogeneities of saving propensity. Findings of this study suggest that the higher saving household, the larger is the marginal propensity to save out of income. Besides, magnitudes of marginal discouragement effect and wealth effect depend on the conditional distribution of saving as well. In consideration of the possible divergence of saving propensities, conceptualized representative agent model with mean saver's behavior is not appealing in empirical analysis, and quantile regression in effect serves a direct and convenient tool to depict a complete picture of the varieties of the household's saving behavior.

There are insightful policy implications that hinge on the heterogeneity of saving propensity. As a matter of fact, various saving propensities across the distribution cast doubt on the existence of Ricardian equivalence. On one hand, if homeowners are encouraged to consume (spend down) their housing windfalls and renter's housing purchased motive are discouraged by housing price appreciation with both effects depending on the distribution of saving, fluctuation of housing market will result in welfare redistribution inter- and intra-generationally, and eventually affect capital formation and economic development in the long-run. On the other hand, since the rich households save more and tend to bequeath more than the poor, tax exemption of retirement saving and tax-favored housing equity system are actually regressive (Dynan et al., 2004). This tax system will inevitably enlarge welfare distribution within and between generations.

Confronting the increase of housing price, the wealthy homeowners benefit from reducing saving on consumption while the disadvantaged renter households suffer from discouragement on saving for delaying or even giving up housing purchase, resulting in unfavorable consequences on child education and human capital accumulation (Chou

et al., 2003). Collective effect of the decrease in savings due to housing price appreciation may be harmful to capital formation in aggregate sense that leads to economic growth slowdown, balance of payment deficit and potential welfare reduction in the long-run (Muellbauer and Murphy, 1990; Pagano, 1990).

To have a complete understanding of the welfare effect of capital windfalls on saving, more researches are needed to assess the heterogeneous propensities of household saving with the consideration of macroeconomics impacts to provide accurate guidance for policy suggestions. Due to the substantial technological development and financial liberalization over the past decades in Taiwan, it will be insightful to incorporate all available waves of SFIE with macroeconomic variables to conduct a structural approach in light with the theoretical predictions of the literature in the future works.

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