Non-Participant or Gambler: Investment Decisions of Low-Wealth Households

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Abstract

Empirical analyses show that low-wealth households tend to be *non-participants* concerning risky assets and tend to hold a large portfolio share of risky asset if they participate at all (*gamblers*). So far, few theoretical models have been able to satisfactorily provide a joint understanding of these two observations. This paper solves a novel life-cycle model in which social links to relatives, friends, and public welfare programs play the key role in explaining both types of behaviors. Social and family transfers induce low-wealth households to over-consume and depress the savings motive since social transfers are available only if personal savings are exhausted. The depressed investment demand further increases the fixed participation cost and thus, increases non-participation. On the other hand, if low-wealth households decide to hold any risky asset, they tend to hold rather large and risky investments because the down side risk is insured by help from relatives and public welfare.

[1] This paper was circulated earlier under the title "Can Social Welfare Explain the Non-participation Puzzle in Asset Markets?". I am grateful for helpful discussions with Johannes Binswanger, Günter Franke, Jens Jackwerth, Harris Schlesinger and the participants at the Netspar Pension Workshop in Amsterdam, the 2006 ARIA Annual Conference in Washington, DC, seminars at the *CEPS/INSTEAD*, the University of Konstanz and the University of St. Gallen.

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1. Introduction

> Welfare benefits are means tested, i.e., they are paid only to those with incomes (and assets) below some level. (…) Over the past four decades, the spending on means tested programs (except Medicaid) has remained relatively constant (rising from 1.0 percent of GDP to 1.3 percent of GDP) …. (Martin Feldstein, the Presidential address of AEA, 2005)

The above quote highlights the importance of understanding the investment decisions of low-wealth/income households to the investment of billions of dollars in welfare programs. However, the literature is puzzled by the seemingly contradictory investment decisions observed among low-wealth households. First, they are more likely to be *non-participants* in risky asset markets than wealthy households. In various data sets, wealth is shown to have a strong positive effect on public equity participation and private business ownership (Haliassos and Bertaut 1995, Campbell 2006, and Calvet et al. 2006). Second, low-wealth households tend to hold rather large and risky investments if they participate at all (*gamblers*), although the portfolio share of risky assets is generally thought to be monotonically increasing in wealth. Campbell (2006) reports that wealth influences the portfolio share of risky assets in a quadratic pattern. In the lower part of the wealth distribution, shares of risky assets decrease with wealth. Similar results can also be found in Vissing-Jorgensen (2002) and Guiso et al. (2002).

As of yet, only a few explanations for the non-participation puzzle have been proposed based on traditional rational models. Vissing-Jorgensen (2002) suggests that half of the non-participation can be optimal in the presence of modest transaction costs. Linnainmaa (2005) shows that the combination of learning about investment opportunities and short-sale constraints can generate the observed non-participation. Liu and Zhou (2006) explain the non-participation by the existence of a large wealth shock and the lack of insurance. Despite an outpouring of research in household portfolios recently, the gambling behavior for low-wealth households has received almost no attention. More importantly, we lack a successful theory that provides a joint explanation of why low-wealth households either cannot tolerate any risk at all or take extremely high risk.

I show that the two investment decisions of low-wealth households can be jointly understood with a simple modification of the standard life-cycle model. The central ingredients are social links to relatives, friends, and public welfare programs, which are added to the standard model in the form of an implicit put option. As households' net worth decreases, the put option becomes more likely to be in the money. The household has two alternative ways of benefiting from the put: either by increasing current consumption so that there would not be enough financial wealth to justify the entry cost of the risky assets; or by increasing the share of risky investments because the downside risk is insured by the put.

I solve numerically for the optimal portfolio and savings decisions for a finitely-lived investor facing mortality risk, short-sale constraints, and receiving labor income with disastrous labor income risk.[2] Cocco et al. (2005) study a similar life cycle model of consumption and portfolio choice with uninsurable labor income risk. Modeling disastrous income risk can be dated back to precautionary saving theory (Carroll 1992, 1997).

Despite these similar features, this paper differs from the previous studies in several important dimensions. First, family and social transfers are modeled as a put option dependent upon wealth and income. The idea comes from the social insurance literature in which Social Security can be regarded as a put option because it is implicitly designed to guarantee a minimal consumption level for participants (Constantinides et al. 2005). I broaden this concept to include monetary help from relatives and friends and explicitly model it in an asset allocation decision. The guarantee of a minimal wealth level differs from the unemployment insurance considered in Michaelides (2003). The unemployment insurance only depends on the event of unemployment, while the transfer option considered in this paper also depends on wealth. Transfers are provided only in the case that the household has experienced the income shock and has limited wealth.

Second, households are allowed to borrow for leveraging the portfolio, but they cannot borrow for consumption. This extension from the standard life-cycle model essentially allows the portfolio share of risky assets to be larger than one, while restricting the net worth to be positive. I do this for two reasons. First, in practice, households do borrow while holding risky assets.[3] Allowing for leverage will show how dramatically the implicit put option of family help and social transfers increase the riskiness of the household portfolio. Second, the portfolio implications of fully relaxing the borrowing constraint are not the focuses of this paper since they have been examined in Cocco et al. (2005). Therefore, allowing for portfolio leverage and keeping the net worth positive seems to be an effective way of investigating the impact of the social welfare while keeping the present model in line with the standard models

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[2] In this paper, the disastrous labor income risk is modeled as receiving zero income with some probability.

[3] According to the 2005 Panel Study of Income Dynamics, about 54% of total households have outstanding mortgages, credit card charges, student loans, medical or legal bills, or loans from relatives. About 49% of total households have both debt and risky assets.

in the literature (See, for instance, Merton 1969, Carroll 1992, 1997, and Cocco et al. 2005).

Finally, I perform an empirical analysis that identifies the effects of family and social transfers on participation and portfolio shares. The analysis is carried out in two steps. In the first step, I estimate a probit model for the dummy of receiving monetary help from relatives and friends or social welfare programs. Based on the estimated model, I further compute the predicted score for each household, which represents the propensity to receive transfers. In the second step, the predicted score is used as a regressor in the probit regression for participation and the OLS regression for portfolio shares in three asset categories, namely stocks, non-home real estate and private business, and primary residence and vehicles. The staged estimation is used to identify transfer effects since transfer effects do not depend on whether the household receives transfers but instead on the likelihood of receiving transfers.

The data strongly supports the prediction that family and social transfers explain both the "*non-participant*" and "*gambler*" choices for low-wealth households. An increase in the predicted score from the 20th percentile to the 80th percentile decreases the probability of being a stockholder from 15.9 to 11.8 percent, increases the portfolio share of stocks from 15.9 to 20.5 percent, and increases the portfolio share in non-home real estate and private business from 29.3 to 35.3 percent for the participants. After the transfer effects are captured, the coefficient of wealth turns positive, implying an increasing wealth effect on portfolio share in risky assets, consistent with common intuition. Most regressors in the regression of the portfolio share of primary residence and vehicles have different signs from the other two asset classes. This is related to the dual purposes (consumption and investment) of owning a primary house and vehicles.[4] Households purchase a primary house and vehicles not only as an investment vehicle but also for deriving utility from consuming them.

The paper is organized as follows. Section 2 describes the economic model. Section 3 discusses households' optimal consumption and portfolio choices. Section 4 presents empirical evidence. Section 5 concludes.

2. The economic model

A. Preferences

The benchmark discrete-time model follows Merton (1969) in a multi-period optimization set up. The household has a time-separable power utility:

[4] In fact, the consumption motive involved in purchasing a house and vehicles has been carefully considered in Cocco (2005), Yao and Zhang (2005), and Van Hemert (2007).

$$U_1 = E_1 \sum_{t=1}^{T} \delta^{t-1} (\prod_{j=0}^{t-2} p_j) \left(p_{t-1} \frac{C_t^{1-\gamma}}{1-\gamma} \right). \quad (1)$$

The household lives for T periods. C_t > 0 is the level of date *t* consumption. γ > 0 is the coefficient of relative risk aversion. δ < 1 is the time preference parameter. p_t denotes the probability that the household is alive at $t+1$, conditional on being alive at date t.

The preferences in (1) are the same as the ones used in Cocco et al. (2005) except that the present model abstracts from modeling the bequest motive. Households with a desire to bequeath wealth would be expected to save more. This could affect the optimal portfolio choice more on the dimension of age than on the dimension of wealth since young and old households face quite different mortality risk. Due to the fact that this paper focuses on the wealth effect rather than the life-cycle effect for the portfolio choice, the absence of the bequest motive will have limited effects on the results. Also, Cocco et al. (2005) conclude that, overall, the effects of the bequest motive are not very large with a moderate intensity of the bequest motive.

Power utility in (1) implies that the consumer's willingness to substitute consumption over time is the reciprocal of the coefficient of relative risk aversion. Yet it is unclear that these two concepts should be linked so tightly. Epstein and Zin (1989) propose a recursive formulation of intertemporal utility which disentangles risk aversion and intertemporal substitution. Cocco et al. (2005) show that increasing the elasticity of intertemporal substitution from 0.1 (corresponding to the risk aversion parameter of 10) to 0.2 or 0.5 makes the investor more willing to substitute intertemporally. Consequently, the investor saves less and increases the share of risky assets. Rather than focus on the intertemporal life-cylce portfolio choice, this paper aims to explain the relationship between wealth and portfolio choice. Therefore, the benchmark model adopts the classical power utility.

Alternative preferences also include habit formation: utility depends on the consumption of a reference group or the individual's own past consumption (see for example Constantinides 1990). Polkovnichenko (2007) and Gomes and Michaelides (2003) introduce habit formation preferences in a life-cycle model of consumption and portfolio choice. In contrast to the risky portfolio and non-saving behavior observed for the low-wealth households, they conclude that habit formation preferences lead to more savings and more conservative portfolios.

B. Investments

The household can invest in a riskfree asset and a risky asset. The riskfree asset has a constant gross real return of R_f and the corresponding log return is r. The risky asset has a gross real return R_t. It follows a geometric Brownian motion and the log return has constant mean μ and volatility σ. For a given proportion allocated to risky assets α_t, the log returns of the portfolio are normally distributed over each discrete time step of length Δt (the time between $t-1$ and t) with mean $\mu_{\alpha,\Delta t} = \left[\alpha\mu + (1-\alpha)r - \frac{1}{2}\alpha^2\sigma^2\right]\Delta t$ and volatility $\sigma_{\alpha,\Delta t} = \alpha\sigma\sqrt{\Delta t}$.

The household is allowed to borrow for leveraging the portfolio, but they cannot borrow for consumption. In addition, the household faces the short-sale constraint. Therefore,

$$\alpha_t \geq 0. \tag{2}$$

The short constraint (2) ensures that the household's allocation to the risky asset is non-negative at all dates. The household, however, can borrow through mortgage loans or credit cards. According to the 2005 Panel Study of Income Dynamics, the mean of mortgage loans across all households is \$53,171 and the mean across credit card loans and student loans is only \$8,513. Since the amount of mortgage loans is much higher than that of credit card loans, mortgage loans are considered the primary way to borrow. For mortgage loans, houses are usually required as collateral. As a result, home equity (difference between the house value and mortgage) is generally positive unless the house value has dropped dramatically. Therefore, it is reasonable to restrict the net worth to be positive. In this case, the borrowing constraint is partially relaxed so that the gambling behavior induced by social welfare can be shown while the main features of the model are kept in line with the literature. The portfolio implications of fully relaxing the borrowing constraint can be found in Cocco et al. (2005).

C. The labor income process

If markets are complete so that labor income can be capitalized and its risk insured, labor income can be regarded deterministic as in Merton (1971). Carroll (1992, 1997) and Cocco et al. (2005) argue that labor income risk is uninsurable due to the market incompleteness. Consequently, the labor income process is described by a random walk model in which households face a temporary shock and a permanent shock. In addition to these shocks, Carroll (1997) also considers a disastrous labor income shock. In particular, labor income is modeled as being zero with some probability.

Modeling risky labor income by a random walk process with temporary and permanent shocks can increase the credibility of the model. The cost, however, is to add another state variable to the optimization. This has barely been a problem for the literature since the indirect utility is homogeneous with respect to current labor income so that current labor income can be normalized to one. Thus, labor income can be eliminated from the state space. In the present model, however, the indirect utility is not homogeneous with respect to current labor income because the insured level of wealth by social welfare is exogenously determined and not dependent on the individual's current labor income. This implies that modeling risky labor income by some normally distributed shocks will add one dimension to the state space of the present model.

Considering the tradeoff between tractability and realistically modeling, this paper adopts a reduced form of modeling risky labor income. Each period, the household faces the possibility of a disastrous labor income shock. In particular, the stochastic process underlying labor income is characterized only by two states: the employed state which receives a deterministic income and the disastrous state which receives zero income. Such modeling of risky labor income assumes that the main source of labor income risk stems from the disastrous income shock. This assumption is supported by the results in Cocco et al. (2005) showing that labor income with normally distributed shocks behaves very similar to deterministic income while a small probability (0.5%) of a zero labor income draw dramatically lowers the optimal equity share. Therefore, the simplified modeling for risky labor income is believed to have minor effects on the main results of this paper.

The transition probabilities between the two states are modeled to be different and conditional on the income state in the previous period.[5] The employed household receives the disastrous shock with probability λ_e, while the distressed household with probability λ_d. Formally, the labor income process is given by:

$$Y_t = \begin{cases} \overline{Y}_t & \text{with prob. } \begin{matrix} 1-\lambda_e \text{ if } Y_{t-1} = \overline{Y}_{t-1} \\ 1-\lambda_d \text{ if } Y_{t-1} = 0 \end{matrix} \\ 0 & \text{with prob. } \begin{matrix} \lambda_e \text{ if } Y_{t-1} = \overline{Y}_{t-1} \\ \lambda_d \text{ if } Y_{t-1} = 0 \end{matrix} \end{cases}, \tag{3}$$

where $\overline{Y}_t$ is the pre-determined labor income received at t.

[5] An example of equal transition probabilities can be seen in Carroll (1997).

D. Family and social transfers

Monetary aid from relatives, friends, and social welfare programs is modeled as a put option, insuring that the household has a minimum wealth *MinW*. Constantinides et al. (2005) admit that social insurance implicitly guarantees a minimum consumption level for its participants and price this put option explicitly. Rather than pricing, this paper aims to investigate the portfolio implications in the presence of such put option. In particular, this paper associates the exercise of the put to the labor income states as well as wealth, given the fact that social welfare programs are usually tailored for low-income or unemployed households. Households qualified for family and social transfers need to be in the disastrous state ($Y_t = 0$) and to have limited resources ($W_t < MinW$).[6] Formally, the wealth held in period t after being adjusted by the put is:

$$W_t' = W_t + \max(0, MinW - W_t) I(Y_t = 0) \tag{4}$$

where I is the indicator function and *max* is a function which takes the larger value between 0 and *MinW* minus W_t.

One may object that the eligibility of social welfare does not necessarily require the qualified household to be fully unemployed with zero income. It will be shown later that a less extreme income shock received in the disastrous state does not affect the main results. This is not surprising. Labor income is part of total wealth. Family and social transfers insure the household to have a minimum total wealth. Therefore, the amount of disastrous income shock will only affect the amount of the transfer. But the wealth level after being adjusted by the put is always equal to the minimum wealth level regardless of how severe the shock is.

It should be noted that the present modeling of social insurance combines two strands of literature. One strand of literature considers social insurance as a "benefits guarantee" or put purely conditional on wealth (see Feldstein et al. 2001, Smetters 2001, and Pennacchi 1999). The other strand focuses on unemployment insurance which essentially provides a positive lower bound for labor income (see Michaelides 2003). The portfolio implications in the case of unemployment insurance have been investigated by Cocco et al. (2005). However, the portfolio implications when social insurance is considered as a put are still not well studied. Thus, this paper contributes to the literature by exploring the portfolio implications in the presence of social insurance.

E. The optimization problem

[6] See Feldstein (2005) for a detailed discussion of welfare programs.

In period t, the household starts the period with wealth W_t. If the household is employed, then labor income Y_t is realized. If the household receives a disastrous income shock, then the wealth is adjusted by the family and social transfers depending on the value of W_t. Following Cocco et al. (2005), I denote cash-on-hand in period t by

$$X_t = W_t' + Y_t \,, \tag{5}$$

conditional on the employment status. This is understood as the wealth that includes labor income and possible family and social transfers received in period t. In the numerical solutions, $\log(X_t)$ is discretized to take values on a grid. Then the household makes decisions for consumption and asset allocation in a portfolio composed of a risky asset and a riskless asset. The intertemporal budget constraint is then given by:

$$W_{t+1} = R_{t+1}^p (W_t' + Y_t - C_t) \,, \tag{6}$$

where R_{t+1}^p is the portfolio return held from period t to period $t+1$:

$$R_{t+1}^p = \alpha_t R_{t+1} + (1-\alpha_t) R_f \,. \tag{7}$$

R_{t+1} is the gross real return of the risky asset and R_f is the gross real return of the riskless asset. The problem the household faces is that of maximizing (1) subject to constraints (2) through (7): the labor income process， the investment process，and the implicit put option. The control variables of the problem are $\{C_t, \alpha_t\}_{t=1}^T$. The state variables are $\{t, X_t, Y_t\}_{t=1}^T$. The previous literature often normalizes the variables with respect to current permanent labor income in order to reduce the dimensionality of the state space, e.g., consumption choice is expressed as the ratio of consumption to current permanent labor income.[7] This normalization does not work in the presence of a fixed strike price of an option that is independent of individuals' labor income, i.e., the minimum wealth provided by family help and public welfare aims to provide basic living necessities but not to compensate the loss of labor income. As is explained in Section 2.C, the state variable labor income (Y_t) is characterized by two states rather than by some more complicated distribution.

The Bellman equation for this problem is given by:

$$J_t(X_t, Y_t) = \underset{C_t > 0, \alpha_t \geq 0}{Max} \left[\frac{C_t^{1-\gamma}}{1-\gamma} + \delta p_t E_t[J_{t+1}(X_{t+1}, Y_{t+1})]\right], \text{ for } t \leq T$$

$$\text{where } W_{t+1} = (X_t - C_t)(\alpha_t R_{t+1} + (1-\alpha_t)\bar{R}_f) \,,$$

[7] See details of such normalization in Cocco et al. (2005).

$$X_{t+1} = W_{t+1} + \max(0, MinW - W_{t+1}) I(Y_{t+1} = 0).$$

The problem cannot be solved analytically due to the discontinuous option payoff. The policy functions are derived numerically by using backward induction. In the last period the investor consumes all available wealth so that the value function corresponds to the indirect utility function. This value function can be iteratively substituted in the Bellman equation, yielding solutions for the previous periods. In order to coincide with the Geometric Brownian Motion of the risky returns, log cash-on-hand values are discretized in a grid structure. The grid has equal time increments as well as equal steps in $\log(X_t)$. From each grid point, I allow for a multinomial forward move to a relatively large number of subsequent grid points (e.g., 41) at the next time step. The associated probabilities are calculated by using the discrete normal distribution with a specified value for the control variables, i.e., the stock proportion α. In order to have the indirect utility by the end of the next period lie on the grid points even with a choice of riskless portfolio (α = 0), the grid structure is assumed to grow at the riskfree rate. Thus, the choices of α vary from 0 to 2 in steps of 0.01. Appendix A shows that the approximated probabilities do not depend on the level of $\log(X)$ or time and they are solely functions of α. Such property saves time when running the numerical algorithm because the probabilities need to be computed only once for all grid points.

In most cases, $\log(X_{t+1})$ including labor income and possible social welfare will not land on grid points at the next time step since labor income and social welfare are not proportional to $\Delta(\log X)$. In order to obtain the corresponding indirect utilities for the $\log(X_{t+1})$ not landing on grid points, spline estimation is used. Given the relatively large number of grid points, the estimation error is limited.[8] Such interpolation has also been used in other recent papers in the literature (e.g., Cocco et al. 2005).[9]

F. Parameterization

[8] For more details about this methodology see Appendix A and Hodder and Jackwerth (2007).

[9] Alternatively, one can avoid interpolation by fixing the $\log(X_{t+1})$ values equal to the grid points at the next step. Since these values have been adjusted by labor income and social welfare, we need to deduct them to obtain the financial wealth at the next time step. Dividing this financial wealth by the current log cash-on-hand value $\log(X_t)$, we obtain the corresponding return. We further compute the associated probability for this return. Such algorithm increases the time of computing because the associated probability for each grid point is different and needs to be computed case by case. A more severe problem with this algorithm is the quality of discretization of the normal distribution. Since the forward nodes are not evenly spaced and are mostly located in the left side of the normal distribution due to the deduction of labor income, the forward nodes cannot well approximate the normal distribution. Therefore, spline estimation is adopted in this paper.

Estimation of the labor income process

The PSID family data from 1970 to 1992 is used to estimate the deterministic labor income as a function of age and other characteristics. One important distinction from previous empirical work is the definition of labor income. I decompose all reported income into two categories: labor income and wealth-dependent transfers. First, labor income includes wage, bonus and commission, and unemployment compensation. Second, wealth-dependent transfers include supplemental social income, help from relatives and friends, and other welfare transfers. Since this paper explicitly models transfers as a put option, transfer income should be separated from labor income. Another advantage is that we can explain what happens to the 0.5% households who do not report any income. From the perspective of this paper, these people are unemployed and do not qualify for welfare and help since they have enough personal savings.[10] All nominal values are converted into real terms by using the Consumer Price Index with 1992 as the base year.

To control for education the sample is split into three groups: the observations without high school and college education, a second group with high school education but without a college degree, and lastly college graduates. The following cross-sectional time series regression is estimated:

$$\log(Y_{it}) = f(t, Z_{it}) + \varepsilon_{it}. \tag{7}$$

For each education group I assume that the deterministic function $\overline{Y}_t = f(t, Z_{it})$ is additively separable in t and Z_{it}. The variable t denotes age. The vector Z_{it} includes other personal characteristics such as marital status and family size. I fit a third-order polynomial to the age dummies to obtain the profiles. Table 1 and Figure 1 report the results for the three education groups. The coefficients of the age dummies are clearly significant and the labor income is shown to have a hump shape in age, in line with intuition and stylized facts (See Cocco et al. 2005 and Gourinchas and Parker 2002). Retirement income is modeled as a constant fraction of the labor income in the last working-year. This fraction, termed as the replacement rate, is calibrated as the ratio of the average of labor income for retirees in a given education group to the average of labor income in the last working-year prior to retirement. The results are shown in the bottom row of Table 1. The R-squared coefficients tend to be low for non-educated and high school graduates and on average are 8% lower than the model estimated in Cocco et al. (2005).

[10] Cocco et al. (2005) attribute this phenomenon to measurement error.

Table 1: Labor income process

The table shows the results of a cross-sectional estimation with fixed effects. The estimation is based on the PSID family data from 1970 to 1992. The log real income is regressed on family size, marital status (dummy), and age dummies. The sample excludes households with female heads, retirees, non-respondents, students, and housewives. T-statistics are in parentheses. ***Significant at 1%; **significant at 5%; *significant at 10%.

Independent Variable Log Real Income	Non-educated Coefficient	High school coefficient	College Coefficient
Family size	0.0148**	0.0081*	0.0316***
	(2.09)	(1.83)	(4.77)
Marital status	0.0409	0.0670***	0.0770***
	(1.32)	(4.25)	(3.41)
Age	0.1223***	0.1993***	0.3561***
	(4.62)	(14.19)	(14.12)
$Age^2/10$	-0.0253***	-0.0409***	-0.0687***
	(-3.94)	(-11.55)	(-11.29)
$Age^3/100$	0.0015***	0.0026***	0.0043***
	(2.93)	(9.12)	(9.12)
Constant	8.1697***	7.1358***	4.5987***
	(23.95)	(41.04)	(13.97)
No. of observations	9445	26388	11875
No. of groups	1138	2898	1199
Average obs per group	8.3	9.1	9.9
R-square within	0.0315	0.0401	0.1425
F-stat	53.92	195.98	354.63
Replacement rate	0.8513	0.6612	0.9350

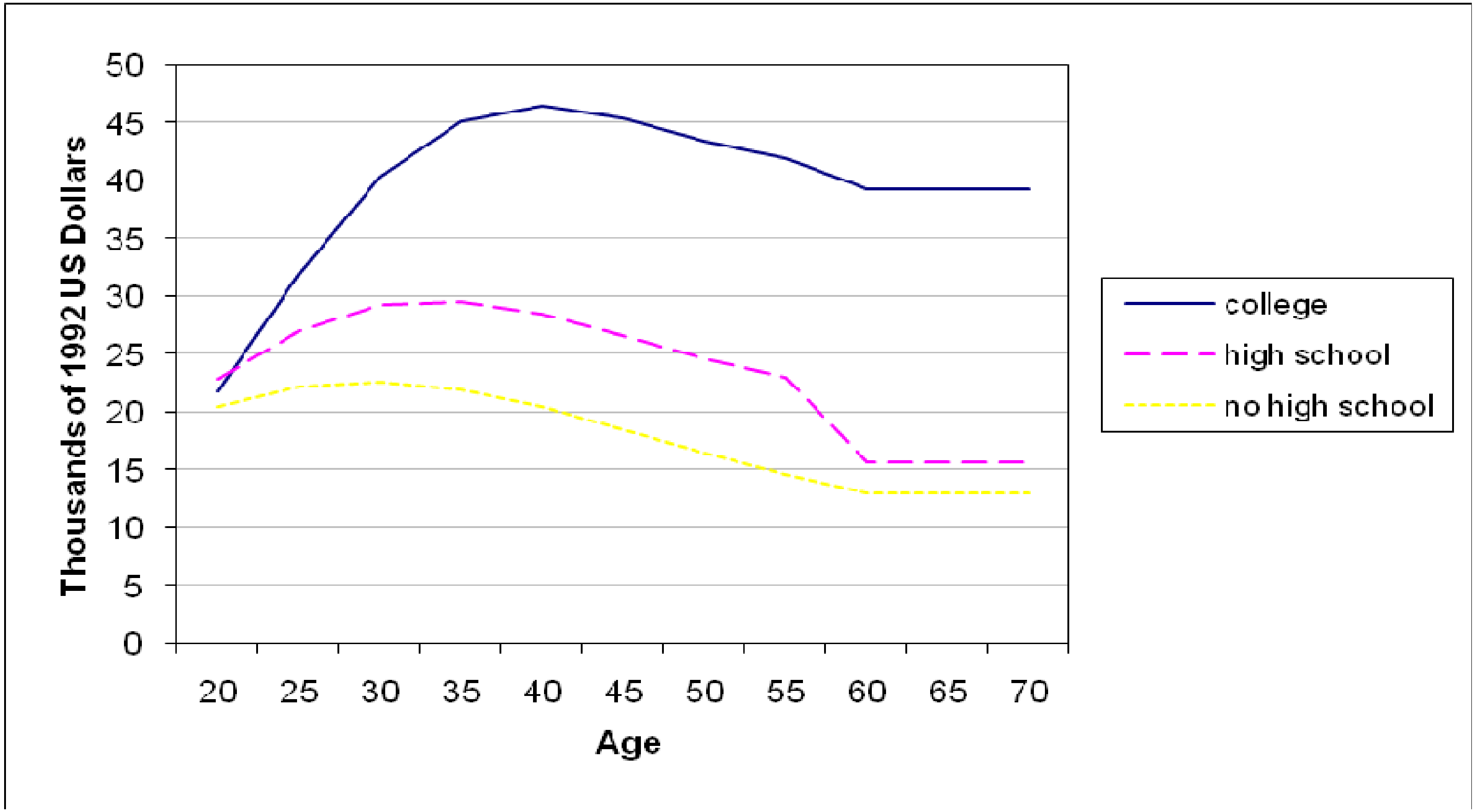
The transition probabilities λ_e and λ_d relate to the income requirement for applying for public welfare. In the United States, the Department of Health and Human Services issues the poverty guidelines each year in the *Federal Register* for administrative purposes – determining, for instance, financial eligibility for certain federal welfare programs[11]. I use three levels, i.e., 100%, 125%, and 150%, as the income threshold for determining whether the household is in the disastrous state and hence eligible for welfare and help. Using the most recent PSID family data in the years 1999, 2001, 2003, and 2005, I compute the proportion of households that have changed their income states within a certain period for using as a proxy of transition probability. Since questions related to income and wealth in the PSID data are retrospective[12] (for instance, those asked in 1999 refer to the 1998 calendar year), I apply the poverty guideline in the previous year to the current sample year. Table 2

[11] For example, the Food Stamp Program sets the income eligibility level at the 125% poverty guidelines in 2007.

[12] Surveys are mostly conducted in Spring of each year, and therefore income and wealth data are for the previous year.

Figure 1: Fitted labor income process

This figure shows the labor income profiles of three education groups across age. The profiles are generated based on the regression results in Table 1. The household is assumed to be married and to have two children.



reports historical frequencies of receiving the income shock from 1999 to 2005 conditional on the income state in the previous period, i.e., whether the family income is above or below the income thresholds.

Table 2: Historical frequencies of transition between income states

The table reports historical conditional frequencies of receiving an income shock within a certain period. The left column denotes the starting year of the period and the upper row denotes the end year of the period. The income shock is defined as having income less than a particular threshold. The thresholds are set to be 100%, 125%, and 150% of the poverty guideline issued by the Department of Health and Human Services. There are two frequencies for each period. The left is conditional on receiving normal income in the previous period and the right is conditional on receiving an income shock in the previous period.

(a) The threshold is 100% of the poverty guideline.

	2001		2003		2005	
1999	0.237	0.241	0.278	0.257	0.274	0.275
2001	-	-	0.263	0.263	0.278	0.257
2003	-	-	-	-	0.277	0.274

(b) The threshold is 125% of the poverty guideline.

	2001		2003		2005	
1999	0.281	0.279	0.316	0.294	0.314	0.317
2001	-	-	0.316	0.296	0.322	0.314
2003	-	-	-	-	0.315	0.317

(c) The threshold is 150% of the poverty guideline.

	2001		2003		2005	
1999	0.318	0.321	0.371	0.327	0.360	0.356
2001	-	-	0.359	0.335	0.363	0.355
2003	-	-	-	-	0.354	0.359

The table shows several interesting facts. First, much poverty is transitory. Only 30% of poor households stay poor in the next period. This observation is also noticed by Barrett and Swallow (2006) and Baulch and Hoddinott (2000). They find that people commonly suffer – or even choose – short-term income losses that push them below an inherently arbitrary poverty line for a relatively brief period of time. Then they recover without explicit external assistance. Second, the probability of an income shock conditional on receiving the shock in the previous period is not significantly higher than the probability conditional on not receiving the shock. This fact supports the implicit assumptions of equal probabilities applied in the previous literature (See Carroll 1992, 1997 and Cocco et al. 2005). Third, the two year probability (on the main diagonals in Table 2) does not differ from the four year and six year probabilities. Such time-stability suggests that the model is robust to the choice of decision frequency. Since the frequency of the PSID data (2 years) is not in accordance to the time steps of the benchmark model (5 years), I use the average of four year and six year transition probabilities as the proxy for using in the calibration. Consequently, λ_e and λ_d for the 100%, 125%, and 150% of the poverty guideline are 0.28 and 0.27, 0.32 and 0.31, and 0.36 and 0.35. Table 2 also shows that the transition probabilities increase as the thresholds increase. The benchmark model is calibrated to the 125% of the poverty guideline. The other two levels (100% and 150%) are also calibrated for robustness. The results do not show qualitative differences.

Other parameters

The discount factor δ is set to be 0.96, and the coefficient of relative risk aversion γ is 10. This is the upper bound for risk aversion considered reasonable by Mehra and Prescott (1985). Lower values are also considered as robustness checks. The mean equity premium is 4% for the benchmark case. The riskfree rate is 2% and the volatility of the risky asset is 0.157. These parameters are taken from Cocco et al. (2005) so that the results of this paper are comparable to the literature.

The minimum wealth that the social welfare insures is $15,000 per year in real terms. This is about the average of the 125% poverty guideline for a one-person family ($12,763) and a two-people family ($17,113). The set of parameters is displayed in Table 3.

Table 3: Benchmark parameters

The table lists the parameters used to calibrate the benchmark model. Investors with cash-on-hand less than the minimum wealth and being unemployed are qualified to receive social welfare which amounts to the difference between the minimum wealth and the cash-on-hand.

Time preference parameter	δ	0.96	Interest rate	r	0.02
Minimum wealth	$MinW$	15000	Mean	μ	0.06
Risk aversion coefficient	γ	10	Volatility	σ	0.157

I consider a household who starts working at age 25, retires at age 65, and dies with certainty at age 75 if this has not happened earlier. The mortality probabilities for different ages are taken from United States Life Tables (Anderson 1998).

3. Optimal consumption and portfolio choices

In this section, I solve the model numerically and characterize the optimal choices for the reference household considered to be a 35 year-old married male with two children and a high school diploma. In order to highlight the novel effects of help and welfare on investment decisions, the results are compared amongst three models: the benchmark model of the paper, the model in Cocco et al. (2005) with deterministic labor income (the CGM model)[13], and the benchmark model without labor income.

A. Consumption decisions

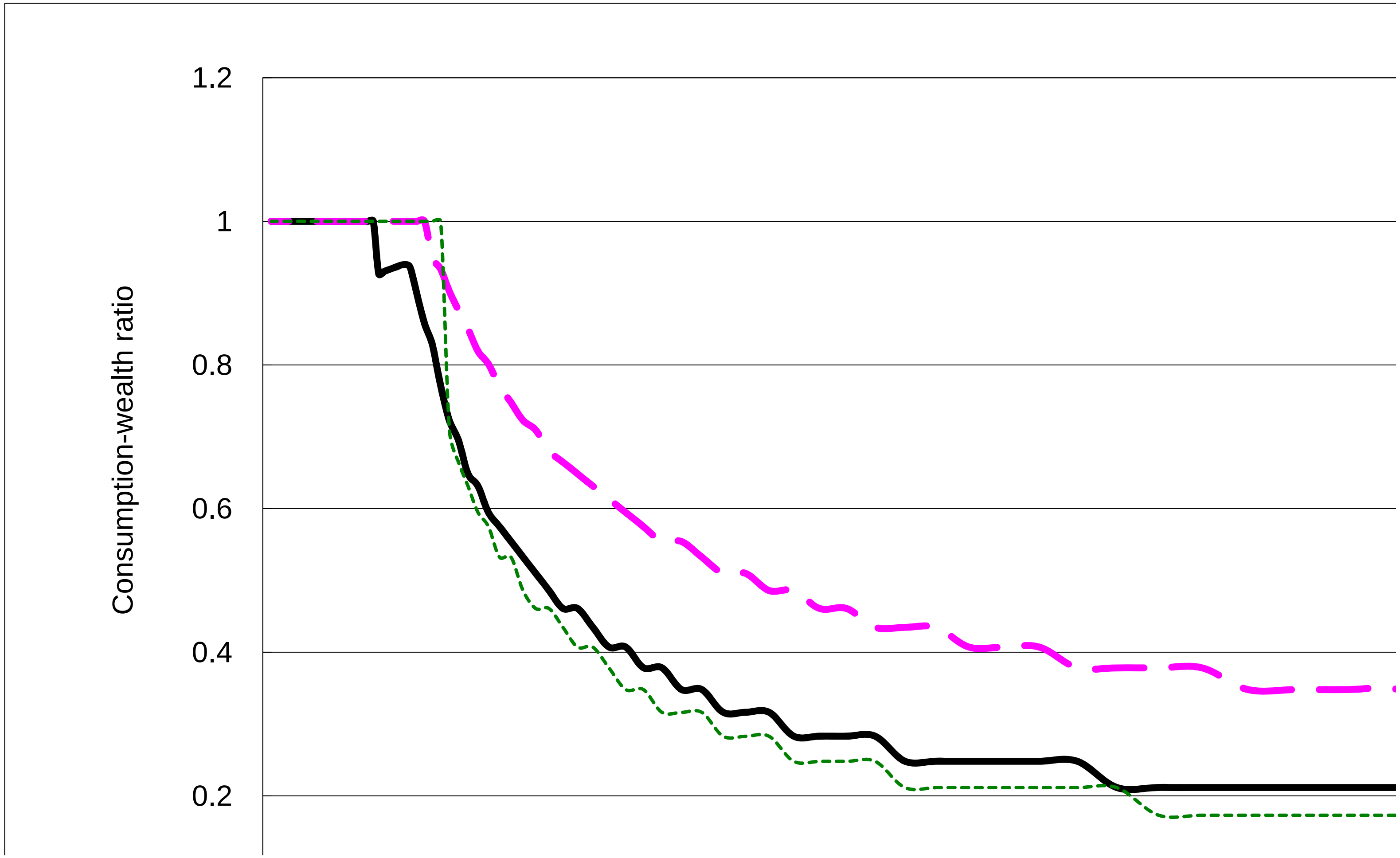
All the three models exhibit a decreasing trend on the consumption-wealth ratio (see Figure 2), deviating from the Merton's (1969) solution. Merton (1969) shows that the optimal consumption-wealth ratio is constant in the absence of labor income. The CGM model (the dashed line) shows that including labor income will increase the consumption propensity for the poor and cause a decreasing consumption-wealth ratio in wealth. However, the put option has the same effect. This can be seen from the benchmark model without labor income (the dotted line). Since labor income is absent in this case, the decreasing pattern of the consumption-wealth ratio should be solely attributed to the put option. This is not surprising since social welfare and family help can be regarded as conditional labor income. Resulting from both of the income and option effects, the benchmark model has a decreasing consumption-wealth ratio as well.

Despite the common decreasing pattern of the consumption-wealth ratio amongst the three models, the speed of decrease is quite different depending on the wealth level. In the model with the option effect only, rich households have a constant consumption-wealth ratio while poor households increase their consumption propensity dramatically. In the CGM model with deterministic labor income, however, the decreasing pattern of the consumption-wealth ratio can be observed for both rich and poor households. This is due to the fact that the put option for rich households is far out of the money and their decisions are barely affected by the presence of the option. So they have a constant consumption-wealth ratio. Low-wealth households, however, are induced to consume more than they would consume without the option. Such over-consumption has two consequences in addition to higher consumption in the current period. First, if the wealth level is above the minimum wealth (the option is out of the money), over-consumption can decrease wealth and increase the likelihood of exercising the option in future periods. Second, if the wealth level is below the minimum wealth (the option is in the money), over-consumption can lead to higher transfer income in future periods. In this case, the household has little incentive to work and

[13] The original CGM model (2005) is calibrated to the risky labor income instead of deterministic labor income. However, it has been found that the portfolio and consumption choices are quite similar in both cases.

Figure 2: Consumption-wealth ratio for the reference household

The figure illustrates the optimal consumption-wealth ratio as a function of total wealth (cash-on-hand) for the reference household.



thus more incentive to completely live on social welfare or family help.

Extraordinary over-consumption induced by the welfare option has an important impact on the non-participation puzzle in the literature. So far, fixed transaction cost theory has been widely acknowledged as an aid in resolving the puzzle (see Vissing-Jorgensen 2002). Households saving less are more likely not to invest in stocks because the small amount of investment does not pay off for the relatively large fixed transaction cost. The help and welfare option significantly decreases the saving motive for low-wealth households and thus makes their risky investment unattractive, thereby lowering participation in risky assets.

B. Portfolio choices

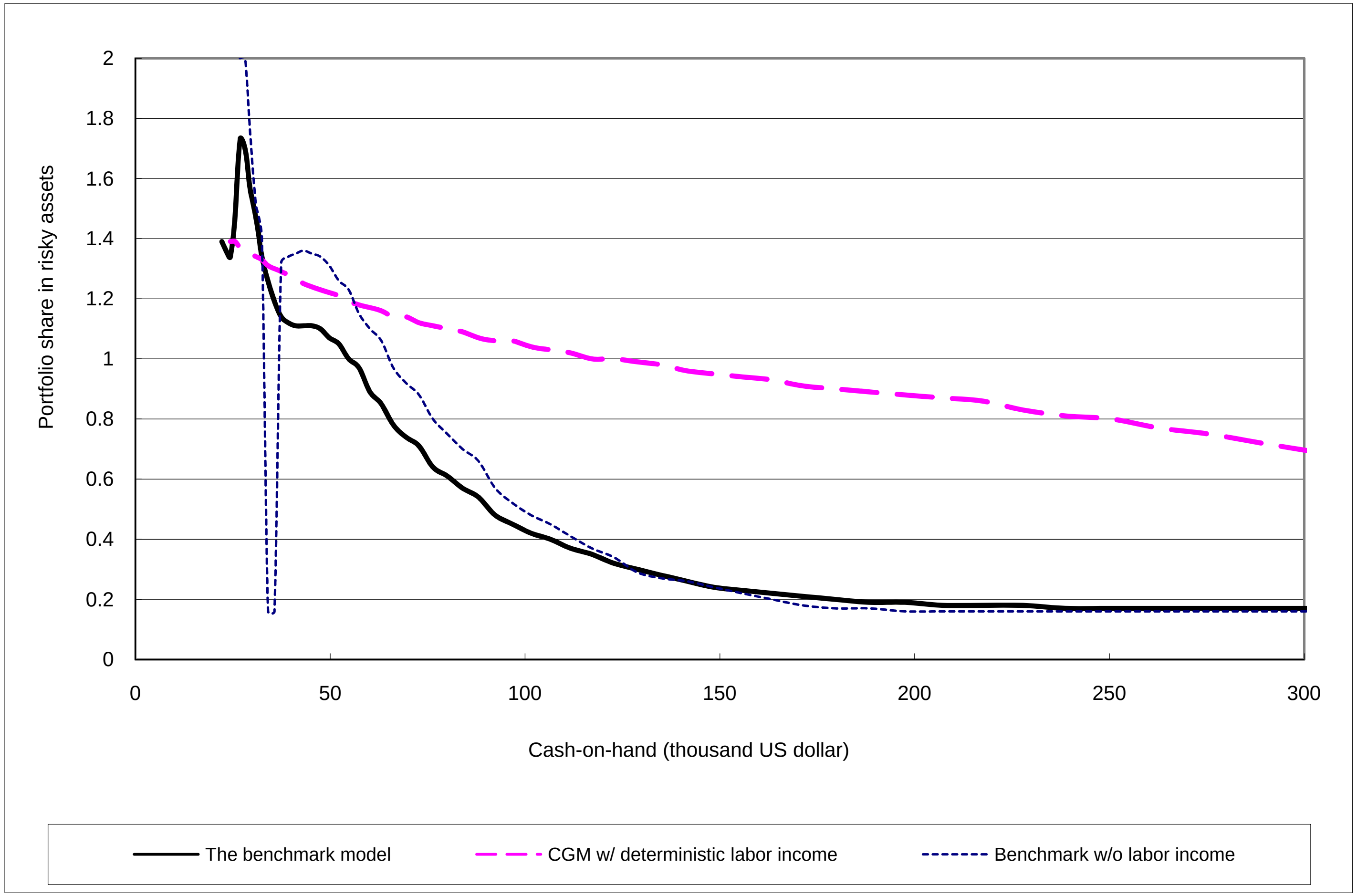
Option effects and labor income effects on household portfolio choices are presented in Figure 3. Labor income effects are illustrated by the CGM model with the deterministic labor income (the dashed line) that is calibrated to a 35 year-old married male with two children and a high school diploma. As is analytically solved in Merton (1971), portfolio share of the risky asset is decreasing in wealth. This is because human capital, behaving much like a riskless asset, takes a higher fraction of total wealth for low-wealth households than rich households. In order to balance the risk taking in the portfolio, low-wealth households should invest more in risky assets. (See, e.g., Campbell et al. 2001, Cocco et al. 2005, Davis and Willen 2000, Haliassos and Michaelides 2003, Jagannathan and Kocherlakota 1996, and Viceira 2001).

In general, option effects are also characterized by deceasing portfolio share of the risky asset in wealth. Such gambling behavior, however, can only be observed among low-wealth households (cash-on-hand below $150,000), while rich households choose according to Merton’s (1969) constant portfolio solved in the frictionless and complete market without labor income. This is illustrated by the benchmark model without labor income (see the dotted lines). Intuitively, if wealth is not far above the minimum wealth, the downside risk of investment is reduced by the possible compensation from social welfare and family help. Therefore, low-wealth households are induced to increase their portfolio share of the risky asset in order to exploit the equity premium given the relatively low risk.

The constant risk taking for rich households not only can distinguish option effects from labor income effects, but also can serve to rationalize the quadratic pattern of portfolio share of the risky asset in the empirical data. Though option effects do not explain the increasing portfolio share of the risky asset for rich households, they do not impose a counterintuitive decreasing portfolio investment as labor income effects do. It means that the introduction of

Figure 3: Portfolio share of risky assets for the reference household

The figure shows the optimal portfolio shares of the risky asset as a function of wealth (cash-on-hand) for the reference household.



the welfare option will lead to heterogeneous risk-taking patterns between low-wealth and rich households. This is an important advantage regarding the calibration of portfolio choices for rich households. In order to adjust the decreasing pattern derived from classical models for rich households to the empirically increasing pattern, we need to assume a rather steeply decreasing risk aversion for rich households. However, with the benchmark model, we only need to change the flat pattern to an increasing pattern. Thus, a modestly decreasing risk aversion for rich households together with the welfare option is sufficient to explain the observed quadratic pattern of the risk-taking in the household portfolio.

We also notice that portfolio share of the risky asset with option effects does not decrease monotonically. Graphically, there are peaks of portfolio share for households with $35000 cash-on-hand. The households would rather reduce their risk taking than gamble further because the welfare option is now deep in the money.[14] These households find that they will benefit from the welfare option for most of the possible portfolio choices. Therefore the marginal value from the welfare option does not compensate the marginal risk.

The benchmark model (the solid line) behaves quite similar to the model with the option effects only, indicating that option effects dominate the labor income effects. This is because the zero income risk in the benchmark model implies that labor income is not a safe asset and households should hold fewer stocks when they are young. Cocco et al. (2005) confirms that even a 0.5% probability of a zero labor income draw dramatically lowers the optimal stock share.

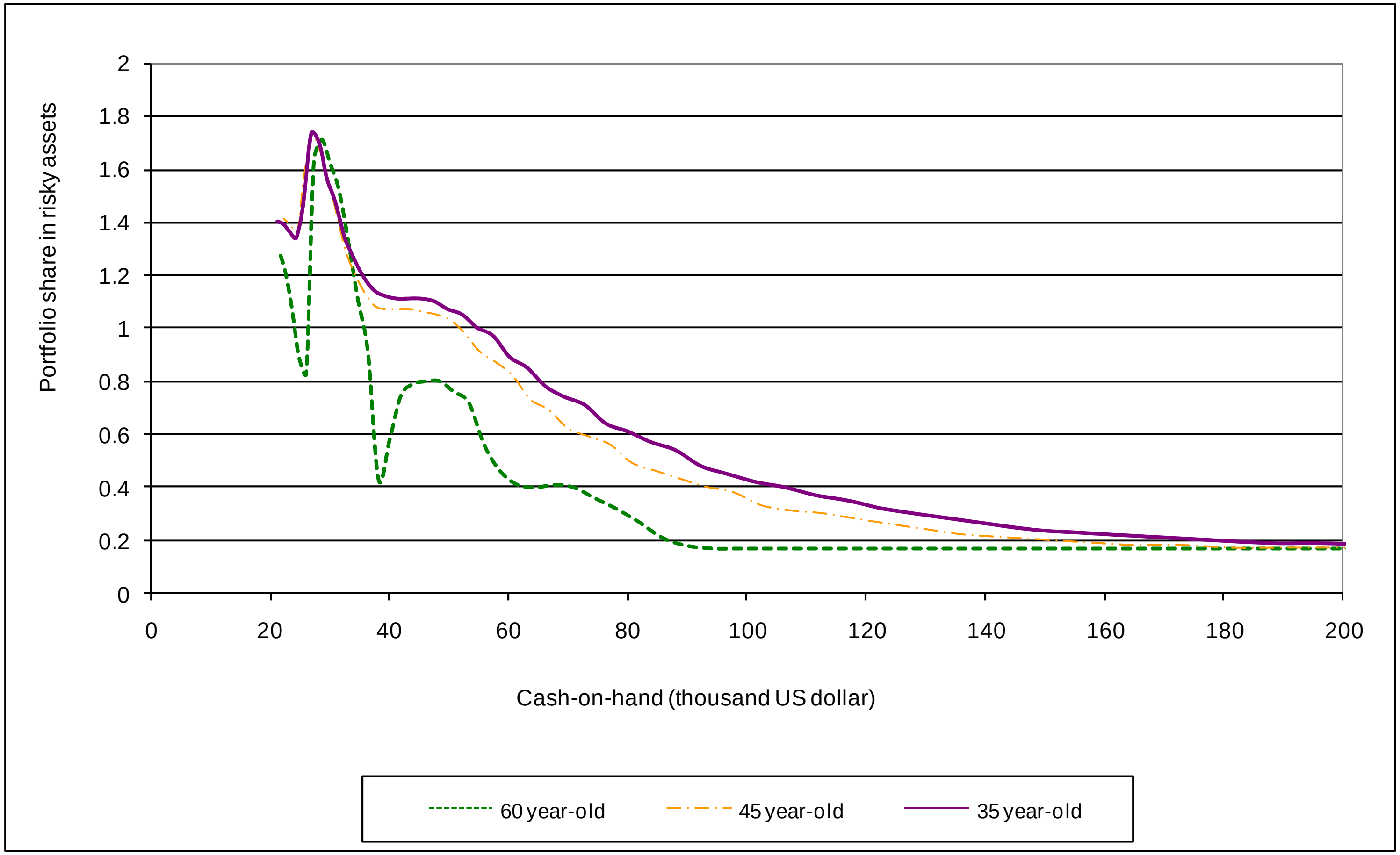
Figure 4 plots the optimal portfolio choices for a married male with two children when he is 35, 45, and 60 years. The policy functions are shifted downwards as the age increases, indicating that young investors should hold more aggressive portfolios than the old. This is because young households have relative longer time to the maturity of the welfare option (death) than the old. In this case, young households can take more risk.

In summary, low-wealth households spend all wealth in consumption when wealth is below a critical value which depends on the probability of income shock, the minimum wealth level insured by family and social transfers, and other standard parameters. Above the critical value, they hold large portfolio shares in risky assets. This portfolio share is decreasing in wealth. Rich households, however, choose the same consumption and portfolio policies as given by the Merton (1969) solution.

[14] Similar peak effects due to the option can also be found in Hodder and Jackwerth (2007).

Figure 4: Life-cycle portfolio choice for the reference household

The figure shows the optimal portfolio shares of the risky asset as a function of wealth (cash-on-hand) for the reference household at the age of 35, 45, and 60.



C. Sensitivity analysis

Risk aversion

The effect of decreasing risk aversion is presented in Figure 5. Lowering risk aversion (reducing the risk aversion coefficient to 5) affects not only the portfolio share directly due to higher risk tolerance (see Figure 5(a)), but also increases consumption propensity and decreases savings (see Figure 5(b)). The increased consumption propensity will leave less wealth to the future. Therefore, the gambling behavior for more risk-tolerant households (gamma = 5) is observed at the wealth level of $30,000 while the gambling for more risk-averse households (gamma = 10) is observed at the wealth level of $26,000. As a result, the portfolio choice is shifted to the right for low-wealth households and shifted upwards for rich households. Interestingly, risk-tolerant households will gamble less heavily than risk-averse households when they face the same option (the peak portfolio share of risky assets for risk-tolerant households is lower than risk-averse households). This is because the incentive effect from the put option is relatively smaller for risk-tolerant households than risk-averse households. Despite these differences, the general shape of the portfolio choice function does not change when the risk aversion is decreased.

Equity premium

With respect to raising the equity premium, Figure 6 presents the effects on portfolio and consumption choices. The equity premium is increased from 4% to 5.75%.[15] Figure 6(b) shows that the optimal consumption choice is barely affected. Figure 6(a) shows that raising equity premium has heterogeneous effects on the optimal portfolio choice depending on the wealth level. For rich households, high equity premium increases the demand for risky assets. For low-wealth households, raising equity premium decreases the portfolio share of risky assets. This is because when equity premium increases, the probability for the investment to drop below the strike price is lower. The incentive to gamble is then smaller. The general pattern of portfolio and consumption choice remains the same.

The insured minimum wealth

The level of the insured minimum wealth is a critical decision for policy makers of Social Insurance. It is interesting to investigate the impact of changing the level of minimum wealth on households' portfolio choice and consumption. Figure 7 presents the effects of

[15] This number is found in Cocco et al. (2005).

Figure 5(a): Different levels of risk aversion – portfolio choice

The figure shows the optimal portfolio shares of the risky asset as a function of wealth (cash-on-hand) for the reference household when the risk aversion coefficient is 5 and 10.

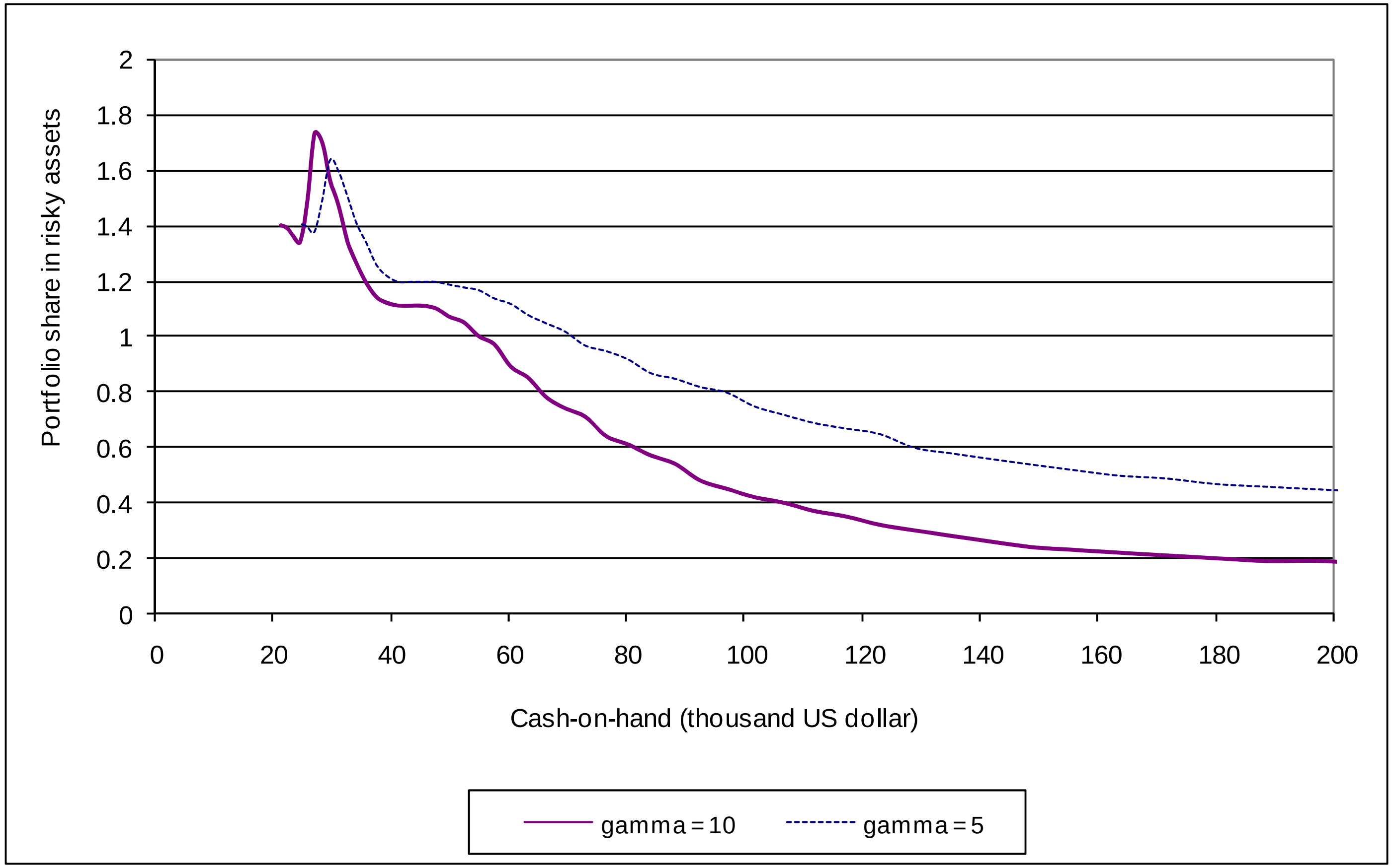


Figure 5(b): Different levels of risk aversion – consumption-wealth ratio

The figure shows the optimal consumption-wealth ratio as a function of wealth (cash-on-hand) for the reference household when the risk aversion coefficient is 5 and 10.

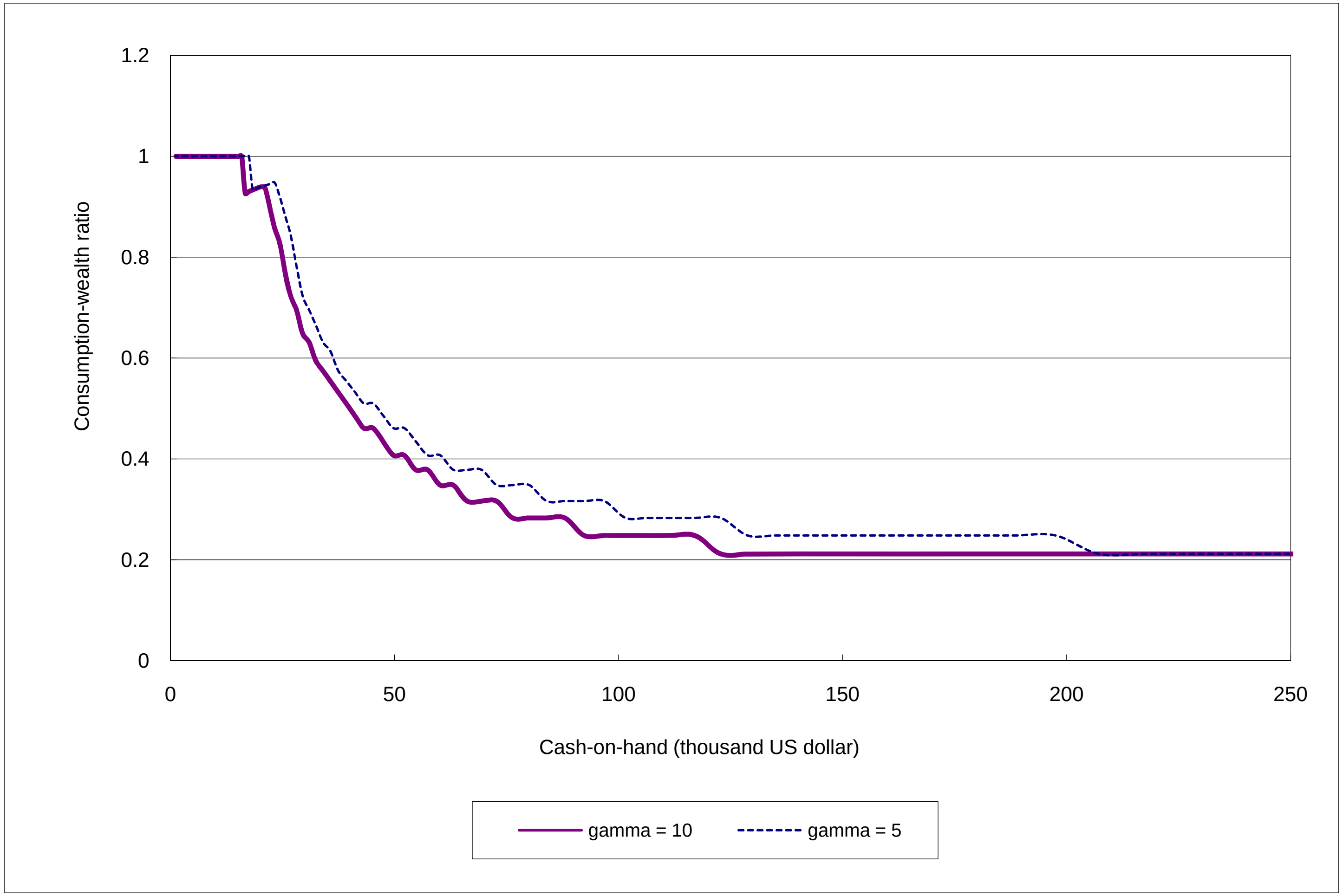


Figure 6(a): Different levels of risk premium – portfolio choice

The figure shows the optimal portfolio shares of the risky asset as a function of wealth (cash-on-hand) for the reference household when the risk premium is 4% and 5.75%.

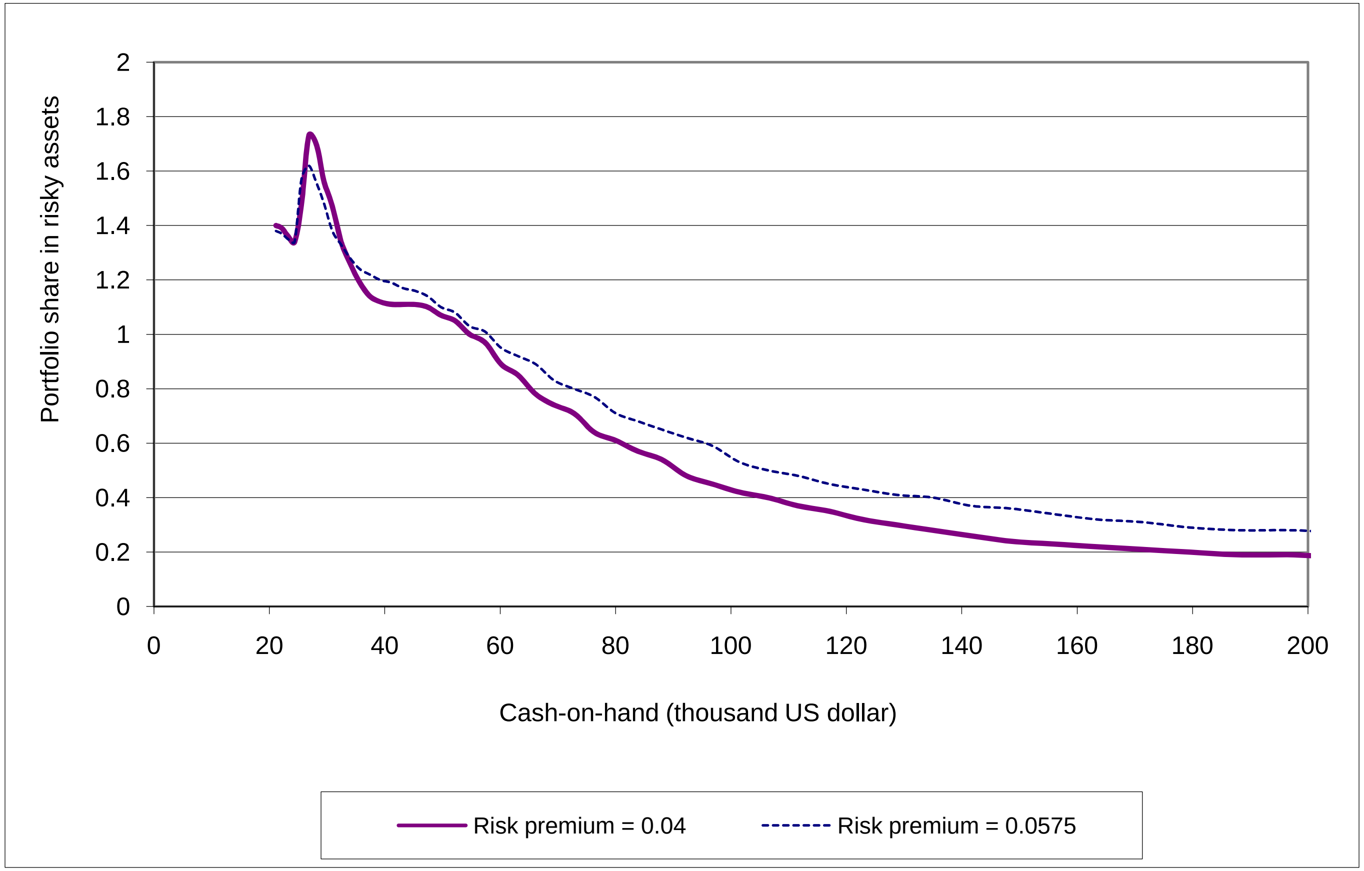


Figure 6(b): Different levels of risk premium – consumption-wealth ratio

The figure shows the optimal consumption-wealth ratio as a function of wealth (cash-on-hand) for the reference household when the risk premium is 4% and 5.75%.

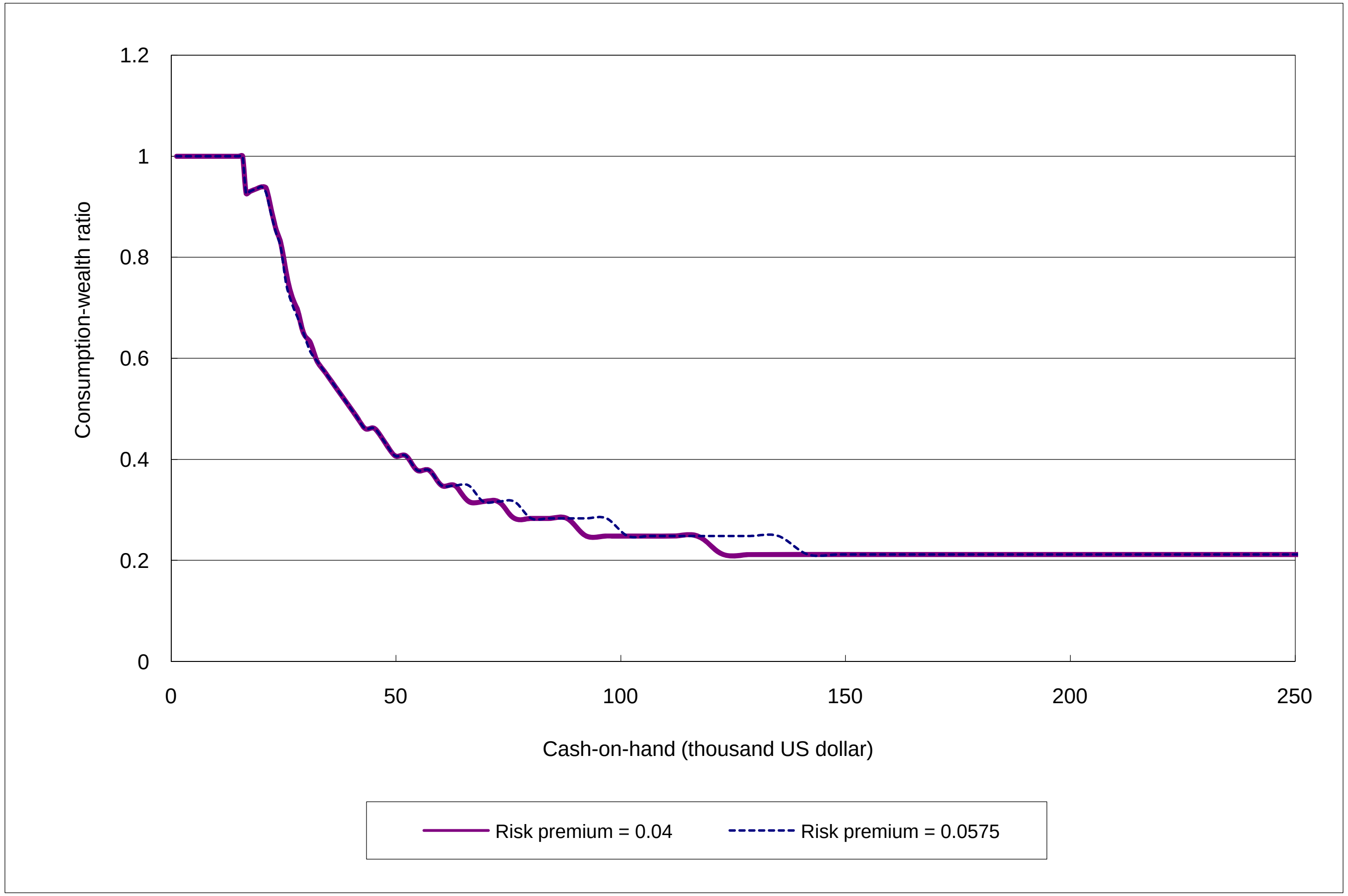


Figure 7(a): Different levels of minimum wealth – portfolio choice

The figure shows the optimal portfolio shares of the risky asset as a function of wealth (cash-on-hand) for the reference household when the minimum wealth is 15,000 and 20,000.

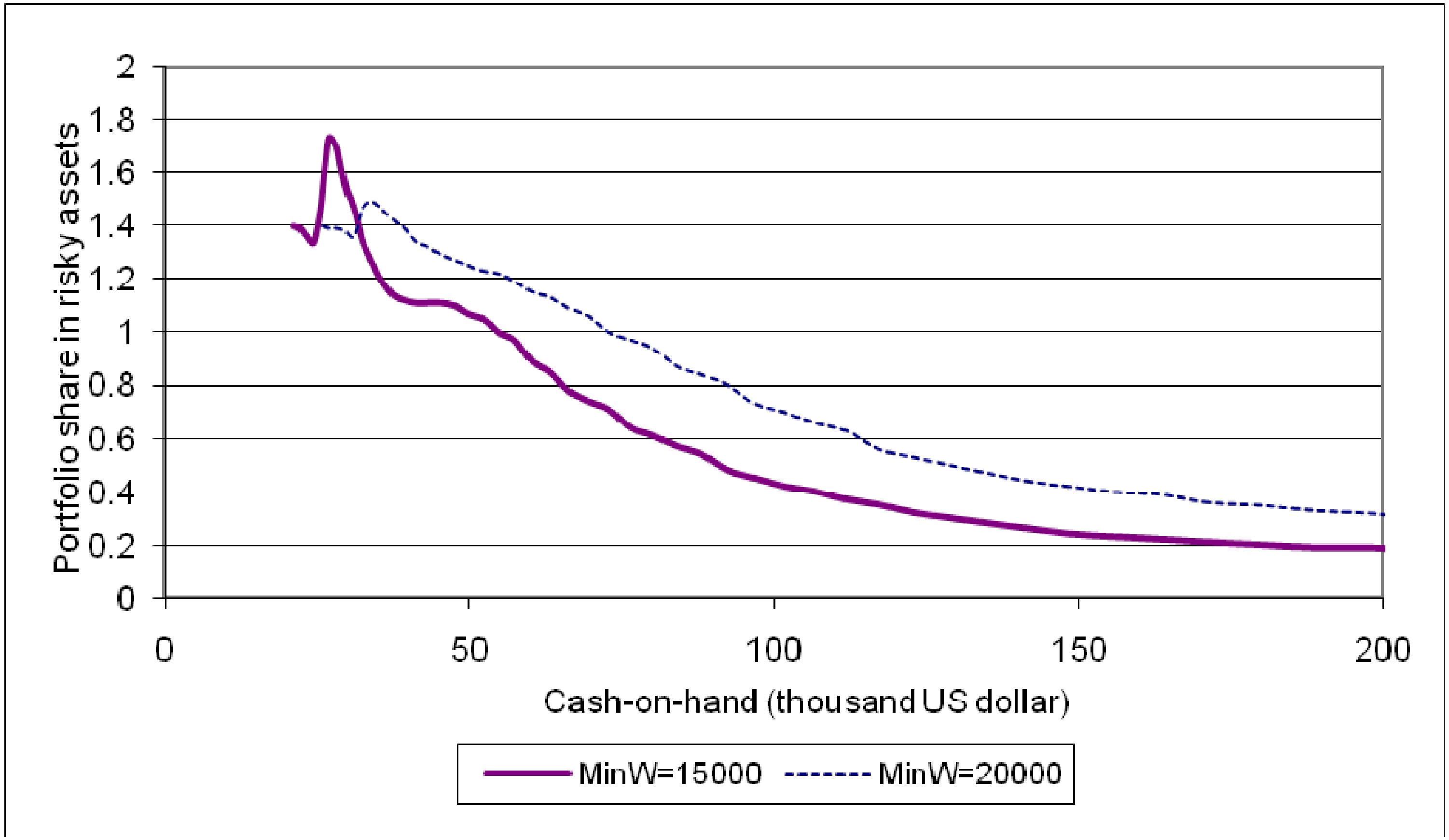
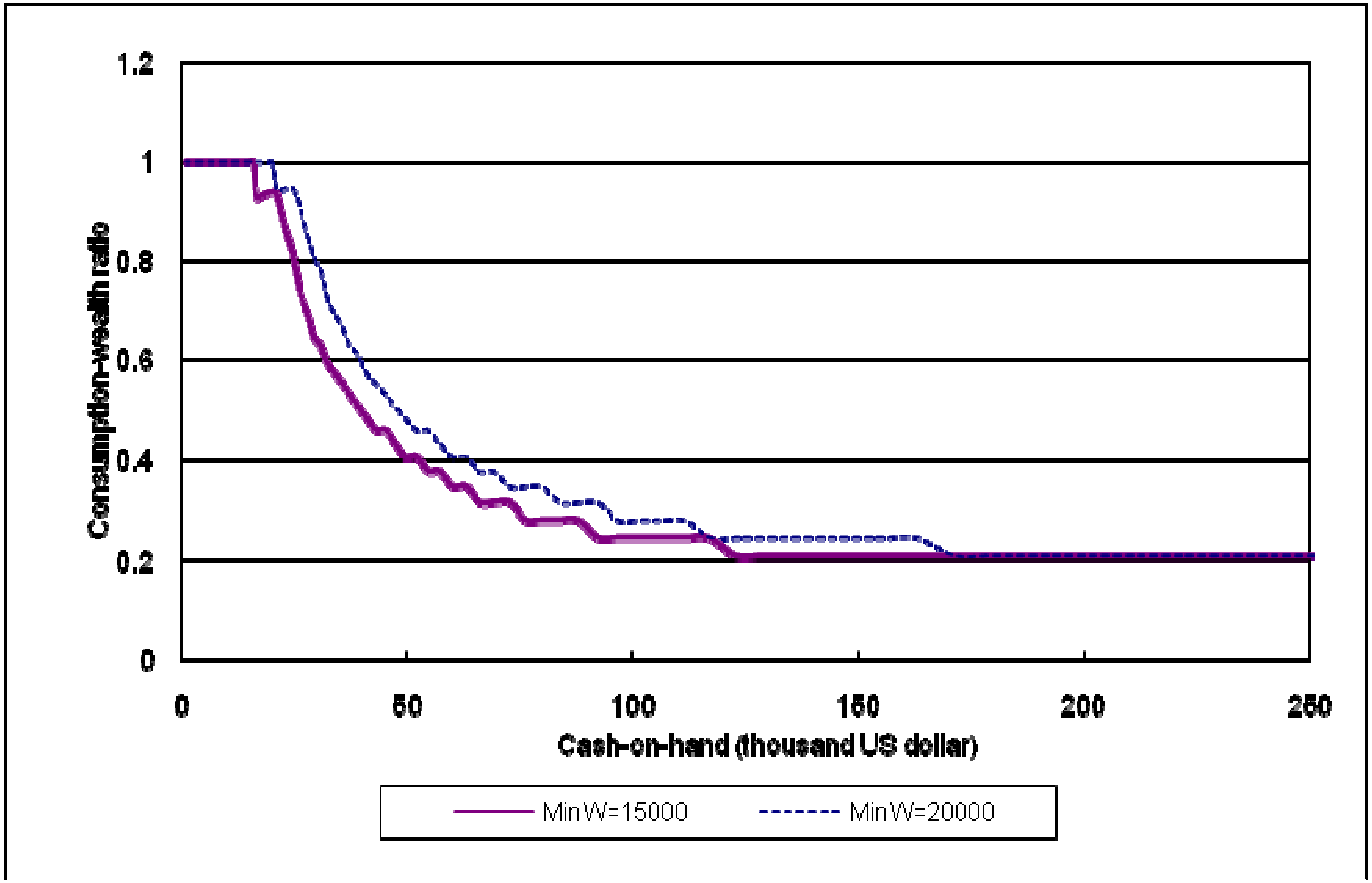


Figure 7(b): Different levels of minimum wealth – consumption-wealth ratio

The figure shows the optimal consumption-wealth ratio as a function of wealth (cash-on-hand) for the reference household when the minimum wealth is 15,000 and 20,000.



increasing the minimum wealth from \$15,000 to \$20,000 on portfolio and consumption choices. The consumption-wealth ratio is increased due to the higher insured minimum wealth. Consequently, there are more low-wealth households that consume everything. The peak of portfolio share of risky assets is also moved to richer households. Graphically, the portfolio share of risky assets is shifted to the right. However, the main result of the benchmark model (social and family transfers increase the propensity to hold the risky asset and portfolio share of risky assets) is not changed.

4. Empirical evidence

In this section, I present the empirical evidence for the effects of social and family transfers on the investment decisions of low-wealth households. Although in recent years abundant research in empirical household portfolio has been carried out due to the increasing accessibility of high-quality datasets, effects of social and family transfers have not been investigated. The challenge is to measure the effects of social and family transfers appropriately. It is important to understand from the analysis in the previous section that the effects of transfers rely on the likelihood of receiving transfers in the future rather than whether the household has received transfers or not in the past.

The following empirical work answers two questions related to the transfer effects. First, does the likelihood to receive transfers decrease households' propensity to participate in the risky asset? Secondly, does the likelihood to receive transfers increase the portfolio share of the risky asset?

The empirical analysis relies on the most recent wave of the PSID family data for 2005. The PSID data provides detailed information on households' income including welfare transfers and family help, which serves well the purposes of this paper. Also, it reports holdings of individual assets, which enables us to carry out conditional analysis for different assets. Following Bertaut and Starr-McCluer (2002), risky assets are classified into three main categories based on risk and liquidity. First, *equity* includes directly held stock and retirement accounts. Second, *non-financial assets* include investment real estate and private business. Third, *other non-financial assets* include primary residence and vehicles. Riskfree assets include all bank accounts and bonds. Debt includes mortgage loans, real estate loans, and credit card loans. Net worth is computed as the sum of all assets less all debts. Table 4 presents summary statistics for different assets as well as other household characteristics. Asset share is the ratio of the asset to net worth. A household is viewed as a *participant* in the particular risky asset if the corresponding asset share is positive. For instance, the equity

Table 4: Summery statistics

The table reports the summary statistics of the main assets and household characteristics in the 2005 PSID survey. The number of observations of households is 5376. There are 1725 equity participants, 956 nonfinancial assets (investment real estate and private business) participants, 4662 other nonfinancial assets (primary residence and vehicles) participants, and 4730 participants in any risky asset.

	All households			Participants			Nonparticipants		
	Mean	Median	Std Dev	Mean	Median	Std Dev	Mean	Median	Std Dev
Equity ($)	52,924	0	506,525	164,938	38,000	883,985	-	-	-
Nonfinancial assets ($)	55.528	0	633,182	312,259	75,000	1,475,208	-	-	-
Other nonfinancial ($)	139,731	74,000	211,997	161,132	104,000	219,951	-	-	-
Riskfree ($)	24,579	2,000	141,714	32,755	5,000	162,781	-	-	-
Debt ($)	61,685	14,000	100,407	87,962	58,000	109,842	-	-	-
Net worth ($)	211,077	36,500	975,141	240,262	55,700	1,036,180	-	-	-
Net worth per unit ($)	97,457	14,500	447,454	110,973	22,099	475,411	-	-	-
Labor income ($)	53,521	34,898	136,834	58,955	40,000	144,892	13,733	7,000	17,478
Age	44.23	43.00	15.63	44.63	44.00	15.26	41.26	39.00	17.84
Family units	2.64	2.00	1.43	2.70	2.00	1.42	2.25	2.00	1.49
High-school dummy	0.73	1.00	0.44	0.76	1.00	0.43	0.53	1.00	0.50
College dummy	0.27	0.00	0.44	0.29	0.00	0.46	0.07	0.00	0.26
Employment dummy	0.78	1.00	0.41	0.82	1.00	0.39	0.54	1.00	0.50
House owner dummy	0.58	1.00	0.49	0.66	1.00	0.47	0.00	0.00	0.04

share of a *participant in equity* is positive. If the variable does not refer to a particular asset, then a *participant* is defined as a household holding a positive share in at least one risky asset.

Table 4 presents weak evidence that risky asset participants tend to have higher labor income, to receive higher education, and to be house owners. The former two elements are traditionally known to be associated with participation in risky assets (Calvet et al. 2007). The last element shows that housing and vehicles are important risky assets in a household portfolio. Housing and vehicle ownership increases risky asset participation significantly. However, housing and vehicles differ from other financial assets in that they serve a dual purpose (Yao and Zhang 2005). It is both a durable consumption good from which the owner derives utility and also an investment tool. Therefore, transfer effects are analyzed separately for these assets in this paper.

A. Identification of the likelihood of receiving transfers

The numerical solution in the previous section demonstrates that transfer effects depend on the probability of income shock, household wealth level, and other demographic characteristics that affect the eligibility to receive social transfers and family help. All of these variables imply a certain likelihood of receiving transfers. This paper adopts a probit model to estimate this likelihood of receiving transfers for each household. The dependent variable is a binary variable that records whether the household has received any social transfers and/or monetary aid from relatives and friends in 2005. The sample has 5376 observations. About 38.2% of households received transfers in 2005. The independent variables include total family wealth and its quadratic term, employment dummy, retirement dummy, family labor income, education dummies, and family units. Table 5 shows the results of the probit model.

Wealth has a negative effect on the probability of receiving transfers. Most social welfare programs exclusively support households with limited resources. Similar to wealth, labor income negatively impacts the likelihood of receiving transfers. This is not only because some welfare programs are targeted at low-income households, but also because low income jobs are characterized by high unemployment risk. In contrast, retirees receive stable pension income and face a limited probability of income shock. Finally, education increases households' skills needed to attain a stable job. This holds true, however, only for college education.

After the likelihood to receive transfers is identified, a linear prediction based on the

Table 5: The probit model for the likelihood of receiving transfers

The table reports the probit estimation for the likelihood of receiving social welfare and help from relatives and friends. The dependent variable is a binary variable that records whether the household has received any social transfers and monetary help from relatives and friends in 2005. The sample includes 5376 observations. ***Significant at 1%; **significant at 5%; *significant at 10%.

Independent variable	coefficient	t-stat
Total wealth/1000000	-0.209***	-4.52
Total wealth/1000000 squared	0.006***	4.61
Employment dummy	-0.178***	-3.14
Retirement dummy	-0.423***	-5.43
Labor income/1000000	-0.279*	-1.78
College diploma dummy	-0.064	-1.50
High school diploma dummy	0.016	0.39
Family units	-0.044***	-3.5
Constant	0.052	0.81

estimates of coefficients can be computed for each household. I assume that such likelihood is stable in the short run, which means in the future the household will receive transfers with this estimated likelihood. Then I can investigate the relationship between portfolio share of assets and this likelihood.

B. Transfer effects on the participation decision

Table 6 reports probit regressions of participation decisions in different asset classes on the likelihood of receiving transfers, on financial characteristics, and on demographic characteristics using the 2005 PSID data. The sample is smaller than in Tables 4 and 5 since households whose net worth lies in the top or bottom one percent of observations are dropped. This step is taken in order to diminish the effect of outliers.

There is clear evidence of a negative effect of the likelihood of receiving transfers on participation decisions in every asset class. These effects are economically important as well as statistically significant. We first look at the participation decision in stock, the asset most extensively investigated in the literature. An increase in the likelihood of receiving transfers from the 20^{th} percentile to the 80^{th} percentile decreases the probability of being a stockholder

Table 6: Transfer effects on participation decisions

The table reports probit regressions of participation decisions in different asset classes on the likelihood of receiving transfers, financial, and demographic household characteristics using the 2005 PSID data. For each regression, the linear coefficient, t-statistics, and marginal effect of each predicting variable are reported. The marginal effect is assessed by computing the impact on the participation decision of increasing a continuous regressor from the 20th percentile to the 80th percentile, or of setting a dummy variable equal to one, while holding the other variables in the regression constant at their means. The sample size and proportion of participation are reported below the regressions.

	Participant in equity			Participant in real estate investment and private business			Participate in primary residence and vehicles		
	Estimate	t-stat	Change	Estimate	t-stat	Change	Estimate	t-stat	Change
Score	-0.855***	-4.13	-4.14%	-1.367***	-6.67	-4.66%	-1.959***	-8.89	-8.57%
Net worth per unit/1000000 ($)	7.033***	20.54	11.14%	4.455***	16.37	5.43%	6.819***	9.00	19.28%
(Net worth per unit/1000000)^2	-4.113***	-13.85	-	-2.416***	-11.24	-	-4.075***	-9.55	-
Age	0.002	1.48	1.45%	-0.005**	-3.02	-2.16%	-0.004**	-2.42	-2.23%
College diploma dummy	0.542***	10.83	13.57%	-0.053	-1.00	-0.81%	0.017	0.22	0.34%
High school diploma dummy	0.296***	5.57	6.04%	0.067	1.24	1.02%	0.239***	4.45	5.05%
Labor income/1000000	4.749***	10.69	7.23%	-0.118	-0.78	-1.33%	13.431***	12.06	22.74%
Constant	-1.900***	-20.66	-	-1.524***	-16.90	-	0.059	0.64	-
Sample size	5268			5268			5268		
Participation rate	32.09%			17.78%			86.72%		

from 15.9 to 11.8 percent, when holding all other variables in the regression constant at their means. The negative marginal effects on the participation in real estate investment and private business and primary residence and vehicles are even larger. The negative effects are consistent with the theoretical prediction that social welfare and family help depress households' investment motive and thus increase the probability of being non-participants in risky assets for low-wealth households.

Education has been found to positively affect participation in stock market in the literature (Vissing-Jorgensen 2002, Campbell 2006, and Calvet et al. 2007). In Table 6, education enters the equity participation regression with the same positive signs. Education effects on private business participation are insignificant as also found in Campbell (2006). This might be due to the fact that entrepreneurship is not a major focus of education. Age effects are very weak and ambiguous. Wealth is found to have positive effects on participation for all assets, consistent with a fixed cost of participation. Labor income has important positive effects for the participation in equity and primary residence but it has an insignificant impact on participation in private business. An intuitive interpretation is that entrepreneurs live mostly on business dividends and not on labor income.

C. Transfer effects on the portfolio choice

It is known that the wealthy invest differently than do poorer households (Tracy et al. 1999, Heaton and Lucas 2000, Carroll 2002). In order to focus on the behavior of a representative household, especially of low-wealth households, the quantile regression of the median is adopted instead of the OLS regression. Just as OLS regressions estimate the mean, median regressions estimate the median of the dependent variable expressed as functions of observed covariates. For household data, medians are more representative than means. Given the extreme skewness of the wealth distribution, median regression renders more robust estimates than mean regression.

Table 7 reports median regressions of portfolio shares of different asset classes on the likelihood of receiving transfers, financial variables, and demographic characteristics. The sample is even smaller than that used in Table 6 since now non-participating households and households with zero or negative net worth are also dropped.

As for portfolio choices on equity and private business, the likelihood of receiving transfers has positive effects on the corresponding portfolio share. An increase in the likelihood of receiving transfers from the 20^{th} percentile to the 80^{th} percentile increases the conditional portfolio share of equity by 4.57 percent and the share of private business and

Table 7: Transfer effects on portfolio choices

The table reports median regressions of portfolio shares of different asset classes conditional on participation on the likelihood of receiving transfers, financial, and demographic household characteristics using the 2005 PSID data. For each regression, the linear coefficient, t-statistics, and marginal effect of each predicting variable are reported. The marginal effect is assessed by computing the impact on the portfolio share of increasing a continuous regressor from the 20th percentile to the 80th percentile, or of setting a dummy variable equal to one, while holding the other variables in the regression constant at their means. The sample size and the median portfolio share of the asset for the participants are reported below the regressions.

	Portfolio share of equity			Portfolio share of real estate investment and private business			Portfolio share of primary residence and vehicles		
	Estimate	t-stat	Change	Estimate	t-stat	Change	Estimate	t-stat	Change
Score	0.208***	2.60	4.57%	0.272***	2.78	6.00%	-0.288**	-2.45	-6.34%
Net worth per unit/1000000 ($)	0.246**	2.56	2.57%	0.519***	4.65	5.44%	-2.982***	-17.53	-31.21%
(Net worth per unit/1000000)^2	-0.084	-1.09	-	-0.113	-1.52	-	1.750***	11.89	-
Age	0.003***	3.91	7.29%	-0.005***	-4.81	-12.44%	-0.004***	-4.15	-10.91%
College diploma dummy	0.087***	4.69	8.69%	-0.051**	-2.00	-5.08%	0.126***	4.14	12.62%
High school diploma dummy	-0.008	-0.33	-0.82%	-0.088***	-2.99	-8.76%	0.119***	3.90	11.91%
Labor income/1000000	0.115***	2.93	0.84%	-0.202	-1.51	-1.48%	0.744***	7.55	5.43%
Constant	0.096**	2.39	-	0.671***	12.49	-	1.252***	23.68	-
Sample size	1615			890			4083		
Median portfolio share	0.23			0.32			1.00		

real estate investments by 6 percent. The 5 percent change is relatively large considering that the median portfolio share of equity is merely 23 percent. These positive effects suggest that the existence of social welfare and family help induce households to gamble as they turn poor.

Further evidence in support of the existence of transfer effects is that after controlling for transfer effects portfolio shares of equity and private business are increasing in wealth. This means that the decreasing pattern for the share of risky asset is due to the transfer effect. Once the decreasing component is explained by the transfer effect, the quadratic pattern of risky portfolio share estimated in Campbell (2006) is replaced by a monotonically increasing function estimated in this paper, which is consistent with intuition in that wealthy households hold more risky portfolios than the poor households.

Age has a positive effect on equity share but negative effects on the shares of private business and primary residence. The negative effects are consistent with the rules of thumb suggested by financial planners: as people age, they should shift investments away from stocks and towards bonds (Jagannathan and Kocherlakota 1996). Table 6 shows that as people age, they shift investments away from private business, real estate investments, primary residence, and vehicles. Another interpretation is that people purchase their primary residence with the help of a mortgage when they are young and net worth is low. As a result, portfolio share of primary residence tends to be high. As they age, they pay back the mortgage loan gradually and the net worth increases. The portfolio share of primary residence thus decreases. The positive effect on equity share is due to the increased holding of stocks through retirement accounts as people age.

Labor income has weak effects on portfolio share of equity and private business. The previous section shows that in the Merton (1971) model, labor income can explain the decreasing portfolio share of the risky asset with wealth (see Figure 3) and that labor income could potentially be the cause of the gambling behavior of low-wealth households. The evidence here, however, does not support this theory.

Most regressors in the regression of the portfolio share of primary residence and vehicles have different signs than those in the other two asset classes. This is related to the dual purposes (consumption and investment) of owning a primary house and vehicles. First, social welfare and family help are not expected to cover mortgage debt. If the net worth becomes low due to a sharp decrease in housing prices and the house owner incurs an income shock, the house can only be foreclosed or liquidated because welfare programs only support basic living expenses. The loss of primary housing consumption and liquidation cost might be larger than the insurance benefit of social welfare. In this case, the likelihood of receiving transfers would not boost the share of the primary housing. Second, due to the inelastic demand of owing a house, low-wealth households have to purchase the house with rather large mortgage loans. With a same house, low-wealth households have a higher share of primary housing than the rich. This is why wealth has a negative sign and quadratic pattern. Third, the present value of future labor income determines the amount of mortgage loan that the household can afford. A high mortgage loan leads to a high portfolio share for primary housing. Therefore, labor income has a positive effect.

D. Robustness

An alternative way to identify the transfer effect is to impose an assumption: those who receive transfers in the current period will be more likely to receive transfers in the future. In this case, we can use the dummy of receiving transfers as an explanatory variable to test the empirical relationship between transfers and household portfolio. Based on the theoretical results in Section 3, we would expect that the sign of the dummy of receiving transfers is negative in the regression of participation and positive in the regression of portfolio risk.

Another robustness check is related to the truncation for the sample. In previous regressions, the richest and poorest households are excluded from the sample in order to eliminate the effect of outliers. However, since median regressions are more robust to outliers than OLS regressions, we should not expect that the results will be qualitatively changed.

The results are presented in Table 8 and 9. The signs of coefficient for the welfare dummy are consistent to the theoretical predictions of this paper. In general, welfare is found to have negative effects on households' decisions to participate in asset markets and positive effects on portfolio shares of risky assets. However, most estimates are statistically insignificant. This suggests that whether the household has received transfers in the current period has less explanatory power than the likelihood of receiving transfers in the future for explaining households' investment decisions.

5. Conclusion

In this paper, I solve a life-cycle model of consumption and portfolio choice in the presence of social welfare and family help. The model is proposed as an explanation of two empirical puzzles simultaneously observed among low-wealth households. They either choose to be *non-participants* in risky asset markets or *gamblers* by taking on a large share of risky assets. Both of these two behaviors are linked to the existence of social welfare and

Table 8: One-stage estimation on participation decisions

The table reports probit regressions of participation decisions in different asset classes on the likelihood of receiving transfers, financial, and demographic household characteristics using the 2005 PSID data. For each regression, the linear coefficient, t-statistics, and marginal effect of each predicting variable are reported. The marginal effect is assessed by computing the impact on the participation decision of increasing a continuous regressor from the 20^{th} percentile to the 80^{th} percentile, or of setting a dummy variable equal to one, while holding the other variables in the regression constant at their means. The sample size and proportion of participation are reported below the regressions.

	Participant in equity			Participant in real estate investment and private business			Participate in primary residence and vehicles		
	Estimate	t-stat	Change	Estimate	t-stat	Change	Estimate	t-stat	Change
Family units	-0.111***	-6.16	-11.74%	0.002	0.11	0.14%	0.201***	5.93	2.82%
Age	0.000	0.07	0.13%	-0.006***	-3.17	-3.83%	-0.011***	-4.43	-1.19%
Labor income/1000000	2.200***	4.88	5.59%	-0.147	-0.79	-0.25%	0.150	0.862	0.05%
Welfare dummy	-0.064	-1.2	-2.22%	-0.083	-1.49	-1.92%	-0.057	-0.64	-0.24%
College diploma dummy	0.518***	10.09	19.06%	-0.060	-1.13	-1.40%	-0.073	-0.7	-0.32%
High school diploma dummy	0.252***	4.31	8.61%	-0.041	-0.67	-0.97%	-0.107	-1.14	-0.42%
Ln(Net worth)	0.432***	23.82	50.97%	0.415***	22.58	35.56%	0.297***	16.01	4.99%
Constant	-5.325***	-28.44	-	-5.190***	-26.09	-	-1.041***	-5.42	-

Table 9: One-stage estimation on portfolio decisions

The table reports median regressions of portfolio shares of different asset classes conditional on participation on the likelihood of receiving transfers, financial, and demographic household characteristics using the 2005 PSID data. For each regression, the linear coefficient, t-statistics, and marginal effect of each predicting variable are reported. The marginal effect is assessed by computing the impact on the portfolio share of increasing a continuous regressor from the 20th percentile to the 80th percentile, or of setting a dummy variable equal to one, while holding the other variables in the regression constant at their means. The sample size and the median portfolio share of the asset for the participants are reported below the regressions.

	Portfolio share of equity			Portfolio share of real estate investment and private business			Portfolio share of primary residence and vehicles		
	Estimate	t-stat	Change	Estimate	t-stat	Change	Estimate	t-stat	Change
Family units	-0.022***	-3.05	-6.50%	-0.048***	-3.72	-14.25%	0.109***	9.99	32.73%
Age	0.004***	5.53	9.91%	-0.005***	-3.99	-14.79%	-0.008***	-7.34	-22.28%
Labor income/1000000	0.049	1.61	0.35%	-0.155	-1.49	-1.13%	0.001	0.18	0.10%
Welfare dummy	0.034*	1.75	3.40%	0.025	0.63	2.48%	-0.031	-0.92	-3.13%
College diploma dummy	0.091***	5.31	9.08%	-0.070**	-2.00	-7.05%	-0.002	-0.04	12.62%
High school diploma dummy	0.011	0.44	1.07%	-0.069	-1.59	-6.91%	0.065*	1.79	6.53%
Ln(Net worth)	-0.022***	-3.42	-8.01%	-0.042***	3.36	15.01%	-0.072***	-8.25	-25.70%
Constant	0.317***	4.29	-	0.292**	1.99	-	1.921***	20.8	-

family help, modeled as a put option. Welfare and help depress the investment motive for the low-wealth households. The decrease in investment increases the marginal cost of the fixed transaction cost of entering risky asset markets. Thus, welfare and aid decrease the propensity to invest in risky assets. On the other hand, the welfare option induces low-wealth households to increase their portfolio share of risky assets. With realistic parameters, the model fits the empirically observed decreasing portfolio share of risky assets with wealth.

Empirical evidence supporting the effects of social welfare and family help on participation decisions and portfolio choices predicted by the theoretical model is presented in this paper. A proxy for measuring the transfer effects, the likelihood of receiving transfers, is shown to have negative effects on participation and positive effects on portfolio shares in equity and private business. The weak labor income effects show that the traditional Merton model cannot fully explain the gambling behavior of low-wealth households. I also find that gambling behavior with respect to the primary residence cannot be explained by the transfer option, emphasizing the dual purposes of owning a primary residence and vehicles.

The paper suggests that some non-linear household portfolio choices can be explained by non-linear return structures or real options within the framework of rational models. The non-linear features of some social welfare programs open a novel dimension for financial planners to advise portfolio choices.

Appendix A: Numerical Solution

The basic structure of the model uses the methodology described in Hodder and Jackwerth (2007). Following their notations, I use grids of cash-on-hand values X and time t, with $\Delta(\log X)$ constant as well as time steps Δt of equal length. I use 120 log value steps with the upper boundary equal to 300,000 and lower boundary equal to 1,000. Hence, $\Delta(\log X)$ is 0.047532. In order to have the indirect utility at the next period lie on the grid points even with a choice of a riskless portfolio (α = 0), the grid structure is assumed to grow at the riskfree rate and so are the upper and lower boundaries. Time to maturity is 50 years. The number of time steps is 10. Hence, Δt is 5 years. The frequency of rebalancing is set to be low because households are reluctant to change their portfolio due to the transaction cost and inertia (see Brunnermeier and Nagel 2006). The choices of α vary from 0 to 2 in steps of 0.01.

To calculate the probabilities of moving from one cash-on-hand value at time t to all possible values that can be reached at $t+\Delta t$, the range of 41 grid points with index i equal to -20, …, 0, …, 20 are used. The probabilities for those possible moves depend on the choice of α (stock proportion). For a given α, I calculate the probabilities based on the normal density times a normalization constant so that the computed probabilities sum to one:

$$p_{i,\alpha,\Delta t} = \frac{\dfrac{1}{\sqrt{2\pi}\sigma_{\alpha,\Delta t}} \exp\left[-\dfrac{1}{2}\left(\dfrac{r\Delta t + i\Delta\log(X) - \mu_{\alpha,\Delta t}}{\sigma_{\alpha,\Delta t}}\right)^2\right]}{\sum_{j=-20}^{20} \dfrac{1}{\sqrt{2\pi}\sigma_{\alpha,\Delta t}} \exp\left[-\dfrac{1}{2}\left(\dfrac{r\Delta t + j\Delta\log(X) - \mu_{\alpha,\Delta t}}{\sigma_{\alpha,\Delta t}}\right)^2\right]} \tag{A1}$$

where $\mu_{\alpha,\Delta t} = \left[\alpha\mu + (1-\alpha)r - \frac{1}{2}\alpha^2\sigma^2\right]\Delta t$ and $\sigma_{\alpha,\Delta t} = \alpha\sigma\sqrt{\Delta t}$. (A1) shows that the approximated probabilities do not depend on the level of $\log(X)$ or time and they are solely functions of α .

For each period, the state space is constructed by 121 grids for cash-on-hand and two states of unemployment and employment. In addition, two special indirect utilities are required for the state of zero cash-on-hand in order to allow zero saving to be admissible. For unemployed households, the grid points below the minimum wealth are adjusted to be the same as the minimum wealth. For the employed households, the cash-on-hand is adjusted by labor income. This adjustment will generally cause the $\log(X_{t+1})$ not to land on grid points at the next time step. In order to obtain the corresponding indirect utilities for the $\log(X_{t+1})$

not landing on grid points, spline estimation is used. Given the relatively large number of grid points, the estimation error is limited. Such interpolation has also been used in other recent papers in the literature (e.g., Cocco et al. 2005). Alternatively, one can avoid interpolation by fixing the $\log(X_{t+1})$ values equal to the grid points at the next step. Since these $\log(X_{t+1})$ values have been adjusted by labor income and social welfare, we need to deduct them to obtain the financial wealth at the next time step. Dividing this financial wealth by the current log cash-on-hand value $\log(X_t)$, we obtain the corresponding return. We further compute the associated probability for this return. Such algorithm increases the time of computing because the associated probability for each grid point is different and needs to be computed case by case. A more severe problem with this algorithm is the quality of discretization of the normal distribution. Since the forward nodes are not evenly spaced and are mostly located in the left side of the normal distribution due to the deduction of labor income, the forward nodes cannot well approximate the normal distribution. Therefore, spline estimation is adopted in this paper. Given the choices of consumption and the proportion of risky assets, the expected utility of being unemployed or employed in the next period can be separately computed. Then the expected utility associated with the given choices can be computed by multiplying the corresponding probabilities of employment and unemployment conditional on the current status of employment. The optimal choices are the results of maximizing over the expected utilities of all admissible choices.

One distinction of this model from previous studies which also assume zero income risk is to allow the household to consume all his cash-on-hand because in the next period his cash-on-hand will either be adjusted to the minimum wealth in case of unemployment or be adjusted by the labor income in case of employment. Both cases will prevent the household from having nothing to eat. However, in other studies (e.g., Carroll 1997) the choice of zero savings is implicitly excluded as an optimal choice since in case of receiving zero income in the next period the power utility will be minus infinity.

When implementing the backward sweep through the grid, one difficulty is in dealing with behavior at the boundaries. The terminal step is trivial in that I calculate the terminal utility using the terminal wealth. To calculate the indirect utilities of the grid points close to the upper and lower boundaries, I use buffers of cash-on-hand values above the upper boundary and below the lower boundary. The lower buffer for the unemployment case is trivial since the indirect utilities associated with grid points which are below the minimum wealth are all equal to the indirect utility for the grid point equal to the minimum wealth. For the indirect utilities associated to the upper buffer grid points, I use an approximation based on the indirect utilities on the upper boundary $J_{t,ub}$, which can be decomposed into two parts according to the Bellman equation:

$$J_{t,ub} = \frac{C_{t,ub}^{1-\gamma}}{1-\gamma} + \delta p_t E_{t,ub}[J_{t+1}(X_{t+1}, Y_{t+1})]. \tag{A2}$$

The first term comes from the current consumption and the second term comes from the expected future utility. The closed form solution in Merton (1971) shows that the optimal consumption is linear in wealth in the absence of labor income. Assuming that the optimal consumption policies (consumption-wealth ratio) for the upper buffer grid points are the same as for the upper boundary, we can compute the first part for the upper buffers with index *ub-i* equal to *ub-20, …, ub-1,* by

$$\frac{(C_{t,ub} X_{t,ub-i} / X_{t,ub})^{1-\gamma}}{1-\gamma}. \tag{A3}$$

Assuming further that the expected future utilities for the buffer grid points are the same as the one on the boundary, we can approximate the indirect utilities for the upper buffer as the following:

$$J_{t,ub-i} = \frac{(C_{t,ub} X_{t,ub-i} / X_{t,ub})^{1-\gamma}}{1-\gamma} + \delta p_t E_{t,ub}[J_{t+1}(X_{t+1}, Y_{t+1})]. \tag{A4}$$

This approach is potentially suboptimal; however, the distortion results in ripples only some 20-50 steps below the upper boundary, affecting mainly the early time steps.

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