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HOUSEHOLD PARTICIPATION IN THE SUPPLEMENTARY PENSION SCHEMES: DETERMINANTS AND THE ROLE OF HOUSING IN ITALY

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INTRODUCTION

High housing rate and low participation in pension schemes in Italy and EU have motivated this research-work. In particular analysing the Italian case, the supplementary pension system does not get off the ground in terms of membership, returns, and organization. It is a result of the recent economic crisis, which makes investments difficult, but maybe there are also responsibilities of a sector that needs to rethink about different strategies in order to involve workers to invest in supplementary pension system. This situation pushes us to examine the supplementary pension system fully, by analysing the determinants that drive and influence households to invest in supplementary pension system in order to draw a picture of situation in terms of characteristics of families that subscribe a complementary pension system. We study Italy for two main reasons: first, the Italian public pension system has been heavily reformed, second, homeownership in Italy is widespread, with housing assets representing a substantial share of the household portfolios; therefore, it is likely to have an impact on other portfolio choices

Because investment in supplementary pension system can be considered as a portfolio choice that household has to face, we first aim to investigate and understand households portfolio choices in order to analyse the optimal investor problem with respect to different elements that an household has to take into account before making a portfolio choice. For households it is fundamental to develop a multiperiod point of view in order to consider all variables that have an impact on consumption, saving and investment of households during their life-cycle. Households portfolio choices are driven by risks that must to be carefully taken into account, especially longevity risk and the insurability of labour income risk.

In analysing the determinants of participation in supplementary pension system, our attention is focused on the role that real estate investments have on decision to invest in complementary pension schemes. The rationale of our analysis is as follows: real estate investments can be seen as another characteristic of individuals in terms of wealth and propensity to invest; homeownership is a form of asset accumulation and homeowners secure themselves a valuable asset which can be drawn upon to provide economic well-being in old age, so real estate investments could crowd out decision to invest in supplementary pension schemes. This intuition is confirmed by Kemeny (1981) who was the first to stress the link between pensions and homeownership: “if homeowners regard their housing assets as a quasi pension fund, they will devote less to standard pension provision because they have lack the need or incentive to do so rather than because they cannot afford to". For this reason our research preliminary checks the influence of some variables linked to property investment on participation in complementary pension system. Our study provides an alternative explanation for the low take up rate of pension funds in Italy by the possibility of a trade-off between investment in residential house and the participation in supplementary pension schemes.

From the analysis of the trade-off between participation in supplementary pension system and residential housing we have developed the second step of our research focusing on the role of housing. In particular, housing decisions incorporate the choice to hedge income risk and for many households the home is the largest asset in the portfolio. In particular owner-occupied housing is the single most important asset in many investors' portfolios. Without financial markets for insurance against volatility in housing prices and labour income, risk averse households use housing purchase to hedge income risk. Specifically, we analyse how covariance between the housing value and labour income affects the decision to invest in residential house and own house by using data relative to the Italian case.

The thesis is organized as follow: the first chapter presents an overview of household portfolio literature illustrating the most important household portfolios models and analyses the optimal investor problem. The second chapter describes the dataset used for our analysis, i.e. the Bank of Italy Survey on Household Income and Wealth, and provides descriptive statistics about demographic and socio-economic factors. Furthermore, the construction of the sample dataset is explained. In the third chapter we present an empirical analysis of the determinants of the participation and an investigation of the most significant variables that are in relation with participation in a complementary pension fund by the side of Italian households. In addition, the trade-off between participation in supplementary pension scheme and residential housing investments is studied and explained. The last chapter further investigates the role of housing: specifically, drawing on Davidoff (2005) we empirically test how covariance between the housing value and labour income affects the decision to invest in residential house.

1. MODELS FOR HOUSEHOLD PORTFOLIOS

The chapter presents an overview of the most important household portfolios models and analyses the optimal investor problem with respect to different elements that an investor has to take into account before making a portfolio choices. For households it is fundamental to develop a multiperiod point of view in order to consider all variables that have an impact on consumption, saving and investment of households during their life-cycle. Specifically, important parameters are: uncertainty of labour income, consideration of the investor retirement period, presence of human wealth, kind of mortgage and credit contracts that an investor stipulate, presence of housing investment, and demographic futures as population ageing. These are all the elements that characterize household portfolio choices.

The goal of the chapter is to provide an overview of household portfolio literature. Before concentrating on multiperiod portfolio models, we expose the single one period model. The rest of the chapter is organized in order to highlight a specific feature that represents the most notable contribution of the papers. Section 1 describes the historical evolution of household portfolio models. In section 2 we illustrate labour income process and its effect on household portfolio models. In Section 3 we illustrate the literature that take into account human capital and its relationship with optimal portfolio choice. Section 4 highlights the link between population ageing and financial portfolio choice. In Section 5 we analyse the presence of annuities in household portfolio models.

1.1 The historical evolution of household portfolio models: one period and multiperiod models

The static one-period model is the basic model for the optimal portfolio selection. It is based on the maximization of a Von Neumann-Morgestern utility function of consumption of a risk-averse household.. The degree of their risk aversion is characterized by the degree of concavity of the utility function. Obviously, change in risk aversion impacts on the demands for risky assets. Most notable result of the model is the development of the two-found separation theorem, i.e. all investors will hold a combination of risk-free asset and the market portfolio. The most important is the Markowitz mean-variance formulation.

The classical static portfolio problem under uncertainty is well exposed in Gollier (2002). Gollier (2002) considers an economy in which investors live for one period; at the beginning of the period, the investor has a sure wealth *X*. The investor does not know the state that will predominate at the end of the one time horizon. There are *N* states of the world indexed by *i*, *i* =1,…,*N*. p_i is the probability that describes the uncertainty, with $\sum_i p_i = 1$. Consumption occurs only after the realization of *i* is observed. The agent invests his endowment in a portfolio of assets that will be liquidated at the end of the period to finance his consumption. It is necessary to assume that markets are complete. Moreover, for each state *i*, there exist an associated state price $\pi_i \geq 0$. Vector $(C_1,...,C_N)$ is the state-contingent consumption plan of the agent, and the equation 2.2 is the budget constraint of the investor. The classical static portfolio problem under uncertainty starts with the following model:

$$\max_{C_1,...,C_N} \sum_{i=1}^{N} p_i u(C_i) \tag{1.1}$$

Subject to:

$$\sum_{i=1}^{N} p_i \pi_i C_i = X \tag{1.2}$$

Where $(p_1,...,p_N)$ and $(\pi_1,...,\pi_N)$ are two vectors of nonnegative scalars and u is a real-valued, increasing, and concave function, and vector $(C_1,...,C_N)$ is the state-contingent consumption plan of the agent. Under the concavity of *u,* the necessary and sufficient condition for the constrained maximization problem can be written as

$$u'(C_i) = \xi\pi_i \qquad i = 1,\ldots,N \tag{1.3}$$

Where ξ is the Lagrangian multiplier associated with constraint.

The main problem of the static model is that it cannot be used for the analysis of the life cycle asset allocation. Usually households have long-term objectives (e.g. retirement) when they invest in financial markets. For this reason it is necessary to extend the one period model to a multiperiod one.

The multiperiod model was treated first by Merton and Samuelson in the 1960s. Generally, the optimal multiperiod portfolio is based on a component; this component is related to the myopic portfolio that is linked with the way in which investors ignore what might happen beyond the immediate next period when choosing portfolios. The optimality of myopic portfolio strategy depends on households utility function and on investment opportunities. Myopia is optimal only if the utility function exhibits constant relative risk aversion. By Gollier (2002) it is possible to individuate three main effects that characterize portfolio consumption ad portfolio rules. The effect of time diversification is the first one, that is longer horizon affords to better smooth shocks and then younger household should take up more risk. The second one is the role of wealth in relation with the time horizon, that is called wealth effect. The last one is the repeated risk effect, that captures the idea that, in a multiperiod setting, taking risk today can influence the possibility to take risk in the future: this depends on risk aversion. The last two effects, that are the wealth effect and the repeated risky effect, depend on the utility function used to represent preferences of household investor.

1.2 Labour income effect on household portfolio choice

First papers by Samuelson and Merton show that optimal portfolio allocation between a riskless and risky asset does not depend on the investment time horizon and that the optimal asset mix between risky and riskless securities should remain constant during the investor life cycle. The necessary conditions that are required for this result to hold are homotetic preferences, i.i.d. returns, absence of market frictions and lack of labour income risk.

Some of the seminal models consider the assumption that markets are complete, so the labour income could be capitalized and its risk hedged. Because of the presence of moral hazard issues, many investors meet borrowing constraints that prevent them from capitalizing future labour income. For that reasons market incompleteness is an important feature to be considered.

In a contest of life cycle asset allocation, consideration of uninsurable labour income is fundamental. The level and the risk of labour income change over the life cycle, so the presence of labour return can provide an explanation for age varying investment strategies. There are several papers that consider effects of labour income risk on household portfolio choice: e.g. Bodie, Samuelson (1989), Bodie, Merton, Samuelson (1992), Heaton and Lucas (1997), Koo (1998), Viceira (2001), Silva (2002), Gomes and Michaelides (2002, 2003, 2005), Cocco (2004), Cocco et all (2005), Yao and Zhang (2005), Benzoni (2007), Cocco and Gomes (2008).

Bodie, Merton, Samuelson (1992) were among the first to analyse the connection between labour supply flexibility and portfolio choice; they show that if labour supply flexibility is allowed in a continuous time life cycle model of consumption, saving, and leisure choices the holdings of risky assets would be positively affected, so individuals with more labour supply flexibility are predicted to hold more risky assets. For the authors it is also more important to consider human capital and traditional financial wealth as part of individual's portfolio. Bodie, Merton and Samuelson, based on the previous paper by Merton (1971), emphasize that the presence of labour supply flexibility over the life-cycle can change the composition of the optimal portfolio.

The authors' proposal is to consider individual's occupation as a good measure of labour supply flexibility. They want to use occupation to explain that asset holdings is likely to be hard to solve endogeneity problems, because individuals choose optimally their occupation and are more likely to choose occupations that offer them more flexibility. For that reason they are likely to make portfolio decisions very differently, leading to a correlation between occupations and risky asset holdings. In their model they emphasize also the role of age, showing the relationship between labour supply flexibility and portfolio allocation is likely to be much weaker between older investors.

One of the main contributions of their work is considering people human capital as one of the major sources of wealth, that is not also tradable. Bodie, Merton and Samuelson (1992) is based on the lifetime consumption and portfolio choice model of Samuelson (1969) and Merton (1969, 1971) to show the implications of the interaction between portfolio choice and labour supply over the life cycle. The authors start from a two-period model and they extend it to a life cycle model in continuous time.

Stepping back, by Bodie and Samuelson (1989) it is possible to illustrate the two-period model. In the first period, they presume that investor has made his optimal labour decision and determines his current investment decision between risky and risk-free asset. In the second speriod, the rate of return of his investment is realized, and given his wealth, the investor may adjusts his labour choice, increasing his labour earnings at the sacrifice of leisure or vice-versa. The individual's objective is to maximize his final period utility, which depends on his realized wealth and leisure. A share of wealth is spent on consumption good, and part on leisure. The share utilized in consumption good is given by:

$$\begin{aligned} C &= \left[1 + xz + (1-x)r\right]W_0 + W_H(1-L) \\ &= \left[1 + r + x(z-r)\right]W_0 + W_H - W_H L \\ &= W(z) - W_H L \end{aligned} \tag{1.4}$$

where:

r is the realized return of the risk free asset

z denotes the realized return of the risky asset

x is the fraction of wealth invested in the risky asset

W_0 is the initial wealth

$W(z)$ is the total wealth

H are the work hours

L are the leisure hours

W_H denotes the maximum wage income that the individual earns if L=0

C is the consumption good

The last line in (1.4) treats the consumption/leisure choice in the standard way, where the individual allocates the total wealth, ($W(z)$), between leisure, purchased at price W_H, and consumption. The investor's objective is to maximize the expected value of his utility function, composed by leisure and consumption. So he has to maximize $E\left[U(C,L)\right]$ subject the budget constraint (1.4).

Bodie, Merton and Samuelson (1992) show the extension of the previous model to a life cycle one. Individuals choose optimal levels of consumption, labour supply and investment portfolio at each point of the time horizon. They maximize their discounted lifetime expected utility given by

$$E_0\left[\int_0^T \exp^{-\delta_s} u\big(C(s), L(s)\big)ds\right] \tag{1.5}$$

○ is the rate of time preference, $C(s)$ is the rate of consumption, $L(s)$ is his leisure and u denotes the individual's utility function. The price of the risky asset follows an Ito's process:

$$dP = \alpha P dt + \sigma P dz \tag{1.6}$$

where α is the instantaneous expected return per unit of time, and σ is the instantaneous conditional standard deviation. The wage paid to labour also follow an Ito process

$$dw = qwdt + \sigma wdz \tag{1.7}$$

Two assumptions are considered: wages are non-stochastic and are correlated with the risky asset. In the case of non stochastic labour income, where σ = 0, they state the analysis in terms of total wealth, $W(t)$, considering this initial condition, $W(0)=F(0)+H(0)$. They introduce the dynamic budget equation:

$$dW = \left[\left(x\left(\alpha - r\right) + r\right)W - C - wL\right]dt + \sigma xWdz \tag{1.8}$$

Bodie, Merton, Samuelson (1992) consider the case of flexible labour supply, showing that the individual's optimization problem is to maximize the expected utility subject to the previous dynamic budget constraint. Based on stochastic dynamic programming they define the derived utility function conditional on the current value of total wealth $W(t)$ and wage $w(t)$

$$J\left(W, w, t\right) = \max E_t\left[\int_t^T e^{-\delta_s} u\left(C\left(s\right), L\left(s\right)\right)ds\right] \tag{1.9}$$

the maximization is with respect to $C(t)$, $L(t)$, and $x(t)$. The authors interpret and evaluate the individual's total wealth $W(t)$, that is the sum of investor financial wealth and the value of his human capital. Because the future wages are non stochastic, the value of the future cash flows is founded by discounting them at the risk free rate of interest r. Therefore the rest of human capital at time t is

$$H(t) = \frac{w(t)\left(1 - e^{-(r-g)(T-t)}\right)}{r - g} \tag{1.10}$$

Using (0.10) they establish the initial total wealth condition *W*(0)=*F*(0)+*H*(0). In the paper it is also analyzed the case in which the labour supply is fixed; in this case the individual is not able to change his labour supply during the life time, so (*L*(*t*)=*L*). They show that there are two differences between the flexible and fixed cases. First, leisure is determined as a flow variable in the first case and as a stock variable in the second one. In the "flexible" case, the individual continuously changes his consumption of leisure basing to the changes in his total wealth and in the wage rate. Second, the value of the individual's available human capital differs between the two cases. The value of fungible human capital when leisure is fixed is:

$$H(t) = \frac{\left[(1 - L)\, w(t)\right](1 - e^{-(r-g)(T-t)})}{r - g} \tag{1.11}$$

In the flexible labour case, the individual incorporates the total of his remaining potential human capital into the current wealth instead the second case where he can call on only (*1-L*) of his potential human capital for the consumption good.

Then the authors turn their attention to the case of stochastic wage. They consider the Ito process

$$dw = gwdt + k\sigma wdz \tag{1.12}$$

in this case changes in the individual's wage are instantaneously perfectly correlated with the risky asset. The analysis of the individual's optimality condition is the same as in the previous section. The presence of wage uncertainty involves both wealth and substitution effects. As in the previous case the authors show that there is a wealth effect, that is the individual's asset demands depend on his total wealth, financial wealth plus human capital. Moreover there is a substitution effect, because the presence of risky wage income generates a differential demand for the risky asset. In the end the same individual will pursue follow different investment strategies on the basis of differences in the risk characteristics of their human capital. This allows them to value human capital as if it were a tradeable asset. The authors choose not to model retirement, but acknowledge that it is a measure of flexibility. Moreover, they put together the life cycle consumption-saving model with the portfolio decision, allowing for flexible labour supply in a continuous time step, and the effect of making labour supply flexible in the investment mix by individuals, and not on the consumption-saving and labour-leisure choices over the life cycle.

One of the milestones in the analysis of household portfolio choices in presence of labour income risk and market incompleteness is the paper written by Cocco, Gomes and Maenhout (2005). The authors provide a model for life-cycle consumption and portfolio rules with borrowing constraints and uninsurable labour income. There are different papers related with it (Cocco et al. (2008), Gomes and Michaelides (2005), Yao and Zhang (2005)). All these papers are based on the main feature and implications introduced by Cocco et al. (2005) and extend the model presented by the three authors. There are also some previous papers, Heaton and Lucas (1997), Koo (1998), Viceira (2001) that analyse the uninsurable labour income effect on portfolio composition, but they do it in an inappropriate way for the analysis of the life-cycle pattern. In fact these papers consider an infinite horizon setting that is the base of the stationary nature models, and obviously they are less suitable to address life cycle issues. The papers by Cocco (2004) and Yao and Zhang (2004) are very close to Cocco et al. (2005) in terms of labour income process but they study also the implications of introducing housing in a life cycle model of which I will talk about it in the next section.

The starting point of Cocco et al. (2005) is the consideration of uninsurable labour risk, that is reflected on assumption of incomplete markets, the inclusion of moral hazard problems, via borrowing constraints, in order to avoid the capitalization future labour income by household. The model specification begins with the description of investor's preferences: the authors denote *t* as adult age, *T* as the uncertain length of investor's life and *K* is assumed to be the exogenous and deterministic working age. After these assumptions the utility function is:

$$E_1 \sum_{t=1}^{T} \delta^{t-1} \left(\prod_{j=0}^{t-2} p_j \right) \left\{ p_{t-1} \frac{C_{it}^{1-\gamma}}{1-\gamma} + b\left(1-p_{t-1}\right) \frac{D_{it}^{1-\gamma}}{1-\gamma} \right\} \tag{1.13}$$

where δ<1 is the discount factor, γ>0 the coefficient of risk aversion, C_{it} is the level of date *t* consumption and D_{it} is the amount of bequest at time *t*.

At each date $t < K$ the investor receives a stochastic labour income stream Y_{it} given by:

$$\log\left(Y_{it}\right) = f\left(t, Z_{it}\right) + v_{it} + \varepsilon_{it} \tag{1.14}$$

where $f\left(t, Z_{it}\right)$ is a deterministic function of age additively separable in t and Z_t, where Z_t is the vector of individual characteristics which includes age dummies, family fixed effect and marital status. ε_{it} is the transitory shock distributed as $N\left(0, \sigma_u^2\right)$ and v_{it} is given by

$$v_{it} = v_{i,t-1} + u_{it} \tag{1.15}$$

where u_{it} is uncorrelated with ε_{it}. The permanent shock u_{it} can be decomposed into an aggregate component ξ_t and an idiosyncratic component ω_{it}, both normally distributed with zero mean and constant variance

$$u_{it} = \xi_t + \omega_{it} \tag{1.16}$$

The authors consider the retirement income, it is modeled as a constant fraction λ of permanent labour income in the last working year:

$$\log\left(Y_{it}\right) = \log\left(\lambda\right) + f\left(K, Z_{iK}\right) + v_{iK} \tag{1.17}$$

Viceira (2001) was one of the first who introduces retirement labour in the analysis. He incorporates retirement into dynamic model and examines how risky labour income and retirement affect portfolio choice. He captures retirement effects through a constant probability of zero labour income forever.

Cocco et al. (2005) assume that there are two financial assets, a risk free asset which has a constant gross real return $\bar{R}_f$ and a risky asset with a gross real return R_t. The gross real excess return over the risk-free is modelled as:

$$R_{t+1} - \bar{R}_f = \mu + \eta_{t+1} \tag{1.18}$$

where η_{t+1} is the innovation that is assumed to be i.i.d., but it is correlated with the aggregate component of labour income with a coefficient ρ. One of the two important assumptions in Cocco et al.(2005) is the borrowing constraint which models the impossibility of household to capitalize future labour income retirement

$$B_{it} \geq 0 \tag{1.19}$$

The following short-sales constraint is introduced to ensure that the investor's asset allocation to equities is non negative:

$$S_{it} \geq 0 \tag{1.20}$$

The investor's optimization problem starts with a wealth W_{it} and with introduction of cash on hand in period t ($X_{i,t} = W_{it} + Y_{it}$). The investor has to maximize his preferences subject to labour income process constraint short-sales constraint, and in addition to the non-negativity constraint on consumption. Then the investor must decide how much to consume, C_{it}, and how to allocate the remaining savings between stocks and treasury bills. The authors solve the model non-analytically, but by using backward induction, after appropriate calibration of the model to real data.

One of the findings of Cocco et al.(2005) is that the investment in stocks is roughly decreasing with age. Young household who have a steep labour income profile, show a rapidly increasing implicit riskless holding represented by labour income and diversify by investing in stocks. Later in life, the labour income profile is not so steep and now the portfolio rule is evaluated at higher wealth levels and the portfolio walk away from stocks. These results follow from the fact that in Cocco et al. (2005) labour is modeled more as bond-like asset than a stock-like asset. The issue of the correlation between labour income risk and stock return is addressed by the paper of Benzoni et al. (2007). In this paper the authors study the optimality of portfolio choice over life-cycle in a setup that is very close to Cocco et al. (2005), but they do not model the retirement income. They investigate the implication of cointegration between aggregate labour income and dividends on the market portfolio for life-cycle portfolio choice. In particular they investigate the optimal portfolio and consumption choices over the life-cycle for an agent with constant relative risk aversion who earns non tradable labour income. The authors assert that labour income can be split up into two components: the aggregate labour income that is cointegrated with the dividend process and a second component that captures both life-cycle predictability and idiosyncratic labour income shocks. Substantially, the results of the paper are as follow. If the numbers of years of remaining employment is larger that the time scales (provided by the inverse of mean reversion coefficient that controls the cointegration), which is the case of young households, then the return on the agent's human capital is highly exposed to market returns. Moreover, most of young agent's wealth is connected with future labour income. Thus, the household will find himself overexposed to market risk. In this case it will be better for the investor to take short position in the market portfolio or, if there are borrowing constraints, to invest the total wealth in risk-free bonds. As the agent ages, the cointegration between labour income and dividends has less time to act. For middle-aged the cointegration has not time to act. These results provide an explanation to limited stock market participation.

One of the paper that is very close to Cocco et al.(2005) in terms of calibration of labour income process is Gomes and Michaelides (2005) that in turn is an extention of papers by Gomes and Michaelides (2002) and Gomes and Michaelides (2003). The main difference regards the preferences and presence of fixed costs. Gomes and Michaelides (2005) assume that households have Epstein-Zin utility functions. If we consider, as in the previous case, C_t and X_t respectively consumption level and wealth at time *t* (cash on hand), then the household's preferences are defined by

$$V_t = \left\{ (1-\beta p_t) C_t^{1-1/\psi} + \beta E_t \left[p_t \left[V_{t+1}^{1-\gamma} \right] + (1-p_t) b \frac{\left(X_{t+1}/b \right)^{1-\gamma}}{1-\gamma} \right]^{\frac{1-1/\gamma}{1-\gamma}} \right\}^{\frac{1}{1-1/\gamma}} \tag{1.21}$$

where ψ is the elasticity of intertemporal substitution and *b* determines the strength of bequest motive. The two authors introduce also the fee that investor must pay before investing in stocks the first time. In this entry fee are included the transaction costs from opening a brokerage account and the opportunity costs of acquiring information about the stock market. The fixed cost is cut out by the level of the permanent component of labour income.

1.3 Human capital and optimal portfolio choices

In this paragraph we will survey the literature regarding the impact of human capital in life-cycle portfolio choices. The portfolio choice models analyzed in the previous section are closely related with this section. Since varying their labour supply, households affect their earnings and therefore the value of human capital. However, neither of these papers take into account explicitly the investment in human capital and the option values.

The individual's wealth can be divided into financial wealth and human wealth. The first one is a tradable financial assets; the second one is the human capital. Human capital can be defined as "the economic present value of an investor's future labour income" (Ibbotson et al. (2007)). The main characteristics human capital that make different from other assets is that it is illiquid, indivisible, it has an uncertain returns and it is not tradable. In the life-cycle on individuals, t, younger investors typically, have far more human capital than financial one because they have many years to work and they have had few years to save and accumulate financial wealth. Obviously, the reverse holds for older investors. Based on some papers about human capital effect it is possible to assert that human capital has to be considered and treated like any other asset class: in terms of risk, return, and correlations with other financial asset classes.

Lindset and Matsen (2011) examine the decisions of a life-cycle investor that can invest in his own human capital, as well as in financial assets. In particular they analyze how an individual should optimally invest in human capital. To start, two authors split up the human wealth into two components: the value of human capital in place and the value of the options to invest in more education (human capital) at later point in the life. Taking into account the irreversibility of human capital investments, they derive the value of the option to invest in more education and the value of the human capital already in place for an individual. The non-marketability of human capital causes demand for hedging its risk. For this reason they also illustrate the individual's optimal consumption and portfolio strategy. Besides the fact that an individual hedges the risk from labour income, as illustrated in the section 1.2, they also consider the risk from the rental price for human capital. Following Lindest and Matsen (2011) it is possible to explain their model. They denote $F(t)$ the individual's financial wealth at time t, while $\alpha(t)$ denotes the share of financial wealth invested in the risky asset. They assume the evolution of financial wealth is given by:

$$dF(t) = \left[\left(\alpha(t)(\mu - r) + r\right)F(t) - C(t)\right]dt + \alpha(t)F(t)\sigma dz(t) + du(t) \tag{1.22}$$

where *du(t)* is the flow of disposable labour income at time *t,* z(t) is a standard wiener process, μ is a constant that represents the instantaneous expected rate return on the asset, σ is the instantaneous standard deviation of the returns. $H(0) = H_0$ is the individual's initial stock of homogenous human capital. $a(t)$ denotes the rental price for a unit of human capital $H(t)$ at time *t* as there is a market in which the services of human capital are treaded. They assume that the rental price $a(t)$ follows a geometric Brownian motion:

$$\frac{da(t)}{a(t)} = \lambda dt + b\sigma dz(t) \tag{1.23}$$

where:

λ is a constant drift coefficient

b is a positive constant.

To obtain manageable analytic results, they assume complete markets where the rental price of human capital is perfectly correlated with risky financial asset return. They use the Cobb-Douglas function to transform human capital into labour income:

$$\hat{y}(t) = a(t)H(t)^{\theta} \qquad 0 < \theta < 1 \tag{1.24}$$

where $\hat{y}(t)$ is realized labour income at time *t.* The cost of increasing the level of skills and knowledge is rising over time; human capital is partially expandable; this assumption certifies that human capital investment tends to occur early in life, despite the infinite time horizon setting assumed. They consider that $dH(t) = Q(t)dt$ be the flow of acquired human capital at time *t*, where $Q(t)$ is the net investment in human capital at time *t*. Differentiating and applying Ito's lemma to (1.24) and substituting (1.23) it is possible to find the flow of disposable labour income (for consumption and investments in financial assets):

$$dy(t) = a(t)H(t)^{\theta}\left[\lambda dt + b\sigma dz(t)\right] - \left[k_0 e^{\rho t} - a(t)\theta H(t)^{\theta-1}\right]Q(t)dt \tag{1.25}$$

The first term on the right hand side is the labour income flow delivered by the previous level of human capital and the second term is the net income from any investment in human capital at time *t;* the term in last square brackets is the net marginal investment cost at time *t,* it increases with time since the unit cost of what *k* increases exponentially over time and it is defined as *I(H,a,t).* In other words, Lindset and Matsen (2010) also evaluate the human wealth analyzing the value of human capital already in place and the option value, at time t, of investing in more human capital now or in the future.

Considering the case of human capital already in place*, H(t)* is the individual's stocks of human capital at time *t* and if the individual does not make investments in human capital, this stock will be constant in time. The rental price will oscillate so at time κ with $t \leq \kappa$, labour earnings are $y(\kappa) = a\left(\kappa\right)H\left(t\right)^{\theta}$. Combining the rental price in (1.23), with the transformation of human capital in labour income in (1.24), it is possible to obtain:

$$\frac{dy}{y} = \lambda dt + b\sigma dz \qquad (1.26)$$

In the next step, by following Bodie, Merton and Samuelson (1992), they show that the value of human capital in place is:

$$V\left(H;a,t\right) = \frac{y(t)}{r + b\left(\mu - r\right) - \lambda} = \frac{a\left(t\right)H\left(t\right)^{\theta}}{r + b\left(\mu - r\right) - \lambda} \qquad (1.27)$$

where denominator $r + b\left(\mu - r\right) - \lambda$ is assumed to be positive. They consider *v(H;a,t)* as the marginal value of acquired human capital at time *t*:

$$v(H; a, t) = \frac{\partial V}{\partial H} = \frac{\theta a(t)H(t)^{\theta-1}}{r+b(\mu-r)-\lambda} \qquad (1.28)$$

Considering the case in which Lidest and Matsen (2010) analyse the individual's options to invest in additional human capital. First, they denote the value of the options with *G(H;a,t).* Supposing to hold one of the unit of the expansion options and sell short *m* units of the risky asset *n*, they find and demonstrate that this gives the differential equation for the value of marginal expansion option $g\left(H;a,t\right) \equiv \frac{-\partial G}{\partial H}$ (an increasing in *H* means exercising some of the future expansion options):

$$\frac{1}{2}(b\sigma)^2 a^2 \frac{\partial^2 g}{\partial a^2} + \left[\lambda - b(\mu - r)\right] a \frac{\partial g}{\partial a} - rg + \frac{\partial g}{\partial t} = 0 \qquad (1.29)$$

This partial differential equation is subject to boundary conditions:

$$g(H;0,t) = 0 \qquad (1.30)$$

$$g(H;a^*,t) = v(H;a^*,t) - I(H;a^*,t) \qquad (1.31)$$

$$\frac{\partial g(H;a^*,t)}{\partial a} = \frac{\partial v(H;a^*,t)}{\partial a} - \frac{\partial I(H;a^*,t)}{\partial a}$$

$$(1.32)$$

$$\lim_{t\to\infty} g(H;a,t) = 0 \qquad (1.33)$$

(1.30) says that if $a = 0$, the opportunity to invest in human capital is valueless. The second and the third boundary condition are respectively the value matching and smooth parting conditions. The (1.31) says that at the value a^* where it is optimal to exercise the marginal option, the individual gets a net payoff equal to the present value of labour income it delivers minus the net marginal cost. The last boundary condition shows that the value of the option to invest in a marginal unit of human capital approaches zero passing the time, and the cost of exercising the option increases with time. The authors demonstrate that the solution of the partial differential equation (1.29) subject to (1.30)-(1.32) is given by:

$$g(H;a,t) = B(H)a(t)^{\beta_1} e^{-qt} \qquad (1.34)$$

Where *B(H)* and *q* are parameters to be determined. And β_1<1 is the first root of (1.28). The second and the third boundary conditions (1.31) and (1.32) applied to solution (1.34) allow to find critical exercise value a^*:

$$a^*(H,t) = \frac{\beta_1}{\beta_1 - 1} \frac{\left[r + b(\mu - r) - \lambda\right] \iota_0 e^{pt}}{\theta H(t)^{\theta-1}} \qquad (1.35)$$

where denominator is interpreted as the instantaneous flow cost of increasing the human capital stock by a marginal unit at time *t*.

(1.35) illustrates that the value of the current marginal labour earnings product $a\theta H^{\theta-1}$ must be a multiple $\frac{\beta_1}{\beta_1 - 1}$>1 of the flow cost to start the investment. The critical exercise value a^* increases over time that is the direct investment cost, increases with time. They show that a^* increases with age and with the human capital level; older individuals and individuals with more human capital require higher wages rates to undertake human capital investments. This option valuation is used in analyzing the optimal human capital investment policy for the individual; the function $a^*(H,t)$ defines the optimal human capital level at every instant. Starting from (1.34) they rearrange $a^*(H,t)$ in terms of $H^*(a,t)$, expressing the optimal level of human capital at time *t*:

$$H^*(a,t) = \left(\frac{\beta_1 - 1}{\beta_1} \frac{a(t)\theta}{\left[r + b(\mu - r) - \lambda\right]\iota_0 e^{\rho t}} \right)^{1/1-\theta} \tag{1.36}$$

If $H^* > H(t)$the individual will add to the human capital stock, if $H^* \leq H(t)$no investment would be undertaken. Summarizing, the purpose of Lindset and Matsen (2010) is to identify the optimal human capital investment policy in relation with the rental price *a*, in a setting where else financial investments are considered. In sum, they get what follows:

$$\begin{aligned} Q^*(a,t;H) &= H^*(a,t) - H(t) \quad \text{if} \quad a^* < a(t), \\ &= 0 \qquad\qquad\qquad\quad\; \text{if} \quad a^* \geq a(t) \end{aligned} \tag{1.37}$$

To conclude, if $a^* < a(t)$,the human capital investment increases in the rental price *a* and decreases with time *t*.

Ibbotson et al. (2007) focus their attention on two different views of human capital: the risk-less view and a risky one. The risk-less view means that human capital acts like a risk free asset and can be treated as though the agent has an implicit holding in this asset like the bond. The papers essentially taking its view are Bodie, Merton, Samuelson (1992), Merton (1971) and Campbell and Viceira (2002). The main conclusion concerning the risk-less view is that the optimal portfolio holdings in the risky asset will generally be high early in the agent's working life and declines with agent ages. More recently paper addressing the risky issue take the view such as these considered in the previous section: e.g. Viceira (2001), Cocco et al. (2005) and Benzoni et al. (2007). The main conclusion related to these papers and this view is that modeling human capital as having stock like properties results in a lower or even negative fraction of financial wealth invested in stocks early in working life.

In the risk-less view of human capital, wealth is invested into two assets, a risky asset and a riskless one, so the portfolio return is derived from the maximization of the power utility function:

$$\max_{\alpha_t}\left(E_t R_{p,t+1}+\frac{1}{2}\left(1-\gamma\right)\sigma_{p,t}^2\right) \qquad (1.38)$$

$$R_{p,t+1}=\alpha R_{t+1}+\left(1-\alpha_t\right)=R_f+\alpha_t\left(R_{t+1}-R_f\right) \qquad (1.39)$$

where γ denotes the individual's risk aversion. To find a solution they use log portfolio returns and log returns of individual assets, and after the use of Taylor approximation as in Campbell and Viceira (2002) they find:

$$R_{p,t+1}-R_f=\alpha_t\left(R_{t+1}-R_{f,t+1}\right)+\frac{1}{2}\alpha_t\left(1-\alpha_t\right)\sigma_t^2 \qquad (1.40)$$

Substituting equation (1.40) into utility function maximization (1.39), the maximization problem becomes:

$$\max_{\alpha_t}\alpha_t\left(E_t R_{t+1}-R_{f,t+1}\right)+\frac{1}{2}\alpha_t\left(1-\alpha_t\right)\sigma_t^2+\frac{1}{2}\left(1-\gamma\right)\alpha_t^2\sigma_t^2 \qquad (1.41)$$

By solving for α_t they obtain the fraction α_t of total wealth invested in the stock, which is independent of the time horizon:

$$\alpha_t=\frac{E_t R_{t+1}-R_{f,t+1}+\frac{\sigma_t^2}{2}}{\gamma\sigma_t^2} \qquad (1.42)$$

Remembering that human capital is non-tradable, the problem that the authors solve is how the optimal asset allocation under equation (1.42) changes when we take into account the non-tradable property of human capital. The agent adjusts his/her portfolio in such a way that the total holdings of each asset equal the optimal holdings under equation (1.42). The optimal fraction of financial wealth invested in stocks then is equal to:

$$\hat{\alpha}=\frac{\alpha\left(FW_t+HC_t\right)}{FW_t}=\frac{\mu+\sigma^2/2}{\gamma\sigma^2}\left(1+\frac{HC_t}{FW_t}\right) \qquad (1.43)$$

where FW_t is financial wealth and HC_t is human capital.

This fraction of financial wealth invested in stocks decreases over the life-cycle because, as the agent ages, he consumes part of his human capital so that HC_t declines, and because his financial wealth increases as he saves part of human capital, hence FW_t increases. This is an high fraction of financial wealth invested in stocks for younger, and a lower one for older workers.

In the risky view on human capital the starting concept is that the human capital risk can be decomposed into two components: an aggregate stochastic component which captures the effect of economy-wide shocks on all individuals, and an idiosyncratic stochastic component which is subject to individual-specific shocks.

Ibbotson at al. (2007) assert that there are two basic types of risk for an investor's human capital, and they construct two scenarios: in the first one, human capital is highly correlated with the stock market, in the second one, it is uncorrelated with the stock market. In the first scenario, an investor will use his financial assets to reduce and balance his human capital risk. In the second scenario, since the investor's labour income risk is independent of financial market risk, individual's optimal financial asset allocation is similar to the riskless view. When the risk of human capital increases the investor will reduce overall risk in the financial portfolio. In general the risky asset holdings over the life-cycle typically are hump-shaped, in fact agents progressively increase stock holdings as they age, and decrease their exposure when retirement is approached. Cocco et al. (2005) and Benzoni et al. (2007) raise doubts about the way of managing human capital as an implicit investment in the riskless asset; they consider the risk profile of human capital as having stock-like properties. The main idea of Benzoni et al. (2007) is that young agents consider themselves overexposed to market risk and for that reason it would be optimal for him to take short position in market portfolio. The main conclusion of the risky view is that modeling human capital as having stock-like properties results in a lower or negative fraction of financial wealth invested in stock early in life; as agent ages this fraction becomes positive and increases until the age of retirement, after which the fraction in stocks will decline to the level it was before.

Following Shibanov (2009), it is possible to simple out three ways to modify the human capital of an agent. The first is to get a university degree; the second is "learning by doing" which means that an individual can change and improve his overall knowledge while he is working; The third is to get a training courses within the job or firm in which the individual works. These ways help to increase future streams of wage income and make earnings endogenous. In his paper the author assume that agents can use training to raise human capital, and this allows the agent to accumulate knowledge faster in younger and middle ages contributes in the increase in wage income with age. The main results of his model are that he shows that the level and shapes of wealth and wage income can be matched and that the level of training shows an inverse U-shaped behavior.

In his model it is assumed that wage follows Markov chain with two states: One is set to be 0 in order to capture the possible unemployment effect for the agent and the other state depends on time.

Following his work it is possible to individuate two ways for increasing human capital. First, the agent experiences "learning by doing" and his human capital improves with more time spend on the labour market. Second, he can improve and train his abilities and increase the future expected income wage. In the model, E_t is the training time and the evolution of human capital is assumed to be:

$$H_{t+1} = e^{a\beta_H E_t^{\lambda_H}}\left((1-\delta_t)H_t + aL_t\right) \tag{1.44}$$

In this case δ_t is the rate of depreciation of human capital and *a* is the learning ability of the agent and it is considered to be fixed for the agent for the whole life cycle. Training costs depend on the state of wage: it is equal to c_e for the unit in employment state, and c_u for the unit in unemployment state. $c(W_t)$ is the costs of training. At the beginning of period *t* the agent knows his wealth X_t, human capital H_t, learning abilities *a* and wage W_t and chooses portfolio allocation, labour, training and consumption. The budget constraint for financial wealth is then:

$$X_{t+1} = \left(W_t H_t L_t + X_t - C_t - c(W_t)E_t\right)\left(\alpha_t R_t + (1-\alpha_t)R_f\right) \tag{1.45}$$

Assumed that *J* is a number of agents who live for a fixed number of periods *T*, it is considered that agents are different in their learning abilities, financial wealth, investment opportunities and initial levels of human capital. Agents $j = 1,...,J_1$ can invest into a risky stock, while agents $j = J_1 + 1,...,J$ can not. Considering the first type of agents, they have a given learning ability, initial financial wealth X_t that is positive, and human capital $(H_0 \geq 0)$, and they are able to invest into a risky asset. Each period the agent has one unit of time and maximizes expected utility which can be separated in consumption and leisure:

$$\max E_1\left[\sum_{s=1}^{T}\beta^s\left(\frac{C_s^{1-\gamma}}{1-\gamma} + v\frac{(1-L_s-E_s)^{1-\lambda_L}}{1-\lambda_L}\right) + \kappa\beta^{T+1}\frac{X_{T+1}^{1-\gamma}}{1-\gamma}\right] \tag{1.46}$$

C_s is the consumption at time *s*

L_s is labour chosen at time s

E_s is training chosen at time s

$\kappa \frac{X_{T+1}^{1-\gamma}}{1-\gamma}$ captures bequest motives and retirement wealth.

The agent maximizes (1.46) taking into account (1.44), (1.45) and no default constraint ($X_t \geq 0$). The agent that is unable to invest in a risky asset $(j = J_1 + 1, ..., J)$ solves the same problem except his share of stock is always 0. For this type of agents uncertainty is generated by changes in wages. The problem is solved numerically using backward induction and Bellman equation and not analytically.

In relation with human capital, Ibbotson et al. (2007) introduce three risk factors associated with human capital that investors need to manage: wage earnings risk, mortality risk, longevity risk. In the major share of portfolio analysis they are often neglected. As said before the first kind of risk is linked to the fact that labour income can be viewed as a dividend on the investor's human capital and although human capital is not tradable, it is often the single largest asset an investor has. One way to reduce wage earnings is to save more. This saving converts human capital to financial capital at higher rate and the way is to diversify it with appropriate types of financial capital. Because human capital is one of the biggest asset an investor has it is necessary to protect it from mortality risk that is the loss of human capital to the household in the unfortunate event, for example premature death of the worker. For that reason life insurance has been used to hedge against mortality risk. In relation with the third kind of risk he says that investors need to make their own decisions not only about how to allocate retirement savings but also what products are better to be used to generate income throughout retirement. Investor has to take into account for two important risk factors when making these kind of decisions. The first one is the financial market risk, as volatility in the capital markets that causes portfolio values to fluctuate. It is important to consider because consequently the portfolio may be unable to give the necessary income for the individual's desired lifestyle. The second important risk is the longevity risk, that is the risk of outliving the portfolio. Each investor but especially those taking off early retirement offers or those who have a family history of longevity encounter this risk.

1.4 The impact of population ageing on household portfolios choice

Population ageing has important effects on financial markets because of its impact on saving rates and the demand for investment funds. Firstly it is necessary to consider three different effects that influenced the relationship age-financial choices. Time effect is the first one and identifies the moment in which choices are made having an impact on the average financial wealth of households and its average allocation. The second one relets to the “individual birth-date” and is known as cohort effect. The historical period in which an individual is born may influence the financial choices of the investor. Finally, the age effect captures the impact that being in a certain point of the life-cycle has on wealth allocations: theoretically, young individual should invest the most of their portfolio in riskier activities because they eventually have more time to recoup, while older people tend to be more risk-adverse than the younger and choose safer assets taking into account the retirement period. In order to combine these three effects it is possible to summarize the problem as follow:

$$a_t = t - c \tag{1.47}$$

where a_t is the age effect, t is the time effect and c identifies the cohort effect, considering that at any time t a person born in year c is a_t years old. Being the three effects a linear combination of each other, they cannot be separately identified, it is necessary to exclude one of them and to evaluate the two remaining.

One of the first studies about the relation between population age structure and financial markets returns is Bakashi and Chen (1994). The hypotheses behind their paper are the following: i) different ages imply different investment needs and different kinds of assets to include into financial portfolios (life-cycle hypothesis); ii) risk aversion increases with age (risk-aversion hypothesis). The authors consider the average age of the working population as demographic variable. The first hypothesis is tested observing the evolution of the demographic variable in relation to two measures that indicate the level of stocks (S&P500) and the housing markets prices. They find that a change in average age is positively correlated to S&P500 and negatively to housing prices. The second hypothesis that an investor’s risk aversion increases with age is tested by estimating the resulting Euler equation. The hypothesis test starts from the optimization problem where the investor maximizes his utility function depended on consumption and on demographic variable that is in this case the average age of population aged more than twenty $\left(\bar{A}_t^{20+}\right)$. The first order condition that solves the optimization problem is just the Euler equation:

$$E\left[\delta\frac{C_{t+1}\exp\left[-\left(\gamma+\lambda\bar{A}_t^{20+}\right)\right]}{C_t\exp\left[-\left(\gamma+\lambda\bar{A}_t^{20+}\right)\right]}-\left(1-R_t\right)-1\,|\,Z_t\right]=0 \qquad (1.48)$$

where:

C_t = consumption

R_t = real rate of return on S&P500

Z_t = set of instrumental variables

δ, γ, λ= coefficients estimated by means of Generalized Method of Moments (GMM).

Substantially, as Poterba (2004) says, "they find the fit of an empirical Euler equation for the intertemporal variation in aggregate consumption could be improved if the parameter describing aggregate risk aversion varied with the average age of the population". Bakshi and Chen (1994) provide empirical evidence of a substantial effect of demographic evolutions on capital markets.

Yoo (1994a) analyzes the role of age in portfolio selection. He uses the following regression:

$$\begin{aligned}\alpha_i &= \beta_0+\beta_1 Pop_i^{25-34}+\beta_3 Pop_i^{45-54}+\beta_4 Pop_i^{55-64}+\beta_5 Pop_i^{65+}+\beta_6 Kids_i+\\&+\beta_7 Adults_i+\beta_8 Male_i+\beta_9 White_i+\beta_{10} Married_i+\beta_{11} HS_i+\\&+\beta_{12} Col_i+\beta_{13} Y_i+\beta_{14} W_i+\varepsilon_i\end{aligned} \qquad (1.49)$$

where α_i is the portfolio share held in each of three assets, that are cash, bonds and equities, and ε_i is the error term. There are also explanatory variables include dummies for age-class, number of children and adults in the household, gender, marriage status, High School education, College education, income and wealth. The author finds that the number of individual with risky assets progressively diminishes along with age and average portfolio allocations in bonds, cash and equities is different in the five age class. The results of the regression suggest that age is a significant factor in the composition of model portfolio and that the share invested in equities increases during the working period and decreases after retirement.

Yoo (1994b) describes the relationship between age distribution and asset returns by using a multi-period OLG asset-pricing model. He uses both model simulation and econometric regression to test the implications of the model. By the OLG simulations he finds that an increase in the size of the part of population with highest financial wealth (45-year-old-group) can reduce the asset returns up to the double. To test the robustness of the results he runs the regression:

$$R_t = \beta_0 + \beta_1 Pop_t^{25-34} + \beta_2 Pop_t^{35-44} + \beta_3 Pop_t^{45-54} + \beta_4 Pop_t^{55-64} + \beta_5 Pop_t^{65+} + \varepsilon_t \quad (1.50)$$

where R_t is the real annual returns of six different types of US securities as common stocks, small company stock, long term corporate bonds, long term government bonds, intermediate-term government bonds and T-Bills. The regression shows that there is not a strong relationship between young population and asset returns (β_1 is not always statistically significant). Since β_3 is strongly significant and negatively signed, an increase in the size of middle-aged population increases the demand for all assets. β_4 has different behavior and different signs on the basis of the asset returns used as dependent variable, for example positive for stocks while negative for bonds; it confirms that people close to retirement period disinvest risky assets preferring long-term risk-free bonds. To sum up, on the basis of simulation models the author concludes that demographic factors play a role in the determination of the financial assets returns.

Tin (1998) uses a OLS regression to investigate the household demand for financial assets:

$$\log m_i = \beta_0 + \beta_1 \log w_i + \beta_2 \log \pi_i + \sum_{n=1}^{N} \delta_n \log \pi_{ni} + \alpha S_i + \varepsilon_i \quad (1.51)$$

where:

m_i = quantity of asset demanded by household *i,*

w_i = either labour income, wealth or net worth of household,

π_i = opportunity cost of holding the asset

π_{ni} = price or user cost of the nth asset other than m_i

S_i = set of socio-demographic control variables.

The regressions are run for several assets and for three age classes (under 35, 35-59, 60 and over). The author asserts that "the results show that the propensities to hold financial assets differ substantially among young, middle-aged, and old householders. The life-cycle hypothesis generally holds as far as the relation between labour income and asset demand is concerned"

James Poterba, (2001,2004), is one of the most influential author in the age-finance literature. In Poterba (2001), he describes the link between demographic variables and capital price by a simplified OLG model and examines the age-profile of corporate stock holdings, net financial asset and net worth for individuals in different age classes. It is supposed that the individual live for two periods: the "young-period" where individual work and save a fixed rate of their wages (*s*) and the "old-period" when they retire and consume. Their production is normalized to one unit and there is only one asset in the market which does not depreciate and thus is fixed in supply (*K*). Supposing that supply and demand for financial assets must correspond, in each period the following equation must hold:

$$p * K = s * N_y \tag{1.52}$$

where N_y is the number of young workers and p the relative price of assets in terms of the numeraire good. From his analyses it emerges that the asset holdings reach their top in the age classes between 30 and 60 and then slightly decrease. Then the analysis moves from single cross-section to repeated cross-section data, used to estimate the following regression:

$$y_{it} = \sum_{j=1}^{13} \alpha_j Age_{ijt} + \sum_{c=1}^{12} \gamma_c Cohort_{ict} + \varepsilon_{it} \tag{1.53}$$

where the dependent variable y_{it} is the level of either common stocks, net financial assets or net worth held by investor *i* at time *t*; Age_{ijt} is an indicator variable for j different 5-year age groups and $Cohort_{ict}$ is a specific intercept term for 5-year of birth cohorts. Following this way the author focuses on age and cohort effects implying no time effect. Analyzing the coefficients α_j he reports that they have " a surprisingly small impact on the estimated age structure of asset holdings". As far as γ_c coefficients concern, the author reports only "surprisingly small differences across cohorts for net worth, equities, and financial assets. Poterba (2004) asserts that his previous model neglects many important real features of asset pricing and that there are four important omissions. The first problem is about the fixed saving rate for young workers: a more sophisticated analysis would allow workers to vary their saving rates in response to expectations about future rates of return. The fixed supply of capital is the second problem; fixing the supply of capital amplifies the impact of shocks to asset demand. Another problem is to consider a closed economy without international capital flows. Finally, the analysis does not consider how a changing age structure might affect non-financial aspects of economy, such as the rate of productivity growth. Poterba (2004) claims that Poterba's (2001) econometric results provide a very limited support for a link between asset markets returns and demographic variables because of simplified hypothesis of the OLG model. Poterba (2001) considers also the historical relationship between population age structure and asset prices an returns, by running the following regression:

$$R_t = \beta_0 + \beta_1 Demo_t + \varepsilon_t \tag{1.54}$$

where the dependent variable $\left(R_t\right)$ is the real return on either T-Bills, long-term Governament Bonds or Stocks and $Demo_t$ are different demographic measures of the population age structure. He considers data for three country (US, Canada, UK) and he finds that there is weak evidence of a link between asset returns and demographic structure, for Canada, the coefficients are statistically significant only for fixed-income assets and point towards a positive relation between real returns and middle-aged. Limited to US, the author also studies the relation between demographic variables and stock prices (*P*) normalized by corporate dividend (*D*), by the following regression both in levels and first differences:

$$\left(\frac{P}{D}\right)_t = \beta_0 + \beta_1 Demo_t + \varepsilon_t \qquad (1.55)$$

when levels are used several demographic variables are significant, but the possibility of spurious regression can not be excluded. In Poterba (2004) the author shows new findings on the correlation between population age structure and asset price returns. He adds Z_t to the regression that represents a set of additional variables included as control variables that are the real interest rate and the economic growth rates. The results are different when the model becomes:

$$\left(\frac{P}{D}\right)_t = \beta_0 + \beta_1 Demo_t + \beta_2 Z_t + \varepsilon_t \qquad (1.56)$$

the coefficients of demographic variables are significant and correctly signed even the model is estimated with the control variables. When the same regression is run in first differences the coefficients become non significant.

Ballante and Green (2004), in contrast with Poterba (2001) find that age is a significant determinant of portfolio allocation, they test the life-cycle risk-aversion hypothesis specifically for elderly using the following OLS regressions:

$$\begin{aligned} \alpha_i &= \beta_0 + \beta_1 \log\left(NW\right)_i + \beta_2 \left[\log\left(NW\right)\right]^2 + \beta_3 Age_i \log\left(W\right)_i + \beta_4 Female_i \\ &+ \beta_5 Male_i + \beta_6 Health_i + \beta_7 Non-White_i + \beta_8 HS_i + \\ &+ \beta_9 College_i + \beta_{10} Kids_i + \varepsilon_i \end{aligned} \qquad (1.57)$$

where α_i is the share of risky assets in the financial portfolio of household, $\log\left(NW\right)_i$ is the log of net worth, *Age* is the age of the head of the household minus 65, *Kids* is the number of children, *Female* and *Male* are two dummies for single-female/male households and health, *Non-White*, *HS* and *College* are dummies respectively for poor health status, race and highest education level. They find that the age coefficient is negatively signed and significant, suggesting that the share held in risky assets tends to decline with age confirming that ageing is typically associated with a stronger relative risk aversion.

Davis and Li (2003) examines the link between some demographics and financial markets (equity returns and bond yields) considering 7 OECD countries. The authors study two different regressions: a panel regression and a normal OLS regression. The first one is estimated by means of GLS:

$$\begin{aligned}\Delta \log\left(P^e\right)_{it} &= \beta_0 + \beta_1 Pop_{it}^{20-39} + \beta_2 Pop_{it}^{40-64} + \beta_3 \Delta GDP_{it}^{HP} + \\ &+ \beta_4 \Delta\left(GDP - GDP^{HP}\right)_{it} + \beta_5 LR_{it} + \\ &+ \beta_6 Vol\left(P^e\right)_{it} + \beta_7 DY_{it-1} + \varepsilon_{it}\end{aligned} \qquad (1.58)$$

where $\Delta \log\left(P^e\right)_{it}$ is the log difference of real equity prices and explanatory variables include both demographic and non-demographic variables. The non-demographic variables are: trend GDP and growth rate $\left(\Delta GDP^{HP}\right)$; $\Delta\left(GDP - GDP^{HP}\right)$ is defined as the difference between the *GDP* and its trend. *LR* represents the long-term real interest rate and $Vol\left(P^e\right)$ the monthly average of equity prices volatility. *i* and *t* denote respectively the country and the year of the observation. The results show that non demographic variables are significant except equity prices volatility, and demographic variables turn out to be strongly significant. The second kind of regression, labelled as "international", is a normal OLS regression where data for each variable are aggregate across countries by using annual GDP as weights. It differs from the previous one only for the absence of country-subscripts *i*. The results of this regression are the following: three out of five non-demographic variables are not significant (equity prices volatility and GDP variables). Among the demographic variables only Pop_{it}^{40-64} has a positive and significant coefficient. Davis and Li (2003) study the link between demographics and long-term government bond yields:

$$\begin{aligned}LR_{it} &= \beta_0 + \beta_1 Pop_{it}^{20-39} + \beta_2 \Delta SR_{it} + \beta_4 \left(LR - SR\right)_{it-1} + \\ &+ \beta_5 \Delta \ln\left(CPI\right)_{it-1} + \beta_6 \Delta\Delta \ln\left(CPI\right)_{it} + \beta_7 \Delta GDP_{it}^{HP} + \\ &+ \beta_8 \Delta\left(GDP - GDP^{HP}\right)_{it} + \varepsilon_{it}\end{aligned}$$

(1.59)

where LR_{it} is the bond yield and explanatory variables include, besides the previous defined, the first difference of the short rate, the lag of the term structure differential, and both lag and acceleration of inflation. They find that demographic are significant and that there is a positive relation between young generation size and bond yields (negative for the middle-aged). The authors conclude that demographic changes can have a significant impact on both stock prices and bond yields.

Ameriks and Zeleds (2004) analyzes separately the equity ownership, the equity portfolio share and equity portfolio share conditional of equity ownership and for each of these portfolio decisions, they perform an analysis of age, cohort and time effect identification problem. They use a probit regression for the equity portfolio share and OLS for the other two in which either no cohort effect is assumed or no time effect is assumed. When no time effect is assumed, all of the three decisions show an increasing pattern along with age. If instead no cohort effect is considered, the decision whether or not to hold risky assets as well as the unconditional equity portfolio shares show hump-shaped patterns along with age, and the age effect disappears only if equity portfolio shares conditional on equity holding are considered. Ameriks and Zeldes (2004) reach the conclusion that age strongly influences portfolio decisions as the extensive margin, but when the decision to hold risky assets is taken, age is not really important in determining how much of financial wealth to allocate to these assets.

Guiso, Haliassos, Jappelli (2002) make an overview of several papers about the impact of age on household portfolio choices in different countries. They consider the paper by Alessie et al. (2002) for the Netherlands, Banks and Tanner (2002) for the UK case, Bertaut and Starr-McCluer (2002) for the US, Eymann and Borsch-Supan (2002) for Germany and Guiso and Jappelli (2002) for Italy. The methodology used in all studies is the same: the financial assets are clustered into three risk categories (bank accounts, government bonds, stocks); then for the decisions concerning how much of financial asset to hold in risky asset (intensive margin of portfolio decision) and the decisions to hold or not risky assets at all (extensive margin of portfolio decisions), the authors make explorative and econometric analysis examining the average household portfolios across different age classes. In general they find that a clear hump-shaped age profile especially for the participation decision. In the US case they observe that average share invested in risky assets reach the top for households aged between 45 and 64, while it declines moving towards younger or older investors. For the Italian case the authors observe that households investing in risk asset increase of those 30 years of age and decrease of the middle-aged. By contrast for Dutch and German cases they report that the elderly are more likely to hold risky assets. They provide results for the Italian case, and they run a regression with both cross-section and panel data, where the dependent variable is in turn the dummy variable or the share invested in risky assets and explanatory variables include the age of the family head (*A*), household income (*Y*), wealth (*W*) both in linear and quadratic terms, the family size (*Size*) and the number of children (*Kids*), dummy variables for the marital status (*Married*), gender (*Male*), geographic zone of residence (*South*), level of education of the family head (*Edu*), unemployment rate (*u*), the index of bank diffusion (*Bank*) in the province of residence together with year dummies (*T*):

$$\begin{aligned}\alpha_i &= \beta_0 + \beta_1 A_i + \beta_2 \frac{A_i^2}{1000} + \beta_3 Y_i + \beta_4 \frac{Y_i^2}{1000} + \beta_5 W_i + \beta_6 \frac{W_i^2}{1000} + \\ &+ \beta_7 Size_i + \beta_8 Kids_i + \beta_9 Married_i + \beta_{10} Male_i + \beta_{11} South_i + \\ &+ \beta_{12} Edu_i + \beta_{13} u_i + \beta_{14} Bank_i + T + \varepsilon_i\end{aligned} \qquad (1.60)$$

Brunetti and Torricelli (2007,2010) examine Italian household portfolios. They group financial assets on the basis of credit and market risk categories, examine the average portfolio by dividing households by age classes and then by both age classes and NW quartiles, for testing whether the age effect persists even under different economic conditions. They find that the average Italian household portfolios are allocated consistently with the life-cycle theory, that is that the middle-aged hold riskier portfolios and older ones tend to disinvest risky financial instruments and turn to safe assets in anticipation of the retirement period.

In all the studies examined, the age factor is one of the most determinants of household portfolio choices. Although the shape of portfolio decision along the life cycle arising by data might differ, hump-shaped rather than linear, depending on the decision on which study is focused, participation decisions or allocation decisions, as well as the dataset used. By the previous overview of the literature, a change in the age structure of the population might translate into different aggregate demand for certain financial assets with direct consequences on their prices and returns. This implies that financial market are affected by ageing population. The regression analysis are used to individuate and to study the correlation between some measures of financial assets prices, or returns, and a set of demographic variables. In some cases, the models focus only on demographic variables and do not include control variables, this is the case for Yoo (1994) and Poterba (2004). In other cases, the models are not comparable since either the dependent financial variable or the explanatory demographic variables includes are quite different. For instance, Ballante and Green (2004) focus on the share invested in some financial activity rather than on its returns. The studies differ in terms of datasets and possible methodologies used; the two possible techniques are: time – series regression as in Poterba (2001,2004) or panel data estimations such as in Ballante and Green

(2004). The studies also differ in terms of model specifications: the dependent variable used might be either asset prices, asset returns, or equity risk premium; the explanatory variables might include only demographic variables or both demographic and economic and financial measures. In turn demographic measures chosen can also differ: in some studies it is used the average age of working population, while others preferring the proportion of different age classes over the total population.

1.5 The presence of annuities in household portfolio models

The necessity to consider annuities in household portfolio models arise from the stochastic nature of an household investment horizon that considers a source of risk called longevity risk; longevity risk can be defined as the risk for the investor of living longer that predicted and hence run out of saving.

Many papers, in order to take into account for this issue have considered, in their portfolio models, uncertainty in the length of life in connection with the role played by a particular type of assets that is annuities. An annuity is an insurance contract providing payments for the remaining life of the insured person and are offered in different kinds, such as deferred or immediate annuities, variable or fixed, with or without guarantee periods, etc.

One of the first papers that studies the problem of uncertain lifetime and life insurance is Yaari (1965). Life annuities provide a certain income for the remainder of the individual's lifetime and annuitization gives an important option when choosing an adequate investment strategy for retirement ages; for this reason, annuities are considered an important parameter to be considered for households portfolio choices. The question that Yaari (1965) treats is how consumers should optimal allocate their limited resources over an uncertain lifetime extending the analysis of optimal consumption plans by maximizing an investor's expected utility function over a random time horizon. Moreover, He shows that an investor without bequest motives will find it optimal to completely annuitize his savings. The seminal papers of Yaari (1965) shows that in a deterministic financial economy and in nonexistence of bequest motives, expected utility maximizers will annuitize their entire wealth. In other words, he finds that all assets should be annuitized if the individual is a rational investor without bequest motive. In the model considered by the author, the investor is only exposed to mortality risk and all annuities are fairly priced from an actuarial standpoint; his model does not consider other sources of risk, such as interest rates, stock market, and inflation risk. Later, Davidoff et al. (2005) show that the conclusions achieved by Yaari (1965) under which full annuitization is optimal are not in total correct: if there is a no bequest motive and the return on the annuity is greater than the one of the reference asset, an individual will fully annuitize financial wealth only in presence of a complete market otherwise partial annuitization becomes optimal. A market is complete if all Arrow-Debreu securities contingent on survival are available to the investor. An investor can purchase annuities that pay a pre-specified amount at one specific date and state. However, a partial annuitization become optimal, if either assumption about completeness is relaxed or the investor has a bequest motive.

A majority of literature focus on dynamic asset allocation with annuities imposed the restriction that financial wealth must be fully annuitied; the problem is that this assumption is considered restrictive and unrealistic because investors are not allowed to hold at the same time both financial wealth and annuities. Milevsky and Young (2007) examine the optimal annuitization strategy with investment and consumption strategies of a utility-maximizing retiree facing a stochastic time of death. Furthermore, they focus their study on the impact of aging on the optimal purchase of life annuities. However, they consider a variety of restrictions and limit their study in different ways: they do not take into account the impact of annuity markets during working life and they do not consider the effect of a pre existent pension income on the investor's annuitization strategy. In other words they ignore the impact of annuity markets during working life. The main conclusion of their work is that the frequent repurchase of life annuities during retirement, that is gradual annuitization, is optimal.

Moreover, another paper that analyses the case of constant life annuities disregarding other important features of the decision problem is Cairns et al. (2006). Cairns et al. (2006) as well as Koijen et al. (2006) include both working life and retirement in their analysis, unlike Milevsky and Young (2007). Koijen et al. (2006) study the optimal portfolio, consumption, and annuity choice, but in order to keep the problem tractable, they exogenously fix the date at which the investor invests all wealth in annuities. Moreover, Cairns et al. (2006) and Koijen et al. (2006) "force" investors to fully annuitize their financial wealth at the beginning of the retirement period in order to make their model more tractable.

Richard (1975) models longevity insurance and endogenizes the annuitization decision. However, the problem of his work is that he does not include the irreversibility of the longevity product purchase, labour income risk, or borrowing constraints. Starting from Merton model (1971) who introduced mortality to individuals portfolio selection models, incorporating a parametric survival model of mortality, Richard (1975) extends this model to consider additionally the optimal amount of life insurance. Moreover, to do this, he substitutes the parametric survival model of Merton (1971) with a more realistic non-parametric survival model; he considers key elements of personal financial planning but his model is not straightforward in terms of implementation due to its complexity.

In a more recent work Horneff et al. (2008) overcome limitations of the previous works and study the optimal strategy of consumption and saving in the presence of constant life annuities, bonds, and stocks in an incomplete market setting. In their model, authors contribute to previous literature on life annuities by "deriving the optimal consumption and savings strategy with constant life annuities, stocks, and bonds and by exploring the welfare implications of incomplete life annuity markets in a realistic calibrated life-cycle model in which annuities can be purchased gradually". Moreover, they calibrate a discrete time asset allocation and consumption model which incorporates three sources of risk faced by a household, that are: risky stocks, untradeable labour income risk during working period, and stochastic time of death. Considering the last two features their model can be seen as an extension of models presented in previous section (1.2) in which labour income effect on household portfolio choice is treated. In particular, the model shares many features of Cocco et al. (2005). Horneff et al. (2008) assume that the utility function of the household is either of the Constant Relative Risk Aversion (CRRA) utility function or Epstein/Zin type and potentially includes a bequest motive. One of the add values of their models is that no one has considered Epstein/Zin utility with respect to the annuitization decision. The model presented in Horneff et al.(2008) is a time discrete model in which the individual has p_t^s to survive from t until *t+1* and has Epstein/Zin utility defined over a single non-durable consumption good. The Epsten/Zin preferences as in Epstein and Zin (1989) are described in the following equation:

$$V_t = \left\{(1-\beta p_t^s)C_t^{1-1/\varphi} + \beta E_t\left[p_t^s V_{t+1}^{1-\rho} + (1-p_t^s)k\beta_{t+1}^{1-\rho}\right]^{(1-\frac{1}{\varphi})/(1-\rho)}\right\}^{1/(1-\frac{1}{\varphi})} \tag{1.61}$$

where C_t is the consumption level, β_t is the bequest at time t, ρ is the level of relative risk aversion, φ is the elasticity of intertemporal substitution, β is the discount factor, and k is the strength of the bequest motive. After preferences, the model takes into account the labour income process and, as well as Cocco et al. (2005), emphatizes the importance of incorporating risky labour income into the asset allocation analysis of households. They consider labour income risk because they "consider labour income risk as key when analizing the trade-off between the inflexibility related to annuity investment and their mortality credit during working life." The process of labour income is in line with Cocco et al. (2005) explained in 1.2. Furthermore, regarding the capital market, Horneff et al. (2008) consider that the individual can invest via direct investments in the two financial assets: riskless bonds and risky stocks. Moreover, an incomplete annuity market is considered; against the payment of an actuarial premium A_t, the annuitant receives a constant payment *L* until death.

$$A_t = Lh_t \text{ with } h_t = (1+\delta)\sum_{s=1}^{T-t}(\Pi_{u-t}^{t+s} p_u^a)\, R_f^{-s} \quad (1.62)$$

where *d* is the loading factor and $\boldsymbol{p}_u^a$ is the survival probability used by the annuity provider, which is higher that the average survival probabilities $\boldsymbol{p}_u^s$. The annuity provider van hedge the guaranteed annuity payments by pooling mortality risks of annuitants; the funds of those who die are allocated among the living member of a cohort and this represent the source of the so called mortality credit that is the excess annuity return over a bond. The annuity market is considered incomplete because only life-long pay-outs are available and funds from annuity are invested in bonds only. Furthermore, the mortality is considered in the model: to give mortality a functional form they apply the Gompertz law; the force of mortality used by the provider and the subjective one are specified as the following function of the parameters m^i and b^i:

$$\lambda_t^i = \frac{1}{b^i} exp\left(\frac{t-m^i}{b^i}\right) \quad (1.63)$$

with *i* = *a,s*. The two parameters m^i and b^i determine the shape of the force of mortality function; the survival probability is given by:

$$p_t^i = exp\left(-\int_0^1 \lambda_{t+s}^i \, ds\right) \quad (1.64)$$

Additionally, the authors model the subjective force of mortality as a linear transformation of the force of mortality derived from the average population mortality table.

As far as wealth accumulation concerns, at each point in time investors have to decide on how to spread wealth on hand across bonds (M_t), stocks (S_t), new annuities purchases (A_t), and consumption (C_t). The constraint is:

$$W_t = M_t + S_t + A_t + C_t \quad (1.65)$$

After the explanation of all parameters, Horneff et al. (2008) try to find the numerical solution of the optimization problem affirming that optimization problem of this type can not be solved because the untradeable income, irreversibility of annuity purchase, and the short selling restrictions. Therefore they decide to adopt the standard approach of dynamic stochastic programming to solve the household's optimization problem. The model is first solved for the baseline case (no loads, no asymmetries between insurer's and annuitant's beliefs, no bequest) so as to isolate the role of the annuities in the portfolio problem. The investment in stocks and bonds results are close to Cocco et al. (2005) given that the setup implies the same interpretation of labour income, which is considered more as a bond-like asset than a stock-like one. However, the presence of annuities in most cases crowds out bonds thus indicating that mortality credit compensate for illiquidity of annuities. Moreover the optimal annuity holding increases over time in contrast to stock holdings and the explanation, as in Cocco et al. (2005) rests on the characterization of labour as a bond-like asset, whose holding decreases with age.

In conclusion, Horneff et al. (2008) try to highlight the trade-off between the illiquidity of purchased annuities and their mortality credit during working life and retirement; they show that the demand for annuities rises when the individual becomes older. They also show that the demand for annuities rises with wealth on hand.

2. DATASET AND DESCRIPTIVE STATISTICS.

2.1 The Dataset: The Survey on Household Income and Wealth.

The main data source on the financial wealth of Italian households is the Survey on Household Income Wealth, conducted every two years by the Bank of Italy. The Survey on Household Income and Wealth (SHIW) was firstly conducted in 1965, although complete data on household financial portfolios are available only starting from 1987. The household is the basic sample unit and it is defined as a group of people, linked by ties of blood, marriage or other relationship, sharing the same house and pooling all or part of their income. For all households interviewed, around 8,000 units, the SHIW provides an in-depth report of the real and financial wealth, as well as a large amount of information on the socio-demographic characteristics of each member, such as the age, the civil status, the city and region residence, the level of education, the job status and income earned.

The SHIW sample is representative of the Italian population. Sampling is carried out in two stages: first, municipalities are divided into 51 groups, determined by 17 regions and 3 classes of population size (less than 20,000, between 20,000 and 40,000 and more than 40,000). Then, for each municipality households are randomly selected from the registry office records.

Starting from 1989, each SHIW includes a group of "panel" households that are households already interviewed in at least one of the previous editions of the survey. Data are collected in personal interviews conducted by professionally interviewers. Typically, interviews are carried out in the first half of the year and refer to household budgets in the previous calendar year. The head of the household, defined as the person most knowledgeable about finances, answers questions concerning the whole household. On the other hand, questions about individual incomes are answered by each member, unless absent. Participation to the SHIW is voluntary and not remunerated. The problem is that the non-response is high, more or less between 30% and 40%.

The SHIW questionnaire has undergone several changes across time and for this reason the Statistic Unit of the Bank of Italy's Research Department constructed a Historical Archive of the Survey of Household Income and Wealth (HA-SHIW), which gathers the data of every wave of the SHIW since 1977. The HA-SHIW comprises two groups of files: the "original" files, that include elementary variables as originally collected in the interviews; and the "derived" files, in which data on income and wealth are aggregated in order to have data as homogeneous as possible. In addition, the HA-SHIW includes adjusted sample weights, which slightly differ from those reported in the single waves as they not only aim to reduce the estimate bias stemming from sampling procedures but also take into account the changes to the sampling procedures occurred across time.

There are two different kinds of errors: sample errors and non-sample errors. Among the non-sample errors there are non-coverage errors, non-response errors and response errors. The first kind of non-sample errors are caused by the unavoidable incompleteness of the lists from which the households (survey units) are extracted. The non-response errors (selection-bias) are caused by the reticence of some households to take part to the Survey, in particular those with higher income. The response errors on the amount of financial assets in household portfolio can draw from either non-memory (the interviewed does not remember), non-reporting (the interviewed does not want to reveal the ownership of a certain financial assets) or under-reporting (the interviewed reports the presence of a certain asset in his/her portfolio, but does not reveal its amount).

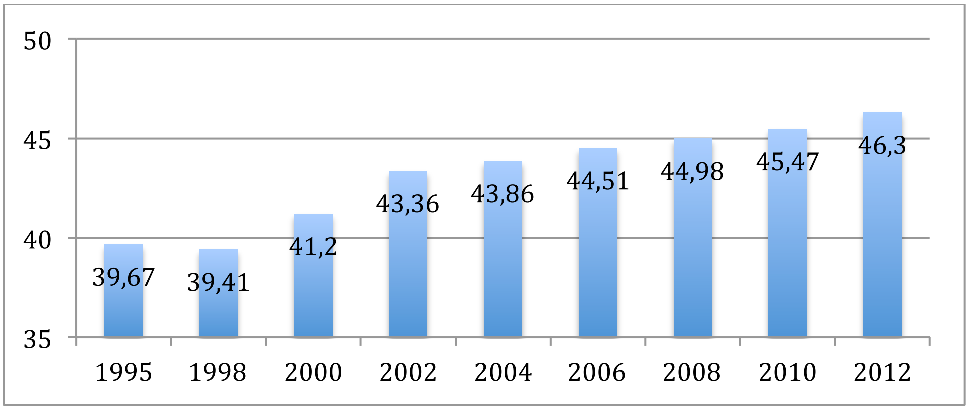
Some of these errors are unavoidable, such as non-coverage and memory errors, so that correction is possible for the estimation bias they induce. On the other hand, several procedures have been proposed in order to lessen the estimation bias stemming from other errors. In the SHIW the estimation bias induced by non-response errors is corrected by means of weighting coefficients: depending on its characteristics, each interviewed household is given an adjusted weight (PESOFIT), computed as the inverse of the ex-ante probability of taking part to the Survey. Then, the sample weights are further adjusted in order to take into account the progressive changes in the sampling procedures and to align the sample to the major socio-demographic distributions provided by ISTAT (obtaining the sample weight named PESOFL).

2.2 Descriptive statistics.

Data for the analysis are taken from the Wave by Wave Archive of the Bank of Italy Survey of Households Income and Wealth, over the period 1995-2010. The first step consists in observing the evolution of the most significant statistics of Italian households across the eight waves available.

Firstly it is interest to analyze the population ageing; population ageing is a phenomenon affecting many countries in the world including Italy. This phenomenon has a lot of financial implications on which, a lot of recent literature has focused their studies, especially on the consequences of ageing on household portfolio choices. Population ageing is reflected in a progressive evolution of financial needs and preferences that translate into in different portfolio allocations as it is possible to see in the previous chapter.

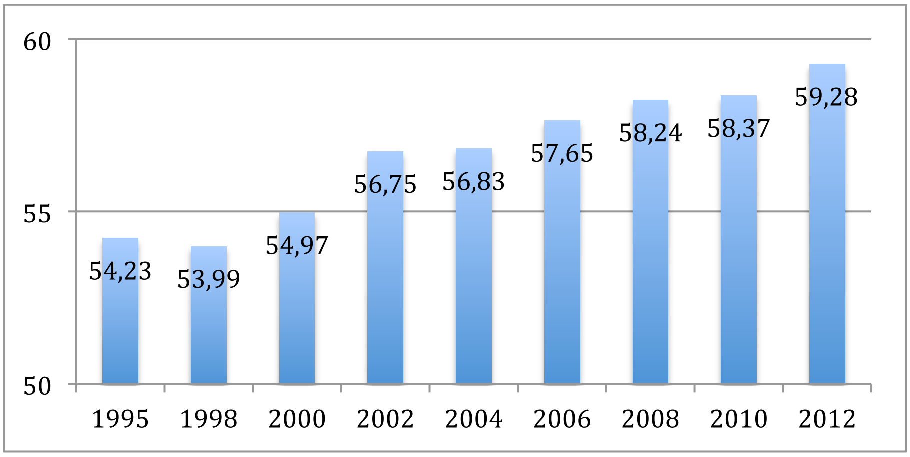
Graph 2.1: Population Ageing.



Source: elaborations on SHIW data.

In Graph 2.1 it is possible to see how Italian population average age shows a constant increase over seventeen years, from 39 years in 1995 to 45 years in 2012. The fact that Italian population is getting older is reflected on the individual choices, for example in terms of participation of supplementary pension system. Furthermore, due to population ageing, it is possible to see how the age of the head of the household is quite high over the analyzed period and also it is clear a progressive ageing of the person who makes financial decision.

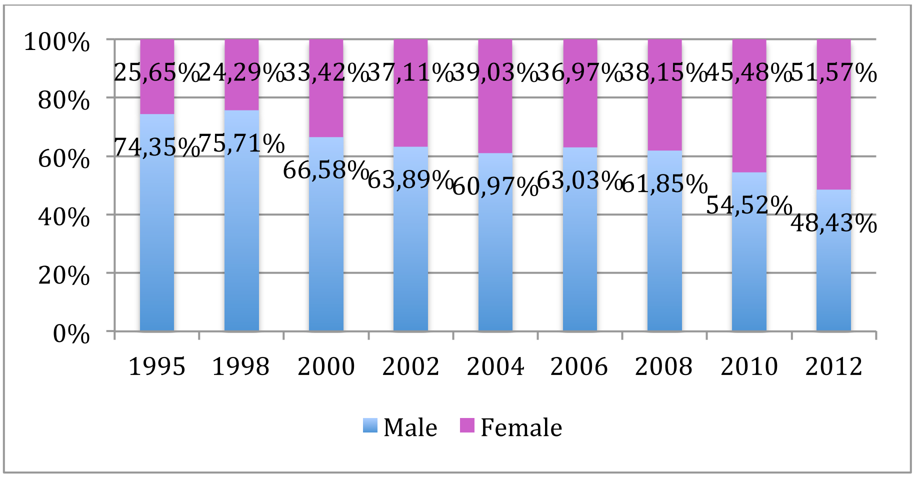
Graph 2.2: Average age of Head of Household.*Source: elaborations on SHIW data.*



Source: elaborations on SHIW data.

As far as gender concerns, it is noticeable a clear difference between the beginning of the analyzed period (1995-1998) and the other periods. The Graph 2.3 shows that in 1995 and 1998 the majority of population is male; this trend changes over years and male's percentage starts to decrease until 2010 and 2012 where female overgrow male.

Graph 2.3: Gender of Head of Household.



Source: elaborations on SHIW data.

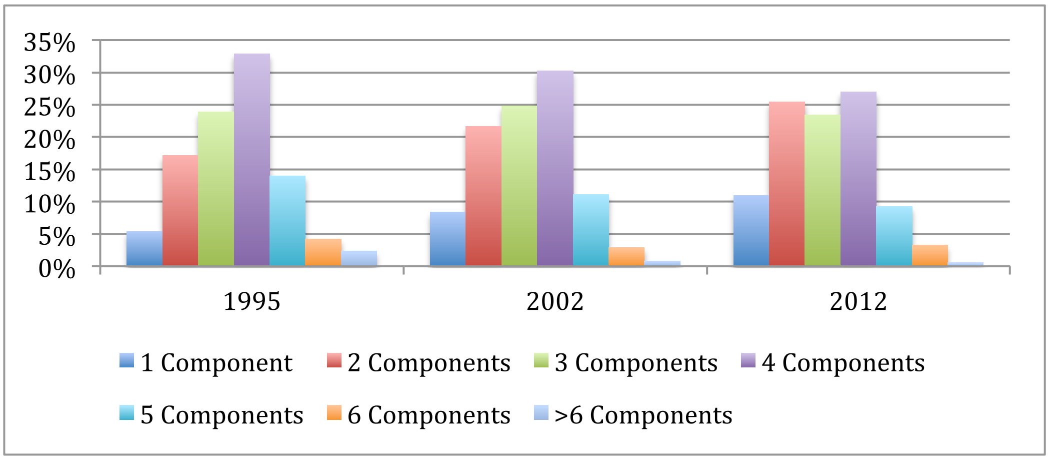
The following two Graphs (2.4 and 2.5) regard components of household. The first one (2.4) represents the family size and it is possible to see how households with one, two and three individuals tend to increase over the analyzed period. On the other hand, families with four people that are the most numerous ones tend to decrease. Furthermore, it is possible to affirm that less numerous households increase while numerous ones tend to decrease over the analyzed period. This phenomenon could be a consequence of the slight reduction of number of children per households shown in Graph 2.5 where the average number of children per households decreases constantly over time.

Table 2.1: Family size.

Number of Components	**1995**	**2002**	**2012**
1	5,39%	8,38%	10,94%
2	17,17%	21,68%	25,42%
3	23,93%	24,84%	23,46%
4	32,89%	30,24%	27,01%
5	14,02%	11,11%	9,26%
6	4,24%	2,93%	3,33%
> 6	2,36%	0,82%	0,56%

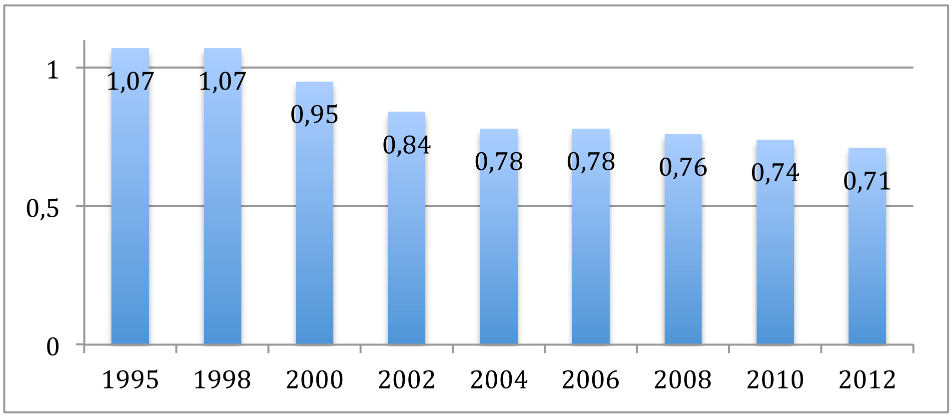
Source: elaborations on SHIW data.

Graph 2.4: Family size.



Source: elaborations on SHIW data.

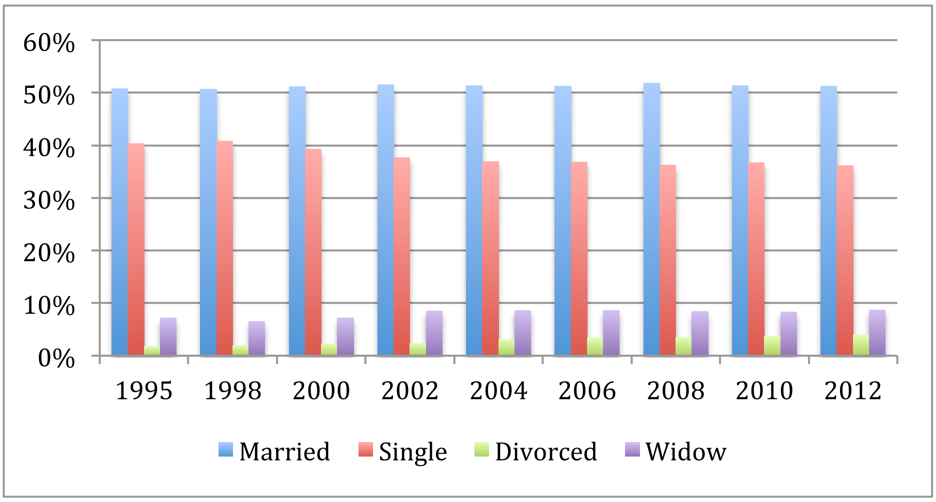
Graph 2.5: Average number of children per household.



Source: elaborations on SHIW data.

The following Graph shows individuals' marital status. How it is possible to see the predominance of people is married (more that 50%) and it remains constant over time. Moreover, the second class of people in terms of percentage is composed by single people (around 40% of population). The last 10% of population is divided between widowed and divorced people that are the less numerous classes.

Graph 2.6: Marital status.



Source: elaborations on SHIW data.

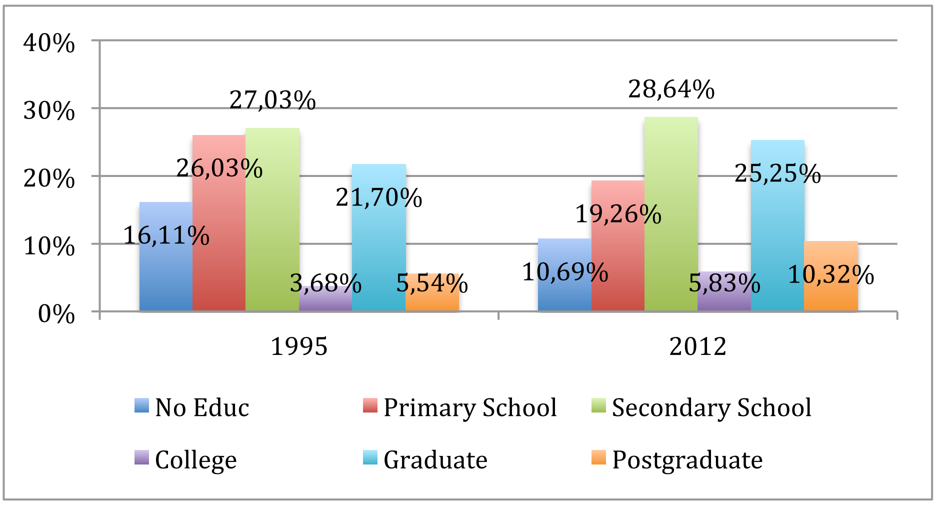
The following table and graph (Table 2.2 and Graph 2.7) show the level of education of population underlying a constant evolution over the analyzed period. People without education is not a big portion and decrease constantly, from 16,11% in 1995 to 10,69% in 2012. Moreover, it is noticeable a general reduction for a low level of education as primary-school and a slightly increase for secondary-school education. As far as highest level of education is concerned, there is a conspicuous decrease of college, graduate and postgraduate educated individuals: post-graduate level percentage doubled over the period (from 5,54% in 1995 to 10,32% in 2012), as well as college education level (from 3,68% in 1995 to 5,83% in 2012); the graduate level shows a small increase from 21,70% to 25,25%.

Table 2.2: Education.

Education	1995	1998	2000	2002	2004	2006	2008	2010	2012
No Education	16,11%	14,84%	14,29%	12,52%	12,51%	11,73%	11,63%	10,99%	10,69%
Primary School	26,03%	22,53%	23,71%	25,36%	23,79%	21,69%	21,64%	19,76%	19,26%
Secondary School	27,03%	27,23%	27,39%	27,73%	28,44%	29,01%	28,51%	28,78%	28,64%
College	3,68%	4,39%	5,03%	4,94%	5,03%	5,80%	6,10%	5,99%	5,83%
Graduate level	21,70%	24,22%	22,70%	22,91%	22,97%	23,55%	23,46%	24,74%	25,25%
Post-graduate level	5,54%	6,79%	6,89%	6,55%	7,26%	8,23%	8,66%	9,75%	10,32%

Source: elaborations on SHIW data.

Graph 2.7: Education.



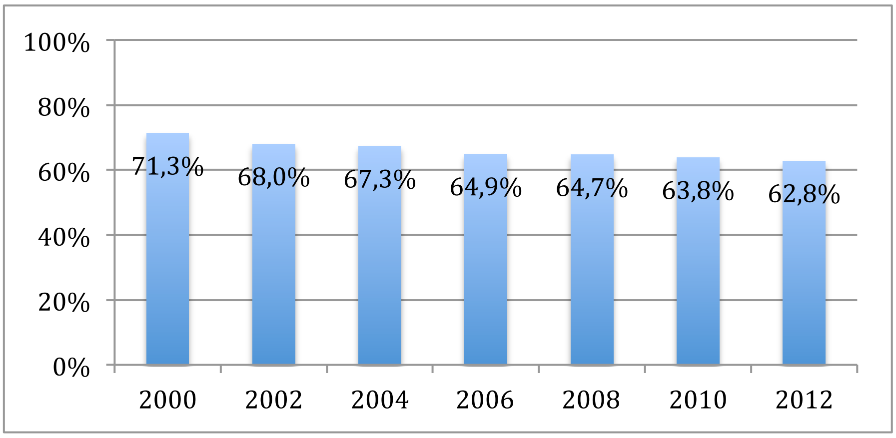
Source: elaborations on SHIW data.

2.3 Relation between public pension and post-retirement period.

The second step of the analysis consists to analyze the role that Italian supplementary pension system plays on household portfolios choices. Moreover, the aim of this section is studying participation in supplementary pension system. First of all, it is fundamental to understand if the public pension system is sufficient to satisfy post-retirement individuals needs.

The following graph, on the basis of SHIW analysis, shows the relation between public pension and labor income of individuals that are at the and of their life-cycle. Over the considered period (2000-2012), there is a constant and continue decrease of the amount that public pension with respect to labour income. In 2012, only 62,8% of labour income is satisfied by the amount of public pension system.

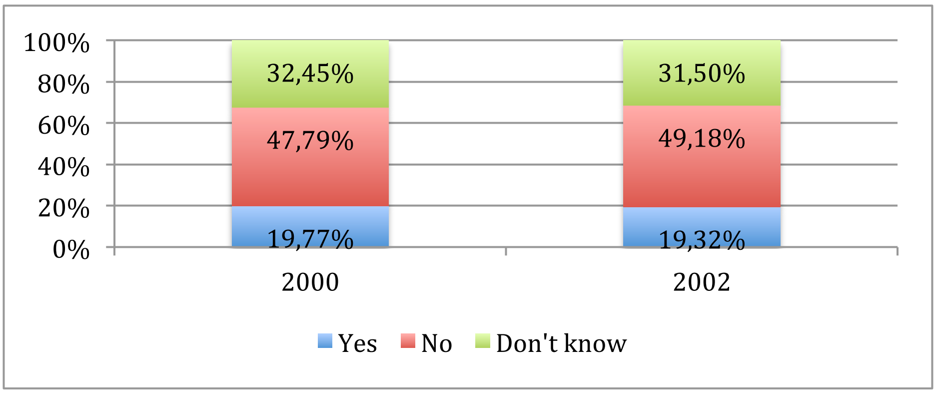
Graph 2.8: Relation between the public pension and labour income.



Source: elaborations on SHIW data.

Analyzing Graph 2.9, it is possible to investigate if workers consider public pension system income inappropriate to satisfy their needs. In fact, analyzing answers of two SHIWs (2000 and 2002) it is possible to collect the answers that post-retirement workers give to the following question: *"Do you think that the public pension amount is appropriate to satisfy post-retirement needs?*". In both years, only 20% of respondents consider the amount of their public pension appropriate, while more or less half of respondents are sure that public pension system income is not able to satisfy their post-retirement needs.

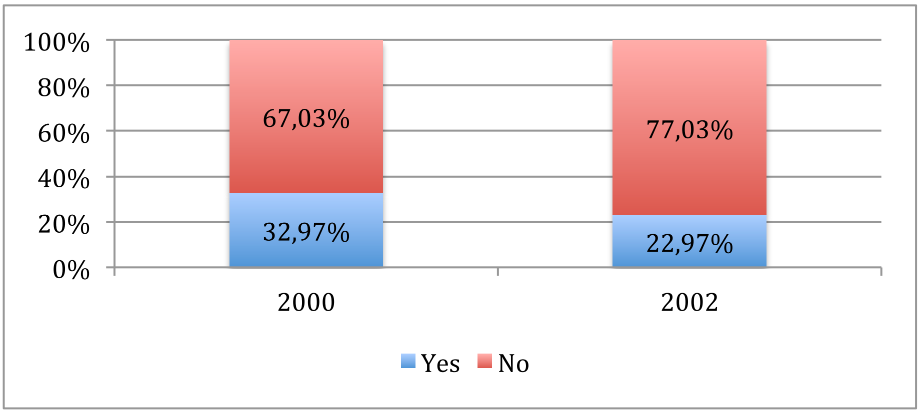
Graph 2.9: "Is the amount of public pension appropriate for post-retirement needs?"



Source: elaborations on SHIW data.

On the basis of the previous analysis, Graph 2.10 shows if post-retirement workers consider participation in supplementary pension system as a method for increasing income amount of public pension. Over two years, post-retirement individuals that have decided to participate in a private pension funds are a small percentage and however this percentage decreases by 10%.

Graph 2.10: "Have you ever participated in a pension fund in order to increase post-retirement income?"

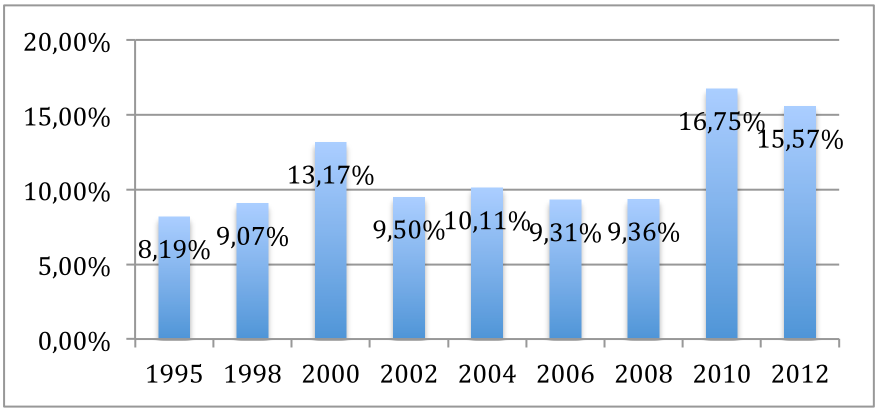


Source: elaborations on SHIW data.

2.4 Participation in supplementary pension system.

After an overview of descriptive statistics of Italian population over the analyzed period (1995-2012) the attention is focalized on participation is supplementary pension system. The aim of this paragraph is investigating descriptive statistics of individuals that decide to participate in a private pension fund.

Graph 2.11: Participation in supplementary pension system.



Source: elaborations on SHIW data.

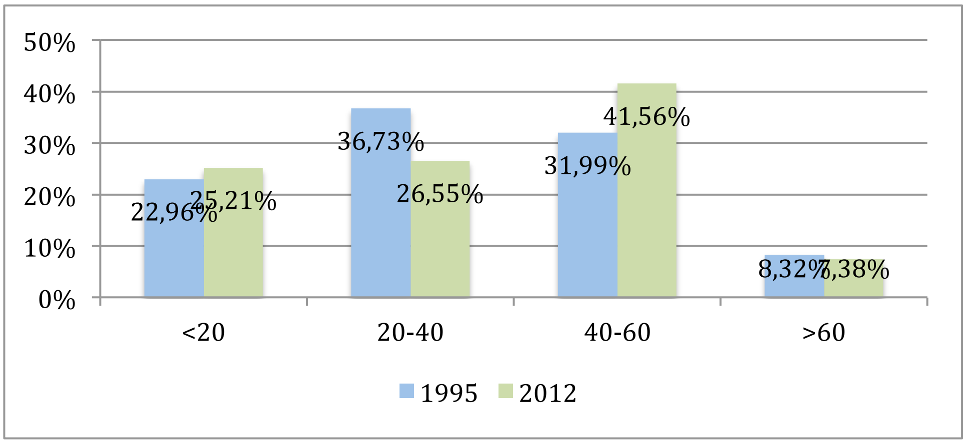
The participation rate in supplementary pension system shows a significant increase between 1995 and 2012, in fact it has doubled from 7,47% in 1995 to 15,57% in 2012. From 1998 and 2000 there was a slight and sudden considerable increase from 9,07% to 13,17%, however participation rate shows a constant trend until 2008 before another considerable peak in 2010 and 2012.

Table 2.3: Participation in supplementary pension system by age-classes.

Age-classes	1995	1998	2000	2002	2004	2006	2008	2010	2012
<20	22,96%	23,43%	24,14%	23,53%	25,24%	24,23%	29,02%	25,16%	25,21%
20-40	36,73%	36,46%	35,15%	31,54%	29,52%	28,90%	27,90%	26,36%	26,55%
40-60	31,99%	31,61%	32,39%	36,32%	35,19%	38,78%	38,09%	41,08%	41,56%
>60	8,32%	8,50%	8,32%	8,61%	10,05%	8,08%	4,99%	7,40%	7,38%

Source: elaborations on SHIW data.

Graph 2.12: Participation in supplementary pension system by age-classes.



Source: elaborations on SHIW data.

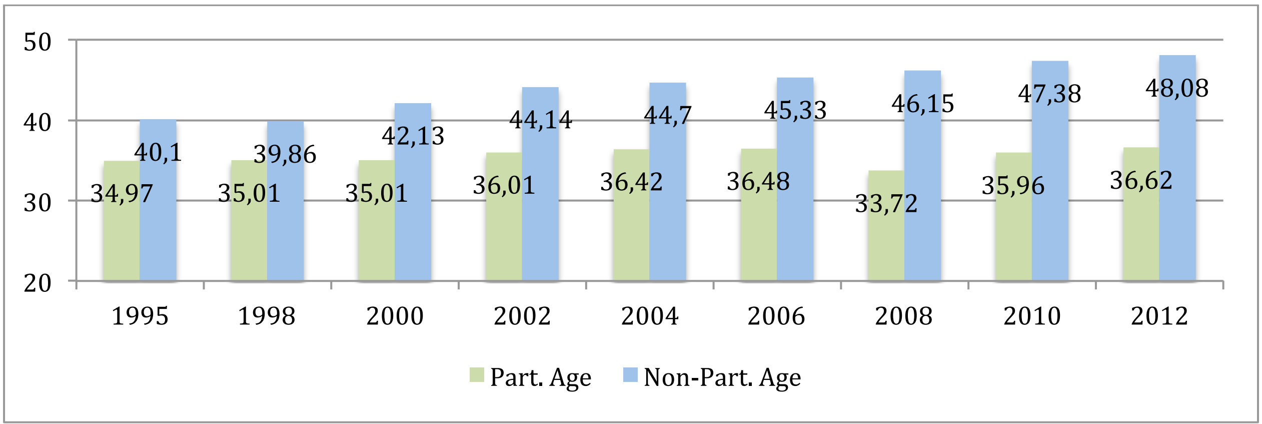
Analyzing the participation rate in supplementary pension system by age-classes it is possible to see that participation rate is higher for middle-age individuals. Comparing 1995 and 2010, it is clear that there is a rightward shift in the participation rate, which may be related to the population ageing. In fact the highest participation rate in 1995 is in individuals between 20 and 40 years old, while in 2012 is between 40 and 60 years old people. Furthermore, considering the participation rate among 20 and 40 years old individuals it is possible to see that there is a constant reduction of participation rate (36,73% in 1995 versus 26,55% in 2012). This means that the percentage of youngers that decide to participate in a supplementary pension system decreases over years.

Table 2.4: Average age of Participating and Non-participating individuals.

	1995	1998	2000	2002	2004	2006	2008	2010	2012
Participants in Supplementary Pension System	34,97	35,01	35,01	36,01	36,42	36,48	33,72	35,96	36,62
Non-participants of Supplementary Pension System	40,1	39,86	42,13	44,14	44,7	45,33	46,15	47,38	48,08

Source: elaborations on SHIW data.

Graph 2.13: Average age of Participating and Non-participating individuals.



Source: elaborations on SHIW data.

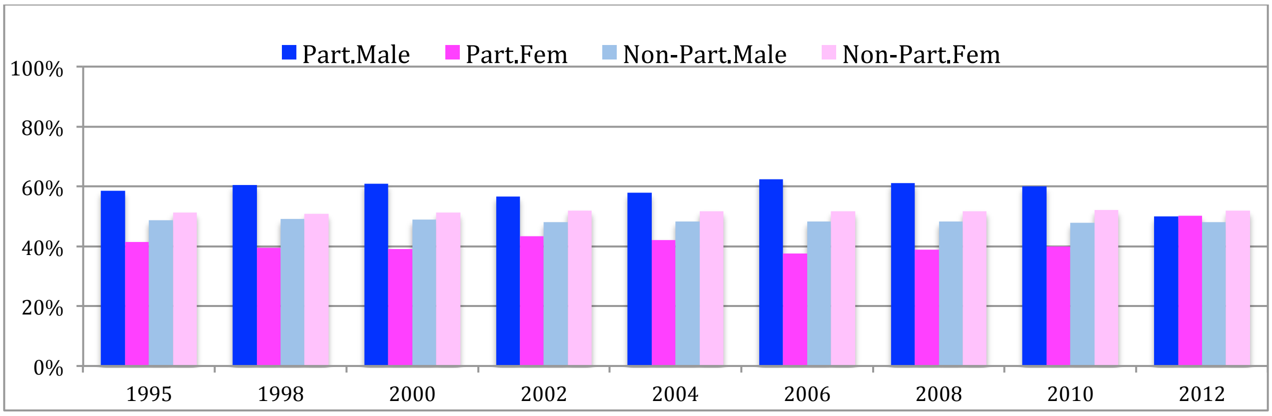
If we consider the above table and graph (Table 2.4 and Graph 2.13) regarding the average age of participating and non-participating individuals it is possible to say that: first of all, the average age of participating individuals is higher than non-participating ones overall the analyzed period. Second, the average age of participants and non-participants in supplementary pension system shows a constant increase reflecting population ageing.

Table 2.4: Gender of participants.

		1995	1998	2000	2002	2004	2006	2008	2010	2012
Participants of Supplementary Pension System	Male	58,52%	60,49%	60,97%	56,70%	57,83%	62,34%	61,10%	60,03%	49,90%
	Female	41,48%	39,51%	39,03%	43,30%	42,17%	37,66%	38,90%	39,97%	50,10%
Non-participants of Supplementary Pension System	Male	48,75%	49,06%	48,83%	48,02%	48,31%	48,38%	48,20%	47,84%	48,16%
	Female	51,25%	50,94%	51,17%	51,98%	51,69%	51,62%	51,80%	52,16%	51,84%

Source: elaborations on SHIW data.

Graph 2.14: Gender of participants.



Source: elaborations on SHIW data.

Gender is a component that influences participation rate in supplementary pension system. Considering participants, it is noticeable that male are more likely to have a private pension fund than female, in fact their participation rate is around 58% in 1995 and it increases until 2010 (60,03%); after 2010 there is a substantial decrease until 39,90%. Gender regarding the non-participants shows an opposite trend compared to the previous one. Furthermore the difference between male and female is less pronounced than the previous case, because both genders are around 50% with a small female predominance, while in participants case there is a clear male dominance. In conclusion, comparing participants with non-participants, gender is a determinant characteristic of participation rate and the majority of individuals that have a private pension fund is male.

Table 2.5: Marital status.

		1995	1998	2000	2002	2004	2006	2008	2010	2012
Participants of Supplementary Pension System	Married	53,11%	53,67%	51,28%	50,75%	51,92%	51,26%	50,54%	48,81%	49,62%
	Non Married	46,89%	46,33%	48,72%	49,25%	48,08%	48,74%	49,46%	41,19%	50,38%
Non-participants of Supplementary Pension System	Married	50,57%	50,43%	51,18%	51,60%	51,24%	51,23%	51,99%	51,82%	51,54%
	Non-Married	49,43%	49,57%	48,82%	48,40%	48,76%	48,77%	48,01%	48,18%	48,46%

Source: elaborations on SHIW data.

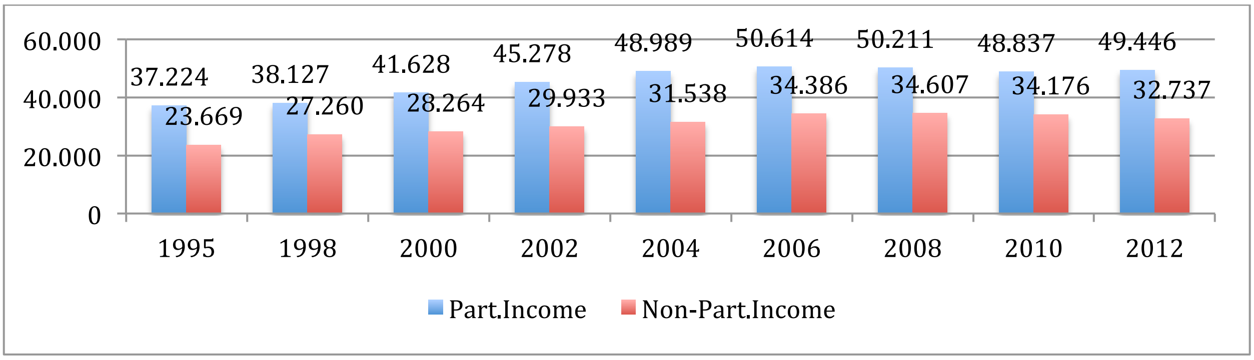
Table 2.5 shows marital status of participants and no-participants. The participation rate is higher for married people than non-married ones. The percentage of participants married people reaches its peak in 1995 and 1998 (around 53%) and decreases constantly until 2010 (48,81%). Furthermore, marital status of non-participant individuals shows the same trend as in participants ones: married people are more numerous than non married even if there is not a considerable discrepancy between married and non-married because both of them are around 50%. Analyzing the percentage of married people and comparing participants with non-participants, it is noticeable that the number of married people is higher for participant individuals until 2000 while it shows an inverse trend until the end of the analyzed period.

Table 2.6: Income.

	1995	1998	2000	2002	2004	2006	2008	2010	2012
Participants of Supplementary Pension System	37.224	38.127	41.628	45.278	48.989	50.614	50.211	48.837	49.446
Non-participants of Supplementary Pension System	23.669	27.260	28.264	29.933	31.538	34.386	34.607	34.176	32.737

Source: elaborations on SHIW data.

Graph 2.15: Income



Source: elaborations on SHIW data.

Table 2.7: Income differential

1995	1998	2000	2002	2004	2006	2008	2010	2012
57,27%	39,86%	47,28%	51,26%	55,33%	47,18%	45,80%	42,89%	51,04%

Source: elaborations on SHIW data.

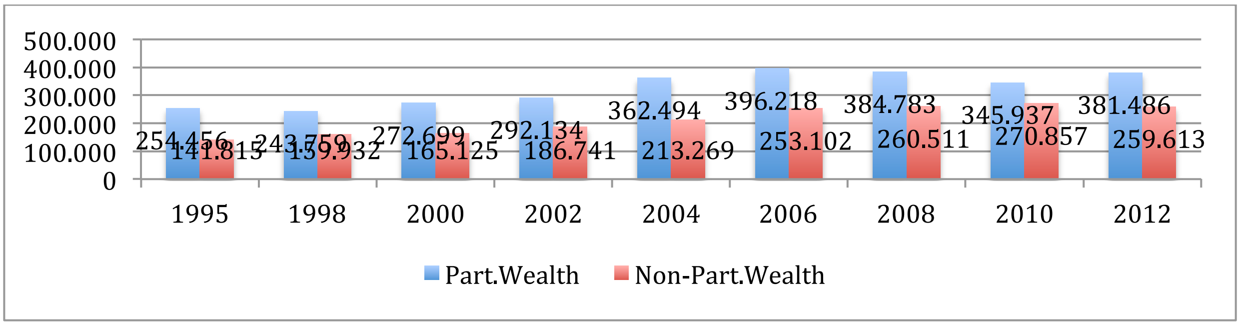
Income of individuals that participate in supplementary pension system (Table 4.8) shows a constant increase over the analyzed period. Moreover, comparing income of individuals that have subscribed a complementary pension fund with people that do not participate in supplementary pension system, it is clear that households that decide to own a private pension fund have an higher income than individuals that are out of this pension system; in general, income differential between participants and non-participants (Table 2.7) remarks that participants have an income that is around an half higher than non-participant households. For this reason, income can be considered an important variable of participant decision in supplementary pension system.

Table 2.8: Wealth.

	1995	1998	2000	2002	2004	2006	2008	2010	2012
Participants of Supplementary Pension System	254.456	243.759	272.699	292.134	362.494	396.218	384.783	345.937	381.486
Non-participants of Supplementary Pension System	141.815	159.932	165.125	186.741	213.269	253.102	260.511	270.857	259.613

Source: elaborations on SHIW data.

Graph 2.16: Wealth.



Source: elaborations on SHIW data.

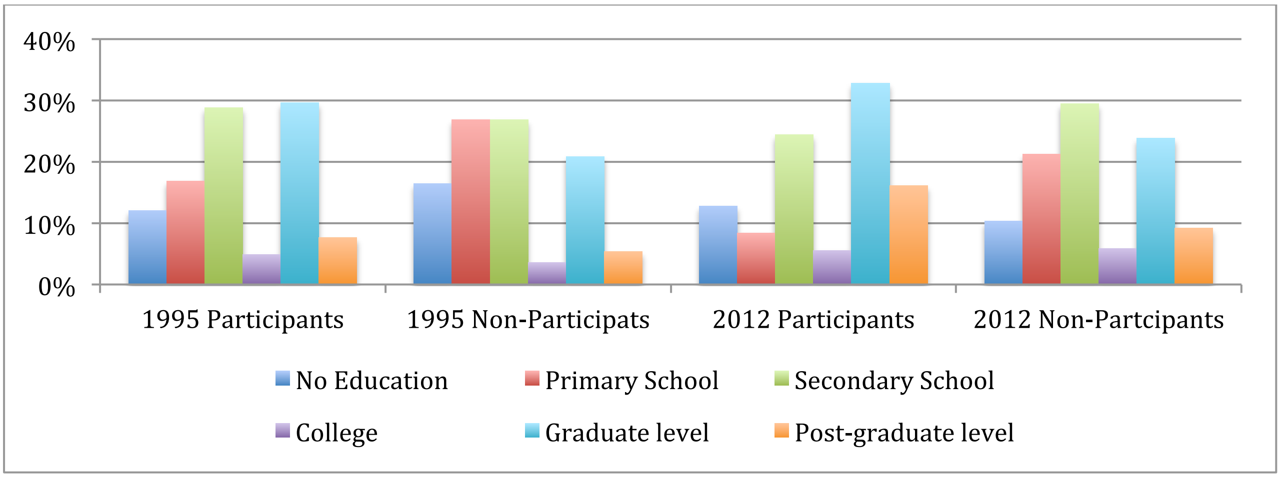
As well as for income, individual's wealth shows a constant increase from 1995 to 2006 for participants people and until 2010 for non-participants ones. After 2006 it is noticeable a slight reduction of average wealth especially for participants. Furthermore, comparing participants with non-participants, it is noticeable that first ones have a higher wealth than the last ones.

Table 2.9: Education level of participants in supplementary pension system.

	1995	2012
No Education	12,09%	12,80%
Primary School	16,84%	8,37%
Secondary School	28,88%	24,41%
College	4,90%	5,58%
Graduate level	29,64%	32,87%
Post-graduate level	7,65%	16,16%

Source: elaborations on SHIW data.

Graph 2.17: Education level.



Source: elaborations on SHIW data.

The last descriptive statistic that we are going to analyze is the level of education of participants people (Table 2.9 and Graph 2.17). If we take into account participants it is easy to see that: the percentage of non-educated individuals remains almost the same over time (around 12%) while primary school educated people decrease by half (from 16,84% in 1995 to 8,37% in 2012); secondary-school educated individuals is one of the most numerous class of education and doesn't change conspicuously over the analyzed period (28,88% in 1995 and 24,41% in 2012); the class of college educated people has the smallest percentage both in 1995 and 2012 showing a weak increase over years; graduate people are more likely to participate in supplementary pension system and increases over time (29,64% in 1995 and 32,87% in 2012); individuals that gained the highest level of education (post-graduate level) represent one of the less numerous class but it almost doubled over years from 7,65% in 1995 to 16,16% in 2012. Overall data clearly show that both in 1995 and 2012 education is related with the participation decision whereby the majority of participants have a college education or are graduated. Moreover people with the highest level of education shows an opposite trend compared to primary-school educated individuals: the first category doubled over time while the second one decrease by half over the analyzed period meaning that probably highest educated people starts to invest more in the last years with respect to less educated people.

3. ANALYSIS OF THE DETERMINANTS OF PARTICIPATION IN THE SUPPLEMENTARY PENSION SYSTEM IN ITALY AND THE TRADE-OFF WITH RESIDENTIAL HOUSING INVESTMENTS

3.1 Introduction

The supplementary pension system in Italy has not taken off in terms of membership, returns, and organization. The last reports of Covip (commissione di vigilanza sui fondi pensione), the supervisory board of pension funds, have shown a critical situation: low returns of pension funds and a low number of participants compared with other European countries. These are a result of the recent economic crisis, which made investments difficult, but maybe they are also the responsibility of a sector that needs to rethink different strategies in order to involve workers in investing in the supplementary pension system. The importance of this work lies in the analysis of the determinants that drive and influence households to invest in a supplementary pension system in order to draw a picture of the situation in terms of the characteristics of families that subscribe to a complementary pension system.

We study Italy for two main reasons. First, the Italian public pension system has been heavily reformed: Dini (1995) marked the passage from the defined benefits system to the notional defined contributions system; Prodi (1997) introduced stricter seniority requirements; Maroni (2004) increased the retirement age from 61 to 62; and Fornero (2011) extended the defined contribution pro rata to all and increased both the retirement age and the seniority requirements, with public pensions for future generations potentially being less generous. Therefore, greater participation in supplementary pension schemes is, from a normative viewpoint, desirable (at least for some types of workers). Second, homeownership in Italy is widespread, reaching a rate of 73% in 2013 according to Eurostat data, with housing assets representing a substantial share of the household portfolios; therefore, it is likely to have an impact on other portfolio choices.

The aims of this chapter are to present an empirical analysis of the determinants of participation and to investigate the most significant variables related to participation in a complementary pension fund on the part of Italian households. The first part of the chapter illustrates the way in which the cross-sectional data set is built: it is based on the 1995–2012 Bank of Italy Survey on Household Income and Wealth (SHIW), which provides the complete situation of the socio-economic and financial condition of roughly 8,000 households every 2 years. The second part shows the main results obtained from the empirical analysis using a probit regression model based on the cross-sectional data set. Furthermore, the cross-sectional data set is transformed into a panel data set in order to investigate the choice to participate in a supplementary pension system of the same household over time. Consequently, a linear probability model with fixed effects is used in order to analyse the behaviour and choices of the same family over the spanned period. Moreover, the results of both data sets and models are described, analysed, and compared in order to investigate the factors that influence the decision to participate in a supplementary pension system. Additionally, the last part of the chapter regards the analysis of a trade-off between participation in a supplementary pension scheme and residential housing investments at the individual level. It shows that being a homeowner has a negative and highly significant effect on the probability of participating in a supplementary pension scheme.

3.2 Data set

In order to construct the data set, first of all a wave-by-wave data set was set up; then it was necessary to construct the final data set pooling all the data sets built wave by wave. The data set spans the 1995–2012 period and draws from the Historical Archive of the Bank of Italy Survey of Household Income and Wealth (SHIW), which provides 8 waves over that period (1995, 1998, 2000, 2002, 2004, 2006, 2008, 2010, and 2012). The SHIW is a biannual survey conducted by the Bank of Italy on a representative sample of the Italian population and includes rich and detailed information on socio-demographic variables, households' assets, work histories, and whether or not households participate in a supplementary pension scheme. In each wave, data are collected for around 8,000 households and in total 36,181 observations are considered. The SHIW basic sample unit is the household, defined as "a group of cohabiting people who, regardless of their relationship, satisfy their needs by pooling all or part of their incomes" and in our analysis we consider the household head as the financial exponent of the household. The household head is defined as "the individual who makes financial decisions among other components of the family". Moreover, for each household head, it is possible to have different demographic information, of which the following are used in the empirical analysis: number of household components, level of education, gender, and marital status. In order to construct the best-fitted data set for the empirical analysis, different choices are made. The dependent variable of our analysis is participation in a supplementary pension system. A dummy variable PARTICIPATION assumes the value 1 if the individual answers positively to the following question in the SHIW questionnaire and 0 otherwise:

Did you or a member of the household pay into a personal retirement plan or supplementary pension fund? Bear in mind that personal pensions (pension funds or retirement plans) pay the holder an income only when he/she becomes eligible for a state pension. Please also consider the transfer of your severance pay entitlement to a pension plan.

As far as marital status is concerned, it is necessary to make a distinction between different categories by creating dummy variables: MARRIED, SINGLE, WIDOWED, and DIVORCED. Following the same method, the dummy variable MALE captures gender: it assumes the value 1 if the individual is male and 0 if she is female. The variable age is an integer variable that represents individuals from 20 to 60 years old. AGE 20–35, AGE 35–45 and AGE 45–60 are three subclasses that assume respectively individuals from 20 to 35 years old, from 35 to 45 years old, and from 45 to 60 years old. The explanatory variable HOUSEHOLD SIZE represents the number of household components ranging between 1 and 9. As far as the level of education is concerned, categorical variables representing the highest level of education achieved are created; individuals are divided into three levels of education: LOW EDUCATION (no education, primary school, and secondary school), MEDIUM EDUCATION (college), and HIGH EDUCATION (graduate and postgraduate level). Beside demographic information, economic information is taken into account: income and net wealth, which are the real and financial assets net of financial liabilities. WEALTH and INCOME are continuous variables representing household wealth and income expressed in thousands of euros; these variables are expressed in terms of households because they represent the income and net wealth of the family in which the individual lives. Furthermore, variables concerning the occupational status of the individual are considered in the data set built for the regression; it is decided not to consider retired people because the aim of the analysis is to focus on individuals who have to make a choice about participation in a supplementary pension system, and retired people have already made this choice in the past. The dummies EMPLOYEE, SELF-EMPLOYED, and NOT EMPLOYED are three classes in which the occupational status of an individual is classified, assuming the value 1 if the individual's occupational status belongs to the class considered and 0 otherwise. EMPLOYEE includes all payroll workers, such as production workers, clerical workers, teachers, etc., as well as workers on atypical contracts; SELF-EMPLOYED includes members of a profession, individual entrepreneurs, self-employed workers, and owners or employees in a family business; NOT EMPLOYED includes homemakers, students, voluntary workers, and individuals living on independent means. However, a finer classification of the occupational status is carried out, introducing occupational sector classes; the dummies AGRICULTURE, COMMERCIAL/HOTEL/RESTAURANT, INDUSTRIAL/CONSTRUCTION, REAL ESTATE/SERVICES, FINANCE/INSURANCE, TRANSPORT/COMMUNICATION, and NON-PROFESSIONAL are seven occupational sectors into which the jobs of the analysed sample are divided. The first class, AGRICULTURE, concerns people who work in the agriculture sector; COMMERCIAL/HOTEL/RESTAURANT is for individuals who work in buying and selling (trade), hotels, and restaurants. The third class, INDUSTRIAL/CONSTRUCTION, refers to the industry sector and the construction industry sector. The REAL ESTATE/SERVICES class considers the real estate industry and business services sectors. The fifth class, FINANCE/INSURANCE, clusters people who work in the financial brokerage sector and the insurance sector. Moreover, the TRANSPORT/COMMUNICATION class covers the transport and communication sectors. The last sector, NON-PROFESSIONAL, clusters all workers who have a non-professional status. The table below shows the data description:

Table 3.1: Data description

MALE	Binary variable: 1 for male, 0 for female.
MARITAL STATUS - MARRIED - SINGLE - DIVORCED - WIDOWED	Binary variables regarding marital status.
AGE 20–35	Dummy variable: age class: people between 20 and 35 years old.
AGE 35–45	Dummy variable: age class: people between 35 and 45 years old.
AGE 45–60	Dummy variable: age class: people between 45 and 60 years old.

EDUCATION - LOW - MEDIUM - HIGH	Categorical variable representing the highest level of education.
HOUSEHOLD SIZE	Number of family components (between 1 and 9).
INCOME	Continuous variable: household income in thousands of euros.
WEALTH	Continuous variable: household net wealth in thousands of euros.
OCCUPATIONAL STATUS - EMPLOYEE - SELF-EMPLOYED - NOT EMPLOYED	Occupational status dummies.
OCCUPATIONAL SECTOR - AGRICULTURE - COMMERCIAL/HOTEL/RESTAURANT - INDUSTRIAL/CONSTRUCTION - REAL ESTATE/SERVICES - FINANCE/INSURANCE - TRANSPORT/COMMUNICATION - NON-PROFESSIONAL	Dummy variables regarding the sector in which the individual works.

3.3 Methodology

In order to analyse the variables associated with participation in a supplementary pension system, a probit model is used for the decision to participate, that is, to invest in a complementary pension fund.

Let us define:

- Y_i as the dependent binary variable that takes the value 1 if the individual participates in a supplementary pension system and 0 otherwise;
- X_i as the regressors' matrix;

The probit model is the following:

$$\Pr(Y_i = 1 | X = x_i) = \Phi(x_i' \beta)$$

where *Pr* denotes the probability that x_i is a row of matrix X and Φ is the CDF (cumulative distribution function) of the standard normal distribution. The parameters β are estimated by maximum likelihood. In this analysis, the dependent variable *Y* is the participation in a complementary pension system in Italy, which is equal to 1 if individuals participate and 0 otherwise; the set of explanatory variables (*X* matrix) contains the predictor variables. This probit regression also considers the year as a factor variable, a categorical variable, which is included in the model as a series of indicator variables. The regression includes a set of time and regional dummies, with the year 1995 and Piedmont taken as reference categories. For this model, it is necessary to run a set of pooled regressions with robust standard errors clustered at the household level. Furthermore, marginal effects are evaluated: they provide an approximation to the amount of change in the dependent variable *Y* that will be produced by a 1-unit change in the regressor; they give a "single number" that identifies the effect of a variable on *P(Y=1)*.

3.4 Description and results

3.4.1 Descriptive statistics

Table 3.2 reports some descriptive statistics of the variables used in the analysis; these descriptive statistics refer to the participants in the supplementary pension system in Italy. According to the Historical Archive of the Bank of Italy Survey of Household Income and Wealth (SHIW), 13.94% of people participate in the supplementary pension system. By analysing the age of participants, it is possible to affirm that there is no consistent difference between the three age classes: participants aged between 45 and 60 years are slightly more numerous (35.54%). It is not possible to notice predominance in the gender of participants because males and females have more or less the same percentages. The majority of participants have a medium level of education because college participants prevail over the other categories; participants with a high education level have the lowest percentage (17.85%). As far as the marital status is concerned, the great majority of participants are married (66.92%) with respect to single, divorced, and widowed participants. The statistics about occupational status show that more than half of participants are employees (62.32%) while self-employed people are the minority; it is surprising that the percentage of not-employed participants is bigger than the percentage of self-employed. To conclude, the majority of participants are the owner of the house in which they live (77.22%).

Table 3.2: Descriptive statistics of participants

AGE CLASSES	
20–35	32.86%
35–45	31.60%
45–60	35.54%
GENDER	
Male	50.01%
Female	49.99%
EDUCATION LEVELS	
Low	29.35%
Medium	52.80%
High	17.85%
MARITAL STATUS	
Married	66.92%
Single	28.53%
Divorced	3.7%
Widowed	0.8%
OCCUPATIONAL STATUS	
Employee	62.32%
Self-employed	16.33%
Not employed	21.35%
HOMEOWNER	
Owner	77.22%
Renter	22.78%

3.4.2 Preliminary analysis of the results

Table 3.3 shows the results of the various regressions used to analyse the relation between the controls defined in Table 3.1 and participation in the supplementary pension system. The estimation strategy that we adopt consists of starting from a regression with a few variables and extending the specification by adding more variables regression by regression in order to capture and explain the influence of each control on the participation in the supplementary pension system. The results are shown in Table 3.3 and are presented starting from regressions with fewer variables to the most complete regression.

The first column (Table 3.3) shows that the marginal effect of the dummy for gender is highly significant and positive, suggesting that males are more inclined to invest in the supplementary pension system than females. The next (column II) specification is extended by introducing the age classes: it is possible to notice that people belonging to the age 35–45 years class are more predisposed to invest in the private pension system, showing positive and significant marginal effect coefficients with respect to the age class of people between 20 and 35 years old. The age category 45–60 years old is significant and positive as well as the previous age class. Moreover, by introducing the marital status (column III), a general negative relation with participation in the private pension system is apparent: people who are single, divorced, or widowed are less likely to participate in the supplementary pension system with respect to married individuals, because the coefficients are negative and highly significant, meaning that unmarried people are generally less likely to invest in the private pension system. Education (column IV) plays an important role in participation in the supplementary pension system. The regression results indicate that individuals with medium and high education levels are more likely to participate than people with a low education level. In particular, the higher is the level of education, the higher is the probability of investing in the supplementary pension system; all the marginal effect coefficients are highly significant, positive, and increase as well as the level of education. By adding another determinant (column V), the size of the household, there are no relevant differences except for the fact that the household size is positive and significant, showing that people who live in a large family are more inclined to invest in a pension system. In the next regressions (columns VI and VII), other explanatory variables are introduced: income and wealth. Both of these variables are considered with linear and quadratic terms. The income variable, as well as wealth, is positive and highly significant, meaning that people with a high income are more inclined to subscribe to a private pension fund; it is possible to affirm that financial means play an important role in subscription to supplementary pension funds. However, when these variables are introduced together (column VIII), wealth loses its impact, meaning that income captures all its significance: the highly significant positive coefficient of income indicates that it is one of the most important explanatory variables and has a substantial impact on investment in private pension systems. When income and wealth are considered, the household size variable loses its significance, while the other explanatory variables remain unchanged. It is decided to consider a further set of explanatory variables in order to investigate the effects of occupational status: the regression in column IX takes into account the occupational status, while in the regression in column X the occupational sector is considered. As far as the first regression (column IX) is concerned, all the marginal effects are highly significant. Self-employed workers and not-employed individuals are less likely to invest in a complementary pension system with respect to employees; the self-employed coefficient is negative and highly significant while the not-employed coefficient is still negative but not significant. Furthermore, in the second regression (column X), the marginal effects of the occupational sectors are analysed while the occupational status controls are omitted: all the sectors are highly significant and positive with respect to non-professional status people except for the agriculture sector; in particular, individuals who work in a finance and industrial environment are more predisposed to invest in the private pension system, probably because they are more familiar with it. The most important change that is apparent in this regression (column X) concerns the gender variable: in the previous regression (column IX) it starts to lose significance and in this one the coefficient turns negative and gains significance, meaning that females are more likely to participate. To conclude, the last regression (column XI) considers all the explanatory variables; the most significant variables are income and all the education variables explaining that people with a high income and education are more inclined to invest part of their money in the supplementary pension system. Furthermore, when both occupational sector and occupational status variables are considered together, some changes happen: the majority of the occupational sector variables lose their significance and some others turn negative; the not-employed category loses its significance as well as the household size.

Table 3.3: Determinants of participation in the supplementary pension system in Italy

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Male	0.0079***	0.0087***	0.0101***	0.0109***	0.0107***	0.0057***	0.0086***	0.0057***	0.0004	-0.0037*	-0.0037*
Age_35–45		0.0324***	0.0157***	0.0198***	0.0209***	0.0166***	0.0176***	0.0164***	0.0137***	0.0145***	0.0145***
Age_45–60		0.0122***	-0.0058	0.0044	0.0061	-0.0098**	-0.0025	-0.0101**	-0.0109***	-0.0097**	-0.0097**
Single			-0.0312***	-0.0396***	-0.0377***	-0.0408***	-0.0393***	-0.0409***	-0.0382***	-0.0375***	-0.0375***
Divorced			-0.0387***	-0.0408***	-0.0355***	-0.0306***	-0.0341***	-0.0305***	-0.0312***	-0.0307***	-0.0306***
Widowed			-0.0353***	-0.0281***	-0.0234**	-0.0217**	-0.0242**	-0.0217**	-0.0231**	-0.0216**	-0.0217**
Medium education				0.0629***	0.0631***	0.0452***	0.0564***	0.0451***	0.0433***	0.0423***	0.0423***
High education				0.1045***	0.1055***	0.0566***	0.0875***	0.0562***	0.0524***	0.0552***	0.0552***
Household size					0.0054***	-0.0014	0.0039**	-0.0014	-0.0003	0.0001	0.0001
Income						0.0014***		0.0014***	0.0013***	0.0012***	0.0012***
Income^2						-0.0000***		-0.0000***	-0.0000***	-0.0000***	-0.0000***
Wealth							0.0001***	0.0000	0.0000	0.0000	0.0000
Wealth^2							-0.0000**	-0.0000	-0.0000	-0.0000	-0.0000
Self-employed									-0.0031		-0.0002
Not employed									-0.0237***		-0.0749
Indus/construction										0.0371***	-0.0422
Comm/hotel/restau										0.0252***	0.0212***
Real estate/services										0.0143***	-0.0600
Transport/communic										0.0419***	-0.0378
Finance/insurance										0.1244***	0.0142
Agriculture										-0.0075	-0.0659**
Observations	36,181	36,181	36,181	36,181	36,181	36,181	36,181	36,181	36,181	36,181	36,181

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%.

3.5 Robustness

In this paragraph, a set of additional regressions is run to check the robustness of the results to a series of alternative specifications of the control variables and of the statistical model actually estimated. Analysing the last two regressions (X and XI) of the previous table (Table 3.3), when the occupational sector variables are introduced, it is notable that the sign of the male coefficient changes suddenly. Furthermore, especially in column X, all the variables related to the occupational sector are significant and positive, giving not important information about the impact that occupational sectors have on the probability of participating; moreover, when the occupational status and sectors are considered together (column XI), the occupational sector variables change their signs and significance consistently (column XI). The change in the gender sign (male variable) and the fact that all the occupational sector variables are significant and positive in regression X give the input to analyse the relation between gender and occupational sector variables in the table below.

Table 3.4: Relation between gender and occupational sectors

Occupational Sector	Male	Female
Industry/construction	72.17%	27.83%
Commercial/hotel/restaurant	49.90%	50.10%
Real estate/services	41.78%	58.22%
Transport/communication	73%	27%
Finance/insurance	63.40%	36.60%
Agriculture	65%	35%

As it is possible to see in Table 3.4, there is male predominance in the majority of sectors. This result has an impact on the gender variable, causing a change in the male sign; it means that the significance of the male variable is "captured" by the significance of the occupational sector variables. For this reason, it is decided to use the regression of column IX as the best regression (Table 3.3). The following table (Table 3.5) is composed of four regressions: the first one (I) is the best regression that it is decided to use (column IX of Table 3.3); in regressions (II) and (III), two different statistical models are estimated; and regression (IV) is run to check the robustness of age, income, and wealth. As far as the regressions in columns (II) and (III) are concerned, it is decided to implement two other models in order to compare the results with the previous probit regression outputs (column I). Ordinary least squares (column II) is a method to estimate parameters in a linear regression model. This model estimates regression coefficients by the OLS method, which finds coefficients such that the residual sum of the squares is minimized. Among the assumptions following this method, it is necessary to recall the assumption about the dependent variable, which can take values between plus and minus infinity. The problem in this analysis is that the dependent variable is binary. For this reason, some of the OLS assumptions are not valid, so the resultant model excludes potentially important variables and provides unreliable estimates. Furthermore, when the binary dependent variable is considered, the basic OLS assumptions about error terms are violated: the error terms do not have equal variance for all the variables and are not normally distributed. In conclusion, with OLS estimates, such a model is not efficient. Moreover, since the expected value is a probability, the estimates may produce values that are not contained in the [0,1] interval; it is necessary to use a function such that the estimated values are contained in [0,1]. Logit and probit are models that use these functions, in which the probabilities are not linear functions. For these reasons, it is better to use linear probability models (LPMs). In this model (column III), the logistic regression coefficients are estimated by the maximum likelihood (ML) method, which finds coefficients such that the value of the likelihood function is maximized. Both probit and logit models produce estimates in the interval [0,1] with small differences that depend on the distribution of the error term (ε), which in the case of probit is $\varepsilon \cong N(0,1)$ and in the case of logit is a log distribution with mean 0 and $var = \pi^2/_3$. By comparing the probit results with those gained by logit, it is apparent that there are no important and consistent differences: the signs and levels of significance remain unchanged for all the variables, in spite of small changes in the coefficients.

In the last column (column IV), an additional regression is run to check the robustness of age, income, and wealth. For age, the variable age is used and its quadratic expression age squared instead of age classes, and then income and wealth are refined and expressed in percentiles. The variable age is highly significant and positive, meaning that the probability of participating is influenced by the age of the individuals. The set of income percentiles confirms that the income of participants plays a fundamental role and influences the rate of participation in the supplementary pension system. Furthermore, the higher is the level of the percentile, the higher is the probability of participating with respect to the first percentile because all the coefficients are significant, highly positive, and increasing. As far as the wealth percentiles are concerned, they are highly significant and positive as well as the income percentiles. When the percentiles of wealth are considered, the variable wealth gains significance instead of the regression of column (I), in which wealth is not significant.

Table 3.5: Robustness regressions

(I)		(II) LPM		(III) Logit		(IV) Robustness: Age, Wealth, and Income	
Male	0.0004	Male	0.0011	Male	0.0053	Male	0.0010
Age 35–45	0.0137***	Age 35–45	0.0160***	Age 35–45	0.1299***	Age	0.0049***
Age 45–60	-0.0109***	Age 45–60	-0.0123***	Age 45–60	-0.1198***	Age^2	-0.0001***
Single	-0.0382***	Single	-0.0442***	Single	-0.3978***	Single	-0.0445***
Divorced	-0.0312***	Divorced	-0.0373***	Divorced	-0.3263***	Divorced	-0.0222***
Widowed	-0.0231**	Widowed	-0.0267***	Widowed	-0.2410*	Widowed	-0.0169
Medium edu	0.0433***	Medium edu	0.0409***	Medium edu	0.4092***	Medium edu	0.0315***
High edu	0.0524***	High edu	0.0496***	High edu	0.4377***	High edu	0.0380***
Household size	-0.0003	Household size	-0.0000	Household size	-0.0062	Household size	-0.0032*
Income	0.0013***	Income	0.0017***	Income	0.0145***	Income II	0.0502***
Income^2	-0.0000***	Income^2	-0.0000***	Income^2	-0.0000**	Income III	0.0850***
Wealth	0.0000	Wealth	0.0000*	Wealth	0.0001	Income IV	0.1054***
Wealth^2	-0.0000	Wealth^2	-0.0000***	Wealth^2	-0.0000	Income V	0.1469***
Self-employed	-0.0031	Self-employed	-0.0034	Self-employed	-0.0452	Wealth II	0.0347***
Not employed	-0.0237***	Not employed	-0.0179***	Not employed	-0.2452***	Wealth III	0.0366***
						Wealth IV	0.0449***
						Wealth V	0.0623***
						Self-employed	-0.0036
						Not employed	-0.0160***

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%.

3.6 Comparison with the previous literature

The methodology adopted in this chapter is also used in different papers. Coppola and Lamla (2013) investigate the determinants of participation in an occupational pension scheme; their analysis is based on the German SAVE study, a longitudinal survey of private households focused on saving and old-age provision that is linked to administrative records containing information on the workers' establishment level. The main purpose of their study is to create an empirical base to understand households' saving behaviour. They use a probit model explaining the determinants of owning an occupational pension conditional on the reported availability at the establishment. The main finding of their work is that lower educated individuals are less likely to participate in an occupational pension scheme because they accumulate lower wealth for retirement and are less likely to participate in a voluntary pension scheme. Moreover, they save less and might accumulate insufficient resources for their retirement; low educated people are less likely to plan for retirement and to seek information on occupational pensions. The paper fits within a broadened strand of the literature initiated by Lusardi (2003): low educated individuals are less likely to plan for retirement; consequently, they accumulate less wealth and are less likely to participate. Furthermore, education can be considered not only as school education, but also as financial education. It means that for a low level of education, people prefer not to participate, while for a high level of education, there is a positive relation.

Another piece of literature that adopts the model used in this chapter is the study by Cappelletti and Guazzarotti (2010). They analyse the pension choices of Italian households using data based on a survey of households' balance sheet. The probit model is used to implement a multivariate analysis of the determinants of participation in a supplementary pension system. Their analysis focuses on the adequacy of pension wealth of households, the degree of knowledge of social pension rules, the determinants of the choice to join supplementary pension funds and the propensity of workers to convert their wealth into an annuity retirement. First of all, they find that there is a low level of pension scheme education and lacking awareness of its retirement condition: there are many people who participate in the complementary pension system but do not know or cannot remember the chosen investment strategy and the amount of their annuity retirement. The second finding of the paper shows that the participation rate is especially low for workers who will mainly need to integrate their pensions: younger workers. Moreover, the fundamental factors that have an influence on the low participation rate are: income restrictions, a low level of education, a lack of knowledge of complementary system schemes, and a low propensity to convert wealth into an annuity retirement. In conclusion, they show that the level of income is considered one of the most important determinants of participation in a voluntary pension system, because they consider income as the availability of resources to allocate to pension savings. Income is one of the most important explanatory variables in the relationship with investments in a financial system: people with a high income have more financial resources to subscribe to private pension funds.

Huberman, Iyenger, and Jiang (2007) analyse the determinants of participation in defined contribution pension plans. They use the Vanguard Group data, which provide 926,104 participation and contribution employee records in defined contribution pensions for the year 2001. Using a probit model, they study different kinds of dependent variables: the participation in defined contribution plans, the individual's maximum amount contribution, and the annual contribution as a percentage of compensation. The main finding of this paper is that women's participation probability is higher that men's and that they contribute more than men. The authors state that women participate more than men because they have a stronger taste for saving, perhaps because they live longer on average; women are more likely than men to have working spouses, and women's working spouses earn more than men's working spouses; comparing a man and a woman with the same income, the woman is likely to live in a household with a higher income and more likely to participate in a defined contribution plan and contribute more to it. Moreover, they affirm that income and wealth are the most important determinants of participation in defined contribution plans; they show that a $10,000 increase in annual compensation is associated with about a 3.7% higher probability of participation.In conclusion, on the basis of the previous literature, it is possible to affirm that the main factors that drive participation in a complementary pension system are the level of income and wealth, the level of education in terms of school education and financial education, and the age of individuals: younger people are less likely to participate. These results can be compared with the results of our analysis showing that even in Italy the variables with a higher influence and significance are the previous ones: income, wealth, age, and level of education.

3.7 Participation in the supplementary pension scheme and homeownership at the household level

The analysis of the determinants of participation in supplementary pension systems is broadened by taking into account real estate investments in order to consider another characteristic of individuals in terms of wealth and propensity to invest. Investment in a residential house could be a variable that has an important influence on the participation rate and for this reason a set of regressions is run to check the influence of some variables linked to property investment on participation in complementary pension systems.

Our study explores another plausible explanation analysed in a strand of literature that developed from the original intuition of Kemeny (1981), namely the possibility of a trade-off between pension plan participation and housing investment. He was the first to stress the link between pensions and home ownership, with the implication highlighted by Fahey (2003) that "if home owners regard their housing assets as a quasi pension fund, they will devote less to standard pension provision because they have lack the need or incentive to do so rather than because they cannot afford to". Because homeownership is a form of asset accumulation (arguably the most important in southern European countries), homeowners secure themselves a valuable asset that can be drawn upon to provide economic well-being in old age. Castles (1998) points out a possible trade-off between the extent of homeownership and the generosity of old-age pensions and shows that, with some exceptions, OECD countries have a negative relationship between homeownership levels and pension provision levels. Housing investment can therefore be seen as an alternative, though not necessarily the most efficient given its illiquidity, to a private pension. Fahey (2003) and Fahey et al. (2004) test the idea that by promoting outright ownership, housing policies can reduce poverty in later life. Similarly, Dewilde and Raeymaeckers (2008**)** test whether and how the trade-off between pensions provision and housing policies influences old-age poverty. The trade-off between homeownership and the generosity of pension systems has been explored at the macro level (Fahey, 2003; Dewilde and Raeymaeckers, 2008), but, to the best of our knowledge, the present study is the first to analyse this relationship at the individual level and with a specific focus on supplementary pension plans.

In the following regressions (Table 3.6), the controls used in the previous section are taken into account and three different variables are introduced to evaluate the predisposition of individuals to invest in properties. Those variables are introduced to evaluate a possible trade-off between participation in a complementary pension system and investments in a residential house. In the first column (Table 3.6), the variable HOMEOWNER is considered besides other variables. This dummy variable assumes the value 1 if the household is the owner of the house in which he/she lives and 0 otherwise. The results of the regression (column I) show that the coefficient is negative and highly significant, meaning that people who own the house in which they live seem to be less likely to invest in the supplementary pension system. On the basis of this result, it is possible to affirm that individuals who own their residential house probably prefer to invest in it instead of investing in their future retirement by participating in the supplementary pension system. In the second regression (column II), the dummy variable PROPERTY INVESTMENT is taken into account. It is decided to build this variable in order to capture the predisposition of an individual to invest in properties other than the residential house. This dummy variable assumes the value 1 if an individual or another member of his/her household bought and owns the following and the value 0 otherwise:

- another dwelling, not including the household's home;

- other premises or buildings, like shops, offices, hotels, warehouses, garages, parking places, and sheds;
- farm land adjoining or separate from the house for agricultural use;
- non-farm land with or without buildings.

The coefficient is positive and highly significant, meaning that investing in other properties has a positive influence on participation in the supplementary pension system. Furthermore, this effect can lead to the fact that individuals who are more likely to invest probably prefer to diversify their investment by taking into account both property investment and retirement investment; for that reason, people who own other dwellings, land, or buildings are more likely to diversify their investment by subscribing to a private pension fund. In the last regression (column III), a new variable is built to give us more information about the impact of property investment on participation. The variable LIQUIDITY INDEX is an alternative measure to give an idea of the liquidity of household portfolios and its value is between 0 and 1. This index captures the liquidity ratio, which is the value of the residential home divided by the gross wealth (real assets plus financial assets) in order to measure the impact that a residential home has on the household financial portfolio. The results (column III) show that the marginal effect is significant and negative, meaning that the liquidity index has a negative influence on participation in a complementary pension system; the strongest is the impact of the home value on the financial household portfolio and the lowest is the probability to subscribe to a private pension fund. This result can be interpreted as showing that individuals are less likely to invest for their future retirement return if they decide to invest more in their residential home.

Table 3.6: Participation in the supplementary pension system and residential housing investment

	(I)	(II)	(III)
Male	0.0009	0.0009	0.0010
Age	0.0103***	0.0102***	0.0101***
Age^2	-0.0182***	-0.0186***	-0.0191***
Single	-0.0379***	-0.0381***	-0.0388***
Divorced	-0.0222***	-0.0223***	-0.0221***
Widowed	-0.0197*	-0.0194*	-0.0195*
Medium education	0.0331***	0.0331***	0.0332***
High education	0.0400***	0.0397***	0.0405***
Household size	-0.0023	-0.0023	-0.0023
Income II	0.0493***	0.0494***	0.0491***
Income III	0.0834***	0.0833***	0.0824***
Income IV	0.1023***	0.1021***	0.1005***
Income V	0.1418***	0.1402***	0.1381***
Wealth II	0.0442***	0.0424***	0.0457***
Wealth III	0.0543***	0.0514***	0.0542***
Wealth IV	0.0642***	0.0598***	0.0597***
Wealth V	0.0828***	0.0753***	0.0703***
Self-employed	-0.0057	-0.0059	-0.0072**
Not employed	-0.0178***	-0.0179***	-0.0181***
Homeowner	*-0.0190****	-0.0172***	
Property investment		*0.0157****	
Liquidity index			*-0.0258****

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%.

3.8 Participation in the supplementary pension scheme: probit regressions vs. linear regression models with fixed effects

The aim of this paragraph is to transform the data set used for the past analysis into a panel data set in order to investigate the choice to participate in the supplementary pension system of the same household over time by using a linear probability model with fixed effects. Panel data, also known as longitudinal or cross-sectional time-series data, constitute a data set in which the behaviour of households is observed across time. Furthermore, this data set follows the sample of families over time, providing multiple observations on each individual in the sample. The first step is to build a panel data set starting from the cross-sectional data set used for the previous probit regressions and afterward choosing the regression model. Moreover, as the last step, the probit regressions' outcomes are compared with those based upon the panel data set. The robustness of the previous paragraph shows us that the LPM and probit results are almost the same; for this reason, we can ignore the linearity component of the dependent variable and estimate a linear probability model with fixed effects. We decide to use a linear probability model with fixed effects instead of a probit model because our goal is to analyse the impact of variables that vary over time. Fixed effects explore the relationship between predictor and outcome variables within the individual; each individual has his/her own characteristics that may or may not influence the dependent variable, which in this case is participation in the supplementary pension system. Furthermore, when using fixed effects, we assume that something within the individual could influence the dependent variable and we need to control for this. This is the rationale behind the assumption of the correlation between the individual's error term and the predictor variables. Fixed effects remove the effect of those time-invariant characteristics from the predictor variables so that we can assess the predictors' net effect. Another important assumption of the fixed-effects model is that the time-invariant characteristics are unique to the individual and should not be correlated with other individual characteristics.

Table 3.7: Participation in the supplementary pension system: probit regressions vs. linear regression models with fixed effects

	I	II	III	IV
	Probit I	**Probit II**	**LPM-FE**	**LPM-FE**
Male	0.0009	0.0010	OMITTED	OMITTED
Age	0.0102***	0.0101***	0.0067	0.0072
Age^2	-0.0186***	-0.0191***	0.0071	0.0079
Single	-0.0381***	-0.0388***	-0.0156	-0.0163
Divorced	-0.0223***	-0.0221***	-0.0045	-0.0044
Widowed	-0.0194*	-0.0195*	0.0012	0.0020
Medium education	0.0331***	0.0332***	0.0042	0.0029
High education	0.0397***	0.0405***	0.0028	0.0009
Household size	-0.0023	-0.0023	0.0113***	0.0113***
Income II	0.0494***	0.0491***	0.0081	0.0074
Income III	0.0833***	0.0824***	0.0249***	0.0231***
Income IV	0.1021***	0.1005***	0.0257***	0.0231***
Income V	0.1402***	0.1381***	0.0550***	0.0509***
Wealth II	0.0424***	0.0457***	0.0075	0.0104
Wealth III	0.0514***	0.0542***	0.0178*	0.0191**
Wealth IV	0.0598***	0.0597***	0.0305***	0.0273***
Wealth V	0.0753***	0.0703***	0.0678***	0.0581***
Self-employed	-0.0059	-0.0072**	-0.0107	-0.0132
Not employed	-0.0179***	-0.0181***	-0.0142**	-0.0148**
Homeowner	-0.0172***	-0.0172***	-0.0332***	
Property investment	0.0157***		0.0089	
Liquidity index		-0.0258***		-0.0462***

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%.

The table above (Table 3.7) shows the results obtained using a linear probability model with fixed effects. The first two columns represent the outcomes gained from the previous probit regressions while the last two illustrate the results from the linear probability model with fixed effects based on the panel data set. Examining the last two regressions, it is immediately noticeable that for two variables, male and household size, the outcomes are omitted because these variables do not change over the analysed period: there is no change in the individual condition over time, since a male remains a male. Furthermore, the majority of outcomes from the regressions based on panel data lose their significance compared with the probit regression's outcomes; only variables like household size, income, wealth, and primary house investments (homeowner and liquidity index) remain highly significant, meaning that a change in the individual conditions related to these variables could have an influence on the participation in the supplementary pension system. On the contrary, variables that lose their significance are an expression of the influence of fixed effects on the probit regression's results. The significance of the income and wealth coefficients (columns II and IV) indicate that households are more likely to invest in the private pension system when they pass from a lower income or wealth class to a higher one: an individual who improves his/her income or wealth condition is more likely to invest in the complementary pension system. This result seems to confirm the high degree of importance and influence that income and wealth have on participation choices as well as our findings from the probit regressions. Another important result that seems to give further confirmation to the results gained with the probit regressions concerns the homeowner and liquidity index coefficients. These coefficients do not change their signs and remain highly significant, meaning that a change in the individual conditions over time related to these variables could have an influence on participation: a household that becomes the owner of a residential house (homeowner) is less likely to invest in the supplementary pension system, validating the idea of a possible trade-off between participation and investment in a residential house. Moreover, the sign and significance of the liquidity index explain that when the value of the residential house has a greater impact on the household portfolio, there is a lower probability that people will invest in complementary pension funds.

To conclude, the aim of this analysis (using a panel data set and a linear probability model with fixed effects) was to "purify" our past results from fixed effects, taking into account only net predictors' effects in order to investigate whether the main results found previously can have further confirmation. Moreover, it is possible to affirm, focusing on homeownership and the liquidity index, that there could be a trade-off between participation in the supplementary pension system and residential house investment.

3.9 Participation in the supplementary pension scheme and homeownership at the individual level

In this paragraph, the estimation sample changes because our aim is to analyse the trade-off between participation in the supplementary pension system and residential house investments at the individual level in order to extend the previous analysis at the household level (Santantonio, Torricelli, and Urzì Brancati, 2014). We use a combination of individual- and household-level data; in our estimation sample, we keep only individuals present in at least two waves, to exploit the panel component, and we restrict our sample to those aged between 20 and 60 and who are not yet retired. The final estimation sample consists of 56,737 observations for 18,322 individuals/8,234 households. Moreover, as in the household analysis, we build the dependent variable PARTICIPATION as a binary variable equal to 1 for individuals who participate in a supplementary pension scheme and 0 otherwise.

In the following table (Table 3.8), we report the participation rates by gender and homeownership status. Because housing tenure is mainly a household choice, regardless of who legally owns the dwelling, we decide to consider homeownership at the household, not the individual level. The participation rates, both for men and for women, are higher among owners than renters.

Table 3.8: Participation in supplementary pension funds by gender and homeownership

	Male		Female		All	
	%	**Obs.**	**%**	**Obs.**	**%**	**Obs.**
Renter	8.0%	*8,272*	5.4%	*8,667*	6.6%	*16,938*
Owner	11.8%	*19,176*	7.4%	*20,623*	9.5%	*39,799*
All	10.6%	*27,448*	6.8%	*29,289*	8.6%	*56,737*

Table 3.9 and Table 3.10 show our results for all the different econometric specifications. In Table 3.9, residential housing investment is represented by the binary variable *Homeowner*, as previously described, while Table 3.10 considers housing investment as the share of housing wealth over total wealth, *Liquidity Index*.

Despite the positive relationship in the descriptive section (Table 3.8), having accounted for socio-economic and demographic features, we find that being a homeowner has a negative and highly significant effect. Moreover, when we take into account individual unobserved heterogeneity, the coefficient increases in size from -0.019 to -0.035 in the linear specification and from -0.021 to -

0.028 in the non-linear one. Considering that the average participation rate in our sample is 8.4%, we can see a 3.5/2.8 percentage point difference as a relatively large effect. Similarly, when using the continuous indicator for homeownership, *Liquidity Index*, we have a negative, highly significant effect, as shown in Table 3.10. Once again, the impact is larger when we take into account unobserved individual heterogeneity (the last two columns), suggesting that a simple regression on a pooled sample may underestimate the relationship of interest. Tables 3.9 and 3.10 also report estimates for the socio-economic control variables. The coefficients are very similar in all the specifications, even though marital status, educational attainment, and self-employed lose significance in the fixed effects/correlated random-effects specifications. One possible explanation is that both marital status and educational attainment do not vary much over time in our sample and are therefore close to being individual fixed effects. Predictably, individuals who are not employed are less likely to participate in a pension fund than employees; interestingly, the coefficient on self-employed is negative even though we might expect self-employed individuals to have a lower replacement rate and therefore be more likely to participate in a supplementary pension scheme. However, it is only significant in the pooled regressions. Despite the negative effect of homeownership, having a mortgage is significantly and positively associated with participation in a supplementary pension scheme. This result may be explained by the fact that households with mortgages are sound both from an economic and from a financial viewpoint (due to the strict screening that Italian banks apply to mortgage requests) and by the greater familiarity that mortgage holder have with financial products.

Table 3.9: Participation in the supplementary pension scheme and homeownership

	LPM	Probit	LPM-FE
Homeowner	-0.019***	-0.021***	-0.035***
Age	0.011***	0.014***	0.010***
Age squared/100	-0.015***	-0.018***	-0.008***
Female	-0.013***	-0.013***	OMITTED
Single	-0.020***	-0.018***	0.000
Divorced	-0.005	-0.006	0.013
Widowed	0.006	0.018	0.019
Medium education	0.024***	0.022***	-0.006
High education	0.034***	0.030***	-0.010
Household size	-0.008***	-0.010***	0.004
Household head	0.040***	0.032***	0.008
Self-employed	-0.007	-0.008*	0.000
Not employed	-0.034***	-0.061***	-0.017***
Years of contribution	0.002***	0.001***	0.002***
HH has a mortgage	0.034***	0.022***	0.021***

II income quartile	0.010***	0.019***	0.006
III income quartile	0.025***	0.031***	0.010*
IV income quartile	0.041***	0.047***	0.022***
II wealth quartile	0.024***	0.024***	0.022***
III wealth quartile	0.033***	0.035***	0.024***
IV wealth quartile	0.051***	0.052***	0.042***
Constant	-0.136***		-0.047

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3.10: Participation in the supplementary pension scheme and the liquidity index

	LPM	Probit	FE-LPM
Liquidity Index	-0.024***	-0.027***	-0.041***
Age	0.011***	0.014***	0.010***
Age squared/100	-0.015***	-0.019***	-0.008***
Female	-0.014***	-0.013***	OMITTED
Single	-0.021***	-0.019***	0.000
Divorced	-0.006	-0.007	0.009
Widowed	0.007	0.020	0.029
Medium education	0.024***	0.022***	-0.007
High education	0.035***	0.031***	-0.011
Household size	-0.008***	-0.010***	0.003
Household head	0.040***	0.033***	0.008
Self-employed	-0.010	-0.011**	-0.002
Not employed	-0.035***	-0.062***	-0.017***
Years of contribution	0.001***	0.001***	0.002***
HH has a mortgage	0.034***	0.023***	0.022***
II income quartile	0.009***	0.018***	0.006
III income quartile	0.024***	0.030***	0.008
IV income quartile	0.039***	0.044***	0.020***
II wealth quartile	0.025***	0.025***	0.022***
III wealth quartile	0.033***	0.035***	0.022***
IV wealth quartile	0.047***	0.048***	0.036***
Constant	-0.137***		-0.051

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%.

3.10 Conclusions

The objective of this study is to explore the determinants of participation in supplementary pension schemes and to provide an alternative explanation for the low take-up rate of pension funds in Italy. Specifically, we investigate the possibility of a trade-off between investment in residential housing and participation in supplementary pension schemes.

Our results show that, after controlling for a wide range of socio-demographic variables and allowing for unobserved individual heterogeneity, investment in residential houses appears to crowd out investment in supplementary pension funds. We show that, despite the positive relationship in the descriptive section, being a homeowner has a negative and highly significant effect on the probability of participating in a supplementary pension scheme.

4. HOMEOWNERSHIP, HOUSING VALUE, AND LABOUR INCOME RISK

4.1 Introduction

In the previous chapter (Analysis of the Determinants of Participation in the Supplementary Pension System in Italy), we found that there could be a trade-off between participation in the supplementary pension system and residential housing. For this reason, the aim of this chapter is to focus our attention on the role of housing. Housing decisions incorporate the choice to hedge income risk and for many households the home is the largest asset in the portfolio. Without financial markets for insurance against volatility in housing prices and labour income, it is natural to expect risk-averse households to use housing purchase to hedge their income risk. We analyse how the covariance between the housing value and the labour income affects the decision to invest in a residential house and own a house by using data relative to the Italian case. We find that when the background risk relative to households' wage increases, individuals reduce the portion of housing in their portfolio and prefer not to own a house. This study can be considered an extension of Davidoff (2005) but focusing on the Italian case. Among US households, Davidoff (2005) analyses how the income–housing price covariance affects the decision to own or rent housing, and conditional on deciding to own, how much housing to purchase. Because "housing is the most important asset, and labour income the most important source of wealth for most households", Davidoff (2005) expects that housing decisions will incorporate the desire to hedge against income risk. He finds that households purchase little housing acting on an extensive margin by deciding to rent rather than own or act on an intensive margin by purchasing an inexpensive home. The empirical approach of Davidoff (2005) is essentially based on two regressions: the first one is a linear regression model that tests the relation between the value of housing owned and the income–housing price covariance while the second regression is a probit regression model that tests the effect of housing purchase on the decision to own or rent. The main findings are that the value of housing decreases in covariance, which in turn has a negative effect on the probability of ownership. On average, an increase of one standard deviation in covariance between income and home prices is associated with a decrease of more or less $7500 in the value of owner-occupied housing. This chapter is organised as follows: the first section illustrates the literature that analyses the role of housing investments in households' portfolio choices; the second section explains the methodology and data used in our analysis; and in the third section the results and comments are presented.

4.2 Literature overview

Housing is considered by far the most important collateral asset for households. In particular, owner-occupied housing is the single most important asset in many investors' portfolio. Based on this theme, there are several papers that consider the role that housing plays in households' portfolio.

Some papers analyse the relationship between housing investments and investments in risky assets. Henderson and Ioannides (1983) explain that homeowners own too much housing due to the fact that their consumption demand for housing exceeds their investment demand because homeowners are unable to sell any of their home equity except by becoming renters. Breuckener (1997) extends this analysis by showing that overinvestment in housing leads to an inefficient portfolio in terms of mean variance because households will hold too few risky financial assets. This portfolio inefficiency is not an indication that consumers are irrational in their financial decisions, but it can be seen as the result of rational balancing of the consumption benefits and portfolio distortion associated with housing investments. Breuckener (1997) studies the interaction between the consumption demand and the investment demand for housing in a mean-variance portfolio model. He considers the case in which consumers hold a composite portfolio of housing, stocks, and riskless bonds. He demonstrates that homeowners who are able to reduce their housing investments and adjust the composition of their financial asset holding can achieve higher returns for the same level of portfolio risk. Moreover, Flavin and Yamashita's (2001) study, similarly to Breuckner's analytical work, shows that overinvestment in housing influences the holdings of financial assets in a mean-variance context. Firstly, they define the house value/net worth ratio; then, they relate this ratio to the proportion of financial assets invested in an individual asset. In their simulation, they illustrate that the optimal proportion of financial assets invested in stocks, which are defined as stocks/financial assets, shows an extreme change by varying the value of the house value/net worth ratio.

There are other papers that support the idea that housing can influence portfolio choices and that housing crowds out investments in stocks. Fratantoni (1998) claims that homeownership can account for the fact that typical households hold no risky financial assets. Analysing the US case, he shows that the majority of households in the United States own a house and most of their wealth is fixed in a house; consequently, the risks linked to homeownership are likely to have significant effects on their financial asset choice. In particular, Fratantoni (1998) explains that once a house is purchased, homeowners make financial choices in order to hedge against the uncertainty linked to their housing investment; this uncertainty is associated with the housing price risk, which is quite volatile, determining insecurity in relation to how much they will be able to sell their houses for in the future. A second type of uncertainty is committed expenditure risk, which is defined by Fratantoni (1998) as "the risk assumed by committing to make mortgage payments over a long horizon out of an uncertain stream of labour income". In this study, he shows that committed expenditure uncertainty related to homeownership has a significant negative impact on risky asset holding. He measures committed expenditure uncertainty as the "mortgage-payment-to-income" ratio, explaining that those who have a high degree of committed expenditure uncertainty hold a smaller proportion of their financial assets in risky form. They invest their financial assets more conservatively. Furthermore, Cocco (2005) shows that investment in housing has an important role in explaining the variation in the composition of wealth and especially in the level of stockholding in portfolio composition. He claims that younger and poorer individuals have limited financial wealth to invest in financial assets because the majority of their investments are in housing. He explains that there is a direct relationship between housing investment, portfolio composition, house prices, and labour income: "the investment in housing may affect the composition of the investors' portfolio because the price of residential real estate may be correlated with labour income shocks and stock returns".

4.3 Data and methodology

We analyse how covariance between the primary house value and the labour income affects the decision to invest in residential housing and own a house by using data relative to the Italian case. This study carries on Davidoff's (2005) study. Our work can be considered an extension of Davidoff (2005) but focusing on the Italian case. The empirical part is based on a data set built by using the 1995–2012 Bank of Italy Survey on Household Income and Wealth (SHIW).

The effect of the residential housing value–labour income covariance, *COV (HV, Y)*, on housing is tested by the following regression:

$$HOUSING\ SHARE = b_0 + b_1 COV(HV, Y) + b_2 Z + \varepsilon \tag{1}$$

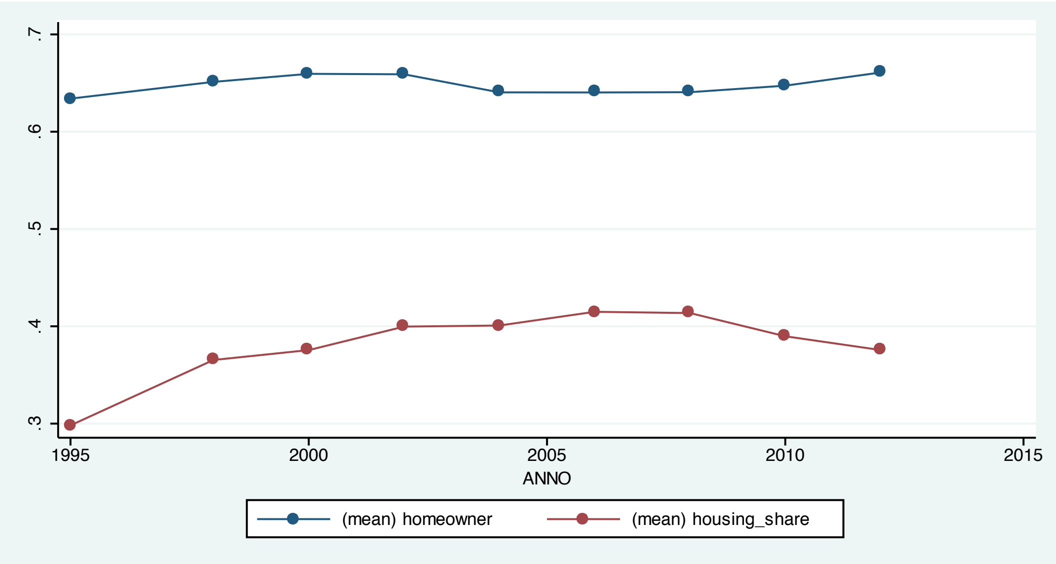
It is a linear regression model (OLS method) in which the dependent variable HOUSING SHARE is a measure of the impact that investment in residential houses has on households' portfolios and its value is between 0 and 1. Mathematically, this index represents the value of the residential home divided by the gross wealth (real assets plus financial assets) and captures the impact that a primary house has on households' financial portfolio. It is decided to use this variable because it can give information on the role that housing plays in households' portfolio. The choice of this dependent variable is suggested by Henderson and Ioannides (1983); they use the dependent variable housing stocks in order to capture the presence and the weight of housing in households' portfolio assets. The other right-hand-side control variables, labelled Z, are the demographic variables. A second way to test directly the effect of *COV (HV, Y)* on the decision to own the house in which an individual lives is by using a probit regression denoting the choice to own by the HOMEOWNER. The dependent variable gives information on whether individuals are the owner of their residential house; in particular, it explains whether individuals decide to invest in housing by becoming the owner of their home. This dummy variable assumes the value 1 if the individual is the owner of the house in which he/she lives and 0 otherwise. The probit regression is the following:

$$\Pr(HOMEOWNER) = \Phi(\delta_1 COV(HV, Y) + \delta_2 Z) \tag{2}$$

where Φ is the standard normal cumulative distribution function and Z the set of demographic variables.

In Graph 4.1, the evolution of our two dependent variables is represented over the analysed period (1995–2012). The average percentage of people who decide to own their residential house (blue line) is between 60% and 70% throughout the period. Furthermore, it is possible to see the percentage of housing share (red line), that is, the percentage of the portion of the housing share in households' portfolio; over the period, the percentage of investment in a residential house in households' portfolio is between 30% in 1995 and roughly 40% in 2012. Analysing the homeowner trend, we can affirm that it is quite stationary; in fact, there is not a huge difference between the beginning and the end of the period. Moreover, until 2002, there is a slight increase followed by a feeble decline until 2006; the percentage of homeowners grows slightly and constantly until 2012. In conclusion, the trend of homeowners shows that in Italy almost 70% of households prefer to invest in the house in which they live, being owners rather than renters. As far as the housing share is concerned, the trend shows a constant increase from 30% in 1995 to more than 40% in 2008. On the contrary, after 2008, the percentage of the share of residential housing in households' portfolios decreases decisively, especially after the financial crisis.

Graph 4.1: Homeowner and housing share: evolution over time



The covariance term, *COV (HV, Y)*, represents the relation between the residential housing value and the labour income. In particular:

- *HV* is the variation in the average value of residential houses by region, metropolitan area, and year for each individual;
- *Y* is the variation in the average value of labour income by occupational sector, education level, and year for each individual.

The correlation between housing values and labour income is attributed to all workers and mathematically its calculation consists of the following equations:

$$GROW(HV) = \sum_{t=1}^{9} \frac{House\ value_t}{House\ value_{t-5}} / 9 \qquad (3)$$

$$GROW(Y) = \sum_{t=1}^{9} \frac{Labour\ Income_t}{Labour\ Income_{t-5}} / 9 \qquad (4)$$

$$VAR(HV) = \sum_{t=1}^{9} \left(\frac{House\ value_t}{House\ value_{t-5}} - GROW(HV) \right)^2 /9 \quad (5)$$

$$VAR(Y) = \sum_{t=1}^{9} \left(\frac{Labour\ Income}{Labour\ Income_{t-5}} - GROW(Y) \right)^2 /9 \quad (6)$$

$$CORR(HV, Y) = \frac{\sum_{t=1}^{9} \left(\frac{House\ value_t}{House\ value_{t-5}} - GROW(HV) \right) * \left(\frac{Labour\ Income}{Labour\ Income_{t-5}} - GROW(Y) \right)}{\sqrt{VAR(HV)} * \sqrt{VAR(Y)}} \quad (7)$$

$$COV(HV, Y) = CORR(HV, Y) * \sqrt{VAR(HV)} * \sqrt{VAR(Y)} \quad (8)$$

A question arises regarding which horizon should be used (lags) as the basis for variance terms. The estimates are based overlapping ten-year horizons for two reasons. First, data sets are noisy, in Davidoff (2005) as well as in general, and the differences are likely to be better measured over long horizons. Second, longer horizons are more relevant since sale within a year or less is quite unlikely. In this work, we decide to use 10 lags instead of 5 as in Davidoff (2005) because the Italian housing market is completely different from the US market analysed by Davidoff (2005). According to Neri (2011), there are three main differences between the euro area and the US as far as the housing market is concerned. First of all, land availability is more plentiful in the US than in the euro area; this could imply that there may be fewer supply constraints in the former economy. Moreover, the US population is more mobile, which means that the housing market is more liquid and efficient than that in the euro area. Nobili and Zollino (2012) show that in Italy in more recent years the number of house transactions has begun to decline sharply, in particular after 2006, confirming that the European housing market is less liquid that the US one. Second, the mortgage market is more developed in the US and it allows a quicker translation of higher house prices into easier access to borrowing. Furthermore, there are even legal restrictions to mortgage securitisation in some European countries. Nobili and Zollino (2012) show that mortgages registered a market slowdown in Italy with the beginning of the financial crisis; moreover, periods of booms and slowdowns in the mortgage sector have been associated with similar developments in the growth rate of loans to construction firms. Third, mortgage lending rates are mainly tied to long-term rates in the US, while in the euro area mortagage rates are predominantly variable, in particular in Italy and Spain. For these reasons, it is decided to use a horizon longer than that in Davidoff (2005): in equations (3)–(7), the summation Σ is between 1 and 9 because they are the numbers that the SHIW took into account to build the data set (1995, 1998, 2000, 2002, 2004, 2006, 2008, 2010, 2012); then the number of lags (*t-5*) means that we consider 5 biannual SHIWs, so the horizon (lags) is ten years. The table below shows the influence that occupational sectors and education levels have on the correlation between *HV* and *Y*. For example, if we analyse the first value (0.6693) of Table 4.1, we can say that the relationship between *HV*, which is the variation in the average value of residential houses, and *Y*, which is the variation in the average value of labour income, is positive with quite a high degree for a low-educated individual who works in the agricultural sector. Moreover, the correlation between *HV* and *Y* is positive in all cases, but it is considerably high and positive for a low-educated individual who works in the defence and education sector: the effect that an increase in the variation in the residential house value has on the labour income growth is relevant. The same analysis can be undertaken for a highly educated individual who works in the transport and communication sector; there is a high and positive degree of correlation between HV and Y (0.6722).

Table 4.1: Correlation between HV and Y on the basis of occupational sector and education level

Occupational Sectors	Education Levels		
	Low	**Medium**	**High**
Agriculture	0.6693	0.4222	0.4730
Manufacturing	0.6890	0.4477	0.6484
Building/construction	0.6600	0.6146	0.5115
Retail trade/lodging/services	0.6577	0.4126	0.5412
Transport/communication	0.4413	0.6285	0.6722
Insurance/services of credit	0.4360	0.6245	0.6244
Real estate/renting services	0.5188	0.6304	0.6284
Domestic services	0.4714	0.3884	0.3145
Defence/educ/health	0.7187	0.4321	0.6203
Extra-territorial organizations	0.3059	0.6798	0.6610

4.4 Results and interpretation

The table below (Table 4.2) shows the results of the regressions described previously. The first one (I) is the linear regression model that tests the decision to invest in a residential house (HOUSING SHARE) regressed on the income–house value covariance, while the second one (II) is a probit model in which the dependent variable is the decision to own the residential house (HOMEOWNER). In addition to demographic variables and covariance, some interactions are considered, as in Davidoff (2005): the interactions between income and occupational sectors, growth of labour and income, age and income, and education levels and income. The first regression (I) shows that the covariation coefficient is negative and highly significant, meaning that an increase in the housing value–labour income covariation influences residential housing choices by reducing the presence of residential housing in households' portfolio. Looking at the other variables, it is possible to affirm that all the coefficients are expected: the age, income, and higher education levels have a positive relation with the housing share. In the second regression (II), it is possible to see that the relation between the covariance and the decision to invest in a residential house is negative and significant, meaning that an increase in the housing value–labour income covariation has a negative impact on the probability of being an owner of a residential house. The other variables' coefficients behave in the same way as the previous regression.

Table 4.3 shows the residential housing value–labour income correlation. It is positive, meaning that the two variables move together.

The results of the regressions and correlation can be interpreted in the following way: the relation between housing value and labour income is positive, while the impact of covariation on the residential housing share and the decision to own a house is negative; this means that when the background risk related to labour income increases, individuals are likely to modify their investment decisions by a hedging action: they decide to reduce the portion of housing in their portfolio and prefer not to own a house.

The results are interesting both because they extend our understanding of household financial risk and because they suggest that households, on average, are aware of these risks and take some measures to reduce them.

Table 4.2: The decision to invest in residential housing (I) and own a residential house (II) regressed on income–housing value covariance and other demographic characteristics

	I	II
covariance	*-0.1175***	*-0.2808**
male	-0.0043	0.0108
age	0.0181***	0.0541***
age_squared	-0.0001**	-0.0002
single	-0.0109	0.0648
divorced	-0.0608***	-0.2012***
widowed	0.0347	0.1389
edu_level_LOW	0.0000	0.0000
edu_level_MEDIUM	0.1162***	0.3262***
edu_level_HIGH	0.1419***	0.7462***
1. occupational_sector	0.0000	0.0000
2. occupational_sector	0.0205	-0.2527*
3. occupational_sector	-0.0884**	-0.6725***
4. occupational_sector	0.0307	-0.1284
5. occupational_sector	0.0483	-0.4333**
6. occupational_sector	0.1250**	-0.0177
7. occupational_sector	0.0807**	-0.2939*
8. occupational_sector	-0.1003***	-0.8995***
9. occupational_sector	0.0829**	-0.2179
10. occupational_sector	0.1534	-0.6358
income	0.0080***	0.0336***
1. occupational_sector × income	0.0000	0.0000
2. occupational_sector × income	0.0025***	0.0082*
3. occupational_sector × income	0.0041***	0.0144**
4. occupational_sector × income	0.0015*	0.0033
5. occupational_sector × income	0.0028**	0.0183***
6. occupational_sector × income	0.0009	0.0082
7. occupational_sector × income	0.0015*	0.0091**
8. occupational_sector × income	0.0045***	0.0238***
9. occupational_sector × income	0.0014*	0.0127***
10. occupational_sector × income	0.0022	0.0364
grow_wage	-0.0458	-0.0232
income × grow_wage	0.0017*	0.0058
income × age	-0.0002***	-0.0003**
1. edu_leve_LOW × income	0.0000	0.0000
2. edu_level_MEDIUM × income	-0.0029***	-0.0063*
3. edu_level_HIGH × income	-0.0035***	-0.0192***
household_size	0.0184***	0.0532***

self-employed	-0.1263***	0.0558
0. metropolitan area	0.0000	0.0000
1. metropolitan area	-0.0027	0.1020***
2000b.year	0.0000	0.0000
2002.year	0.0174	0.6849***
2004.year	0.0191	0.5556***
2006.year	0.0480**	0.5101***
2008.year	0.0497**	0.5118***
2010.year	0.0279	0.5113***
2012.year	0.0160	0.5941***
1b. region	0.0000	0.0000
2. region	0.0114	-0.0740
3. region	-0.0153	0.2013***
4. region	0.0496	0.2455**
5. region	-0.0051	0.2260***
6. region	-0.0298	0.4461***
7. region	-0.0088	-0.0957
8. region	0.0075	0.0745
9. region	0.0510**	0.4228***
10. region	-0.0856***	0.3390***
11. region	0.0312	0.2806***
12. region	0.0065	0.1633**
13. region	-0.0178	0.2401**
14. region	0.0025	0.5715***
15. region	-0.0038	0.0264
16. region	0.0322	0.5516***
17. region	-0.1067**	0.2976*
18. region	0.0437	0.5751***
19. region	0.0158	0.4301***
20. region	0.0491*	0.3804***
Constant	-0.3470***	-3.3239***
Observations	15036	15036

Table 4.3: Correlation between the variation in the average value of houses (HV) and the variation in the average value of labour income (Y)

Correlation	HV	Y
HV	1	
Y	0.5556	1

CONCLUSIONS

The main objective of this study is to explore the determinants of participation in the supplementary pension schemes and to provide an alternative explanation for the low take-up rate of pension funds in Italy. Specifically, we investigate the possibility of a trade-off between investment in residential housing and participation in supplementary pension schemes both at household and individual level. The main factors that drive participation in a complementary pension system are the level of income and wealth, the level of education in terms of school education and financial education, and the age of individuals: younger people are less likely to participate. The analysis of the determinants of participation in supplementary pension systems is broadened by taking into account real estate investments. Investment in a residential house may in principle have an important influence on the participation rate and for this reason a set of regressions is run to check the influence of some variables linked to property investment on participation in complementary pension systems.

After controlling for a wide range of socio-demographic variables and allowing for unobserved individual heterogeneity, investment in residential houses appears to crowd out investment in supplementary pension funds. The aim focuses to analyse the trade-off between participation in the supplementary pension system and residential house investments at the individual level (see also Santantonio, Torricelli, and Urzì Brancati, 2014) by using a combination of individual- and household-level data. We show that, despite the positive relationship in the descriptive section, being a homeowner has a negative and highly significant effect on the probability of participating in a supplementary pension scheme.

From the analysis of the trade-off between participation in supplementary pension system and residential housing we have developed the second step of our research focusing on the role of housing. Housing decisions incorporate the choice to hedge income risk and for many households and housing is considered by far the most important collateral asset for households.

Specifically, we analyse how covariance between the housing value and labour income affects the decision to invest in residential house and own house by using data relative to the Italian case. This study carries on Davidoff's (2005) study. Our work can be considered an extension of Davidoff (2005) and focuses on the Italian case.

In addition to demographic variables and covariance, some interactions are considered: the interactions between income and occupational sectors, growth of labour and income, age and income, and education levels and income.

Our results show that an increase in the housing value–labour income covariation influences residential housing choices by reducing the presence of residential housing in households' portfolio. Looking at the other variables, it is possible to affirm that the age, income, and higher education levels have a positive relation with the housing share.

REFERENCES

Ameriks, J., S. P. Zeldes, 2004, How do household portfolio shares vary with age? Columbia Business School, Working Paper.

Bakshi, G., Z. Chen, 1994, Baby boom, population aging, and capital markets, *Journal of Business* 67:165-202.

Bellante, D., C. A. Green, 2004, Relative risk aversion among the elderly, *Review of Financial Economics* 13:269-281.

Benzoni, L., Collin-Dufresne, P., and Goldstein, R. S. (2007). Portfolio Choice over Life-cycle when the Stock and the Labor Markets are Cointegrated, *Journal of Finance*, *62* (5), 2123–2167

Benzoni, L., P. Collin-Dufresne, R.S. Goldstein, 2007. Portfolio Choice over the Life-Cycle when Stock and Labour Markets are Cointegrated, *Journal of Finance*, 62, 2123-2167.

Bodie, Z., Merton, R. C., and Samuelson, W. F. 1992. Labor Supply Flexibility and Portfo Choice in a Life Cycle Model, *Journal of Economic Dynamics and Control*, 16 (3-4), 427–449.

Brueckner, J., 1997. Consumption and investment motives and portfolio choices of homeowners, *Journal of Real Estate Finance and Economics* 15 (2) 159–180.

Brunetti M, C. Torricelli, 2007, The population ageing in Italy: Facts and impact on household portfolios. In Balling M., Gnan E., Lierman F., *Money, Finance and Demography: The consequences of Ageing.*

Brunetti M., Giarda E., Torricelli C. (2012). “Is financial fragility a matter of illiquidity? An appraisal for Italian households”, CeFin Working Paper No. 32, Ceis Research Paper No. 242.

Cairns, A., Blake, D., Dowd, K., 2006, Stochastic lifestyling: optimal dynamic asset allocation for defined-contribution pension plans. *Journal of Economic Dynamics and Control* 30, 843–877.

Campbell, J., 2006, Household Finance, *Journal of Finance*, 61, 1553–1604.

Campbell, J. Y., J.F. Cocco. 2003. Household risk management and optimal mortgage choice. *Quart. J. Econom*. 118(4) 1449-1494.

Campbell, J.Y., and Viceira, L.M. 2002. Strategic Asset Allocation -Portfolio Choice for Long-Term agents. *Oxford University Press*.

Cappelletti G, G. Guazzarotti, 2010. Le scelte previdenziali nell'indagine sui bilanci delle famiglie della Banca d'Italia. *Working Paper No.77, Banca d'Italia.*

Castles, F. G. 1998. The really big trade-off: home ownership and the welfare state in the New World and the Old. *Acta Politica,* 33, 5-19

Coppola M, B. Lamla, 2013. Is it all about access? Perceived access to occupational pension in Germany. *MEA Discussion Paper No.277-2013.*

Chen, En, 2006. Why do so few hold stocks?: Theory and Evidence. In Chen, S (Ed.) *Proceedings of the 2006 NTU International Conference on Finance*, 13 - 14 December 2006, People's Republic of China, Taiwan, Taipei.

Cocco, J. F., 2004. Portfolio Choice in the Presence of Housing, *The Review of Financial Studies* 18, 535-567.

Cocco, J. F., 2005. Portfolio choice in the presence of housing. *The Review of Financial Studies 112, 61–156.*

Cocco, J. F., F. J. Gomes, and P. J. Maenhout, 2005. Consumption and Portfolio Choice over the Life-Cycle. *The Review of Financial Studies* 18, 491-533.

Cocco, J. F. and F. J. Gomes, 2008. Longevity risk and retirement savings. *London Business School, Mimeo*.

Davidoff, T. 2005. Labour Income, Housing Prices, and Homeownership. *Journal of Urban Economics*

Davidoff, T., Brown, J., Diamond, P., 2005. Annuities and individual welfare. *American Economic Review* 95 (5), 1573–1590.

Davis, E. P., C. Li, 2003. Demographics and financial asset prices in the major industrial economies. *Brunel University-West London, Working Paper.*

Dewilde, C., Raeymaeckers, P. 2008. The trade-off between home-ownership and pensions: individual and institutional determinants of old-age poverty. *Ageing and Society*, 28: 805-830.

De Jong, F., J. Driessen, O. Van Hemert. 2008. Hedging house price risk: Portfolio choice with housing futures. *Working paper, Tilburg University, Tilburg, The Netherlands*.

Epstein, L.G., Zin, S.E., 1989. Substitution, risk aversion and temporal behaviour of consumption and asset returns: a theoretical framework. *Econometrica 57 (4), 937–969.*

Fahey, T. 2003. Is there a trade-off between pensions and home-ownership? An exploration of the Irish case, *Journal of European Social Policy*, 13: 159–7.

Fahey, T., Nolan, B. and Maitre, B. 2004. Housing expenditures and income poverty in EU Countries. *Journal of Social Policy*, 33: 437–54.

Flavin M.A., Yamashita T., 2001. Owner-occupied housing and the composition of the household portfolio, *manuscript, University of California, San Diego*.

Gollier C., 2002. What does classical theory have to say about household portfolios?, In Guiso L, Haliassos M, Jappelli T., (eds.) *Household Portfolios*, The MIT Press, Cambridge.

Gomes F. J., A. Michaelides, 2003. Portfolio Choice with Habit Formation: A Life-Cycle Model with Uninsurable Labor Income Risk. *Review of Economic Dynamics, Volume 6, Issue 4, pp. 729-766.*

Gomes F. J., A. Michaelides, 2005. Optimal life cycle asset allocation: Understanding the Empirical Evidence. *Journal of Finance*, American Finance Association, 60(2), 869-904.

Gomes F. J., A. Michaelides, 2002. Life cycle asset allocation: A model with borrowing constraints, uninsurable labor income risk and stock market participation costs. *Working Paper, LBS and LSE.*

Green, R. K., S. M. Wacther, 2007. The Housing Finance Revolution. Institution for Law & Research Paper 09-37. *University of Pennsylvania.*

Guiso L., Haliassos M. and Jappelli T., 2002. Household Portfolios.*The MIT Press Cambridge, Massachusetts.*

Haliassos, M, C. C. Bertaut. 1995. Why do so few hold stocks?, *The Economic Journal* 105, 1110-1129.

Heaton, J., and D. J. Lucas, 1997. Market Frictions, Saving Behavior and Portfolio Choice. *Macroeconomic Dynamics*, 1, 76–101.

Henderson J.V., Ioannides Y. 1983. A model of housing tenure choice. *American Economic Review 73 (1) (1983) 98–113.*

Horneff, W., Maurer, R. and Rogalla, R., 2010. Dynamic Portfolio Choice with Deferred Annuities, *Journal of Banking and Finance*.

Huberman, G., S. Iyengar, and W. Jiang, 2003. Defined Contribution Pension Plans: Determinants of Participation and Contribution Rates. Working paper, September 2003 draft. Columbia University

Ibbotson, R.G., Milevsky, M.A., and Zhu, K.X. 2007. Lifetime Financial Advice: Human Capital, Asset Allocation, and Insurance. *The Research Foundation of CFA Institute.*

Kemeny, J., 1981. The Myth of Home Ownership. *Routledge, London*.

Koijen, R., Nijman, T., Werker, B., 2006. Dynamic asset allocation with annuity risk. *Discussion Paper, Center for Economic Research, Tilburg University.*

Leamer, E. E., 2007. Housing in the business cycle. *NBER Working Paper 13428, National Bureau of Economic Research, Inc.*

Lindset, S., E. Matsen, 2011. Human capital investment and optimal portfolio choices. *European Journal of Finance*, 17 (7), 539-552.

Lusardi, Annamaria. 2003. Planning and Saving for Retirement. *Working paper*. Dartmouth College.

Merton, R., 1971. Optimum consumption and portfolio rules in a continuous-time model. *Journal of Economic Theory* 3 (4), 373–413.

Milevsky, M., Young, V., 2007. Annuitization and asset allocation. *Journal of Economic Dynamics and Control* 31, 3138–3177.

Minderhoud, I., Molenaar, R., Ponds, E.H.M., 2011. The Impact of Human Capital on Life-Cycle Portfolio Choice: Evidence for The Netherlands. NETSPAR *Discussion Paper, Vol. 02/2011-006.*

Mishkin, F. S., 2007. Housing and the monetary transmission mechanism. NBER Working Paper *13518, National Bureau of Economic Research,* Inc.

Merton, R., 1971. Optimum Consumption and Portfolio Rules in a Continuous-Time Model. *Journal of Economic Theory*, 3, 373–413.

Neri, S., 2011. Housing, consumption and monetary policy: how different are the U.S. and the Euro area? *Journal of Banking and Finance*, v.35, 11, pp. 3019-3041, TD No. 807.

Nobili, A., F. Zollino. 2012. A structural model for the housing and credit markets in Italy. *Bank of Italy, Economic Working Papers No. 887.*

Poterba, J. M., 2001, Demographic structure and asset returns, *Review of Economics and Statistics* 83:565-584.

Poterba, J. M., 2004, The Impact of Population Aging on Financial Markets. NBER Working Paper 10851.

Richard, S., 1975, Optimal consumption, portfolio and life insurance rules for an uncertain lived individual in a continuous time model. *Journal of Financial Economics* 2, 187–203.

Rinaldi, A. 2011. Pension Awareness and the Nationwide Auto-enrolment: the Italian Experience, *CeRP WP 104/11*

Roussanov, N. (2010), Human Capital investment and portfolio choice over the life-cycle

Santantonio,M., Torricelli, C., Urzì, MCB. 2014. Does homeownership partly explain low participation in supplementary pension schemes? *CEFIN Working Paper No.48*.

Samuelson, P. A. 1969. Lifetime Portfolio Selection by Dynamic Stochastic Programming, *Review of Economics and Statistics*, 51, 239–246.

Shibanov, O., (2009), Human Capital, Training and Portfolio Choice over the Life Cycle, London Business School.

Silva, H. B., 2003. Labor supply flexibility and portfolio choice: an empirical analysis. *Working Paper 2003-056*, Michigan Retirement Research Center.

Shiller, R. J., 2007, Understanding the recent trends in house prices and homeownership. Working Paper 07-16, Yale ICF.

Tin, J., 1998. Household demand for financial assets: A lifecycle analysis. *Quarterly Review of Economics and Income* 38, no. 4:875-897.

Williams, J. T.,1978. Risk, Human Capital, and the Investor's Portfolio. *Journal of Business*, *51* (1), 65–89.

Williams, J. T. 1979. Uncertainty and the Accumulation of Human Capital Over the Life Cycle, *Journal of Business*, *52* (4), 521–548.

Yaari, M., 1965. Uncertain lifetime, life insurance, and the theory of the consumer. *Review of Economic Studies 32, 137–150*.

Yao, R., and H. Zhang, 2005, Optimal Consumption and Portfolio Choices with Risky Housing and Borrowing Constraints, *The Review of Financial Studies*, 18, 197-239.

Yaron, A, Huggett M,Ventura, G. 2006. Human capital and earnings distribution dynamics, *Journal of Monetary Economics*, vol. 53, no. 2, pp. 265-290.

Yoo, P. S., 1994a. Age dependent portfolio selection. *Federal Reserve Bank of St.Louis, Working Paper 3.*

Yoo, P. S., 1994b. Age distribution and returns for financial assets. *Federal Reserve Bank of St.Louis, Working Paper 2.*

Van Hemert, O., 2007.Household Interest rate risk management. *Working Paper,* New York University.

Viceira, L. M., 2001. Optimal Portfolio Choice for Long-Horizon Investors with Non tradable Labor Income. *Journal of Finance*, 56, 433–470.

Voicu, C., M. J. Seiler. 2011. Deriving Optimal portfolios for Hedging Housing Risk. *Journal of Real Estate Finance and Economics.*