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THE ROLES OF TEMPTATION AND SOCIAL SECURITY IN EXPLAINING INDIVIDUAL BEHAVIOR

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THE ROLES OF TEMPTATION AND SOCIAL SECURITY IN EXPLAINING INDIVIDUAL BEHAVIOR

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Abstract

I simulate a life-cycle model with preferences described by a utility function à la Gul and Pesendorfer (2001). I show that temptation to consume contributes to explain the saving, retirement consumption, and asset allocation puzzles. I perform two analyses, with and without Social Security protection, separately for the US and Italy. The pension replacement rate is endogenous in the model and varies with income realizations. The results also show that the optimal behavior differs remarkably between the two countries when Social Security is considered. In particular, the more generous Italian system depresses savings and investments of more tempted individuals.

JEL classification codes: D91, E21, G11.

Keywords: temptation and self-control preferences; life-cycle models; consumption and investment choice; economic puzzles; Social Security.

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1. Introduction

This paper investigates the role of temptation as a possible explanation for sub-optimal consumption and investment choices. It is a well-known economic puzzle that individuals save less than they should do according to standard life-cycle models (Hall and Mishkin, 1982), and that their consumption drops at retirement (Banks et al., 1998). This evidence is consistent with rule-of-thumb theories of wealth accumulation, in which agents choose to consume just their income, instead of smoothing their consumption over the life-cycle. A way to model this behavior in a life-cycle model is to consider a "quasi-hyperbolic discounting" (Laibson, 1997) instead of a standard exponential one. This discount factor produces a behavior compatible with the empirical evidence (Angeletos et al., 2001), but gives rise to time inconsistent preferences. An agent may value actions differently *ex post* than at the time they are taken, and so may later regret those actions. This issue makes the resulting behavior hard to interpret. With a utility function based on Gul and Pesendorfer's (2001) "temptation and self-control preferences" it is possible to obtain the same results using standard dynamic programming techniques. Sub-optimal behavior is explained by temptation rather than myopia. Temptation causes agents to repeatedly delay savings and investments that they know to be necessary.

This paper contributes to the literature inserting a utility function à la Gul and Pesendorfer (2001) in a life-cycle model and analyzing the consumption, saving and investment behavior of representative agents. The literature on this field usually assumes that individuals just follow either a forward-looking or a rule-of-thumb behavior. Empirical evidence, nevertheless, suggests that they are not extreme, but prudent and impatient, forward-looking and rule-of-thumb at the same time. I therefore study the optimal behavior considering different degrees of temptation. With this model I also analyze whether temptation can explain the asset allocation puzzle. There is evidence of a participation rate in the equity market smaller than predicted by standard models (around 50 percent in the US, see for instance Gomes and Michaelides, 2005). Since temptation postpones personal saving and the accumulation of wealth, it should be responsible for lower participation rates at early ages.

Temptation also provides a justification for government intervention. Workers with higher levels of temptation have less resources available for consumption after retirement. Social Security, guaranteeing a stable income during the lifespan, protects their wellbeing at later ages.

I develop my analysis separately in a *laissez-faire* economy, where no Social Security program is implemented, and in a *paternalistic* economy, in which the current system is considered. While the case of a paternalistic economy is more realistic and appropriate to study puzzles such as the retirement consumption drop, I expect the *laissez-faire* case to produce the pure, unaffected result of temptation in individual behavior. Social Security programs may indeed influence individual decisions, and may do so differently for diverse degrees of temptation. For this reason in the paper I provide an estimate of the substitution effect between Social Security payroll tax and personal saving.

My model includes uninsurable labor income risk, and uncertainty on market returns and lifespan. I also consider the political risk that government does not respect its promises and reduces retirement benefits to keep Social Security balance sound. Under the paternalistic economy, contrary to most existing literature, I do not assume the replacement rate to be fixed and exogenously given. In the model Social Security accumulation enters the optimization problem as a state variable. Different realizations of the labor income process can then modify an individual's projections about her future replacement rate, and eventually produce a variable replacement rate.

The model, that does not admit a closed-form solution, is simulated with respect to two countries: the United States and Italy. The two countries differ in the generosity of their Social Security programs and in the formulas used in the calculation of their benefits. The payroll tax collected by the government and devoted to Social Security only is 10.6 percent in the US, and 32.7 percent (employed) or 16.8% (self-employed) in Italy. The benefits depend on past income realizations, and are expected to be roughly equal to 40 percent in the US, and 60 percent in Italy. The Italian system collects thus a higher tax and promises a larger benefit. The main difference between the two systems is however in their nature. Both Pay-As-You-Go (PAYGO), and therefore sensitive to demographic trends such as the decline in birth rates and rises in life expectancy, the American program is essentially of a Defined Benefit (DB) type, while the Italian one follows a Notional Defined Contribution (NDC) scheme after the 1995 Dini reform[1]. In a DB scheme the worker pays a tax and is guaranteed a subsidy after retirement. In the US, in particular, a progressive formula is used to compute higher replacement rates for those with lower earnings. A NDC scheme is non-redistributional instead – although redistribution may be accommodated within the scheme – but more transparent compared with a DB scheme. It guarantees a closer link between contributions and benefits. Each individual has a personal account to which she pays a prescribed annual amount of share of earnings; after retirement the benefit is computed as an actuarially fair fraction of the wealth accumulated in the personal account. I include these characteristics in the model and investigate how they affect individual behavior. My thesis is that Social Security is not neutral on saving and investment decisions. In particular I expect that the higher protection of the more generous Italian system causes individuals with more temptation to save sensibly less than the American counterparts would do.

[1] Although it will be fully phased in only around 2030.

The paper is organized as follows. Section 2 summarizes the main characteristics of the model, while Section 3 presents the calibration results. In Section 4 I discuss the results for the baseline case in a *laissez-faire* and in a paternalistic economy; in Section 5 I report results on the sensitivity analysis. Finally, Section 6 summarizes the results and concludes. The appendix provides some mathematical details.

2. The model

To simplify the problem I consider a life-cycle model in which individuals, rather than households, are the decision makers. A model based on households as the economic unit would need to adjust for the household size, age of the household members and possibly their inter-relationships. The requirement of this information would bring additional noise to the model. Deaton and Paxson (2000) finds indeed empirical support for the life-cycle model at the individual level much more than at the household level.

In the model time is discrete and t denotes adult age (effective age minus 19). Each period corresponds to one year, and an agent lives for a maximum of $T = 81$ periods (age 100), $R = 46$ (age 65) as a worker and $T - R = 35$ as a retiree. For simplicity, the retirement age is taken as exogenous. I define π_t as the probability that a person is alive at time t conditional on being alive at time $t-1$.

I consider Gul and Pesendorfer's (2001) "temptation and self-control preferences" and define a period utility function similarly to Hurst and Willen (2004):

(1) $$U(C_t, CH_t) = u(C_t) - \tau\big(u(CH_t) - u(C_t)\big)$$

where C_t denotes consumption at time t of non-durable goods, CH_t is cash-on-hand (Deaton, 1991) at time t, i.e., the sum of resources available for consumption, $u(.)$ is a CRRA utility function with relative risk aversion coefficient γ, and $\tau \geq 0$ measures temptation.

An individual with utility function (1) is both a farsighted planner and a myopic doer. The planner, whose behavior is described by the first component $u(C_t)$, is concerned with lifetime utility, while the doer, described by the second component $u(CH_t) - u(C_t)$, looks for immediate gratification and is completely myopic. The more τ is larger, the more temptation to consume takes control of the individual's behavior. The extremes represent two stylized behaviors: a "disciplined" (planner) individual with $\tau = 0$ is the standard *forward-looking* agent, whereas an "undisciplined" (doer) individual with $\tau \to \infty$ is the standard *rule-of-thumb* agent who, including liquidity constraints ($C_t \leq CH_t$) and assuming selfishness (no bequest motives), consumes each year all her income (see §A.1). Social Security, through its system of taxes and benefits, restricts the doer's opportunities and – if well designed – may approximate the planner's choice. In the model I also assume uncertainty on labor income, market returns and policy decisions regarding Social Security.

2.1. Labor income process

Following Zeldes (1989), the labor income process before retirement L_t is exogenously described by

(2) $$L_t = P_t U_t$$

(3) $$P_t = G_t P_{t-1} N_t\,, \quad P_0 = 1$$

with G_t deterministic function of age and other personal characteristics, P_t permanent component with innovation N_t, and U_t transitory component. I assume that $n_t = \log\left(N_t\right)$ and $u_t = \log\left(U_t\right)$ are independent and identically distributed with mean and variance $\left\{-0.5\sigma_n^2, \sigma_n^2\right\}$ and $\left\{-0.5\sigma_u^2, \sigma_u^2\right\}$ respectively. The log of P_t, $p_t = \log\left(P_t\right)$, evolves as a random walk with a deterministic drift G_t.

Earnings in retirement depend on Social Security benefits and are computed endogenously. I model the Social Security system in the following way. During working life the individual saves a fraction α of current labor income as retirement wealth. During working life retirement wealth is illiquid; the individual cannot consume it or borrow against it. At age $t = R+1$ DB wealth is rolled into a risk-less annuity A, according to the formulas described in §A.2 (equations 27 and 28). This assumption of risk-less annuitization affects the retiree's portfolio composition. Disposable income is thus given by

(4) $$Y_t = \begin{cases} \left(1-\alpha\right) L_t & t \le R \\ A & t > R \end{cases}$$

2.2. Financial assets

An individual can invest in two financial assets, one risk-less (T-bills or cash) with gross real return R^f, and one risky (equities), with excess return

(5) $$R_t^E - R^f = \mu + \varepsilon_t$$

and $\varepsilon_t \sim N\left(0, \sigma_\varepsilon^2\right)$. I allow the equity shock to be correlated with the (log of) permanent income shock n_t:

(6) $$corr\left(n_t,\varepsilon_s\right)=\begin{cases}\rho_{n\varepsilon} & t=s\\ 0 & t\neq s\end{cases}$$

The correlation between equity shock and transitory income shock is instead assumed to be null. According to this formulation, the one-period correlation between equity market returns and labor income growth is approximately given by $\rho_1^{LE}<\rho_{n\varepsilon}$:

(7) $$\rho_1^{LE}=\rho_{n\varepsilon}\frac{\sigma_n}{\left(\sigma_n^2+2\sigma_u^2\right)^{1/2}}$$

and the correlation from the beginning to the end of the working life is (see §A.4):

(8) $$\rho_{R-1}^{LE}=\rho_{n\varepsilon}\frac{\sigma_n}{\left(\sigma_n^2+2\dfrac{\sigma_u^2}{R-1}\right)^{1/2}}$$

To explain limited market participation, I consider a fixed period participation cost F to have access to the equity market, rather than a one-period trading cost. Both costs appear to be relevant in explaining market non-participation (Vissing-Jorgensen, 2002), and are consistent with the fact that the participation rate is strongly increasing in financial wealth. Although the existence of both costs is easily recognized, the lifetime-horizon nature of one-period trading costs prevents one from obtaining accurate estimates. I therefore choose period participation costs in order to calibrate the model with a more reliable estimate.

A period participation cost represents brokerage account fees and the opportunity cost of time spent throughout the year to acquire information. A period participation cost can explain why some do not participate when they have low financial wealth; in the model this is more likely for those with a positive temptation τ. The cost deters young individuals from buying equities, but later in the life-cycle these individuals might find it worthwhile to begin participating if their wealth levels are high enough to justify paying the cost. Further, period participation costs rationalize the evidence that many households exit from the market, i.e., they do not participate even though they made some investment in the past years (Vissing-Jorgensen, 2002).

2.3. Political risk

The government needs to revisit benefits or taxes from time to time, when there are changes in the demographic and macroeconomic variables that support PAYGO programs. Social Security is thus subject to a political risk (Diamond, 1996). In particular I assume that the government is passive in changing the parameters of the Social Security program; it does not make any intervention and, as a result, it might not be able to pay the promised benefit at retirement. The risk is modeled with a Bernoulli random variable ϕ associated to the annuity benefit:

$$\phi = \begin{cases} \omega & q \\ 0 & 1-q \end{cases} \tag{9}$$

The benefit is thus reduced of a fraction ω with probability q. The average $E\left[\phi\right] = q\omega$ may be interpreted from an individual's perspective as the subjective probability of being "cheated" by the government, that pays a benefit lower than the one promised.

2.4. The optimization problem

Let β denote the discount rate, and $\exp\left\{\delta' Z_t\right\}$ an exogenous individual demographic factor as in Attanasio et al. (1999). Z_t is a vector of observable variables considered exogenous for the determination of consumption, but that can affect the marginal utility of consumption. The value function at any time t is defined as

$$V_t = U\left(C_t, CH_t\right)\exp\left\{\delta' Z_t\right\} + E_t\left[\beta \pi_t V_{t+1}\right] \tag{10}$$

with $V_{T+1} = 0$. Each year the individual determines her optimal consumption $C_t \le CH_t$, whether to enter the equity market, and the portfolio investment in equities $x_t \in \left[0,1\right]$, according to this system of first order conditions:

$$\begin{cases} C_t = \min\left\{ CH_t, E_t\left[\beta \pi_{t+1} \exp\left\{\delta' \Delta Z_{t+1}\right\}\left(R^f + \left(R_{t+1}^E - R^f\right)x_t\right)\left(\left(C_{t+1}\right)^{-\gamma} - \dfrac{\tau}{1+\tau}\left(CH_{t+1}\right)^{-\gamma}\right)\right]^{-\frac{1}{\gamma}} \right\} \\ 0 = E_t\left[\beta \pi_{t+1} \exp\left\{\delta' Z_{t+1}\right\}\left(R_{t+1}^E - R^f\right)\left(\left(C_{t+1}\right)^{-\gamma} - \dfrac{\tau}{1+\tau}\left(CH_{t+1}\right)^{-\gamma}\right)\right] \end{cases} \tag{11}$$

where the first is the Euler equation that incorporates a liquidity constraint $C_t \le CH_t$. Note the presence of the temptation parameter τ and the *variation* $\Delta Z_{t+1} = Z_{t+1} - Z_t$ occurred in the demographic variables between the two periods. The complete description of the model is provided in §A.2. The problem does not admit analytical solutions; details on the numerical solution are given in §A.3.

3. Parameter calibration

I simulate the model referring to two countries: the United States and Italy. Before doing that, several parameters have to be calibrated. Some of them are established by law: in particular I set the payroll tax $\alpha = 0.106$[2] for the US and $\alpha = 0.327$ (for employed) or $\alpha = 0.1689$ (for self-employed) in Italy when I consider Social Security protection.

Given the paucity of literature for Italy, I obtain *ex novo* estimates of most of the exogenous parameters for such country. I do the same for the US to keep the comparison as much reliable as possible.

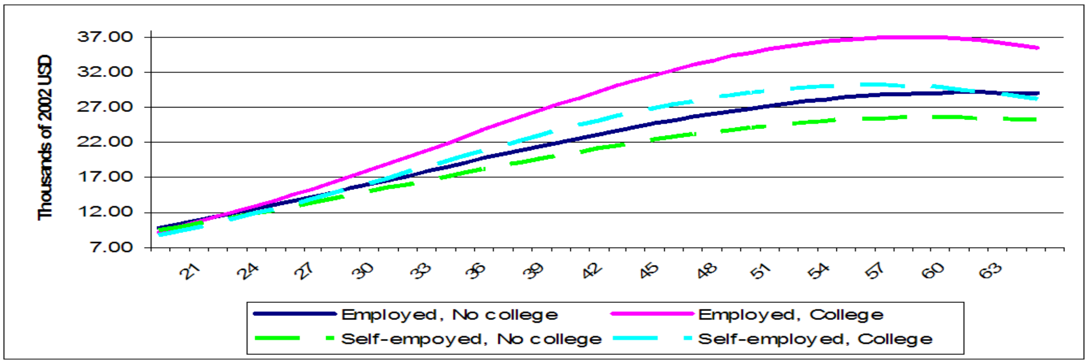
3.1. Labor income process

The deterministic profile of the labor income process, G_t, reflects the hump shape of earnings over the life cycle, and is considered separately for four different groups: employed individuals with at most high school education (baseline case) or college education, and self-employed individuals with at most high school education or college education (figure 1).

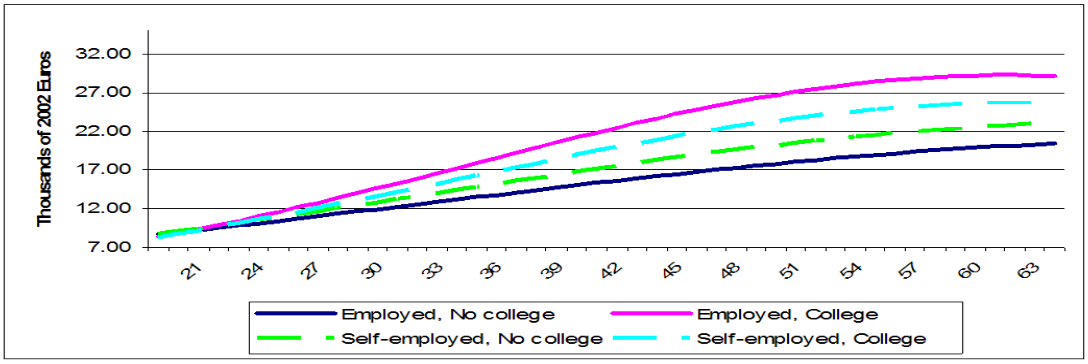
Figure 1. Age-Labor income profile

The figure describes the age-labor income profile of an American (top panel) and an Italian (bottom panel) individual, with respect to their education and occupation. The profiles are derived from a fixed effect panel regression of log-income over age, age squared, and marital status. The dependent variable is corrected for inflation and productivity growth. I included in the sample only workers in age between 20 and 64.
Data: panel data from 1990-2003 PSID (US) and 1989-2002 SHIW (Italy) surveys.

US



Italy



[2] The part of the tax devoted to Social Security only. The overall tax also includes disability and Medicare's hospital insurance.

This sample split is intended to accommodate the well-established finding that age profiles differ in shape across education and occupation groups. The profiles are derived from a fixed effect pseudo-panel regression[3] of log-income over age, age squared, family size and marital status; the dependent variable is corrected for inflation and productivity growth as in Diamond et al. (1976). The panel data sets used are those in the PSID (US) and SHIW (Italy) surveys; the sample covers the period 1989:2002 (1990-2003 PSID, 11 waves; 1989-2002 SHIW, 7 waves). I consider only workers in age between 20 and 64.

Earnings for the group with more education are higher on average, rise and fall more steeply, and peak at later age than for the group with less education. On average, the deterministic income grows at a rate of 2.03% in the US, close to Carroll and Samwick (1997), and 1.44% in Italy; the last income ($t = R$) is predicted to be about three times higher than the first income ($t = 1$) in the US, as in Diamond et al. (1976), and about 2.5 times higher in Italy.

The procedure adopted for estimating the standard deviation of permanent and transitory shocks closely follows that in Carroll and Samwick (1997) and is described in §A.5; estimates used in the simulation are reported in table 1. In one case (Italian self-employed with at most high school education) the OLS procedure estimates a negative permanent shock variance; as in Campbell et al. (2001) I set it to zero and attribute all the variance to the transitory shock.

Table 1. Standard deviation of permanent and transitory shock

*The table describes the estimates of the permanent and transitory component of the income risk. The estimates are the result of a regression from panel data, and are computed separately for groups differing in education and occupation; details are provided in §A.5. Standard errors in parentheses; * means that the variable is significant at 95% level. Data: panel data from 1990-2003 PSID (US) and 1989-2002 SHIW (Italy) surveys.*

Group		US		Italy	
Maximum Education	**Occupation**	**Permanent shock σ_n**	**Transitory shock σ_u**	**Permanent shock σ_n**	**Transitory shock σ_u**
High school	Employed	0.1323* (0.0115)	0.2095* (0.0126)	0.1436* (0.0215)	0.2162* (0.0255)
College or more	Employed	0.1440* (0.0143)	0.2002* (0.0150)	0.1431* (0.0193)	0.2225* (0.0214)
High school	Self-Employed	0.1516* (0.0139)	0.2079* (0.0119)	0 (-)	0.2070* (0.0157)
College or more	Self-Employed	0.1623* (0.0164)	0.1997* (0.0125)	0.1687* (0.0185)	0.2822* (0.0215)

The magnitude of the estimates is in line with the literature, where the standard deviation of the permanent shock ranges between 0.10 and 0.32, and the standard deviation of the transitory shock

[3] Details on this methodology are provided in §A.6.

ranges between 0.15 and 0.32. In particular, the baseline estimates are close to those in Carroll and Samwick (1997) and in Gourinchas and Parker (2002), who report 0.15 for the permanent shock and 0.21 for the transitory shock. From the above table one can draw the following comments. First, both shocks are more volatile for a self-employed, consistently with Campbell et al. (2001). Second, a college graduate faces more risk than a non-college graduate with similar occupation. This is consistent with the idea that the higher returns emanating from increased education come at the cost of higher earnings risk. Third, the variance associated with a permanent income shock is much smaller than the variance of a transitory income shock.

3.2. Financial markets

Following the standard calibration in the literature, the constant net real interest rate $R^f - 1$ is set at 2%; for the equity return process I consider a mean equity premium μ of 4.39% (US) and 3.73% (Italy), and a standard deviation σ_ε of 16.96% (US) and 20.15% (Italy). The estimates highlight, as expected, a better performance of the US market, and are consistent with the existing literature on US market returns (e.g. Campbell et al, 2001; Cocco et al., 2005). I obtain these numbers from inflation-corrected S&P500 and MSCI Europe annual return time series, covering monthly the sample period January 1973 – December 2002 (360 observations). I make use of the European equity market for Italy since, after the launch of a single currency in Europe, investment home bias turns out to be much smaller (Danthine et al., 2000).

Notwithstanding asset returns have received substantial attention from financial researchers, only a handful of scholars has investigated their correlation in the US with labor income, often coming to opposite conclusions. Some authors find that labor income covaries with stock returns positively (e.g. Campbell et al., 2001) or negatively (Heaton and Lucas, 2000). For some others the correlation between the two processes is not significant (Fama and Schwert, 1977). I follow the algorithm developed in Campbell et al. (2001) (details in §A.5), and obtain the estimates shown in table 2.

The data provide evidence of an insignificant correlation in the US, as in Davis and Willen (2000) and Cocco et al. (2005), and a significantly large correlation for Italy. The result for Italy is confirmed by the application of the same algorithm on MSCI Italy returns rather than MSCI Europe data. Using formulas (7) and (8) in the baseline case (employed with at most high school education), the correlation between income growth and market returns is equal to zero for the US and 0.15 (in one period) and 0.3363 (over all the working life) in Italy. According to Haliassos and Bertaut (1995), a positive correlation between labor income and stock returns exacerbates consumption risk. The result thus provides a rationale for a low level of investment in equities, as typically observed in Italy (Guiso et al., 2002).

Table 2. Correlation between labor income permanent shock and equity returns

*The table describes the estimates of the correlation between equity market returns and the permanent component of the income risk. The estimates are the result of a regression from panel data, and are computed separately for groups differing in education and occupation; details are provided in §A.5. Standard errors in parentheses; * means that the variable is significant at 95% level.*
Data: stock market excess returns (S&P500 and MSCI Europe), covering annually the period 1989:2002; panel data from 1990-2003 PSID (US) and 1989-2002 SHIW (Italy) surveys.

Group		Correlation $\rho_{n\varepsilon}$	
Maximum Education	**Occupation**	**US**	**Italy**
High school	Employed	0.0819 (0.0465)	0.3526* (0.0534)
College or more	Employed	-0.1133 (0.0647)	0.4043* (0.0542)
High school	Self-Employed	-0.1381 (0.0751)	0.3527* (0.0531)
College or more	Self-Employed	0.0681 (0.0536)	0.3875* (0.0718)

Existing literature states that fixed market participation costs are significant but small in magnitude. I therefore set a conservative estimate of $F = \$100$ in the US, according to Vissing-Jorgensen (2002) and Attanasio and Paiella (2006), and $F = €150$ in Italy, following Paiella and Tiseno (2005). The difference between the two countries finds support in Guiso et al. (2003). Their analysis shows that country differences in actual and perceived transaction costs play an important role in reconciling international differences in stockholding participation. Such costs appear to be larger in Italy than in the US.

3.3. Political risk

I set the cut in Social Security benefits at $\omega = 30\%$ in the US and $\omega = 15\%$ in Italy. The estimate for the US is based on the prediction from Social Security Administration that, without any correction to the current program, the US system would still be able to pay about 73 percent of scheduled benefits. The estimate for Italy comes from the direct comparison between the expected replacement rates in the 2000 and 2002 waves of the SHIW survey (the average perceived reduction is 16.42%).

The probability to suffer for a reduction in Social Security benefits, q, is harder to quantify. I set $q = 0.6$ in the US and $q = 0.5$ in Italy, sample median value from an *ad hoc* question in the 2002 waves of the HRS for the US and SHARE for Italy. The question asks for the chances, on a 0-100 scale, that before the individual retires the government will reduce the pension.

The average perceived reduction in Social Security is therefore $q\omega = 0.18$ in the US and $q\omega = 0.075$ in Italy. Not surprisingly, political risk seems to be smaller in Italy than in the US. This is plausibly the consequence of the implementation of several major reforms during the 90s (1992, Amato reform; 1995, Dini reform; 1997, Prodi reform) and the beginning of the new century (2004, Maroni reform).

3.4. Preference parameters

To estimate the parameters β (discount factor) and γ (relative risk aversion) I adopt the four-step procedure described in §A.6. Table 3 shows the output results assuming different levels of temptation.

Let us first focus on the case $\tau = 0$. The output shows that in the US, where a higher equity premium is expected from the financial market (see indeed §3.2), individuals are more risk averse, with a parameter of about 3 against 1.5. Both estimates are compatible with Imrohoroglu et al. (2003), that suggests a coefficient in the neighborhood of 2 to be a reasonable base case. Note, however, how large the standard error for this measure is. According to the estimates, an American individual also exhibits a smaller discount factor.

Table 3. Discount factor and risk aversion for different levels of temptation

*The table describes the estimates of the discount factor and the relative risk aversion coefficient. The parameters are estimated following a four-step procedure, described in detail in §A.6, which uses GMM and a panel regression based on macro and micro data. A Hansen test of over-identifying restrictions and a Newey-West test of parametric restrictions (estimates equal to those with no temptation) are also provided. Standard errors in parentheses; * means that the parameters are significantly different at 95% level from those with no temptation.*
Data: stock market capitalization and excess returns (S&P500 and MSCI Italy), total non-durable consumption and disposable income (BEA for the US and Istat for Italy) covering quarterly the period 1982:2004; 1980 cohort survival probability from SSA (US) and INPS (Italy); panel data from 1990-2003 PSID (US) and 1989-2002 SHIW (Italy) surveys.

Temptation	US				Italy			
	Discount factor β	**Risk aversion γ**	**Hansen test**	**Newey-West test**	**Discount factor β**	**Risk aversion γ**	**Hansen test**	**Newey-West test**
$\tau = 0$	0.9219* (0.0433)	2.7504* (1.1892)	27.7173	-	0.9447* (0.0346)	1.2620 (0.8649)	16.6991	-
$\tau = 1/3$	0.9653* (0.0238)	2.8164* (1.0694)	28.1721	7.3117*	1.0984* (0.0915)	1.3285 (0.8753)	16.9774	37.2254*
$\tau = 1$	0.9866* (0.0142)	3.2757* (0.9743)	28.3807	29.0370*	1.2614* (0.1741)	1.5731 (0.8644)	17.5341	147.6170*
$\tau = 3$	1.0099* (0.0362)	3.5902* (0.9160)	28.5112	64.5657*	1.3778* (0.2882)	1.9777 (0.7806)	18.3680	328.0935*
$\tau \to \infty$	1.0117* (0.0676)	3.8303* (0.8761)	28.6052	113.3445*	1.4423* (0.4468)	2.4410 (0.6785)	19.3029	575.3519*

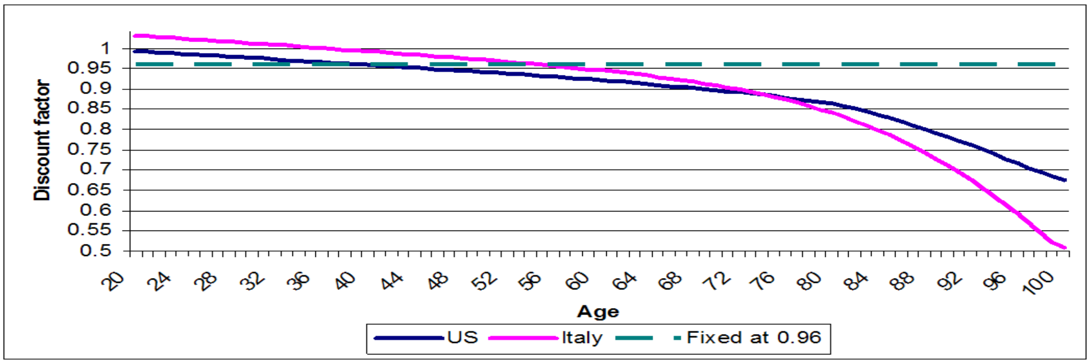
Allowing the temptation parameter to change, while keeping the same dataset, risk aversion remains consistently larger, and the discount factor smaller, in the US than in Italy. The estimates reveal that, as

τ increases, both β and γ grow. The variation is statistically significant as shown by a Newey-West test of parametric restrictions, in which the null hypothesis is that the parameters β and γ are equal to the values when $\tau = 0$. The behavior observed in the data can be explained as a combination of either small risk aversion and discount factor with low temptation, or larger parameters with more temptation. In other words, an increase in temptation is coherent with these data only if the discount factor and risk aversion coefficients are larger, although the discount factor gets a value unreasonably above one for $\tau \geq 3$ in the US and $\tau \geq 1/3$ in Italy. This way the effect of more temptation (more immediate consumption) is offset by more concern about the future (β) and a higher accumulation of precautionary saving (γ). A Hansen test of over-identifying restrictions always accepts the null, and it does so more firmly when temptation τ is smaller. The data are therefore more supportive of the hypothesis that the aggregate behavior follows a forward-looking rather than a rule-of-thumb strategy. I therefore set my benchmark RRA parameter at $\gamma = 3$ in the US and $\gamma = 1.5$ in Italy. This level implies an intertemporal elasticity of substitution of $1/\gamma = 0.33$ in the US and $1/\gamma = 0.67$ in Italy. Accordingly, my calibration for the discount factor is $\beta = 0.92$ for the US and $\beta = 0.94$ for Italy. The value is in line with, for instance, Gourinchas and Parker (2002).

Figure 2 describes the resulting "total" life-cycle discount factor, $\beta\pi_{t+1}\exp\left\{\delta'\Delta Z_{t+1}\right\}$, the product of the fixed discount factor with the survival probability and the demographic effect. To estimate the parameter $\pi_t, t = 1,\ldots,T$ I use 1980 cohort survival probabilities of Social Security Administration (SSA) and INPS, the Italian National Social Security Institute. The variation across time of the factor mainly depends on the demographic effect, which decreases steadily over time; the factor declines more steeply after age 80, when the survival probability falls. The parameter is larger in Italy at earlier ages (the demographic effect is more important than in the US) and smaller at later ages (the survival probability is lower than in the US). This subjective discount rate is on average equal to 0.95 in the US and 0.96 in Italy; it is larger than a standard discount factor of 0.96 at ages younger than 39 in the US and 54 in Italy.

Figure 2. Discount factor profile

The figure shows the age-total discount factor profile of American and Italian individuals, as opposed to a fixed discount rate of 0.96. The total discount factor is the parameter that discounts next-period consumption in the Euler equation (top equation in system 11). It is the product of the standard discount factor with the survival probability and the demographic effect. The factor is estimated following a four-step procedure, described in detail in §A.6, which uses GMM and a panel regression based on macro and micro data.
Data: stock market capitalization and excess returns (S&P500 and MSCI Italy), total non-durable consumption and disposable income (BEA for the US and Istat for Italy) covering quarterly the period 1982:2004; 1980 cohort survival probability from SSA (US) and INPS (Italy); panel data from 1990-2003 PSID (US) and 1989-2002 SHIW (Italy) surveys.



4. Simulation results

In this section I report results based on 1,000 simulations over random realizations of labor income, equity market, and political risk. I first consider a model in which no Social Security system is present (*laissez-faire* economy), and then a model under the current Social Security system (*paternalistic* economy).

4.1. Laissez-faire economy

Table 4 summarizes the average optimal consumption, investment, and saving[4], for a generic baseline individual living in the US or Italy with levels of discipline $\tau = 0$, $1/3$, 1, 3, and $\tau \to \infty$[5], and over all the lifespan, only the working or the retirement period. All the variables are standardized dividing by disposable permanent income $(1-\alpha)P_t$.

It is clear from the table that the optimal average behavior is similar in both countries, when Social Security programs are absent. During the working life, consumption is larger (and consequently saving smaller) and investment smaller as τ increases; during retirement, consumption is smaller as τ increases. Since a person with more temptation makes less saving while working, a smaller stock of

[4] The average values are taken using an actualizing factor based on the risk free rate of return R^f.
[5] The levels of discipline are chosen in such a way to be representative of the full range of possible behaviors. The importance $\tau/(1+\tau)$ of cash-on-hand relative to consumption is this way equal to 0, 0.25, 0.5, 0.75, and 1 respectively.

wealth is available to be converted in consumption. Note that, over the retirement life, saving is negative and corresponds, with an opposite sign, to consumption. This is a consequence of having no Social Security protection. Also investment is smaller as τ increases, although in this case the change does not seem to be significant. On average over all the lifespan, an individual with higher τ consumes and invests less. Over lifetime, saving is on average negative because the investment in the financial market generates additional wealth that is ultimately spent in the absence of bequest motives.

Table 4. Average consumption, investment, and saving

The table describes the average consumption, investment and saving of American and Italian baseline (employed and with high school education at most) individuals with different degrees of temptation. The average is based on 1,000 simulations of the model with no Social Security protection and is taken using the risk free rate of return as actualizing factor.

	Average Consumption		**Average Investment**		**Average Saving**	
Temptation	**US**	**Italy**	**US**	**Italy**	**US**	**Italy**
	Lifetime					
$\tau = 0$	0.9193	0.7651	0.8030	0.3451	-0.1542	-0.0192
$\tau = 1/3$	0.8807	0.7632	0.6475	0.2357	-0.1131	-0.0146
$\tau = 1$	0.8541	0.7604	0.4377	0.2218	-0.0897	-0.0164
$\tau = 3$	0.8340	0.7561	0.3544	0.2059	-0.0656	-0.0108
$\tau \to \infty$	0.7673	0.7492	0	0	0	0
	Working Life					
$\tau = 0$	0.9282	0.9393	0.8580	0.2194	0.0713	0.0576
$\tau = 1/3$	0.9295	0.9458	0.6557	0.0734	0.0673	0.0509
$\tau = 1$	0.9487	0.9552	0.3820	0.0559	0.0509	0.0434
$\tau = 3$	0.9628	0.9578	0.2725	0.0561	0.0336	0.0381
$\tau \to \infty$	1	1	0	0	0	0
	Retirement Life					
$\tau = 0$	0.7755	0.2473	0.6253	0.7190	-0.7755	-0.2473
$\tau = 1/3$	0.6556	0.2093	0.6219	0.7184	-0.6556	-0.2093
$\tau = 1$	0.6091	0.1942	0.6207	0.7031	-0.6091	-0.1942
$\tau = 3$	0.5182	0.1563	0.6204	0.6515	-0.5182	-0.1563
$\tau \to \infty$	0	0	0	0	0	0

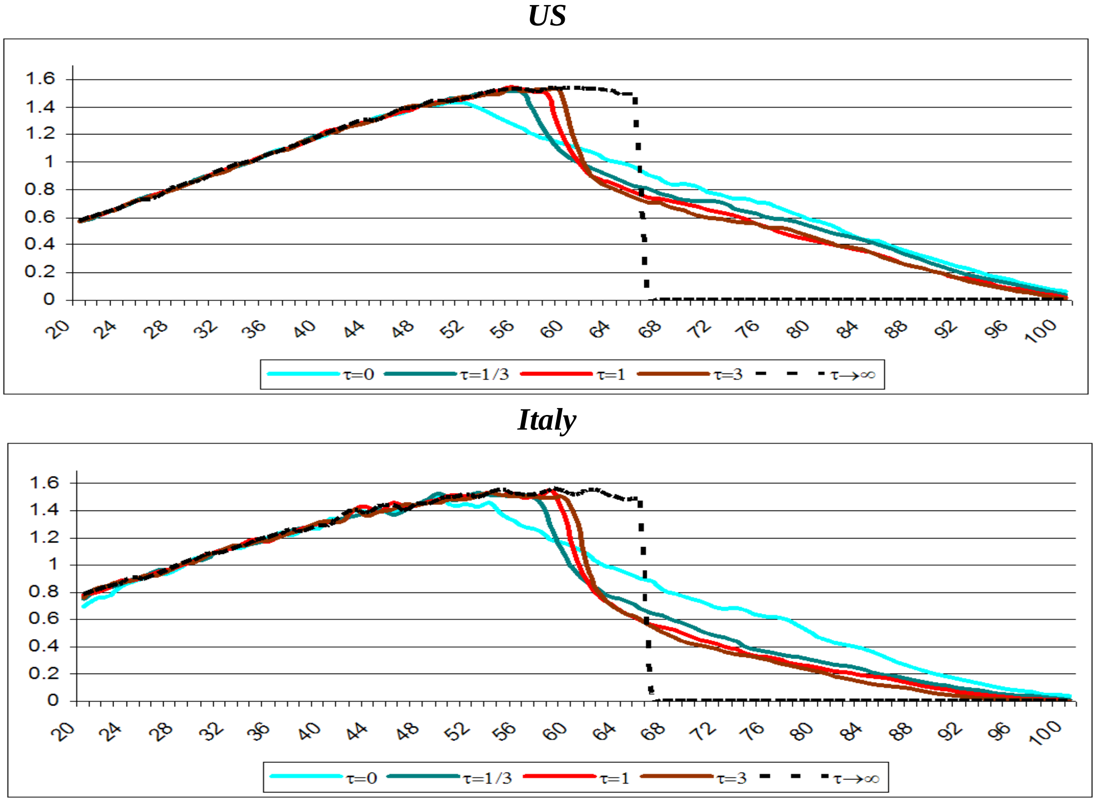
Although the cases $\tau = 1/3$, 1, 3 reveal very close choices of consumption and – especially – investment, the two cases $\tau = 0$ and $\tau \to \infty$ manifest a very different behavior. A completely undisciplined individual, in particular, does not invest in the equity market and does not save at all. In a model with no Social Security she makes no consumption during retirement, and her lifetime equivalent consumption is inevitably null.

From the table we also conclude that in most cases the average equity investment is significantly larger over retirement. This result, in sharp contrast with the typical advice from financial planners, who recommend to shift investments away from stocks and toward bonds when aging, is coherent with empirical (Poterba and Samwick, 2001) and theoretical (Viceira, 2001) findings. The key explanation relies on the uninsurable riskiness of labor income. Bodie et al. (1992) show that, when future labor income is certain, it is optimal for employed investors to hold proportionately more equities in their portfolios than it is for retired investors. But risky labor income increases the willingness to save and reduces the equity portfolio allocation during the working life (Viceira, 2001).

Figure 3 illustrates, for a baseline individual in the US or Italy, the average consumption profile as a ratio of average *per capita* disposable income. The consumption path of an undisciplined person equals the (normalized) income earned during lifetime, and is set to zero after retirement.

Figure 3. Average Age-Consumption profile

The figure describes the average age-consumption profile of American (top panel) and Italian (bottom panel) baseline (employed and with high school education at most) individuals with different degrees of temptation. The average is based on 1,000 simulations of the model with no Social Security protection.



The profile is essentially the same in both countries. A less disciplined individual starts saving later, but approaching retirement her savings are larger (although close for $\tau = 1/3,\ 1,\ 3$). In such period the doer succumbs to the planner, and temptation exerts a weaker influence than the concern of having no consumption in the future; this delayed discipline results in a consumption drop close to retirement. After retirement consumption decreases steadily, especially in Italy, as a result of a larger probability of dying.

Figure 4 plots the optimal consumption function when $\tau = 0$ for an American (left panel) and an Italian (right panel) individual, for each adult age according with different levels of cash-on-hand. The behavior of Americans and Italians is one more time very similar. During the working life consumption is equal to cash-on-hand up to a fixed point (hereafter I call it the "threshold point"), approximately corresponding to permanent income, constantly decreasing over time. Consuming less than cash-on-hand at any level below the threshold is considered unacceptable, and therefore no saving is made. For any cash-on-hand above the threshold point, the slope of the consumption function is much smaller, and the individual makes a progressively larger saving. As the agent gets older, a smaller cash-on-hand is considered a reasonable threshold, and the individual starts saving sensibly more for her retirement. The threshold point over retirement is equal to zero. In other words, the individual always saves part of her cash-on-hand, because there is no guaranteed subsidy from the government. This saving gets smaller approaching the terminal age T, and is ultimately null (note the 45-degree line) because of the assumption of no bequest motives.

Figure 4. Optimal consumption function, $\tau = 0$

The figure describes the optimal time consumption function of American (left panel) and Italian (right panel) baseline (employed and with high school education at most) disciplined (with temptation = 0) individuals. The consumption function is obtained solving recursively the system of first order conditions (11) under the model with no Social Security protection.

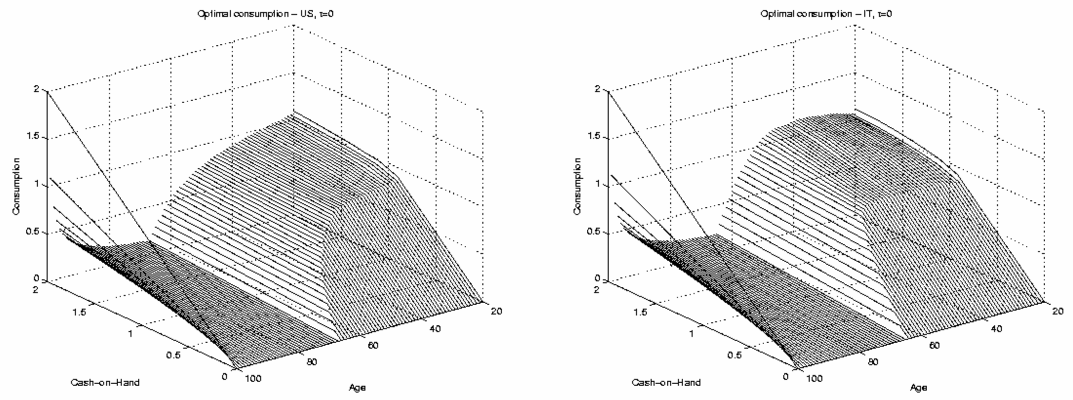
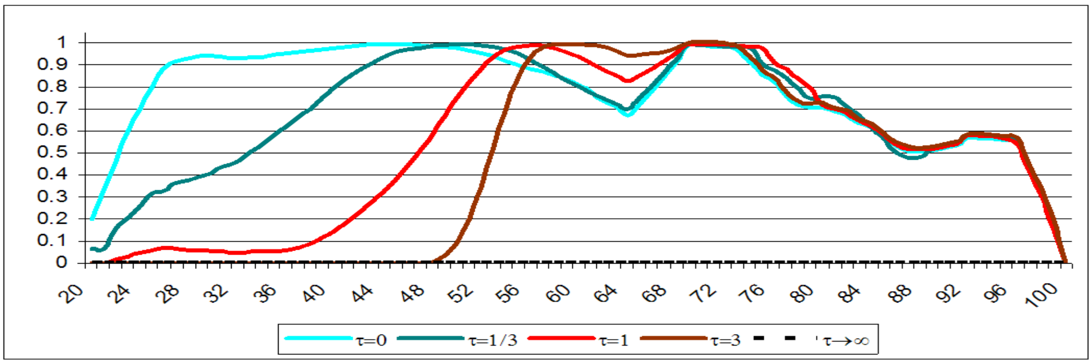


Figure 5 plots the lifetime investment profile of the baseline individual with different levels of temptation. To understand the behavior, let us think of the overall personal wealth as given by the sum of financial and human wealth. There are essentially two contrasting effects brought by human capital. On the one hand, a larger weight of human capital – similar to an implicit investment in bonds – promotes diversification and therefore investments. Thus, investments should progressively decrease as human capital shrinks. On the other hand, human capital is risky – although it has a small correlation with equities – and therefore discourages investments. Investments should thus progressively increase as human capital gets less risky, i.e., as income realizations are observed. The combination of these two effects determines the optimal choice.

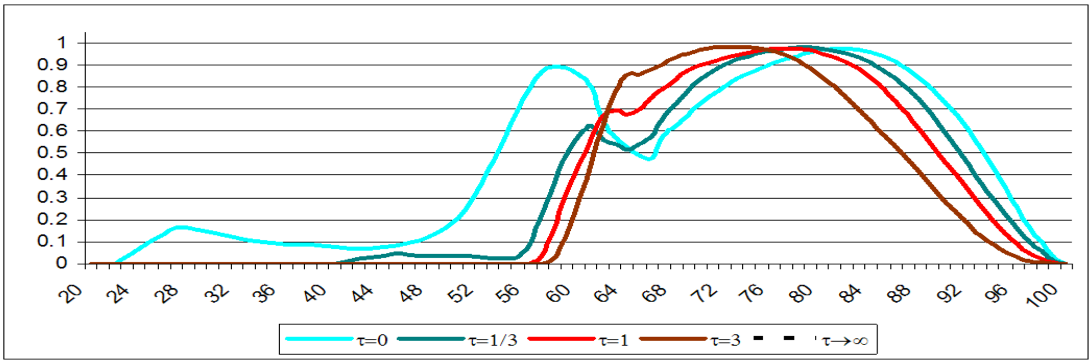
Figure 5. Average Age-Investment profile

The figure describes the average age-investment profile of American (top panel) and Italian (bottom panel) baseline (employed and with high school education at most) individuals with different degrees of temptation. The average is based on 1,000 simulations of the model with no Social Security protection.

US



Italy



In the first few years the market participation cost is binding and prevents potential investors from entering the market. The cost is relatively less important as time goes by, when more wealth is accumulated and labor income typically increases. After a few years, indeed, the individual starts investing. At the beginning, there are essentially no financial wealth and a large amount of human capital. Given this disequilibrium, she is willing to make a progressively larger investment in equities as time goes by, when the relative weight of human capital declines, and financial wealth grows. When approaching retirement, there is more financial wealth than human capital, and the individual optimally starts allocating a smaller fraction of financial wealth to equities. This happens less remarkably as temptation is higher, and the point in which financial wealth is larger than human capital comes later and more marginally[6]. Over retirement, there is no more human capital, and the individual's portfolio includes just financial wealth. In this case the optimal decision is to invest everything in equities, as the correlation with income is no longer a restraint. The investment gets progressively smaller after 75 when the survival probability reduces sizeably, the individual starts dissaving and prefers to avoid unnecessary risk.

The behavior is different between the US and Italy, as a consequence of a different market performance (better for the US) and a different correlation with labor income (null for the US and positive for Italy). More tempted individuals start investing later, but after retirement the behavior is essentially the same disregarding temptation. This result highlights that the investment decision is mainly driven by the saving behavior over the working life. More tempted individuals tend to postpone savings, accumulate wealth more slowly and therefore make no investment at early ages since they have no wealth to invest.

I also consider the optimal behavior of agents other than the baseline case, employed and with high school education at most. In particular I refer to other three groups: employed with college degree, self-employed with high school education at most, and self-employed with college education. These groups differ in the parameters associated with their income process. The results (not reported, but available upon request) do not manifest any significant difference with what described above. It only appears that, in both countries, a self-employed or an agent with a college degree tends to save and invest more. The relation between consumption, investment and temptation is still preserved.

4.2. Optimal payroll taxation

It is finally interesting to determine the optimal Social Security payroll taxation, and to study how it changes in the four groups. Let us focus on rule-of-thumb agents ($\tau \to \infty$) and disregard for a moment their consumption after retirement. I compute the optimal, mandatory and fixed level of savings as the solution $\tilde{\alpha}^*$ to the problem

[6] See indeed that an American with $\tau = 3$, who invests proportionately more than any Italian, reduces her investment near retirement by just a small amount.

(12) $$\min_{\tilde{\alpha}} \sum_{t=1}^{R} \frac{\prod_{r=1}^{t} \pi_r}{\left(R^f\right)^{t-1}} E\left[\left(C_t^0 - \left(1-\tilde{\alpha}\right) L_t\right)^2\right]$$

where $C_t^0,\ t=1,\dots,R$ is the stream of optimal consumption of a completely disciplined ($\tau = 0$) agent, and $\left(1-\tilde{\alpha}\right) L_t,\ t=1,\dots,R$ the disposable income, i.e., the consumption of an undisciplined individual. $\tilde{\alpha}^*$ thus minimizes the square distance between the consumption profiles of disciplined and undisciplined individuals, discounted and corrected for survival probabilities. It is a way to force rule-of-thumb agents to replicate the saving made on average by forward-looking agents.

The results using consumption and income realizations from the simulation are reported on the third and fourth columns of table 5. The optimal tax $\tilde{\alpha}$ is computed as the result of a Weighted Least Squares regression of C_t^0 on the average sample realizations of L_t, where the weights are given by the product between survival probabilities and a discount factor based on the risk free rate of return. According to the table, the optimal payroll tax is equal to about $\tilde{\alpha} = 8\%$ in both countries, and its confidence interval ranges between 4 and 12 percent.

Disregarding consumption after retirement, we are implicitly assuming that both individuals, disciplined and undisciplined, act similarly at the end of their working life. This is clearly false: suppose that the government forces both to pay a contribution of 8% of labor income, returned as a lump-sum at retirement. A disciplined agent will save and invest this wealth, smoothing her consumption over the remaining part of life. An undisciplined individual will rather choose to immediately consume the wealth, and will have no more resources to spend afterwards.

It is thus reasonable that the optimal taxation is measured over both the working and the retirement life. I therefore assume that the government receives a tax $\tilde{\alpha}$, accumulates it in a fund with growth rate R^f, and returns after R an annuity computed as

(13) $$A\left(\tilde{\alpha}\right) = \frac{\sum_{t=1}^{R} \tilde{\alpha} L_t \left(R^f\right)^{(R+1)-t}}{\sum_{t=R+1}^{T} \left(\left(\frac{1}{R^f}\right)^{t-(R+1)} \prod_{s=R+1}^{t} \frac{\pi_s}{\pi_{R+1}} \right)} = \tilde{\alpha} A$$

The optimal tax solves

(14) $$\min_{\tilde{\alpha}} \sum_{t=1}^{T} \frac{\prod_{r=1}^{t} \pi_r}{\left(R^f\right)^{t-1}} E\left[\left(C_t^0 - C_t^{\infty}\left(\tilde{\alpha}\right)\right)^2\right]$$

where $C_t^{\infty}(\tilde{\alpha})$, $t = 1,\ldots,T$ is the consumption profile of the undisciplined agent when the tax is $\tilde{\alpha}$. The inclusion in the analysis of the retirement period brings additional variation that the undisciplined agent will probably prefer to reduce with a larger payroll tax. The last two columns of table 5 report the estimates using consumption and income realizations from the simulation. The optimal tax is also computed as the result of a WLS estimate of the equation

$$C_t^0 = (1-\tilde{\alpha}) L_t D_t + \tilde{\alpha} A (1-D_t) + \varepsilon_t \tag{15}$$

where D_t is a dummy variable that takes the value one when $t \le R$. The estimates keep similar between the two countries and are higher than before, ranging between 12 and 13 percent. With a payroll tax of 12-13 percent an undisciplined agent would thus reach the consumption profile closest to the one of a disciplined agent. The estimate is close to the actual 10.6% payroll tax under the current US Social Security program, but very far from the 32.7% tax for Italian employed workers. This result is thus supportive for the adequateness of the current payroll tax in the US; the conclusion is not new and finds support in, for instance, Hurst and Willen (2004). The tax required by the Italian government seems instead to be too severe, and it might potentially have a negative impact on personal saving and investment.

Table 5. Optimal payroll taxation

*The table describes the optimal payroll taxation for American and Italian individuals differing in occupation (employed or self-employed) and education (high school degree at most or college degree). I define optimal taxation the fixed parameter that minimizes the square distance between the optimal consumption of disciplined (zero temptation) and undisciplined (infinite temptation) individuals. Optimal consumption for undisciplined agents corresponds to their disposable labor income or Social Security benefits. The tax is computed over the working life, according to equation (12), or over the lifetime, according to equation (14). I use for disposable income and optimal consumption average values based on 1,000 simulations of the model with no Social Security protection. The optimal taxation is computed separately for several groups differing in education and occupation. Standard errors in parentheses; * means that the variable is significant at 95% level.*

Group		Tax (over working life)		Tax (over lifetime)	
Maximum Education	**Occupation**	**US**	**Italy**	**US**	**Italy**
High school	Employed	0.0846* (0.0187)	0.0854* (0.0212)	0.1267* (0.0381)	0.1275* (0.0413)
College or more	Employed	0.0761* (0.0133)	0.0846* (0.0214)	0.1286* (0.0365)	0.1293* (0.0432)
High school	Self-Employed	0.0813* (0.0164)	0.0864* (0.0432)	0.1260* (0.0357)	0.1283* (0.0561)
College or more	Self-Employed	0.0833* (0.0158)	0.0650* (0.0150)	0.1310* (0.0036)	0.1254* (0.0073)

When τ is not infinite, a closed-form solution is not available, since consumption is smaller than disposable income or annuity benefit. It is still possible, however, to find $\tilde{\alpha}$ numerically, comparing

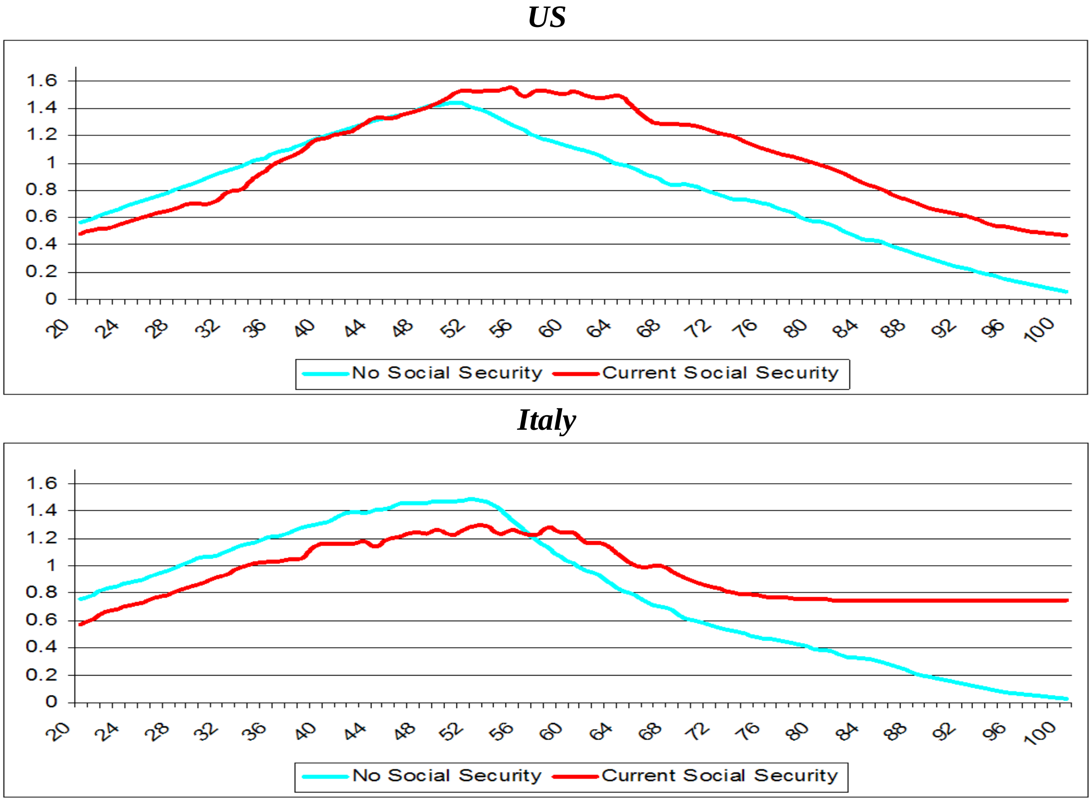
$C_t^0,\ t=1,\ldots,T$ with $C_t^\tau(\tilde{\alpha}),\ t=1,\ldots,T$, consumption profiles obtained from the simulation for different levels of temptation and assuming specific parameters $\tilde{\alpha}$. It turns out that the optimal taxation is always equal to zero. The behavior of tempted individuals is thus biased by the application of any mandatory taxation; any tax would increase rather than decrease the difference with the consumption profile of the disciplined agent. This is explained by the fact that i) $\tilde{\alpha}$ is fixed, but tempted individuals would prefer to have it increasing with age, and compensate for it consuming more when approaching retirement, and ii) Social Security invests in bonds, whereas such individuals would recur at least partly to the equity market, thus obtaining a larger annuity benefit.

4.3. Current Social Security program

Figure 6 compares the optimal consumption profiles for a disciplined agent with and without a Social Security program.

Figure 6. Average Age-Consumption profile

The figure describes the average age-consumption profile of American (top panel) and Italian (bottom panel) baseline (employed and with high school education at most) disciplined (temptation = 0) individuals. The average is based on 1,000 simulations of the model with and without Social Security protection.



Social Security effectively prevents an individual from having a too small consumption in the final years, when an excessively low survival probability discourages from keeping personal wealth. The magnitude of this protection is however different between the two countries. According to the simulation, a baseline individual expects to receive an average replacement rate of 32.52% in the US and 62.05% in Italy. The generosity of the Italian system makes the lifetime consumption profile much flatter than it would be in a *laissez-faire* economy. Thus the Italian government seems to produce a larger influence with its pension system.

Table 6 summarizes statistics relative to a simulation under the current Social Security program. Also here, an individual with less discipline consumes more, saves and invests less; the magnitude of consumption drop for individuals with some temptation is similar to that observed in the reality[7].

Table 6. Average consumption, investment, and saving

The table describes the average consumption, investment and saving of American and Italian baseline (employed and with high school education at most) individuals with different degrees of temptation. The average is based on 1,000 simulations of the model with Social Security protection and is taken using the risk free rate of return as actualizing factor.

	Average Consumption		**Average Investment**		**Average Saving**	
Temptation	**US**	**Italy**	**US**	**Italy**	**US**	**Italy**
	Lifetime					
$\tau = 0$	0.9429	0.9031	0.6971	0.3690	-0.0655	0.0039
$\tau = 1/3$	0.9079	0.8980	0.6591	0.0230	-0.0616	0.0001
$\tau = 1$	0.9072	0.8898	0.6218	0.0030	-0.0625	0.0001
$\tau = 3$	0.9063	0.8884	0.4551	0.0005	-0.0980	0.0000
$\tau \to \infty$	0.8401	0.8767	0	0	0	0
	Working Life					
$\tau = 0$	0.9761	0.9838	0.7011	0.4391	0.0206	0.0196
$\tau = 1/3$	0.9877	0.9942	0.6912	0.0254	0.0072	0.0035
$\tau = 1$	0.9920	0.9945	0.6849	0.0038	0.0070	0.0014
$\tau = 3$	0.9993	0.9957	0.6070	0.0007	-0.0553	0.0003
$\tau \to \infty$	1	1	0	0	0	0
	Retirement Life					
$\tau = 0$	0.6755	0.6632	0.6836	0.1605	-0.3503	-0.0427
$\tau = 1/3$	0.6408	0.6075	0.5976	0.0157	-0.2893	-0.0098
$\tau = 1$	0.6295	0.5783	0.5232	0.0005	-0.2924	-0.0040
$\tau = 3$	0.5850	0.5740	0.2992	0	-0.2392	-0.0008
$\tau \to \infty$	0.3466	0.5508	0	0	0	0

[7] Bernheim et al. (2001) finds that 31% of US households reduce their expenses by 20-35% at retirement. A similar percentage is estimated in Italy by Miniaci et al. (2003) when disregarding leisure. In the simulation results described in this section, an American (Italian) individual with $\tau = 1/3$ consumes over the ages 66-70 an average of 18.60% (25.11%) less than over the ages 61-65.

There are, nevertheless, several differences with the behavior in a *laissez-faire* economy. First of all, the larger generosity of the Italian pension system makes a person better off in the present situation, with the possibility to consume a larger portion of wealth, especially over retirement. Because of Social Security protection, individuals save less – on average over the working life, an agent with full self-control saves now 2% instead of 7% of her disposable income. Also, the investment is generally lower, especially after retirement. Finally, an individual with positive temptation $\tau > 0$ makes almost no saving; an Italian one does not even invest.

Figure 7 reports the optimal consumption function when $\tau = 0$ for American (left) and Italian (right) agents. Compared with the *laissez-faire* case in figure 4, the threshold point is now significantly above zero after retirement, and is approximately equal to the pension replacement rate, thus higher in Italy. During the working life it is slightly smaller in Italy, where the NDC formula, more connected with labor income risk, produces an incentive for accumulating each year some precautionary saving.

Figure 7. Optimal consumption function, $\tau = 0$

The figure describes the optimal time consumption function of American (left panel) and Italian (right panel) baseline (employed and with high school education at most) individuals with temptation equal to 0. The consumption function is obtained solving recursively the system of first order conditions (11) under the model with Social Security protection.

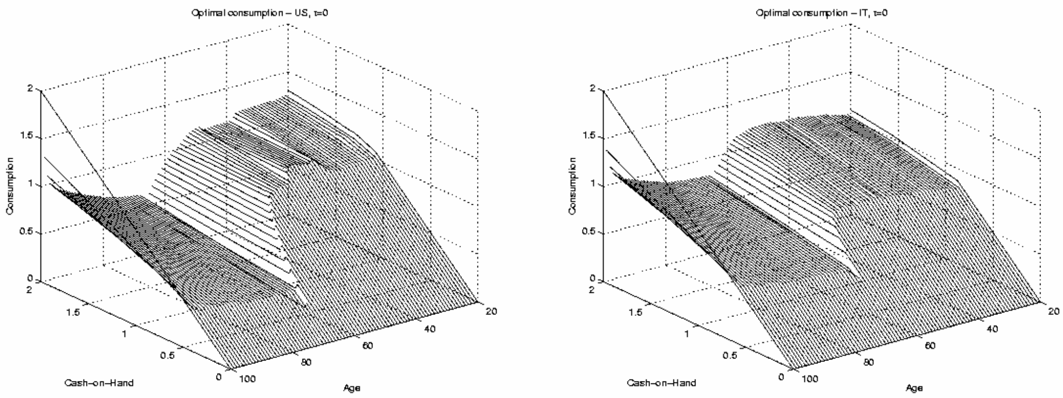


Figure 8 shows the same function when $\tau = 1$. One further effect of Social Security is here evident. An Italian exhibits immediately after R a consumption function already close to the 45-degree line. Italians feel more protected by Social Security and, therefore, start immediately consume more than just their pension. This result matches with the evidence in table 6 that an Italian with less discipline hardly saves and invests.

Figure 8. Optimal consumption function, $\tau = 1$

The figure describes the optimal time consumption function of American (left panel) and Italian (right panel) baseline (employed and with high school education at most) individuals with temptation equal to 1. The consumption function is obtained solving recursively the system of first order conditions (11) under the model with Social Security protection.

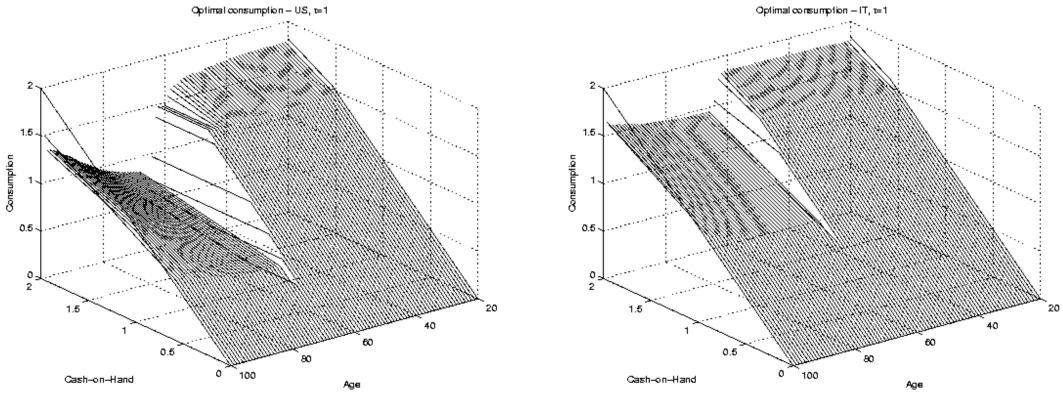


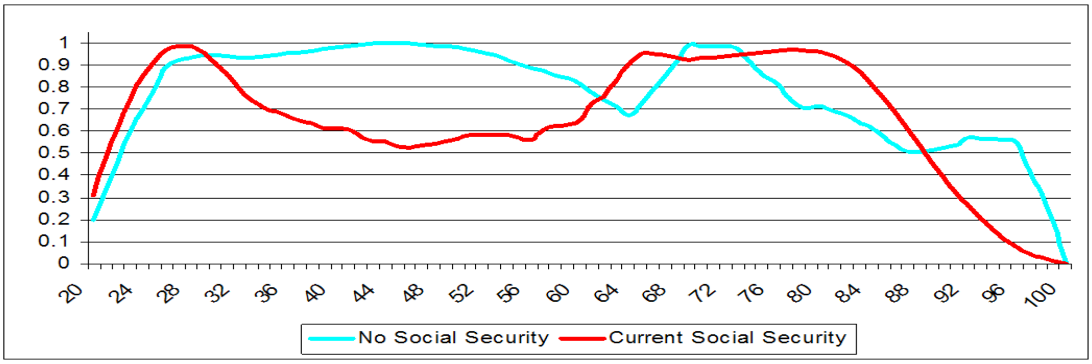
Figure 9 compares the optimal investment profile for a disciplined individual with and without Social Security programs. The profile is quite different, also within the two countries. Essentially, investment in the US is lower over the working life and higher over retirement; in Italy the contrary seems instead true. In any case, equity holding is still higher after retirement, consistently with empirical findings (Guiso et al., 2002).

To understand this behavior, consider that an individual's portfolio includes an additional asset when Social Security is present. Aside from financial and human wealth, one has to take into account retirement wealth. This takes the form of the expected present value of future annuities and is uncertain, with its uncertainty related to lifetime income realizations and political risk. The uncertainty reduces progressively as time goes by, when more information on labor income is available. After retirement, when also the political risk is vanished, the fund is completely risk-less. The size of this fund decreases only after retirement, when benefits are finally received. The addition of this fund depresses investment at early ages in Italy (where a high, positive correlation is observed) and tends to promote them later, as the fund becomes closer to a risk-less asset. The generosity of the Italian system, however, causes the weight of this fund to be large, which provides an incentive to invest generally more in equities. In the US, on the contrary, the fund does depress investment more persistently because of more uncertainty on future pensions, arising from a different (redistributive) benefit formula and a larger political risk. After retirement a risk-less fund should promote risky investments, but the already mentioned generosity of the Italian system discourages from saving.

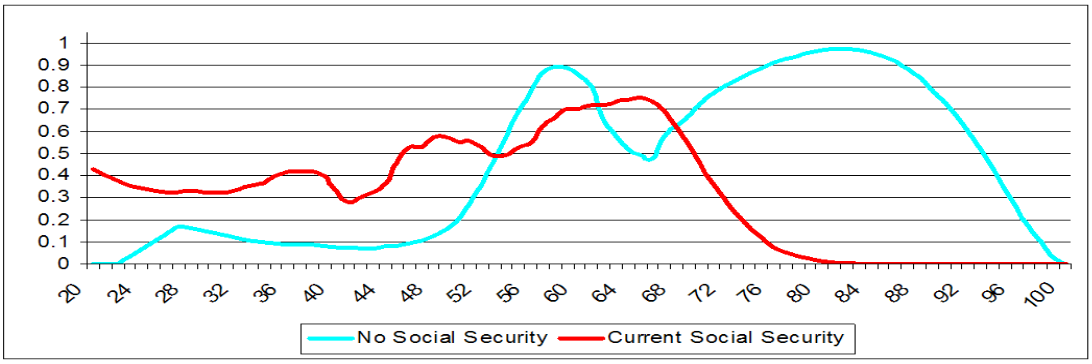
Figure 9. Average Age-Investment profile

The figure describes the average age-investment profile of American (top panel) and Italian (bottom panel) baseline (employed and with high school education at most) disciplined (temptation = 0) individuals. The average is based on 1,000 simulations of the model with and without Social Security protection.

US



Italy



One can compare the aggregate saving and investment participation rates obtained from the models with those observed in the reality, to get a rough estimate of the fraction of rule-of-thumb individuals in a population. Aggregating the participation rates using the 2004 population distribution taken for the US and Italy from Human Mortality Database, and using the data in the 2004 SCF and 2004 SHIW surveys, I consider an over-simplified world with just baseline agents with no ($\tau = 0$) or extreme ($\tau \to \infty$) temptation, and use an OLS regression to estimate the portion of forward-looking and rule-of-thumb agents. This way I get a fraction of 31.34% (51.89%) rule-of-thumb individuals in the US (Italian) population, close to that obtained in the literature (see Campbell and Mankiw, 1989). The fraction is larger for Italy mainly because of the very small number of investors observed in the reality. A model of heterogeneous individuals with different degrees of temptation seems thus able to explain the behavior observed in the reality.

The analysis on different groups still confirms that individuals with more education or working as self-employed save and invest more than the baseline case. In general, this behavior is due to precautionary reasons, because i) labor income is more uncertain and ii) Social Security is less generous for these categories.

4.4. Substitution effect between personal saving and payroll tax

I finally report an estimate of the substitution effect between payroll tax and personal saving. Social Security is expected to have an impact on personal saving through its contributions and benefits, but the size and the direction of this impact is controversial. Although in some, isolated cases it is found that Social Security arrangements boost saving (e.g. Koskela and Viren, 1983), most of the literature supports the view that Social Security is not a perfect substitute for private saving, since i) future Social Security benefits are not liquid until retirement, ii) the implicit rate of return on pensions is different from that on financial saving, and iii) there is a political risk that might affect future benefits. In particular, a substitution effect around 20-35 percent in the US (see Feldstein and Pellecchio, 1979, and King and Dicks-Mireaux, 1982) and 10-20 percent in Italy (Brugiavini, 1987, and Rossi and Visco, 1994) is estimated.

I estimate the effect by comparing the two average personal saving profiles in a *laissez-faire* economy with those in a paternalistic economy under the current Social Security program. The effect is estimated running a simple OLS regression in which the dependent variable is the optimal average life-cycle saving profile over the working life, and the explanatory variables are a polynomial on age (to capture age effects, see Attanasio and Brugiavini, 2003) and the mandatory payroll tax. The regression function is therefore:

$$\begin{bmatrix} s_t^{Laissez-Faire} \\ s_t^{Current}\left(1-\alpha\right) \end{bmatrix} = \beta_1 \begin{bmatrix} t \\ t \end{bmatrix} + \beta_2 \begin{bmatrix} t^2 \\ t^2 \end{bmatrix} + \beta_3 \begin{bmatrix} 0 \\ \alpha \end{bmatrix} + \varepsilon_t, \quad t = 1,\ldots,R \tag{16}$$

where $s_t^{Laissez-Faire}$ and $s_t^{Current}$ are the saving profiles relative to the *laissez-faire* and the paternalistic economies. The two profiles are reported on the same scale multiplying $s_t^{Current}$ by $\left(1-\alpha\right)$. The parameter β_3 describes the change in saving when the payroll tax increases by one unit, and thus estimates the substitution effect. My expectation is that the introduction of a Social Security program determines a significant reduction in personal savings, possibly small, and that this reduction is less relevant in those with some temptation.

Table 7 describes the substitution effects between payroll tax contributions and personal savings for the four groups of individuals and different levels of discipline; the estimates of the parameters β_1 and β_2, not reported, are always negative and positive respectively. The point estimates in the table are in line with what found in the literature, and are in particular remarkably lower than 1. For the baseline, disciplined case, the estimated substitution effect equals 0.38 in the US and 0.15 in Italy. These numbers mean that an additional 1 percent of payroll tax causes a decrease in private savings corresponding to 0.38 percent of permanent income for a disciplined American individual, and 0.15 percent for a disciplined Italian individual. As expected, the effect is smaller, i.e., the agent is less affected on her decision, as temptation τ gets larger. A rule-of-thumb ($\tau \to \infty$) individual, who makes no saving in any case, is totally indifferent about Social Security taxation and has therefore a substitution effect equal to zero. According to the table, the substitution effect is smaller also when the agent is more educated, or works as a self-employed. Two differences between the two countries are, however, remarkable. First, the substitution effect is always smaller in Italy. Second, the substitution effect in Italy is less influenced by temptation, and there seems to be no influence at all from education or the occupation. When $\tau \geq 1$ in the US it is not even possible to reject the null of zero substitution effect.

Table 7. Substitution effect between personal saving and payroll tax

*The table describes the substitution effect between personal saving and Social Security payroll tax for American and Italian individuals with different degrees of temptation. I estimate the effect according to equation (16), running a OLS regression of personal saving during the working age over a polynomial on age and the mandatory payroll tax. I use for personal saving average values based on 1,000 simulations of the model with and without Social Security protection. The substitution effect is computed separately for several groups differing in education and occupation. Standard errors in parentheses; * means that the variable is significant at 95% level.*

	Employed				**Self-Employed**			
Maximum education	**High school Or less**		**College**		**High school or less**		**College**	
Temptation	**US**	**Italy**	**US**	**Italy**	**US**	**Italy**	**US**	**Italy**
$\tau = 0$	-0.3814* (0.0777)	-0.1519* (0.0355)	-0.2641* (0.0554)	-0.1510* (0.0353)	-0.3229* (0.0632)	-0.2565* (0.0870)	-0.3024* (0.0597)	-0.2325* (0.0822)
$\tau = 1/3$	-0.2405* (0.1113)	-0.1258* (0.0388)	-0.2506* (0.1010)	-0.1256* (0.0391)	-0.2398* (0.1030)	-0.2325* (0.0854)	-0.2624* (0.1002)	-0.1873* (0.0831)
$\tau = 1$	-0.1841 (0.1207)	-0.1185* (0.0383)	-0.2076 (0.1175)	-0.1172* (0.0378)	-0.1841 (0.1196)	-0.1954* (0.0852)	-0.1873 (0.1165)	-0.1559* (0.0729)
$\tau = 3$	-0.1436 (0.1272)	-0.1139* (0.0375)	-0.1519 (0.1214)	-0.0955* (0.0364)	-0.1345 (0.1243)	-0.1926* (0.0745)	-0.1474 (0.1268)	-0.0809 (0.0683)
$\tau \to \infty$	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

5. Sensitivity analysis

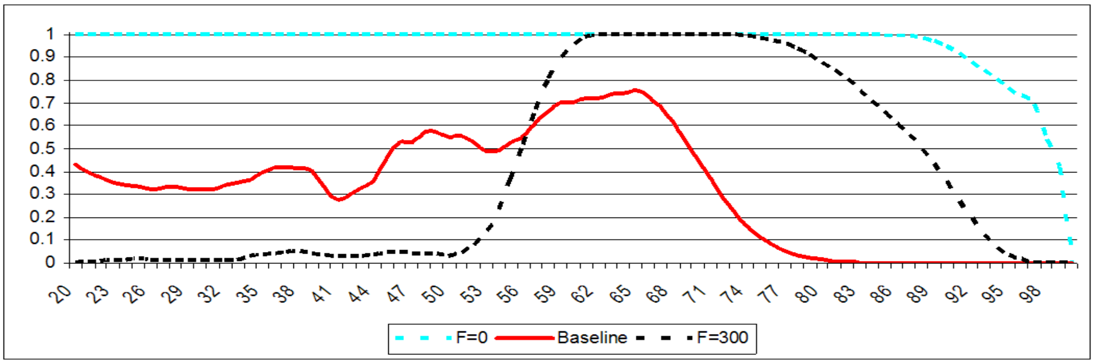
In this section I report simulation results for the baseline individual allowing several parameters to change from the benchmark case. I also studied the consequence of various degrees of political risk, but it seems that higher political risk promotes just slightly precautionary saving and lets investment essentially unchanged.

5.1. Savings and investment

The absence of market participation costs favors a complete investment in equities (even in Italy, where the life-cycle average investment would be an unrealistic 98.30% instead of 36.90% with the calibrated participation cost), whereas a cost ($F = 300$) larger than the benchmark one ($F = 150$ in Italy) would be responsible for a counter-factual absence of investments until age 53 (see Figure 10 for Italy). To compensate, when the entry in the equity market is optimal, the agent chooses to invest all her wealth in equities. Similar conclusions arise for the US.

Figure 10. Average Age-Investment profile for different market participation costs (Italy)

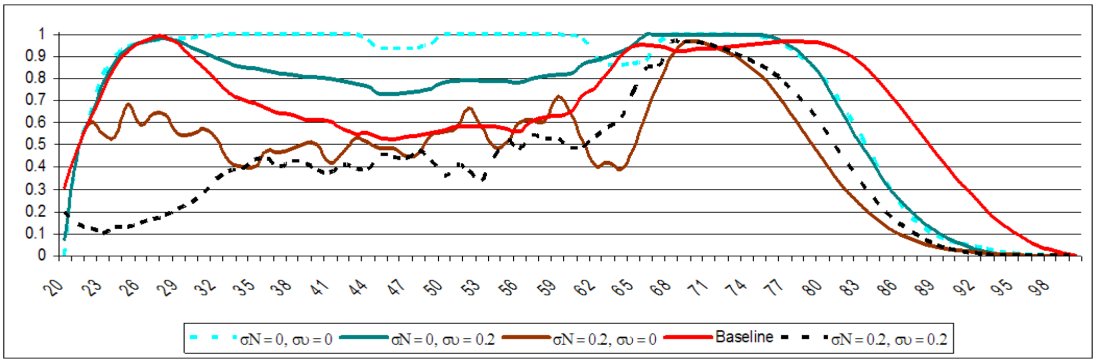
The figure describes the average age-investment profile of Italian baseline (employed and with high school education at most) disciplined (temptation = 0) individuals. The average is based on 1,000 simulations of the model with Social Security protection assuming different levels of market participation costs.



Consumption and equity investment decline monotonically when background income risk increases; agents become more prudent, increase savings and make more conservative investment decisions to prepare against a possible decline in income. An increase in transitory shock, however, produces a smaller effect than an increase in permanent shock, and in particular its effect on personal saving is negligible. Figure 11 draws the equity market holdings in the US under the current Social Security program when the labor income process is risk-less ($\sigma_n = \sigma_u = 0$), with only a transitory ($\sigma_n = 0.2$, $\sigma_u = 0$) or a permanent ($\sigma_n = 0$, $\sigma_u = 0.2$) risk, or both ($\sigma_n = \sigma_u = 0.2$). In the same figure I also report the benchmark case ($\sigma_n = 0.13$, $\sigma_u = 0.21$). With no risk in the labor market, an agent invests almost always all her wealth in equities. Introducing a transitory risk, the optimal investment is less than complete over all the working life. On the contrary, a permanent risk reduces the optimal investment more heavily, starting earlier, and promotes the accumulation of precautionary saving. Individuals show to be much more concerned about permanent than transitory shocks, since a permanent shock has repercussions over all the lifetime income realizations, whereas the effect of a transitory shock disappears after one period. The joint effect of both shocks further reduces personal investments. A comparison between the baseline case and the one with just permanent shock risk highlights that it is the permanent component to mainly drive the optimal decision: investment is higher on average when this risk decreases (from $\sigma_n = 0.2$ to $\sigma_n = 0.13$), although a transitory shock risk appears (equal to $\sigma_u = 0.2$). I do not report the figure for Italy since the conclusion is analogous.

Figure 11. Average Age-Investment profile for different labor income risks (US)

The figure describes the average age-investment profile of American baseline (employed and with high school education at most) disciplined (temptation = 0) individuals. The average is based on 1,000 simulations of the model with Social Security protection assuming different levels of permanent and transitory income shock risks.



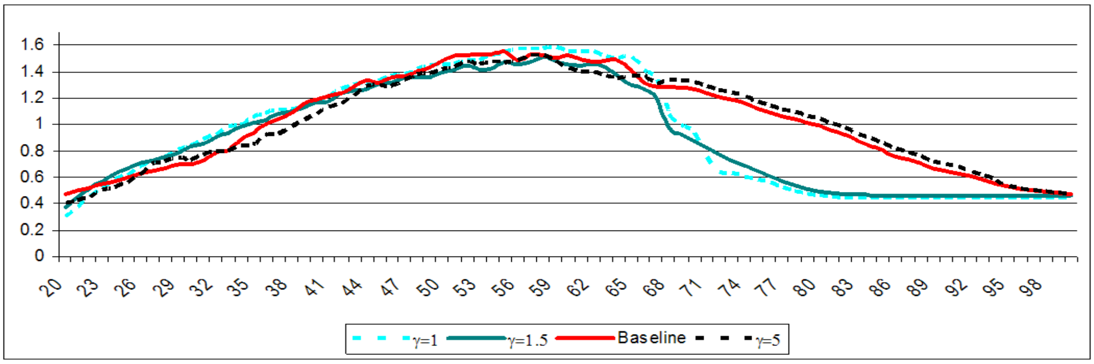
An individual responds to a better performance in the equity market increasing the equity holding and reducing saving (now less necessary for the higher expected market return).

In the model I make the assumption of zero correlation between market returns and transitory income shocks. When the parameter varies, there do not appear to be a qualitatively significant difference with the benchmark model. The behavior seems to be more affected by the correlation between market returns and permanent income shocks; in particular when there is no correlation – the benchmark case in the US – a difference is clearly visible. In this case, investors allocate a higher fraction of their wealth to equities.

A reduction in risk aversion makes an investor less sensitive to uncertainty, and increases the optimal share invested in equities, but also decreases wealth accumulation at every stage of the life-cycle. Figure 12 shows how the consumption profile changes with risk aversion in the US. Individuals with a low risk aversion save less, especially over their 30s and 40s, and consume more when approaching retirement. As a consequence, their consumption drops after the working life because less wealth has been accumulated.

Figure 12. Average Age-Consumption profile for different levels of risk aversion (US)

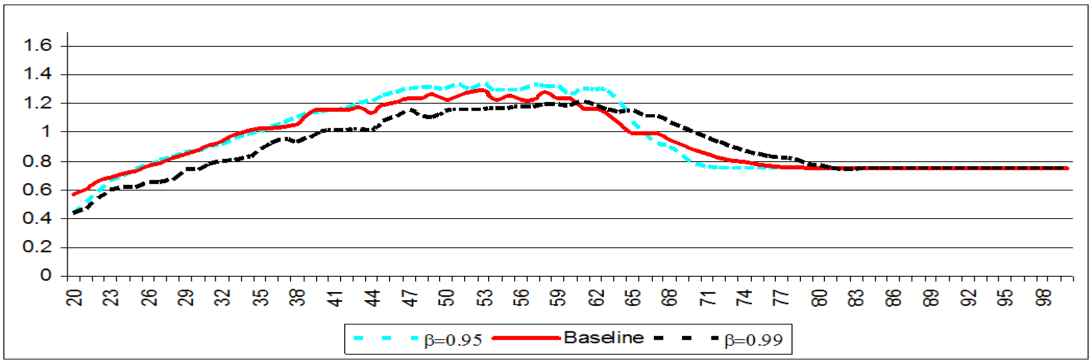
The figure describes the average age-consumption profile of American baseline (employed and with high school education at most) disciplined (temptation = 0) individuals. The average is based on 1,000 simulations of the model with Social Security protection assuming different levels of relative risk aversion.



The discount factor has a similar effect. Figure 13 reports the life-cycle consumption profile of an Italian when the parameter β changes; a more prudent (i.e., with higher β) person exhibits a smoother profile and tends to consume constantly less during the working life, especially at early ages. A higher β, however, does not imply more concern about risk, and does not reduce investments. On the contrary, investments are boosted by the availability of more financial wealth.

Figure 13. Average Age-Consumption profile for different discount factors (Italy)

The figure describes the average age-investment profile of Italian baseline (employed and with high school education at most) disciplined (temptation = 0) individuals. The average is based on 1,000 simulations of the model with Social Security protection assuming different discount factors.



NO!

5.2. Optimal payroll tax and substitution effect

In most cases the optimal payroll tax for undisciplined agents is still roughly equal to 13% in both countries when some parameters change from the benchmark case. The optimal payroll tax seems to be particularly sensitive to the risk aversion and the income risk shocks. When $\gamma = 5$ or $\sigma_n = \sigma_u = 0.2$ the optimal tax grows to about 18% both in the US and Italy. In such cases, the current US payroll tax (10.6%) happens to be smaller than optimal.

Also the substitution effect between payroll tax and personal saving is consistent with the benchmark estimates 38% (US) and 15% (Italy) when several parameters change. It is even unaffected by parameters such as the correlation between equities and labor income, the market participation cost, or the political risk. It is more sensitive, instead, to risk aversion. In particular, it shows to range between 15% ($\gamma = 1$) and 47% ($\gamma = 5$) in the US, and between 6% and 23% in Italy under the same levels of γ. In any case, it is significantly smaller in Italy.

6. Concluding remarks

In this paper I develop a life-cycle model to investigate the effect of temptation on individual consumption and investment choice. Temptation provides a rationale for apparently sub-optimal phenomena such as under-saving and under-investment. I simulate the model for two countries, the US and Italy, in the absence and in the presence of their current Social Security program. The model accounts for the main differences in the two retirement systems and, contrary to most of the literature, includes Social Security wealth as a state variable in the problem. This way an optimizing agent is allowed to project and revise annually her expectation about Social Security benefits. Furthermore, uncertainty on labor income and political risk may produce a replacement rate different from the promised average. The results show to be robust to changes in the exogenous parameters.

The simulation shows that an individual with more temptation always saves and invest in equities less than an individual with less temptation. In particular, the decision to save and invest is delayed over time. As a consequence, the consumption profile gets less smooth and, during retirement, a drop is observable. Absent Social Security, the average behavior is similar between the two countries, and I estimate an optimal payroll taxation for an undisciplined agent to be around 13 percent. This number is very close to the actual 10.6% in the US, but far from the 32.7% in Italy.

Including Social Security, the effect is still the same, but savings and investments are now reduced. Social Security guarantees more protection and provides therefore a strong incentive to cut savings and investments. This incentive affects primarily individuals with more temptation. Especially in Italy, agents with more temptation almost quit their savings.

I estimate a substitution effect between payroll tax and personal saving of about 38% for a baseline US individual with no temptation, and 15% for a corresponding Italian one. The effect decreases with more temptation, more education, or in case of self-employment. In Italy, however, where its magnitude is smaller (coherently with the existing literature), the measure seems to be essentially unaffected by temptation, education, and occupation.

The comparison between the two countries shows that, while American and Italians would act similarly in the absence of mandatory programs, under the respective retirement programs the behaviors are instead different. Social Security appears to exert a stronger influence in Italy, where its higher generosity discourages personal savings, and its NDC nature, closely linked with labor income risk, increases the uncertainty in the actual replacement rate.

Future research will be devoted to studying the impact of a reformed Social Security program in the behavior of individuals with different degrees of temptation. Most reform proposals include a DC component, whose benefit depends on the market performance. This might cause a change in the behavior with respect to saving and especially investment, also between the two countries, where my calibration shows that the correlation between income and market risks is not significant in the US but positive and large in Italy. Another interesting issue to investigate with this model is the so-called annuity puzzle. An individual subject to temptation tends to prefer an annuity to a lump-sum transfer more than one with no temptation, as this is the only way to receive a stable income over retirement.

A. Appendix

A.1. Rule-of-thumb behavior

Gul and Pesendorfer (2005) study in detail the limiting case of an individual with $\tau \to \infty$ from an axiomatic perspective. Consider here the system of equations (11) for a rule-of-thumb individual:

$$(17)\begin{cases} C_t = \min\left\{ CH_t, E_t\left[\beta\pi_{t+1}\exp\{\delta'\Delta Z_{t+1}\}\left(R^f + \left(R^E_{t+1} - R^f\right)X_t\right)\left(\left(C_{t+1}\right)^{-\gamma} - \left(CH_{t+1}\right)^{-\gamma}\right)\right]^{-\frac{1}{\gamma}} \right\} \\ 0 = E_t\left[\beta\pi_{t+1}\exp\{\delta' Z_{t+1}\}\left(R^E_{t+1} - R^f\right)\left(\left(C_{t+1}\right)^{-\gamma} - \left(CH_{t+1}\right)^{-\gamma}\right)\right] \end{cases}$$

Since bequest motives are absent, at the terminal age $t = T$ an individual chooses $C_T = CH_T$ and $X_T = 0$. This in turn implies that at $t = T-1$ $C_{T-1} = CH_{T-1}$, from the first FOC, with the second FOC simply stating the identity $0 = 0$. Consequently, $X_{T-1} = 0$ (no wealth is saved). Going backwards, an undisciplined agent consumes $C_t = CH_t$ and invests $X_t = 0$ at a generic time t. In particular, assuming that the initial wealth is zero, consumption equals disposable income, $C_t = Y_t$.

The reason for this behavior is that such individual always succumbs to temptation; contrary to a hyperbolic discounting individual, she cares about the future as much as the fully disciplined counterpart, and differs only in the ability to exercise discipline.

A.2. The model in detail

Following Carroll (1997) I standardize the variables dividing by the disposable part of the permanent income, $(1-\alpha)P_t$; since the labor income process is defined only until age $t = R$, all the variables after that time are divided by the last income realization, $(1-\alpha)P_R$. I will denote the standardized variables by lower-case letters. This allows me to reduce the number of state variables to three: two continuous state variables (cash-on-hand, ch_t, and Social Security accumulated capital, db_t, if $t \le R$, or Social Security pension, a, if $t > R$), and one discrete state variable (age t). Note that, under this reparameterization, a describes the Social Security replacement rate assuming $E[U_R] = 1$.

Retirement life

When $t > R$ the individual maximizes the following value function, where the expectation is relative to market returns:

(18) $$V_t(ch_t, a) = \max_{c_t, I_t, x_t} \left\{ U(c_t, ch_t)\exp\{\delta' Z_t\} + E_t\left[\beta\pi_{t+1}V_{t+1}(ch_{t+1}, a)\right]\right\}$$

subject to the budget constraint:

(19) $$ch_{t+1} \le R^L_{t+1}(ch_t - c_t) - I_t f_R + a$$

where $f_R = F/((1-\alpha)P_R)$ is the market entry barrier and R^L_{t+1} the return to the liquid portfolio:

(20) $$R^L_{t+1} = x_t R^E_{t+1} + (1-x_t)R^f = x_t\left(R^E_{t+1} - R^f\right) + R^f$$

The individual chooses the optimal level of consumption, c_t^*, whether to enter the equity market, $I_t^* = \{0,1\}$ and, if $I_t^* = 1$ (entrance), the portfolio investment in equities, x_t^*. The final condition is that $ch_{T+1} = 0$; also $V_{T+1} = 0$.

Absent any bequest motive, at age $t = T$ the agent consumes all her wealth; since $ch_{T+1} = 0$, from the budget constraint (19) it must be that $c_T^* = ch_T$. In any previous time the solution is computed numerically (see §A.3). The decision to enter the equity market is obtained by comparing the optimal value function when the agent does not enter the market (therefore bearing no cost) with the optimal value function when the agent does enter the equity market (bearing the participation cost) and chooses optimally her financial portfolio:

(21) $$I_t^* = \arg\max\left\{V_t\left(ch_t, a \middle| I_t = 0\right), V_t\left(ch_t, a \middle| I_t = 1\right)\right\}$$

Optimal investment and consumption are determined through the first order conditions. I first get the derivative of $V_t\left(ch_t, a\right)$ with respect to c_t,

(22) $$\frac{\partial U\left(c_t, ch_t\right)}{\partial c_t}\exp\left\{\delta' Z_t\right\} = E_t\left[\beta\pi_{t+1}R_{t+1}^L V_{t+1}{}'\left(ch_{t+1}, a\right)\right]$$

and with respect to x_t:

(23) $$\begin{aligned} 0 &= E_t\left[\beta\pi_{t+1}\left(R_{t+1}^E - R^f\right)V_{t+1}{}'\left(ch_{t+1}, a\right)\left(ch_t - c_t\right)\right] = \\ &= E_t\left[\beta\pi_{t+1}\left(R_{t+1}^E - R^f\right)V_{t+1}{}'\left(ch_{t+1}, a\right)\right] \end{aligned}$$

I now use the envelope theorem, deriving $V_t\left(ch_t, a\right)$ relative to ch_t, obtaining that

(24) $$\frac{\partial V_t\left(ch_t, a\right)}{\partial ch_t} = \frac{\partial U\left(c_t, ch_t\right)}{\partial ch_t}\exp\left\{\delta' Z_t\right\} + E_t\left[\beta\pi_{t+1}R_{t+1}^L\frac{\partial V_{t+1}\left(ch_{t+1}, a\right)}{\partial ch_t}\right]$$

Substituting (22) into (24) it turns out that

(25) $$\begin{aligned} \frac{\partial V_t\left(ch_t, a\right)}{\partial c_t} &= \exp\left\{\delta' Z_t\right\}\left(\frac{\partial U\left(c_t, ch_t\right)}{\partial c_t} + \frac{\partial U\left(c_t, ch_t\right)}{\partial ch_t}\right) = \\ &= \exp\left\{\delta' Z_t\right\}\left(\left(1+\tau\right)u'\left(c_t\right) - \tau u'\left(ch_t\right)\right) \end{aligned}$$

It is possible to rewrite the two first-order conditions as follows:

(26) $$\begin{cases} u'\left(c_t\right) = E_t\left[\beta\pi_{t+1}\exp\left\{\delta'\Delta Z_{t+1}\right\}R_{t+1}^L\left(u'\left(c_{t+1}\right) - \dfrac{\tau}{1+\tau}u'\left(ch_{t+1}\right)\right)\right] \\ 0 = E_t\left[\beta\pi_{t+1}\exp\left\{\delta' Z_{t+1}\right\}\left(R_{t+1}^E - R^f\right)\left(u'\left(c_{t+1}\right) - \dfrac{\tau}{1+\tau}u'\left(ch_{t+1}\right)\right)\right] \end{cases}$$

or, including the liquidity constraints and using a CRRA utility function,

(27) $$\begin{cases} c_t = \min\left\{ch_t, E_t\left[\beta\pi_{t+1}\exp\left\{\delta'\Delta Z_{t+1}\right\}R_{t+1}^L\left(\left(c_{t+1}\right)^{-\gamma} - \dfrac{\tau}{1+\tau}\left(ch_{t+1}\right)^{-\gamma}\right)\right]^{-\frac{1}{\gamma}}\right\} \\ 0 = E_t\left[\beta\pi_{t+1}\exp\left\{\delta' Z_{t+1}\right\}\left(R_{t+1}^E - R^f\right)\left(\left(c_{t+1}\right)^{-\gamma} - \dfrac{\tau}{1+\tau}u'\left(ch_{t+1}\right)^{-\gamma}\right)\right] \end{cases}$$

This system is the counterpart of system (11) when variables standardized by $(1-\alpha)P_t$ are taken into account. From system (27) one can get the optimal choice functions

(28) $$\begin{cases} c_t^* = c_t(ch_t, a) \\ x_t^* = x_t(ch_t, a) \end{cases}$$

Both optimal consumption and equity investment depend only on same-period variables so that, with the information available at time t, it is not possible to predict the choice variables at time $t+1$ (Hall, 1978).

Transition from work to retirement

At time $t = R$ the optimal value function is given by

(29) $$V_R(ch_R, db_R) = \max_{c_R, I_R, x_R} \left\{ U(c_R, ch_R)\exp\{\delta' Z_R\} + E_R\left[\beta\pi_{R+1}V_{R+1}(ch_{R+1}, a)\right]\right\}$$

with an expectation relative to market returns and political risk. From $t = R$ to $t = R+1$ the state variables change. When $t \leq R$ retirement wealth is indeed accumulated into Social Security accounts db_t. They are then converted into annuities a according to the formula

(30) $$a = \begin{cases} 0.9db_{R+1} & db_{R+1} < lb \\ 0.9lb + 0.32(db_{R+1} - lb) & db_{R+1} \in [lb, ub] \\ 0.9lb + 0.32(ub - lb) + 0.15(db_{R+1} - ub) & db_{R+1} > ub \end{cases}$$

for the US, with lb and ub standardized lower and upper bend points, and

(31) $$a = \varpi db_{R+1}$$

for Italy, with ϖ coefficient of actuarial fairness. In the simulation I assume $LB = \$7,104$ and $UB = \$42,804$ (2002 SSA annual levels), and $\varpi = 0.06136$ in a normal retirement age of 65.

The maximization is subject to the motion equations:

(32) $$ch_{R+1} \leq R_{R+1}^L(ch_R - c_R) - I_R f_R + a$$

(33) $$db_{R+1} \leq \frac{1}{R+1} R^B db_R R$$

and still gives rise to the system of equation (27). R^B is the interest rate of the Social Security account, assumed to be fixed and equal to the average income growth for the US and the real GDP growth in Italy. In the simulation the parameter is assumed to be equal to 2.16% in the US, average income growth on BEA data from 1998 to 2002, and to 2.24% in Italy, average per capita GDP over the same years.

Working life

During the working life the value function is given by

$$(34)\quad V_t\left(ch_t, db_t\right)=\max_{c_t, I_t, x_t}\left\{U\left(c_t, ch_t\right)\exp\left\{\delta' Z_t\right\}+E_t\left[\beta\pi_{t+1}\left(G_{t+1}N_{t+1}\right)^{1-\gamma}V_{t+1}\left(ch_{t+1}, db_{t+1}\right)\right]\right\}$$

with the expectation in terms of labor income and market returns, and with $\left(G_{t+1}N_{t+1}\right)^{1-\gamma}$ scale factor resulting from the standardization by $\left(1-\alpha\right)P_t$.

The individual maximizes (34) subject to the intertemporal budget constraint

$$(35)\qquad ch_{t+1}\le\frac{1}{G_{t+1}N_{t+1}}\left(R_{t+1}^{L}\left(ch_t-c_t\right)-I_t f_t\right)+U_{t+1}$$

and the Social Security accumulation constraint

$$(36)\qquad db_{t+1}\le\frac{1}{t+1}\left(\frac{R^B}{G_{t+1}N_{t+1}}db_t t+U_{t+1}\right)$$

for the US, and

$$(37)\qquad db_{t+1}\le\frac{1}{t+1}\left(\frac{R^B}{G_{t+1}N_{t+1}}db_t t+\frac{\alpha}{1-\alpha}U_{t+1}\right)$$

for Italy. The initial conditions are $ch_1=E\left[U_1\right]=1$, $db_1=\left(\alpha E\left[U_1\right]\right)/\left(1-\alpha\right)=\alpha/\left(1-\alpha\right)$ (Italy) or $db_1=E\left[U_1\right]=1$ (US).

The system of equations to be solved in order to get optimal consumption and investment choices is now

$$(38)\quad\begin{cases} c_t=\min\left\{ch_t, E_t\left[\beta\pi_{t+1}\exp\left\{\delta'\Delta Z_{t+1}\right\}\left(G_{t+1}N_{t+1}\right)^{-\gamma}R_{t+1}^{L}\left(\left(c_{t+1}\right)^{-\gamma}-\frac{\tau}{1+\tau}\left(ch_{t+1}\right)^{-\gamma}\right)\right]^{-\frac{1}{\gamma}}\right\} \\ 0=E_t\left[\beta\pi_{t+1}\exp\left\{\delta' Z_{t+1}\right\}\left(G_{t+1}N_{t+1}\right)^{-\gamma}\left(R_{t+1}^{E}-R^f\right)\left(\left(c_{t+1}\right)^{-\gamma}-\frac{\tau}{1+\tau}u'\left(ch_{t+1}\right)^{-\gamma}\right)\right] \end{cases}$$

where an additional factor $\left(G_{t+1}N_{t+1}\right)^{-\gamma}$ appears, as a consequence of the standardization by $\left(1-\alpha\right)P_t$.

A.3. Numerical simulation

Because of the uncertainty on labor income realizations, analytical solutions to this problem do not exist; I therefore use a numerical solution method. The approach is based on the first order conditions, rather than the value function, because the consumption function is smoother than the value function and therefore the numerical approximation to the solution reaches a greater accuracy. I approximate the random variable distributions by means of a Gauss-Legendre quadrature method (see Tauchen and Hussey, 1991), and discretize the state space along saving ($s_t = ch_t - c_t$) and Social Security wealth using equally-spaced grids. For points that do not lie on the state space grid, I evaluate the policy functions using a cubic spline interpolation.

I solve the model using backward induction. In the last period, $c_T^* = ch_T$ and $x_T^* = 0$, regardless of the state variables. In each earlier time t, then, for each point in the state space I compute optimal consumption and investment from the system of equations (11). I follow Carroll's "method of endogenous gridpoints" and solve the system in two phases. I first get the solution x_t^* from the second equation in (11), check if $x_T^* \in [0,1]$, and then substitute it on the first equation in (11) to obtain c_t^*. Once x_T^* and c_t^* are known, cash-on-hand is endogenously derived as $ch_t = s_t + c_t^*$. To reach a valid approximation it is crucial to include as a grid point for ch_t the one under which the liquidity constraint becomes binding, $c_t^* = ch_t^*$; in order to do that it is essential to consider the case $s_t = 0$. The point $c_t^* = ch_t^*$ represents a threshold over which an individual starts saving; when ch_t is low, the agent is willing to consume more than available, but the liquidity constraint prevents her from spending more than $c_t = ch_t$. For any level of $ch_t \le ch_t^*$, thus, the consumption function is a 45-degree line. For levels of $ch_t > ch_t^*$, instead, the agent does not consume all the cash-on-hand, and the consumption function turns out to be less inclined. Substituting the decision rules in the Bellman equation I obtain the value function V_t^*, which is then used to solve the previous period's maximization problem. The process is iterated until $t = 1$.

A.4. Correlation between income growth and market returns

Note that

$$l_t = \log(L_t) = \log(P_t) + \log(U_t) = \log(G_t) + \log(P_{t-1}) + \log(N_t) + \log(U_t) = \\ = g_t + p_{t-1} + n_t + u_t = \sum_{r=1}^{t} (g_r + n_r) + p_0 + u_t \tag{39}$$

The income growth from time s to time t is

$$r_{s,t}^L = \frac{L_t - L_s}{L_s} \cong l_t - l_s = \left(\sum_{r=1}^{t} (g_r + n_r) + p_0 + u_t \right) - \left(\sum_{r=1}^{s} (g_r + n_r) + p_0 + u_s \right) = \\ = \sum_{r=s+1}^{t} (g_r + n_r) + u_t - u_s \tag{40}$$

The return in the equity market over the same period is given by

$$(41) \qquad r_{s,t}^{E}=\prod_{r=s+1}^{t} R_{r}^{E}-1=\prod_{r=s+1}^{t}\left(R^{f}+\mu+\varepsilon_{r}\right)-1 \cong \sum_{r=s+1}^{t} \varepsilon_{r}+(t-s)\left(R^{f}+\mu-1\right)$$

with the last passage approximately true over small time horizons of length $t-s$. The covariance between labor income growth and equity market returns between s and t is then given by

$$(42) \qquad \operatorname{cov}\left(r_{s,t}^{E}, r_{s,t}^{L}\right) \cong \operatorname{cov}\left(\sum_{r=s+1}^{t} \varepsilon_{r}, \sum_{r=s+1}^{t} n_{r}+u_{t}-u_{s}\right)=(t-s) \rho_{n\varepsilon} \sigma_{n} \sigma_{\varepsilon}$$

and the correlation is

$$(43) \qquad \rho_{t-s}^{EL}=corr\left(r_{s,t}^{E}, r_{s,t}^{L}\right) \cong \frac{(t-s) \rho_{n\varepsilon} \sigma_{n} \sigma_{\varepsilon}}{\left((t-s) \sigma_{\varepsilon}^{2}\right)^{1/2}\left((t-s) \sigma_{n}^{2}+2 \sigma_{u}^{2}\right)^{1/2}}=\rho_{n\varepsilon} \frac{\sigma_{n}}{\left(\sigma_{n}^{2}+2 \dfrac{\sigma_{u}^{2}}{t-s}\right)^{1/2}}$$

The correlation between labor income growth and the return from the equity market is smaller than $\rho_{n\varepsilon}$, unless $\sigma_{u}^{2}=0$, but tends to increase as the time horizon $t-s$ gets large, since the transitory shock is progressively less important than the permanent shock. In particular, the one-period correlation is

$$(44) \qquad \rho_{1}^{LE}=\rho_{n\varepsilon} \frac{\sigma_{n}}{\left(\sigma_{n}^{2}+2 \sigma_{u}^{2}\right)^{1/2}}$$

and the correlation over all the working life ($R-1$ periods) is

$$(45) \qquad \rho_{R-1}^{LE}=\rho_{n\varepsilon} \frac{\sigma_{n}}{\left(\sigma_{n}^{2}+2 \dfrac{\sigma_{u}^{2}}{R-1}\right)^{1/2}}$$

A.5. Parameters on labor income risk

I first remove from a panel data set of observed labor income realizations the predictable life-cycle movements computed through the pseudo-panel regression described in §3.1; what remains is the stochastic component of labor income for the i-eth individual at time t. This is modeled as the sum of two independent shocks, one permanent and one transitory:

$$(46) \qquad v_{i,t}=p_{i,t}+u_{i,t}=\left(p_{i,t-1}+n_{i,t}\right)+u_{i,t}$$

Define now a k-year difference at time t as

$$(47) \qquad d_{i,k}^{t}=v_{i,t}-v_{i,t-k}=\left(p_{i,t}+u_{i,t}\right)-\left(p_{i,t-k}+u_{i,t-k}\right)$$

Substituting now (46) into (47) recursively yields

$$(48) \qquad d_{i,k}^{t}=\left(n_{i,t-k+1}+n_{i,t-k+2}+\cdots+n_{i,t}\right)+\left(u_{i,t}-u_{i,t-k}\right)$$

The variance of both sides of (48) produces

$$\text{var}\left(d_{i,k}^{t}\right)=k\sigma_n^2+2\sigma_u^2 \tag{49}$$

since $u_{i,t}$ and $n_{i,t}$ are assumed to follow an iid distribution and to be uncorrelated with each other. Following Carroll and Samwick (1997) I estimate σ_n^2 and σ_u^2 running an OLS regression where the dependent variable is the sample estimate of $\text{var}\left(d_{i,k}\right)$ and the independent variables are the number of lags k and the constant 2; I consider a maximum of four lags.

Following Campbell et al. (2001), let us assume now that the permanent income shock $n_{i,t}$ is given by the sum of two components, one aggregate, ξ_t, and one idiosyncratic, $\zeta_{i,t}$, uncorrelated across individuals:

$$n_{i,t}=\xi_t+\zeta_{i,t} \tag{50}$$

I rewrite the 1-year difference at time t accordingly:

$$d_{i,1}^{t}=\nu_{i,t}-\nu_{i,t-1}=\left(\xi_t+\zeta_{i,t}\right)+\left(u_{i,t}-u_{i,t-1}\right) \tag{51}$$

Being the shocks uncorrelated across individuals, and assuming further $E\left[\zeta_{i,t}\right]=0$, an average with respect to i yields

$$d_1^t=E_i\left[d_{i,1}^t\right]=\xi_t \tag{52}$$

The correlation between permanent shock and equity market is easily computed from an OLS regression of the sample estimate of d_1^t on demeaned excess returns:

$$\hat{d}_1^t=\beta\left(R_t^E-R^f\right)+\psi_t \tag{53}$$

Since

$$\beta=\frac{\text{cov}\left(\hat{d}_1^t,R_t^E-R^f\right)}{\text{var}\left(R_t^E-R^f\right)}=\frac{\text{cov}\left(\hat{d}_1^t,R_t^E-R^f\right)}{\sigma_\varepsilon^2} \tag{54}$$

the correlation coefficient is computed as

$$\rho_{n\varepsilon}=\beta\frac{\sqrt{\text{var}\left(R_t^E-R^f\right)}}{\sqrt{\text{var}\left(\hat{d}_1^t\right)}}=\beta\frac{\sigma_\varepsilon}{\sqrt{\text{var}\left(\hat{d}_1^t\right)}} \tag{55}$$

With the Italian data, however, information on the annual income variation is not available, since the SHIW survey is carried out every other year. In this case one may consider a two-year average difference:

(56) $$d_2^t = E_i\left[d_{i,2}^t\right] = \xi_t + \xi_{t-1}$$

and regress its sample estimate over the sum of the excess returns at time t and $t-1$:

(57) $$\hat{d}_2^t = \beta\left(\left(R_t^E - R^f\right) + \left(R_{t-1}^E - R^f\right)\right) + \psi_t$$

Given the independence of ξ_t and R_t^E across time and with each other, the correlation is given by

(58) $$\rho_{n\varepsilon} = \beta\frac{\sqrt{\mathrm{var}\left(R_t^E + R_{t-1}^E\right)}}{\sqrt{\mathrm{var}\left(\hat{d}_2^t\right)}} = \beta\frac{\sqrt{2}\sigma_\varepsilon}{\sqrt{\mathrm{var}\left(\hat{d}_2^t\right)}}$$

A.6. Relative risk aversion and discount factor: estimate

I follow a four-step procedure to estimate the relative risk aversion and the discount factor parameters. I first consider a GMM estimate of

(59) $$m = E_t\left[\overline{\beta_{t+1}}R_{t+1}^E\left(\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} - \frac{\tau}{1+\tau}\left(\frac{CH_{t+1}}{C_t}\right)^{-\gamma}\right) - 1\middle|\Im_t\right]$$

which restates the Euler equation in (11), assuming $X_t = 1$, and with $\overline{\beta_{t+1}}$ population average of the "extended" discount factor $\beta\pi_{t+1}\exp\left\{\delta'\Delta Z_{t+1}\right\}$. $\Im_t$ is the information set at time t [8]. My data are stock market capitalization and excess return (S&P500 and MSCI Italy[9]), total non-durable consumption, and disposable income from Bureau of Economic Analysis (US), and ISTAT (Italy); I use *per capita* stock market capitalization plus disposable income as a proxy for cash-on-hand. All the data are deflated according to the respective CPI, and cover the period 1982:2004 on a quarterly basis (92 observations). I follow the two-step procedure suggested in Hansen and Singleton (1982) and get the efficient estimates of $\overline{\beta_{t+1}}$ and γ for different levels of temptation τ.

In the second step I run a specification search of the variables Z_t and estimate the individual-specific parameters δ. Consider the log-linear version of the Euler equation in (11), in which $\tau = 0$:

(60) $$\gamma\Delta\log\left(C_{t+1}\right) = \log\left(\pi_{t+1}\right) + \log\left(R_{t+1}^E\right) + \delta'\Delta Z_{t+1} + \psi_{t+1}$$

[8] I consider as instruments two lags of R_{t+1}^E, C_{t+1}/C_t, and CH_{t+1}/C_t. A test of over-identifying restrictions accepts the null that the implied restrictions are not binding with the data used in this analysis.

[9] In this case I consider the Italian rather than the European market since the goal is to estimate preference parameters from regularities in the past, where the home investment bias was very large.

I replace γ with its estimate $\hat{\gamma}$ from the first step, and estimate (60) with a pseudo-panel regression based of PSID (US) individuals data covering the period 1989:2002. For Italy, since the SHIW survey is run only every other year, instead of (60) I consider the equation

$$\gamma\Delta^2 \log\left(C_{t+1}\right) = \Delta \log\left(\pi_{t+1}\right) + \Delta \log\left(R_{t+1}^E\right) + \delta'\Delta^2 Z_{t+1} + \tilde{\psi}_{t+1} \tag{61}$$

where $\Delta^2 \log\left(C_{t+1}\right) = \Delta \log\left(C_{t+1}\right) - \Delta \log\left(C_t\right) = \log\left(C_{t+1}\right) - \log\left(C_{t-1}\right)$. Since each unit is observed over a small number of periods only, especially in the Italian dataset, to study life-cycle behavior I use the cohort technique developed in Browning et al. (1985). This consists of dividing the sample into year-of-birth cohorts and averaging the relevant variables within each cohort and time period. This way, 533 observations for the US and 392 for Italy are available. After some specification search, the only demographic variable to be significant is the number of components in the household, consistently with Attanasio and Weber (1995). The variable shows to be more significant in Italy.

The third step consists in estimating, from the same data, an average life-cycle profile for $\exp\left\{\delta' Z_t\right\}$ to be used in the simulation as an exogenous demographic factor; family size appears to decline more slowly in Italy.

The final step is to derive an estimate for the discount factor β. I consider the relation

$$\beta = \frac{\overline{\beta}_{t+1}}{E\left[\pi_{t+1} \exp\left\{\delta'\Delta Z_t\right\}\right]} \tag{62}$$

where $\overline{\beta_{t+1}}$, π_{t+1}, δ, and $Z_t, t = 1,\ldots,T$ are known from the previous steps, and the expectation is weighted using 2003 population age groups from Human Mortality Database.

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