Mortgage Debt and Social Externalities*

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January 30, 2014

Abstract

I analyse the implications of social status concerns on debt holdings at individual and aggregate level, in a partial equilibrium life-cycle framework with heterogeneous agents. The focal point of the analysis is the explicit consideration of durable goods, in their triple role as a part of utility, a collateralizable portion of life-time wealth and a social positioning device. In an economy featuring social status concerns, the debt-to-income ratio is higher, a shift of resources towards the beginning of life arises and the effects of changes in financial conditions are more pronounced. *JEL Classification:* E21, E50, G11.

*I thank Michael Binder, Nicola Fuchs-Schündeln, Michael Haliassos, and seminar participants at Goethe University for helpful comments and suggestions.

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I. Introduction

Understanding the factors behind households' consumption, leverage and investment decisions is essential for maintaining macroeconomic and financial stability. In standard rational choice models, the absolute level of consumption given by the optimal inter-temporal allocation is the only component of household utility. However, an early tradition in economics, as well as recent empirical evidence, suggest that what agents value in addition is how well they perform relative to the immediate peer or competitor group. If this is the case, it has been shown that systemic inefficiencies can build up, despite the fact that decisions are entirely rational at individual level - and especially so with respect to social externalities, taking the form of positional concerns. Moreover, if the object which provides a competitive advantage or against which one simply judges success is not readily affordable and the agents have to transfer resources inter-temporally in order to be able to purchase it, the quest for social status may also lead to higher aggregate indebtedness.

The main focus of this paper is to analyze this connection between the preference for social status and the levels of debt at individual and aggregate level, first in a stylized simple household allocation model and second in a heterogeneous agents partial equilibrium economy, calibrated to match survey data for the United States.

Compared to most of the previous literature, my concern is however not on consumption as a social positioning device, but on the level of durable goods - for three reasons. First, it seems reasonable to believe that goods more prone to be conspicuous tend to be more durable. Second, especially in the US during the last decades, consumers face a plethora of financial products designed at making borrowing against collateral easier and faster while, by definition, the durability of the

good used as collateral has to bear a close relationship with the maturity of the loan. From the perspective of the individual agent, it is also natural that the decision of whether to take up a one-period loan to buy an expensive good is different if the good depreciates fully after the one period or if, after having payed back the loan, the agent can still enjoy the social benefits associated with it for some time to come. Third, from a purely empirical perspective, a cross-sectional analysis of the interaction between consumption and indebtedness is not possible within the limitations of currently available surveys. On the other side durable goods are also a wealth item and high-quality detailed data on the balance sheets of households is readily available.

The core part of the paper consists of building a partial-equilibrium household model featuring status concerns, which is shown to be able to replicate stylized facts of the US debt-asset-durables distribution. The model is used to analyze the effects on the life-cycle allocation of resources and discuss the role of collateral constraints, across three educational cohorts. The results suggest that the debt-to-income ratio is 10 to 30 percent higher in an economy in which the quest for social status is pervasive, the associated consumption losses being of the order of 5 percent. Concerning the life cycle dimension, a shift of resources towards the beginning of life arises - and this is especially pronounced for the more educated group. The agents can thereby relax the borrowing constraints during the first period of life, while durable investment also pays off in the long run in terms of being better able to meet the social standards. The effect of financial conditions is shown to be more pronounced in an economy featuring social status concerns, in terms of aggregate net financial assets and in terms of the indebtedness ratio in the population.

The paper contributes to the debate on the aggregate financial and macroeconomic implications of the cross-sectional distribution of agents in the economy. It is now widely acknowledged that the international financial imbalances, loose standards in oversight and supervision, as well as inadequate risk management practices that led to the financial crisis of 2008 were mirrored especially in the US over the last decades by a dramatic increase in income inequality. There are three channels through which this can affect macroeconomic and financial stability: first of all, investors at the high end of the income distribution transfer at least part of their newly available resources to poorer households, such that interest rates decrease and financial vulnerability rises[1]. Second, the government reacts in its role as a redistributive authority by expanding credit to low-income households, which induces consumption and employment growth in the short run, but increases the exposure to sovereign and debt crises in the future. Third, greater inequality also means that the population is forced to find ways to maintain their social position by increasing consumption, supplying more labor and taking on more debt. This latter point lies at the core of the motivation of my approach, the main focus here being the mechanism through which preferences for social positioning affect optimal decisions.

The paper is also part of the recent literature on durable consumption across the life cycle and in these terms it is mostly related to the contribution of Fernández-Villaverde and Krueger (2011). Their results concerning both the inter-temporal allocation of resources and the differences in consumption-savings behavior across income and wealth groups continue to hold entirely in the present setup. As concerns

[1]This mechanism is damaging from a systemic point of view when coupled with inert or at least non-contractionary monetary policy, as well as with large-scale asset-backed securitization, which were defining characteristics of the developments in recent decades. For a discussion on this issue, see Kumhof and Ranciere (2010).

the empirical dimension of the paper, I relate to the contributions of Gourinchas and Parker (2002), Cocco et al. (2005) and Storesletten et al. (2004). All particular details concerning the calibration of income processes and household preferences come from simulated method of moments estimation of partial life-cycle partial equilibrium models, resulting out of this strand of literature. On the other side, Hintermaier and Koeniger (2010) and Díaz and Luengo-Prado (2010) are benchmark references in terms of the methodological issues concerning the specification and numerical simulation of my model framework. Their main insights concern the dominant role of assumptions about the income process in determining cross-sectional distributions of assets holdings, either financial products or durable goods.

The explicit modeling of social status concerns and the analysis of the implications of social externalities on aggregate outcomes is the central pinpoint of my approach, so I dedicate the next section to a detailed review of the way in which this literature has advanced so far. In section III, I use a simple two-period model to document the reaction of households to changes in aggregate conditions and formalize the idea of a social multiplier, discuss the implications of income inequality and analyze the role of financial constraints. In section IV, I discuss the data source and review a series of observations concerning the evolution of debt and income in the US over the last years, with a focus on establishing a link between income, debt and financial vulnerability. Section V contains a description of the life-cycle heterogeneous agents model, as well as the core results of the paper and section VI concludes.

II. The Idea of Social Status

The idea of preferences for social status goes back to Adam Smith, who identifies the desire for social positioning[2] as a fundamental determinant of economic activity. In recent years, however, our understanding of the desire for social status has increasingly been shaped by evolutionary ideas[3]. The *vanity* that Adam Smith talks about is not seen as an incidental behavioral idiosincracy, but as a reflection of the inherent competition of survival among genes. The desire for social status is then a direct outcome of natural selection.

Through time, the only difference is then how this desire materializes, i.e. which is the object which has the most potential to differentiate oneself from one's evolutionary competitors. Veblen (1899) introduced the term conspicuous consumption to represent an attitude towards consumption, typical of the *nouveau riche*. Broadly interpreted, it means that consumption goods are not only valued for their intrinsic utility, but also for the social status associated with the act of consuming them. He also noted that the amount of consumption perceived as adequate from a social perspective is rising as a society becomes richer and more developed. Along similar lines, Max Weber (1946) builds his social stratification theory around the ideas of *property*, *prestige* and *power*. In this sense, the effort to increase one's position in society is not merely an instance of vanity, but it bears the seeds of future material benefits through a better bargaining position or better access to information.

[2]Adam Smith, The Theory of Moral Sentiments: "To what purpose is all the toil and bustle of the world? [...] It is our vanity which urges us on. [...] It is not wealth that men desire, but the consideration and good opinion that wait upon riches."

[3]The most comprehensive review in this regard is the one by Truyts (2010).

In the field of economics, Pigou (1903) was the first to formalize the idea that the utility function of agents is not only depending on the quantities of different commodities that they consume, but also of the quantities that others consume. Somewhat intricately, Pigou even goes one step further and introduces the fundamental distinction between two forms of social status: the "desire to be in the swim", i.e. a preference for being in line with society and the "desire for the uncommon" (see p. 60, op.cit.), i.e. an aversion to goods that are in common use, a preference for differentiation and originality. Recently, the terminology has changed and a similar distinction is made between "keeping up with the Joneses" and "getting ahead of the Joneses".

In recent years, these ideas have found fertile ground in a wide spectrum of areas connected to macroeconomics and finance. Cole et al. (1992) document the emergence of multiple equilibria in the context of a model featuring social status concerns and they show how concerns for relative position can arise endogenously, such that higher income implies higher status. In Gali (1994), the presence of externalities is shown to affect the optimal risky share, as well as the size of adjustments in response to exogenous changes in the risk-adjusted equity premium. In equilibrium, the equity premium is also affected by the sign and the intensity of the externalities. Ljungqvist and Uhlig (2000) examine the role for tax policies in economies with catching-up-with-the-Joneses utility functions. They show how the optimal tax policy affects the economy countercyclically via procyclical taxes. Cole et al. (2001) show that wealthier individuals are more successful in matching, which results in investment bias and home country bias. Dupor and Liu (2003) discuss jealousy and compare it to "keeping up with the Joneses". DeMarzo et al. (2008) show how relative wealth concerns can contribute to the emergence of financial bubbles and Roussanov (2010)

explains investment in private equity. Becker and Rayo (2006) comes closest to the approach taken in this paper and focuses on the interaction between durable goods and indebtedness.

On the empirical side, the bulk of the work in this regard is psychological or sociological in nature, however economists also started dedicating efforts to the empirical identification of status concerns in recent years. Easterlin (1995) is the benchmark study on happiness across and within countries, introducing empirical evidence for preferences for social positioning in terms of income. Their main result is that higher aggregate GDP does not raise the average wellbeing in the population, but there is strong correlation within a country between levels of income and levels of happiness. This finding is generally interpreted as strongly in favor of social status concerns, especially when coroborrated with survey evidence on direct comparisons. Recent contributions in this regard are Luttmer (2005), who find that happiness depends negatively on the income of neighbours, Dynan and Ravina (2007) who discuss the connection between income inequality, external habits and self-reported happiness and Kuhn et al. (2011) who show that living next to a winner in the Dutch Postcode Lottery increases the level of own car consumption.

In an experimental study, Solnick and Hemenway (1998) show that both absolute well-being and relative position seem to matter to people: "Evidence indicates that positional concerns are extremely important. [...] half of the respondents said they would prefer a world in which they have 50 percent less real income, so long as they have high relative income. The majority of respondents to our survey rejected the prospect of everyone becoming richer if it was accompanied by a fall in their own relative standing. For them, a policy that increased their absolute income but lowered

their relative income did not make them feel better off." Winkelmann (2011) analyzes household panel data and finds that the prevalence of luxury cars in the area has a negative impact on others' satisfaction, with the biggest impact arising for the poor. Along similar lines, Vissing-Jorgensen (2011) shows that one can infer the default rate on consumer loans from the product group that people buy on credit. Products which indicate a high probability of default are generally luxuries and they tend to be purchased by individuals who consume abnormally large fractions of luxuries given their income. These patterns are robust to controlling for household demographics and past repayment behavior, so she attributes the fact of spending an abnormally high fraction on luxuries on the agent being more subject to temptation, having a high preference for indulgence or low self-control.

Finally, concerning the type of objects more likely to be used as social positioning devices, Solnick and Hemenway (2005) find the quantity of durable assets like e.g. the size of one's house to be most positional. Regarding this distinction, Kuhn et al. (2011) conclude: "Unlike an expensive party or vacation, a household's neighbors are continuously reminded of its new car after it has been purchased." Becker and Rayo (2006) argue similarly: "Nondurables, by definition, disappear once consumed. Durables, in contrast, remain in the consumer's possession for further display. For example, if I consume an expensive lunch, only those present can directly observe it. In contrast, if I wear a fancy suit, any person crossing my path can be a witness. Durables can also be displayed while simultaneously engaging in other activities-my guests can instantly see my home appliances even when not under use." Vissing-Jorgensen (2011) also mentions that it is mostly durable goods like jewelry and other luxury products that bear the potential of being bought by agents who are not actually able to pay them off eventually and thus they could have been bought

simply in an attempt to signal or enhance social acceptability.

III. Theoretical Insights

Utility function The per-period utility function considered in this paper has the following additive CRRA form:

$$U(c, C) = \frac{c^{1-\sigma}}{1-\sigma} + \eta \underbrace{\frac{1}{1-\sigma}\left(\frac{c}{C}\right)^{1-\sigma}}_{S(c,C)}$$

where the first term corresponds to the direct utility from consuming the quantity c and the second term corresponds to the preference for social status, defined over the relative quantity $\frac{c}{C}$ versus the aggregate social reference level C.

The analytical properties of this specification of the utility function imply that:

$$S_C = -\frac{c^{1-\sigma}}{C^{\sigma-2}} < 0 \text{ and } S_{cC} = (\sigma - 1)\frac{c^{-\sigma}}{C^{2-\sigma}} > 0$$

which means that the marginal utility effect of an increase in aggregate reference levels is negative, corresponding to the idea of jealousy or envy, as discussed by Dupor and Liu (2003). The second order cross-derivative with respect to own consumption and the reference level is positive, such that in turn the marginal utility of consumption is increasing in the reference level. This concept is usually termed "keeping up with the Joneses" and has been introduced by Abel (1990). This stands in contrast to the status specification proposed by Roussanov (2010), where the marginal utility of consumption decreases in aggregate reference levels and which would imply "getting ahead of the Joneses". However, in the Roussanov (2010) case social status

is defined in terms of relative wealth, which stands in sharp contrast to the more traditional definition of status used in this paper. Also, there is strong empirical and experimental evidence mentioned above, that suggests a positive reaction of own consumption to an increase in the consumption level of the reference group.

The additive property of the Roussanov (2010) status function is nevertheless retained here, first because of the formal and analytical simplicity and second because I share the opinion that utility should not be exclusively defined in terms of relative positioning (as it is in almost all theoretical studies), but instead the goods should provide direct utility, even when one's relative social standing does not change.

Setup I start by using a simple model to formalize the idea that the quest for social status is linked to higher indebtedness through the degree of durability of the goods and progressively add features in order to capture a richer set of results.

Consider first the case of a single consumer living for two periods, during which she receives a deterministic stream of income equal to y_1 in period 1 and y_2 in period 2. During the course of the lifetime, the consumer can freely allocate these endowments inter-temporally by saving or borrowing at a rate r in a financial asset a, in order to implement a consumption path (c_1, c_2) which maximizes discounted life-time utility:

$$U(c_1) + \eta S(c_1, C_1) + \beta U(c_2) + \beta\eta S(c_2, C_2)$$

subject to the set of budget constraints:

$$c_1 + a = y_1$$
$$c_2 = (1 + r)a + y_2 + (1 - \delta)c_1$$

In addition to direct per-period utility U from consumption, the agent also values social status according to the function S and relative to the subjective benchmark consumption levels C_1 and C_2 corresponding to periods 1 and 2 respectively.

The consumption good provides utility during the period in which it is purchased, but it only depreciates up to a factor δ during consumption and it is thus also available in future periods, when it can be either consumed or sold freely in the market. The limiting case in which the good is a pure consumption good in the traditional sense corresponds thus to $\delta = 1$.

The first order condition of this problem is given by:

$$U_{c_1} + \eta S_{c_1} = \beta(\delta + r)(U_{c_2} + \eta S_{c_2})$$

where respective partial derivatives are denoted by subscripts. This equation is of the usual Euler-equation type, saying that the marginal benefit from consuming one more unit in the first period is equal to the discounted marginal benefit of transferring one unit of wealth to the next one. The inter-temporal allocation is governed by the factor $\beta(\delta + r)$, which implies that the lower the depreciation rate δ, the lower marginal utility in the first period compared to the second, the higher thus the shift of resources towards the beginning of life.

As discussed in the previous section, it is assumed that both direct and indirect

(status) utility are of CRRA form, such that the optimal policy functions for net holdings of financial assets are given by:

$$a = y_1 - \frac{y_1(1+r) + y_2}{\delta + r + \left[\beta(\delta + r)\frac{1+\eta C_2^{\sigma-1}}{1+\eta C_1^{\sigma-1}}\right]^{1/\sigma}} \tag{1}$$

First, since the denominator of the right-hand element of the expression from above is a positive function of δ, it holds:

$$\frac{\partial a}{\partial \delta} > 0$$

which implies that the saving/borrowing rate depends positively on the depreciation rate. Intuitively, this result is simply the flip-side of the discussion of the Euler equation from above.

When $\eta \neq 0$, the inter-temporal structure of the (subjectively perceived) aggregate social reference level C affects the inter-temporal allocation of individual consumption, as is discussed below.

Temporary and permanent shocks Consider first a case in which the aggregate economy is in a deterministic steady state, so the agent faces the same social reference level $\bar{C}$ in both periods. A transitory shock ε is defined as a persistent change to $\bar{C}$, such that $C_1 = (1+\varepsilon)\bar{C}$ and $C_2 = (1+\varepsilon\rho)\bar{C}$ with $\rho < 1$.

In terms of marginal effects, it holds:

$$\frac{\partial a}{\partial \varepsilon} < 0 \text{ and } \frac{\partial^2 a}{\partial \varepsilon \partial \delta} < 0$$

First, since the indirect utility function S features the keeping up with the Joneses property, the reaction to a perceived increase in the social reference level unambigously leads to a decrease in the holding of financial assets or to higher indebtedness. Second, this effect is magnified by the influence of the durability of the good: the more durable the good, the stronger the reduction in savings associated with the response to a higher aggregate reference level. Third, the more persistent the aggregate shock, the more subdued the reaction of the savings rate.

In the extreme, this latter point leads to the following case. Let the shock ε be permanent, such that $\rho = 1$ and $C_1 = C_2 = (1 + \varepsilon)\bar{G}$. It thus follows:

$$\frac{\partial a}{\partial \varepsilon} = 0$$

The intuition behind this result is straightforward: if the reference level increases by the same proportion in both periods, the effect on the marginal utilities cancels out inter-temporally. In an attempt to keep up with the higher level in the first period, the agent would worsen its social position in the second one, such that overall the permanent shock does not influence consumption allocations and savings.

Nevertheless, this latter case assumes $C_1 = C_2$, and so is quite special. If $C_1 > C_2$ a permanent shock has quantitatively the same implications like a transitory shock (decreasing savings and increasing borrowing), however if $C_1 < C_2$, the optimal response to a permanent shock is to consume less in the first period and to save more.

Social multipliers Consider now an economy composed of two agents with endowments (y_1, y_2) and (y_1^*, y_2^*). Assume $\eta > 0$, $\eta^* > 0$ and the levels which define

the social position are symmetric:

$$C_1 = c_1^*, C_2 = c_2^* \text{ and } C_1^* = c_1, C_2^* = c_2$$

The steady state equilibrium of this economy is defined by an allocation of goods (c_1, c_2, c_1^*, c_2^*), such that:

$$c_1 = \frac{y_1(1+r) + y_2}{\delta + r + \left[\beta(\delta + r)\frac{1+\eta(c_2^*)^{\sigma-1}}{1+\eta(c_1^*)^{\sigma-1}}\right]^{1/\sigma}} \text{ and } c_2 = c_1\left[\beta(\delta + r)\frac{1+\eta(c_2^*)^{\sigma-1}}{1+\eta(c_1^*)^{\sigma-1}}\right]^{1/\sigma}$$

$$c_1^* = \frac{y_1^*(1+r) + y_2^*}{\delta + r + \left[\beta(\delta + r)\frac{1+\eta^*(c_2)^{\sigma-1}}{1+\eta^*(c_1)^{\sigma-1}}\right]^{1/\sigma}} \text{ and } c_2^* = c_1^*\left[\beta(\delta + r)\frac{1+\eta^*(c_2)^{\sigma-1}}{1+\eta^*(c_1)^{\sigma-1}}\right]^{1/\sigma}$$

Rewrite these equilibrium equations as a fixed point: $\begin{pmatrix} c_1 & c_2 \end{pmatrix} = I\left[\begin{pmatrix} c_1 & c_2 \end{pmatrix}\right]$

Consider now iteratively the equilibrium fixed point effect of a (transitory) shock $(1+\xi)$ to y_1:

$$y_1 \nearrow \quad c_1 \nearrow \quad (c_2 \nearrow \text{ by less }) \quad c_1^* \nearrow \quad (c_2^* \nearrow \text{ by less })$$
$$c_1 \nearrow \quad \text{etc. until convergence}$$

In terms of marginal effects, it holds:

$$\frac{\partial c_1}{\partial \xi} > 0 \quad \text{and} \quad \frac{\partial c_1}{\partial \xi \partial \eta} > 0 \quad \text{and} \quad \frac{\partial c_1}{\partial \xi \partial \eta^*} > 0$$
$$\frac{\partial a^*}{\partial \xi} < 0 \quad \text{and} \quad \frac{\partial a^*}{\partial \xi \partial \eta} < 0 \quad \text{and} \quad \frac{\partial a^*}{\partial \xi \partial \delta} > 0$$

Borrowing constraints The mechanics of the social multiplier mentioned above generates an equilibrium which is inefficient. This can be easily seen for example from the fact that social status does not depend on the absolute value of one's own consumption, but on the ratio with respect to the reference level and this ratio could also be implemented by the same allocation which would prevail in the absence of social status concerns. It is thus the allocation which maximizes pure direct utility that is the efficient one. The role of borrowing constraints in this context is straightforward: it limits the degree to which the social concerns push agents too far off in negative regions in terms of financial asset holdings. Whether borrowing or collateral constraints also improve efficiency inherently depends on the precise constellation of functional form assumptions and model parameters.

Income inequality Assume now that the income shock is distributed cross-sectionally between the two agents according to the factor α: an increase of $\alpha\xi$ to y_1 and $(1-\alpha)\xi$ to y_1^*.

First of all, observe that:

$$\frac{\partial a}{\partial \xi} < 0 \text{ at } \alpha = 0$$

Assume now the distribution of agents in the aggregate population is γ and $1-\gamma$ respectively. Define $A = \gamma a + (1-\gamma)a^*$, such that:

$$i.) \quad \exists \bar{\alpha} \in [0,1] \text{ such that } \frac{\partial a}{\partial \xi} < 0, \forall \alpha \in [0, \bar{\alpha}]$$

$$ii.) \quad \eta > 0 \text{ and } \eta^* > 0 \Rightarrow \exists (\bar{\alpha}, \gamma) \text{ such that } \frac{\partial A}{\partial \xi} < 0$$

Therefore, if the agents have positive preference for social status, for any configuration of model parameters, if the income distribution is sufficiently unequal, a certain increase in aggregate wealth decreases net savings or increases net borrowing. Moreover, the effect is magnified if the goods are more durable.

IV. Data and Stylized Facts

For the core part of our analysis, we use data from the Survey of Consumer Finances (SCF). The survey is conducted by the Federal Reserve Board and contains comprehensive and high-quality information about a representative cross-section of U.S. households: balance sheet and income data, demographical and personality characteristics. The survey is released on a triennial basis and our focus is on the 2007 wave, representative for the situation just before the outbreak of the financial crisis. Each wave includes between 3,000 and 4,500 households and weights are provided to make the results representative of the full population[4].

Savings correspond to the total sum of liquid assets, certificates of deposit, directly held pooled investment funds, stocks, bonds, quasi-liquid assets, savings bonds and life insurances, as well as a small portion of other uncategorized assets.

Durable goods correspond to the total value of all vehicles owned, the value of the primary residence, of other residential real estate, the net equity in nonresidential real estate and the sum of other non-financial assets, such as gold, silver (incl. silverware), antiques, furniture, art objects, paintings, sculpture, textile art, ceramic art,

[4]For more information about the survey, see Kennickell (2009)

photographs, (rare) books, coin collections, stamp collections, musical instruments, records, wine etc.

Debt holdings correspond to the principal residence debt (mortgages and HELOCs), other lines of credit, debt for other residential property, credit card debt, installment loans and other debt.

Income corresponds to household income for the previous calendar year. It includes wages, self-employment and business income, food stamps and other support programs provided by the government, pension income and withdrawals from retirement accounts, social security income, alimony and other support payments, as well as other miscellaneous sources of income. It does neither include interest payments (taxable or nontaxable), nor dividend income.

Figure 1 depicts the evolution of the debt-to-income ratio, which has increased substantially over the last years. The interesting issue in the context of this paper is the decomposition of debt in its components: it is therby apparent that the bulk of the increase in the debt-to-income ratio can be attributed to the increase in secured debt - mortgages and vehicle purchases - and even more substantially so for less educated people.

There are many other possible reasons for this development: financial innovation has relaxed borrowing constraints by giving households more access to credit, the low interest rates have discouraged spending and spurred borrowing, the increases in house prices generated a positive wealth effect on the household balance sheets and the booming times have generally created the illusion of a substantial decrease in income uncertainty, thereby decreasing the precautionary savings motive.

Taking into account the fact that, as can be seen in Figure 2, over the same period income inequality has also increased strongly, one can attribute at least partially the relatively more pronounced increase of the debt-to-income ratio for less educated people to the higher dispersion between the income categories. As has been suggested often in the literature, as one part of society gets richer, the other struggles to keep up in terms of the higher social standards and thus ends up being more indebted. Since the surge in mortgage indebtedness has been accompanied by a contruction boom and a house price bubble, one can see this at least as suggestive evidence that the reference levels along which people judge their position in society have increased strongly. On the other side, Figure 3 shows that higher debt-to-income ratios have constantly been associated with more financial vulnerability, so understanding the determinants of household indebtedness is directly linked to macroeconomic outcomes. The presence of social status concerns can thus generate higher aggregate indebtedness and higher aggregate systemic vulnerability, despite the fact that the overall economy is subject to positive output and income shocks over long periods of time.

In the next section, I analyze the role of social status in a fully-fledged partial equilibrium household finance model framework, with a particular focus on how financial market conditions interact with the social positioning motive.

V. The Life-Cycle Model

V.A. Setup

The economy consists of a continuum of adult agents, each of them living at most T periods. Following Cocco et al. (2005) and Fernández-Villaverde and Krueger (2011),

I assume that agents of age $t \leq T$ face the conditional probability $\pi_{t+1|t}$ of surviving through to period $t+1$ and they die with probability 1 at age T. All individuals of a given age face the same mortality risk, irrespective of idiosyncratic characteristics.

There are two types of goods in the economy: non-durable goods c which get consumed instantly in each period and durable goods d which are consumed gradually through time, the real stocks thereof depreciating at a deterministic rate δ. Expected life-time utility is inter-temporally additive over the finite lifetime and the per-period utility function $U(c, d)$ is strictly concave and non-separable in c and d. In addition to the direct utility the durable goods provide, agents also value their relative position in society, which I assume is determined in terms of the accumulated stock of durables relative to the individually established reference point D. Following Roussanov (2010), I assume the preference for social status $\eta S(d, D)$ to be linearly separable from the direct utility from consumption, with the parameter η capturing its relative importance.

Since the employment-leisure trade-off is beyond the scope of the paper, individuals are assumed to be endowed with one unit of labor in each period, which they supply inelastically and receive stochastic income streams. Similarly to Carroll and Samwick (1997), I distinguish between two periods in life: the active working period and the retirement period. First, during the working period, individual income follows the following exogenous stochastic process:

$$y_t = p_t q_t, \forall t = 1, \ldots, \bar{T} \tag{2}$$

Income can thus be decomposed into a permanent and a transitory component. The permanent component, p_t, grows deterministically at the rate g_t and is subject to

multiplicative shocks n_t:

$$p_t = g_t p_{t-1} n_t. \tag{3}$$

Following Cocco et al. (2005), the deterministic part of the permanent component $g_t \equiv f(t, Z_t)$ is assumed to depend on age t and a set of individual characteristics Z_t. The transitory component q_t, as well as the shock n_t to the permanent component are assumed to follow the independent log-normal distributions:

$$\log q_t \sim N\left(-\frac{\sigma_q^2}{2}, \sigma_q^2\right) \tag{4}$$

$$\log n_t \sim N\left(-\frac{\sigma_n^2}{2}, \sigma_n^2\right) \tag{5}$$

During the retirement period, income is assumed to consist of deterministic cash flows taking the form of retirement benefits:

$$y_t = b(t, Z_t) y_{\bar{T}}, \forall t = \bar{T}, \ldots, T. \tag{6}$$

Retirement income is thus assumed to be a function of household characteristics Z_t and the income in the last active period $y_{\bar{T}}$.

I assume incomplete markets in the sense that there is no trade in Arrow state-contingent securities and thus there are no cross-sectional insurance mechanisms at work. Agents can only self-insure by saving in the safe financial asset which pays a deterministic risk-free interest rate r and by obtaining short-term one period bank loans at the same market rate. Net holdings of financial assets are denoted by a_t.

Following Díaz and Luengo-Prado (2010) and Fernández-Villaverde and Krueger

(2011), agents are subject to a borrowing constraint by which the lender can make sure that loans are at least partially covered in the event of financial distress. Specifically, there are two accepted collateral sources, labor income and the real stock of durables:

$$(1+r)a_t \geq -\mu_y f(t, Z_t) - \mu_d E_t(1-\delta)d_{t+1} \tag{7}$$

Since labor income is stochastic, it is the level of permanent income, conditional on the observable set of characteristics, that the lender uses in its assessment of the creditworthiness of the household. This first type of debt, which can reach up to a fraction μ_y of labor earnings, could be seen as reflecting credit card balances or short-term unsecured loans, since in the risk profiles by which banks assess creditworthiness, wage income features a prominent role. Regarding the portions of debt which are secured by the housing stock, they resemble traditional mortgage contracts with a down-payment $1-\mu_d$, but also more sophisticated home equity loans which became widely used in recent periods, not as means of financing the purchase of residential property, but by providing funds that are cheap and - at least from the perspective of the lender - less risky. What matters for the risk assessment of the lender is thus the expected value of the real stock of durables in the next period, i.e. net of the depreciation δ. Since there is no inflation in the model, all quantities should be thought of in real terms, with the value of durables thus being normalized by a constant price of one. Finally, in order to replicate the fact that the debt holdings of old agents in the SCF are close to zero, I impose that the loan-to-value ratio of mortgage loans is zero after agents reach the age of 80.

When changing the stock of durables, agents incur a transactions cost $\Psi(d_{t+1}, d_t)$,

which reflects the illiquid feature of durable goods in terms of commissioning and brokerage fees or opportunity costs associated with the divestment.

V.B. Model equations

In each period, the model consists of a sequence of agents mapped on a continuum indexed by $i = 0, \ldots, 1$, which define the cross-sectional distributions of labor income $\{y_t^i\}$, financial assets $\{a_t^i\}$, nondurable consumption $\{c_t^i\}$ and real durable holdings $\{d_t^i\}$, as well as durable reference levels $\{D^i\}$ and Lagrange multipliers $\{\lambda_t^i\}$, such that, for all periods t=0,...,T-1:

$$w_t^i(a_t^i, d_t^i, p_t^i) = \max_{a_{t+1}^i, d_{t+1}^i} U(c_t^i, d_t^i) + \eta S(d_t^i, D^i) + \beta \pi_{t+1|t} E_t w_{t+1}^i(a_{t+1}^i, d_{t+1}^i, p_{t+1}^i) \tag{8}$$

$$\begin{aligned} \text{s.t. } & a_{t+1}^i + d_{t+1}^i + c_t^i + \Psi(d_{t+1}^i, d_t^i) = \\ & \qquad (1+r)a_t^i + (1-\delta)d_t^i + y_t^i \\ & y_t^i = p_t^i q_t^i \\ & p_t^i = f(t, Z_t^i) p_{t-1}^i n_t^i \\ & (1+r)a_t^i \geq -\mu_y f(t, Z_t^i) - \mu_d E_t (1-\delta) d_{t+1}^i \qquad |\lambda_t \end{aligned}$$

The durable reference level is a subjective measure of one's position in society, therefore it carries an index i. However, since the model corresponds to partial equilibrium and there is no aggregate dynamics, the reference level is assumed to be constant over the course of the life time. This is an admittedly strong assumption, also considering

the fact that in reality durable production is subject to market forces. There is no empirical evidence on the variability of the social status reference levels across the life time, so any particular assumption would be quite ad-hoc in this context.

The first-order condition with respect to a^i_{t+1} is given by:

$$\frac{\partial U(c^i_t, d^i_t)}{\partial c^i_t} = \beta \pi_{t+1|t} E_t \frac{\partial w^i_{t+1}(a^i_{t+1}, d^i_{t+1}, p^i_{t+1})}{\partial a^i_{t+1}} + (1+r)\lambda^i_t \tag{9}$$

which says that the marginal utility loss of a unit of savings today has to equal the marginal benefit from future discounted utility, considering the possibility of facing a binding collateral constraint.

The first-order condition with respect to d^i_{t+1} is given by:

$$\frac{\partial U(c^i_t, d^i_t)}{\partial c^i_t}\left(1 + \frac{\partial \Psi(d^i_{t+1}, d^i_t)}{\partial d^i_{t+1}}\right) = \beta \pi_{t+1|t} E_t \frac{\partial w^i_{t+1}(a^i_{t+1}, d^i_{t+1}, p^i_{t+1})}{\partial d^i_{t+1}} + \mu_d(1-\delta)\lambda^i_t \tag{10}$$

where it can be seen that the presence of adjustment costs increases the marginal utility loss from transferring durables to the next period. Also, the marginal gain from investing in durables is affected by the fact that durables are collaterisable up to a fraction μ_d.

Finally, the envelope conditions are given by:

$$\frac{\partial w^i_t(a^i_t, d^i_t, p^i_t)}{\partial a^i_t} = (1+r)\frac{\partial U(c^i_t, d^i_t)}{\partial c^i_t} \tag{11}$$

and:

$$\frac{\partial w_t^i(a_t^i, d_t^i, p_t^i)}{\partial d_t^i} = \frac{\partial U(c_t^i, d_t^i)}{\partial c_t^i}\left((1-\delta) - \frac{\partial \Psi(d_{t+1}^i, d_t^i)}{\partial d_t^i}\right) + \frac{\partial U(c_t^i, d_t^i)}{\partial d_t^i} + \eta \frac{\partial S(d_t^i, D^i)}{\partial d_t^i} \tag{12}$$

In period T the agent dies with certainty, which implies for the decisions taken in period $T-1$ that:

$$a_T^i = d_T^i = 0 \tag{13}$$

and:

$$c_{T-1}^i = (1+r)a_{T-1}^i - \Psi(0, d_{T-1}^i) + y_{T-1}^i \tag{14}$$

with the value function taking the form:

$$w_{T-1}^i = U(c_{T-1}^i, d_{T-1}^i) + \eta S(d_{T-1}^i, D_{T-1}^i) \tag{15}$$

The individual problem of the agent is therefore defined recursively until the first period of life.

V.C. Functional forms

Per-period felicity is assumed to be of CRRA form, with the consumption bundle consisting of both durable and nondurable goods:

$$U(c_t^i, d_t^i) = \frac{\left[(c_t^i)^\theta (d_t^i)^{1-\theta}\right]^{1-\sigma} - 1}{1-\sigma}. \tag{16}$$

The coefficient of relative risk aversion is σ and the relative importance of durable vs. nondurable goods is governed by the parameter θ. I adhere in the choice of the aggregation function to Hintermaier and Koeniger (2010) and Fernández-Villaverde and Krueger (2011), who argue that the Cobb-Douglas functional form is in line with empirical micro-level evidence on the intra-temporal rate of substitution between durables and non-durables.

I follow Hintermaier and Koeniger (2010) when assuming that the cost function is symmetric, continuously differentiable in both d_{t+1}^i and d_t and the reference adjustment level is $(1-\delta)d_t^i$, such that net costs are zero when the stock of durables is simply let to depreciate:

$$\Psi(d_{t+1}^i, d_t^i) = \frac{\alpha}{2}\left(\frac{d_{t+1}^i - (1-\delta)d_t^i}{d_t^i}\right)^2 d_t^i \tag{17}$$

The preference for social status is assumed to be of CRRA form and defined over the individual standing in terms of durable goods, relative to the subjective reference point:

$$S(d_t^i, D^i) = \frac{\left(\frac{d_t^i}{D^i}\right)^{1-\gamma} - 1}{1-\gamma}. \tag{18}$$

V.D. Calibration

The calibrated parameters are summarized in Table 1.

As individual characteristics, I focus on education and distinguish between three categories: *No Highschool*, *Highschool* and *College*.

Conditional survival probabilities $\pi_{t+1|t}$ are taken from the 2007 release of the Life Tables published by the United States Social Security Administration. The deterministic component of the life cycle profile of earnings corresponding to the three educational groups is taken from Cocco et al. (2005). Life-cycle specific model components are depicted in Figure 3.

The stochastic properties of the income shocks and the levels of the retirement benefits are taken from Gourinchas and Parker (2002). Agents with no highschool degree face considerably larger income uncertainty than college graduates with respect to both the transitory and the permanent components. Initial asset holdings are also taken from Gourinchas and Parker (2002), since however they do not distinguish between durable goods and financial assets as parts of wealth, I assume equal shares in both asset categories in the first period of life. The replacement rate in retirement is taken from Cocco et al. (2005), since Gourinchas and Parker (2002) do not explicitly model the labor income process after the retirement age.

Heterogeneity across consumer groups stems also from the different discount rates and relative risk aversions, which are taken from Cagetti (2003). There are several attempts in the literature at characterizing empirically the preference heterogeneity along the education dimension, I have chosen however to use the parameters estimated by Cagetti (2003) because he uses data from the SCF and thus I would expect

his results to characterize best the data sample used here to calibrate the set of free parameters.

For the social reference levels, I assume they are equal for each education group to the median level of durables in the 2007 wave of the Survey of Consumer Finances. Since the empirical median is not necessarily equal to the model-implied one, at each point during the fixed point iterations the respective reference level is calculated, according to the respective implied percentile levels.

The two parameters, the interest rate r and the parameter governing the preference for social status η, are calibrated by matching a set of two moments corresponding to the means of the cross-sectional distributions of durable holdings and financial assets in the 2007 wave of the Survey of Consumer Finances. The optimal parameters are obtained at $r = 0.036$ and $\eta = 0.104$.

The details of the numerical solution procedure are given in the Appendix. As in standard in the literature since Carroll (1992), I normalize the necessary variables by dividing them by the permanent component of income, which reduces the number of endogenous state variables to two, namely the ratio of cash on hand to permanent income and the ratio of the level of durables to permanent income[5].

[5]For simplicity of interpretation and in order to avoid confusion, in my discussion of the results variables are always mentioned in terms of their absolute value and not in terms of ratios with respect to permanent income. Whenever this distinction is necessary, I mention it explicitly.

V.E. Results

V.E.1. Individual investment behavior

Figure 4 shows a set of policy functions across age-education cohorts, conditional on start-of-period holdings of durable goods equal to 25% of the age-education specific permanent income level. Durable consumption is always positive, increasing and concave in cash on hand. At low wealth levels, the agent is constrained in her attempt to choose optimal durable holdings and thus the policy function exhibits substantial nonlinearities around the point at which the constraint is binding. Net holdings of financial assets mirror are decreasing in this region of the state space, since any additional unit of cash on hand amounts to a relaxation of the constraint and thus allows for a higher durable stock, with corresponding higher debt levels. As the level of cash on hand increases, the savings motive dominates and the agents start accumulating positive stocks of financial assets.

Since the income profiles are upwards sloping when agents are young and they attempt at smoothing both consumption and the holdings of durable assets, there is a stronger incentive to borrow early in life for all education groups. This effect is more pronounced for college graduates because they can expect higher income growth and also face less income uncertainty. At the same time, college graduates are more likely to face binding borrowing constraints when young and less so when old.

As households age, they also must prepare for retirement. However, unlike in models of portfolio choice with no durable holdings, one has here two very different ways of doing this, namely either through the accumulation of durables or through

the financial instrument. As has been widely documented in the literature[6], elderly tend to reduce housing equity only later in life, in most instances in the United States only after they reach their early 70s. This issue is well captured by the model, in that as agents approach retirement, they tend to reduce slightly their holdings of financial assets, but tend to only slowly adjust the durable stock.

V.E.2. Aggregate implications of social status concerns

Table 2 displays the model-implied means based on a simulated cross-sectional dataset of 50,000 agents tracked along the life cycle and corresponding to the actual age distribution in the US during 2007.

Since r and η are calibrated to match these moments, model-implied mean holdings of financial assets and mean durable holdings in the population are by construction equal to their data counterparts. In terms of the heterogeneity across education groups, the model performs well, with the durable holdings of less educated agents slightly underestimated and the durable holdings of more educated agents slightly overestimated. For the intermediate group the holdings of net financial assets are overestimated by a substantial amount, which can be attributed to other unobserved sources of heterogeneity.

Table 3 summarizes the role of social status concerns, as captured by the model. First, social status concerns change significantly the allocation of resources among durable goods and financial instruments. In the counter-factual case in which social status concerns are absent, the stock of durable goods would be by between 7 and 17

[6]See e.g. Chiuri and Jappelli (2010) for an extensive review.

percent lower, with the strongest effect accruing to the more educated agents. The consumption gains associated with not caring for social status in terms of durables would, on the other side, be of the order of 5 percent for college graduates and less than 2 percent for agents holding no high-school degree. The effect on the debt-to-income ratio is rather strong: it is 7 percent lower for less educated agents and 25 percent lower for college graduates. Overall, I conclude that, albeit the utility weight on social status is rather small compared to the previous literature, the calibrated model does imply significant first-order effects on aggregate quantities.

As the preference for social status gets stronger, reaching e.g. $\eta = 0.2$, which is double the benchmark case, the reaction of the durable goods level and the debt-to-income ratio are more muted. Albeit, it is interestingly the case that all education cohorts respond more or less by the same degree to this increase in η, unlike above. For college graduates even a small preference for social status seems to induce higher borrowing, while for less educated agents keeping up is more costly and thus they react only when the preference for social status reaches higher levels. College graduates have more resources at their disposal, so they can afford to keep up, while the only way in which poor agents can keep up is through borrowing against the durable good.

In terms of analyzing the life cycle effects of social status, Figure 9 shows that the durable goods purchases are significantly higher during the first period of life when agents care about their relative position, with the thereby implied higher durable level being only slightly adjusted as the agents get older. This is a direct consequence of the durability of the status goods: since agents need to keep up with the social standards throughout their lifetime, the optimal strategy is to buy into durable goods

early in life.

V.E.3. The role of collateral constraints

Table 4 displays the results of relaxing the collateral constraint from a benchmark loan-to-value ratio of $\mu_d = 0.75$ to $\mu_d = 0.95$. The natural effect of a relaxation in borrowing constraints are higher aggregate debt levels and indeed mean net financial assets decrease and the debt-to-income ratio rises across education groups. However, for the present analysis the important effect is the interaction between the concerns for social status and the changes in financial conditions.

First of all, the reaction of net financial assets to the higher loan-to-value ratio is much more pronounced in the economy with social status: for example, note the decrease of 6 percent versus 2 percent for college graduates. Interestingly, however, this effect does not come from relatively higher debt levels, since the response of the debt-to-income ratio is actually slightly lower in the status economy, but from a higher indebtedness ratio. In terms of absolute values, the response of the aggregate variables to the financial shock is indeed magnified by the presence of social status concerns in all respects and most importantly in the case of the debt-to-income ratio. The absolute figures are important also in quantitative terms: the relaxation of the collateral constraint increases the debt-to-income ratio of college graduates by 25 percentage *points* and the debt-to-income ratio of the less educated agents by 17 percentage *points*.

V.E.4. The role of social reference levels

Table 5 contains an overview of relative changes in the debt-to-income ratio under different assumptions for relative changes in the social reference levels. An increase by 50% in the reference levels across education groups is thus shown to induce an increase in the debt-to-income ratio by between 5 and 12 percent. Interestingly, the response to changes in aggregate conditions seems to be heterogeneous across groups and asymetric. First of all, college graduates react strongest and less educated people considerably less. College graduates can afford to keep up with the higher reference levels, while for people with no higschool degree this is more difficult. Second, college graduates respond more to a decrease of the reference level, than to a corresponding proportional increase. For less educated people, however, the contrary is true: they react much stronger to increases in aggregate reference levels than to corresponding decreases. This can be attributed to the fact that for poorer less educated people keeping up is anyway very costly, so increases in reference levels make them much worse off than corresponding decreases.

Figure 11 summarizes the interaction between collateral constraints and increases in aggregate reference levels. The collateral constraints only very marginally influence the response of the aggregate durable level to the reference point: along the life cycle, agents manage their finances optimally to insure they keep up best, while collateral constraints only induce changes in the timing of the decisions along the life cycle and in the consumption-durables trade-off. Indeed, as concerns aggregate consumption, it is apparent that the looser the borrowing constraint, the higher the decrease in response to a higher social status motive.

In Figure 10 the sensitivity of selected variables to aggregate social reference

levels is reported at different values for the depreciation rate. The motive to keep up is shown to be stronger, the more durable the goods. The intuition behind this is mirroring the discussion from the theoretical part. Consequently, also the debt-to-income ratio increases more steeply in response to the social status motive the more durable the goods are - higher debts can be sustained longer if the goods against which one borrows are more durable. Finally, the consumption effect of keeping up is stronger the more non-durable the real assets are. There are two channels at work here. First, a substitution effect: the more durable a good is, the more an agent is willing to forgo consumption in order to buy it and second a wealth effect: a higher durable stock implies lower savings or more borrowing, thus life-time resources decrease.

V.E.5. Status defined over relative consumption

In the context of the same model structure and the same calibration of model parameters, I analyze the effects of defining the social status motive in terms of relative pure consumption[7]. Table 6 summarizes two versions of the model-implied means for this case. The top panel shows these values for the aggregate variables when $r = 0.036$ and $\eta = 0.104$, like in the benchmark case. The results suggest that the effect of concerns about social status in terms of consumption are to increase strongly the level of savings and to reduce the level of durable goods. Compared to

[7]Because the endogenous gridpoints method is not applicable to a case where the value function is non-homogeneous in consumption, the preference for social status is defined hereby as $S(c, C) = (1-\sigma)^{-1}(c^{\theta}/C^{\theta})^{1-\sigma}$, where θ is the utility weight of consumption, c is the individual choice and C is the aggregate reference level. This is a purely technical assumption and does not affect the nature of the results. Reference levels in terms of consumption are calibrated such that they correspond to the same model-implied quantiles like the durable reference levels considered above.

the benchmark case, consumption levels are naturally higher, the interesting issues, however, is that agents support the higher consumption level by a substantial decrease in durables, which allows for higher consumption and higher savings at the same time. In the bottom panel, I recalibrate the model such that the level of asset holdings in the economy matches the one in the 2007 wave of the SCF. The interest rate which insures that this is the case is $r = 0.0104$.

VI. Conclusion

In their attempt to keep up with the social standards defined by the holdings of durable assets in their peer or reference group, households can use collateralized lending to signal social value. However, because in the social status game somebody's advance is always somebody else's regress, this induces negative externalities and can thereby lead the economy as a whole to be more highly indebted. In a calibrated life cycle framework, I show that social status concerns lead to a higher build-up of durable goods during the young period of life and to a magnified response of the aggregate net financial position to changes in collateral requirements.

The role of social externalities for macro-financial dynamics is still relatively underexplored, especially as concerns the interaction between durable holdings, collateral constraints and aggregate indebtedness. The propagation of financial shocks in a world in which the preferences of heterogeneous agents are inter-dependent certainly deserves more attention in the future, also in view of the implications for policy making and financial supervision. When one considers for example the housing stock as an indicator of social positioning, the connection between the housing sector and

the concerns for social status is immediate. Since status-conscious agents are less risk-averse with respect to aggregate sources of risk, this mechanism could explain overinvestment and overborrowing along several dimensions.

Finally, there are important empirical issues still waiting to be tackled in the context of status concerns, the most prominent of them being the identification of the individual reference levels. Economic understanding, as well as policy-oriented institutions would benefit significantly from a clear empirical perspective on how agents react to aggregate developments, i.e. what the point is against which they judge their social standing with respect to peer groups.

Appendix

Parameterization of Expectations

The stochastic components of the model are approximated by using the Gauss-Hermite numerical integration technique. This is characterized by a set of N points $\bar{x}$ and weights ω which deliver an approximation of the integral:

$$\int_{-\infty}^{\infty} g(x)e^{-x^2}dx \approx \sum_{i=1}^{N} \omega_i g(\bar{x}_i)$$

However, when computing expectations of a function $g(x)$ of a normally distributed variable $x \sim N(\mu, \sigma)$, the interest lies in computing an integral of the form:

$$E[g(x)] \equiv \int_{-\infty}^{\infty} \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} g(x)dx$$

By operating an appropriate change of variables, it then holds:

$$E[g(x)] \approx \sum_{i=1}^{N} \frac{1}{\sqrt{\pi}} \omega_i g\left(\sqrt{2}\sigma\bar{x}_i + \mu\right)$$

which is the formula used in Step 1 below, given the N standard Gauss-Hermite nodes $\bar{x}$, weights ω and parameters characterizing the different stochastic processes, summarized in Table 1.

Solution Algorithm

Given life-time sequences for income $\{y_t\}$ and survival probabilities $\{\pi_{t+1|t}\}, \forall t = 0, \ldots, T-1$, the algorithm proceeds recursively starting with period $T-1$, for which we have:

$$x_T = a_T = d_T = 0 \text{ and } c_{T-1} = (1+r_f)a_{T-1} - \Psi(0, d_{T-1}) + y_{T-1} \tag{19}$$

where we define $x_t \equiv (1+r)a_t + (1-\delta)d_t$ to be cash on hand available in period t. In each period $t < T-1$, the algorithm consists of the following steps:

$$x_{t+1} \text{ and } c_{t+1} \xrightarrow{1} d_{t+1} \text{ and } \lambda_t \xrightarrow{2} c_t \xrightarrow{3} a_{t+1} \xrightarrow{4} x_t$$

Step 1 by using the first-order conditions (9) and (10), together with the envelope conditions (11) and (12), we obtain an implicit equation for d_{t+1}:

$$\begin{aligned}
&\beta\pi_{t+1|t}E_t\frac{\partial U(c_{t+1}, d_{t+1})}{\partial c_{t+1}}\left(v_{t+1}(1-\delta) - v_t(1+r) - \frac{\partial\Psi(d_{t+2}, d_{t+1})}{\partial d_{t+1}} - \frac{\partial\Psi(d_{t+1}, d_t)}{\partial d_{t+1}}\right) \\
&+ \beta\pi_{t+1|t}E_t\frac{\partial U(c_{t+1}, d_{t+1})}{\partial d_{t+1}} + \eta\beta\pi_{t+1|t}\frac{\partial S(d_{t+1}, D_{t+1})}{d_{t+1}} = \lambda(1+r)\left(v_t + \frac{\partial\Psi(d_{t+1}, d_t)}{\partial d_{t+1}}\right) \\
&- \lambda\mu_d(1-\delta)E_t v_{t+1}
\end{aligned} \tag{20}$$

Two cases arise: the collateral constraint is either not binding such that $\lambda = 0$ or the constraint is binding, such that:

$$d_{t+1} = \frac{x_{t+1} + \mu_y f(t, Z_t)}{(1-\delta)(v_t - \mu_d E_t v_{t+1})} \tag{21}$$

with equation (20) giving the expression for the Lagrange multiplier.

STEP 2 the first-order condition (9) and the envelope condition (11) define an Euler-type implicit function for c_t:

$$\frac{\partial U(c_t, d_t)}{\partial c_t} = \beta(1+r)\pi_{t+1|t}\frac{\partial U(c_{t+1}, d_{t+1})}{\partial c_{t+1}} \tag{22}$$

STEP 3 the holdings of financial assets are given by the definition of total wealth:

$$a_{t+1} = \frac{x_{t+1} - (1-\delta)d_{t+1}}{1+r} \tag{23}$$

STEP 4 the endogenous grid points are inferred from the period t budget constraint:

$$x_t = a_{t+1} + v_t d_{t+1} + c_t + \Psi(d_{t+1}, d_t) - y_t \tag{24}$$

References

Andrew B Abel. Asset Prices under Habit Formation and Catching Up with the Joneses. *American Economic Review*, 80(2):38–42, May 1990.

Gary S. Becker and Luis Rayo. Peer Comparisons and Consumer Debt. *University of Chicago Law Review*, 73(1):231–248, 2006.

Christopher D. Carroll. The Buffer-Stock Theory of Saving: Some Macroeconomic Evidence. *Brookings Papers on Economic Activity*, 23(2):61–156, 1992.

Christopher D. Carroll and Andrew A. Samwick. The nature of precautionary wealth. *Journal of Monetary Economics*, 40(1):41–71, September 1997.

Maria Chiuri and Tullio Jappelli. Do the elderly reduce housing equity? An international comparison. *Journal of Population Economics*, 23(2):643–663, March 2010.

Joao F. Cocco, Francisco Gomes, and Pascal Maenhout. Consumption and Portfolio Choice over the Life Cycle. *Review of Financial Studies*, 18(2):491–533, 2005.

Harold L Cole, George J Mailath, and Andrew Postlewaite. Social Norms, Savings Behavior, and Growth. *Journal of Political Economy*, 100(6):1092–1125, December 1992.

Harold L. Cole, George J. Mailath, and Andrew Postlewaite. Investment and Concern for Relative Position. *Review of Economic Design*, 6:241–261, 2001.

Antonia Díaz and María José Luengo-Prado. The Wealth Distribution With Durable Goods. *International Economic Review*, 51(1):143–170, 02 2010.

Peter M. DeMarzo, Ron Kaniel, and Ilan Kremer. Relative Wealth Concerns and Financial Bubbles. *Review of Financial Studies*, 21(1):19–50, January 2008.

Bill Dupor and Wen-Fang Liu. Jealousy and Equilibrium Overconsumption. *American Economic Review*, 93(1):423–428, March 2003.

Karen E. Dynan and Enrichetta Ravina. Increasing Income Inequality, External Habits, and Self-Reported Happiness. *American Economic Review*, 97(2):226–231, May 2007.

Richard A. Easterlin. Will raising the incomes of all increase the happiness of all? *Journal of Economic Behavior & Organization*, 27(1):35–47, June 1995.

Jesus Fernández-Villaverde and Dirk Krueger. Vintage Article: Consumption and Saving Over the Life Cycle: How Important are Consumer Durables? *Macroeconomic Dynamics*, 15(5), 2011.

Jordi Gali. Keeping Up with the Joneses: Consumption Externalities, Portfolio Choice, and Asset Prices. *Journal of Money, Credit and Banking*, 26(1):1–8, February 1994.

Pierre-Olivier Gourinchas and Jonathan A. Parker. Consumption Over the Life Cycle. *Econometrica*, 70(1):47–89, January 2002.

Thomas Hintermaier and Winfried Koeniger. The method of endogenous gridpoints with occasionally binding constraints among endogenous variables. *Journal of Economic Dynamics and Control*, 34(10):2074–2088, October 2010.

Arthur B. Kennickell. Wealth and Income in the U.S., 1989 to 2007. Technical report, The Federal Reserve Board, 2009.

Peter Kuhn, Peter Kooreman, Adriaan Soetevent, and Arie Kapteyn. The Effects of Lottery Prizes on Winners and Their Neighbors: Evidence from the Dutch Postcode Lottery. *American Economic Review*, 101(5):2226–47, August 2011.

Michael Kumhof and Romain Ranciere. Inequality, Leverage and Crises. IMF Working Papers 10/268, International Monetary Fund, November 2010.

Lars Ljungqvist and Harald Uhlig. Tax Policy and Aggregate Demand Management under Catching Up with the Joneses. *American Economic Review*, 90(3):356–366, June 2000.

Erzo F. P. Luttmer. Neighbors as Negatives: Relative Earnings and Well-Being. *The Quarterly Journal of Economics*, 120(3):963–1002, August 2005.

Arthur C. Pigou. Some Remarks on Utility. *The Economic Journal*, 13(49):58–68, 1903.

Nikolai Roussanov. Diversification and Its Discontents: Idiosyncratic and Entrepreneurial Risk in the Quest for Social Status. *Journal of Finance*, 65(5): 1755–1788, October 2010.

Sara Solnick and David Hemenway. Is more always better?: A survey on positional concerns. *Journal of Economic Behavior & Organization*, 37(3):373–383, November 1998.

Sara J. Solnick and David Hemenway. Are Positional Concerns Stronger in Some Domains than in Others? *American Economic Review*, 95(2):147–151, May 2005.

SSA. Period Life Table. Technical report, Social Security Administration, 2007.

Kjetil Storesletten, Christopher I. Telmer, and Amir Yaron. Consumption and risk sharing over the life cycle. *Journal of Monetary Economics*, 51(3):609–633, April 2004.

Tom Truyts. Social Status In Economic Theory. *Journal of Economic Surveys*, 24 (1):137–169, 02 2010.

Thorsten Veblen. *The Theory of the Leisure Class: An Economic Study of Institutions*. Penguin, New York, 1899.

Annette Vissing-Jorgensen. Consumer Credit: Learning Your Customer's Default Risk from What (S)he Buys. Technical report, Northwestern University, 2011.

Max Weber. *Essays in Sociology*. New York: Oxford University, 1946.

Rainer Winkelmann. Conspicuous Consumption and Satisfaction. Technical report, University of Zurich, 2011.

Table 1
Benchmark calibration of model parameters

Market arrangements			
Depreciation rate of durable goods	δ :	0.02	Hintermaier and Koeniger (2010)
Share of durable goods in utility	θ :	0.19	Krueger and Villaverde (2011)
Debt-to-income ratio for unsecured debt	μ_y :	0.30	SCF (2007)
Loan-to-value ratio for secured debt	μ_d :	0.75	Diaz and Luengo-Prado (2010)
Nominal interest rate	r :	0.03	
Adjustment costs for durable goods	α :	0.05	Diaz and Luengo-Prado (2010)

Table 2
Benchmark model-implied variable means

	No highschool degree	Highschool degree	College degree	Total population
		Data		
Net financial assets:	0.053	0.206	2.891	1.620
Durable goods:	1.629	2.423	5.415	3.920
		Model		
Permanent income:	0.419	0.653	1.359	1.000
Net financial assets:	0.051	0.513	2.693	1.620
Durable goods:	1.470	2.299	5.527	3.920
Net worth:	1.953	3.504	9.722	6.633
Consumption:	0.367	0.566	1.146	0.850
Debt-to-income ratio:	1.008	0.985	1.149	1.076

Note: Model statistics stem from stochastic simulations of 50000 agents over the life cycle.

Table 3
Effects of social status

	$\eta = 0$	$\eta = 0.05$	$\eta = 0.15$	$\eta = 0.2$
		No Highschool degree		
Net financial assets	2.406	1.679	0.448	-0.090
Durable goods	0.931	0.967	1.026	1.052
Consumption	1.016	1.007	0.994	0.988
Debt-to-income ratio	0.929	0.975	1.031	1.055
		Highschool degree		
Net financial assets	1.236	1.112	0.914	0.832
Durable goods	0.927	0.968	1.024	1.047
Consumption	1.017	1.008	0.994	0.989
Debt-to-income ratio	0.895	0.956	1.022	1.044
		College degree		
Net financial assets	1.239	1.100	0.934	0.876
Durable goods	0.830	0.937	1.042	1.078
Consumption	1.046	1.018	0.988	0.978
Debt-to-income ratio	0.754	0.938	1.031	1.059

Note: The numbers correspond to relative values versus the benchmark case.

Table 4
Effects of an increase in the loan-to-value ratio to $\mu_d = 0.95$.

	Status			**No status**		
	No highschool degree	Highschool degree	College degree	No highschool degree	Highschool degree	College degree
			Absolute values			
Net financial assets:	-0.006	0.473	2.542	0.074	0.604	3.266
Debt-to-income ratio:	1.178	1.117	1.414	1.098	1.005	1.085
Indebtedness ratio:	0.494	0.360	0.297	0.463	0.336	0.260
			Relative values versus benchmark			
Net financial assets:	-0.116	0.920	0.943	0.600	0.952	0.980
Debt-to-income ratio:	1.170	1.133	1.224	1.171	1.140	1.245
Indebtedness ratio:	1.028	1.011	1.030	1.027	1.003	1.010
			Absolute changes versus benchmark			
Net financial assets:	-0.057	-0.041	-0.154	-0.049	-0.030	-0.073
Debt-to-income ratio:	0.172	0.131	0.259	0.160	0.124	0.213
Indebtedness ratio:	0.013	0.004	0.009	0.012	0.001	0.003

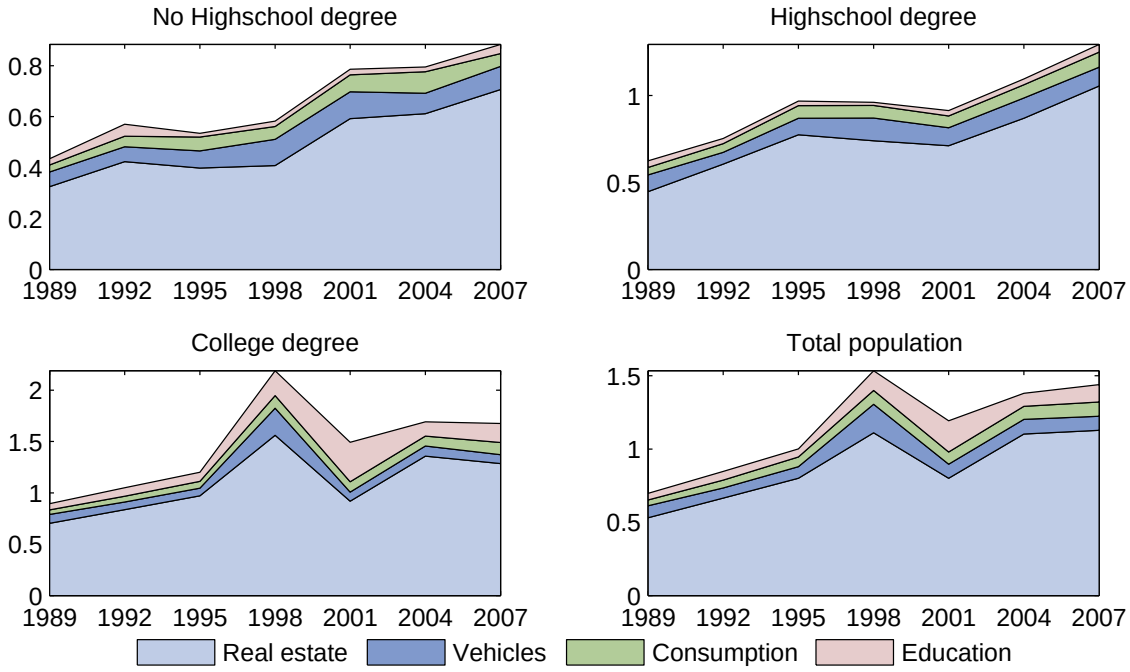
Table 5
Effects of an increase in social reference levels

Reference level index	Debt-to-income ratio relative to benchmark		
	No highschool degree	Highschool degree	College degree
0.5	0.963	0.930	0.853
0.8	0.983	0.963	0.927
1.3	1.033	1.058	1.072
1.5	1.051	1.092	1.117
2.0	1.097	1.176	1.208
2.5	1.142	1.258	1.283
3.5	1.226	1.425	1.419

Table 6
Model-implied variable means under status from consumption

	No highschool degree	Highschool degree	College degree	Total population
		Benchmark		
Financial assets	0.489	1.386	5.100	3.259
Durable goods	1.383	2.138	4.583	3.348
Net wealth	2.326	4.254	11.269	7.759
Consumption	0.377	0.583	1.213	0.893
		Recalibration		
Financial assets	-0.502	0.427	2.883	1.620
Durable goods	2.081	3.181	6.596	4.866
Net wealth	1.999	4.286	10.909	7.533
Consumption	0.347	0.520	1.042	0.777

Figure 1
EVOLUTION OF DEBT-TO-INCOME RATIO

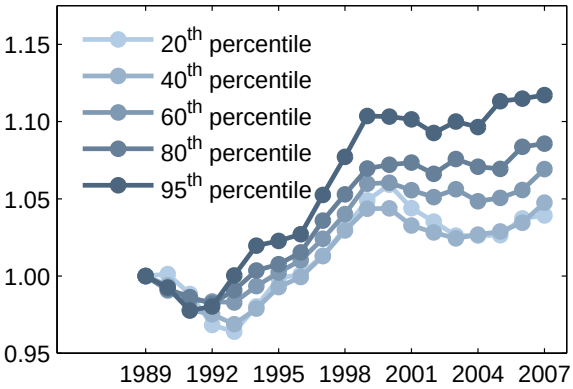


Source: Survey of Consumer Finances

Figure 2
EVOLUTION OF CROSS-SECTIONAL VARIABLES

Income inequality

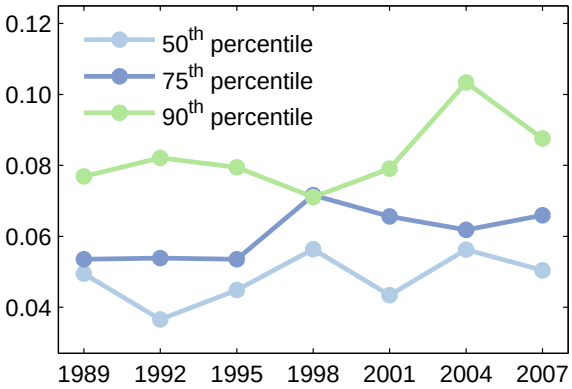
Evolution of real income quantiles



Source: U.S. Census Bureau (2007)

Financial fragility

Share of agents with late payments across debt-to-income quantiles

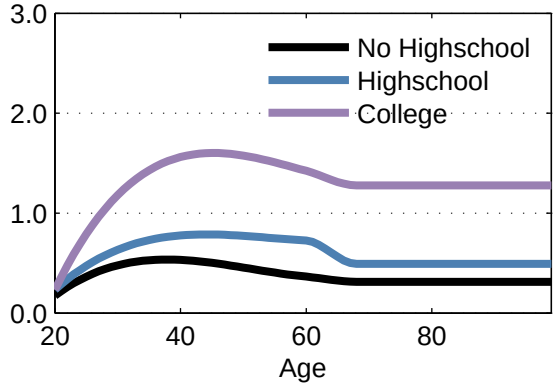


Source: Survey of Consumer Finances

Figure 3
BENCHMARK CALIBRATION OF LIFE CYCLE MODEL COMPONENTS

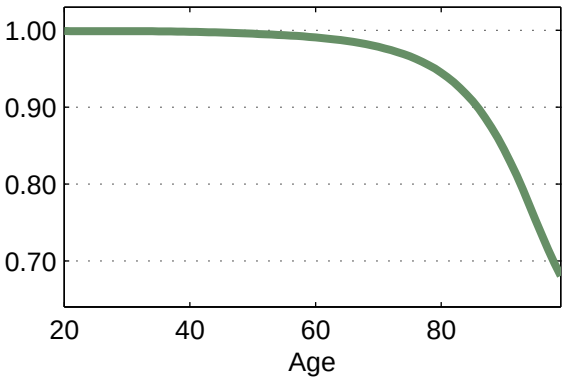
Deterministic income profiles

$f(t, Z)$



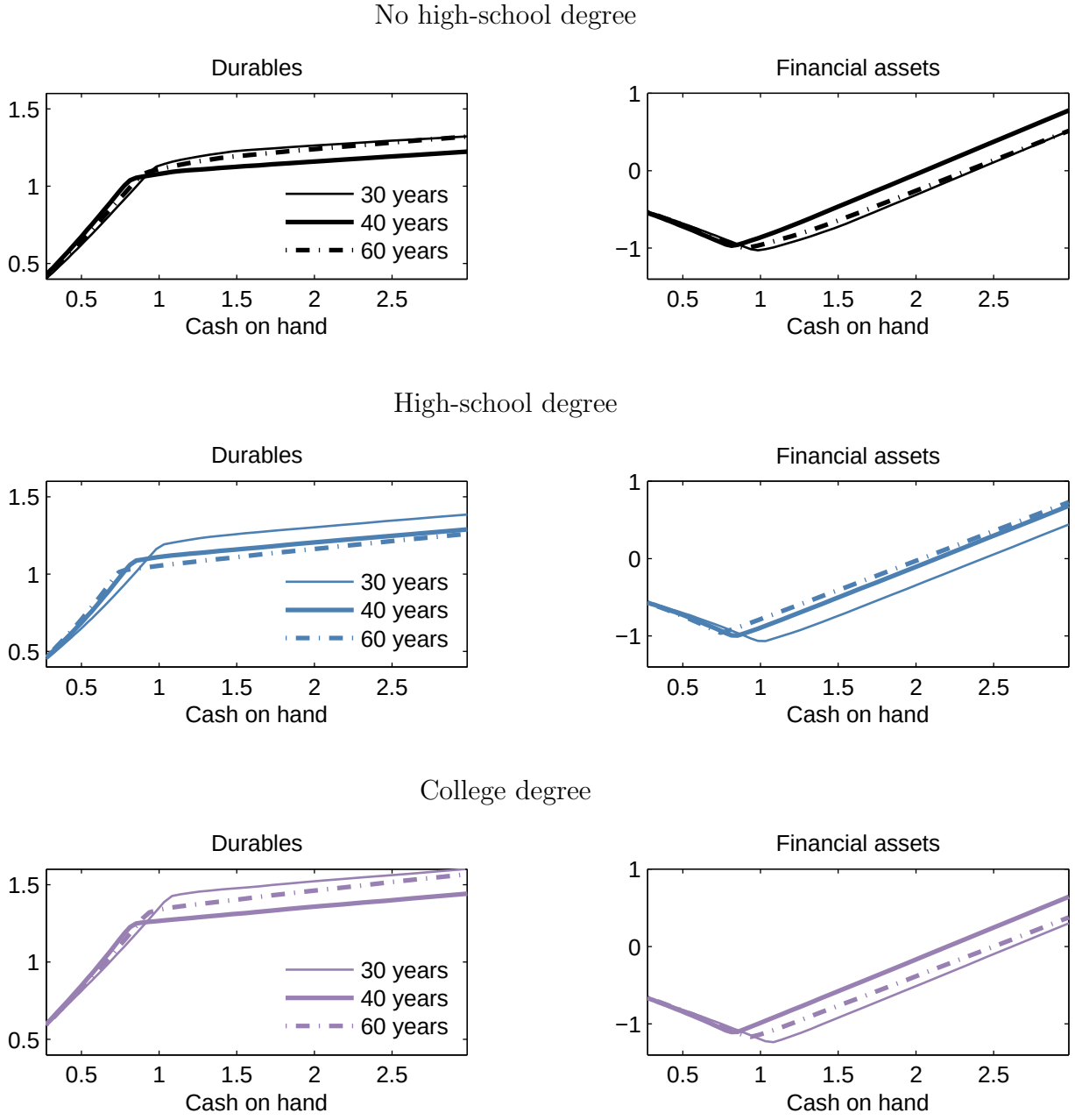
Conditional survival probabilities

$\pi_{t+1|t}$



Note: The income profiles correspond to fitted 3rd order polynomials, taken from Cocco et al. (2005) and normalized by the average mean income in a population corresponding to the 2007 wave of the Survey of Consumer Finances. Since retirement occurs deterministically at age 65, this implies a one-off drop in permanent income, which creates numerical algorithm problems. In order to correct for this discrete jump, the profiles are smoothed through cubic interpolation between the ages 62 and 68. The source of the survival probabilities is the 2007 release of the SSA Life Tables.

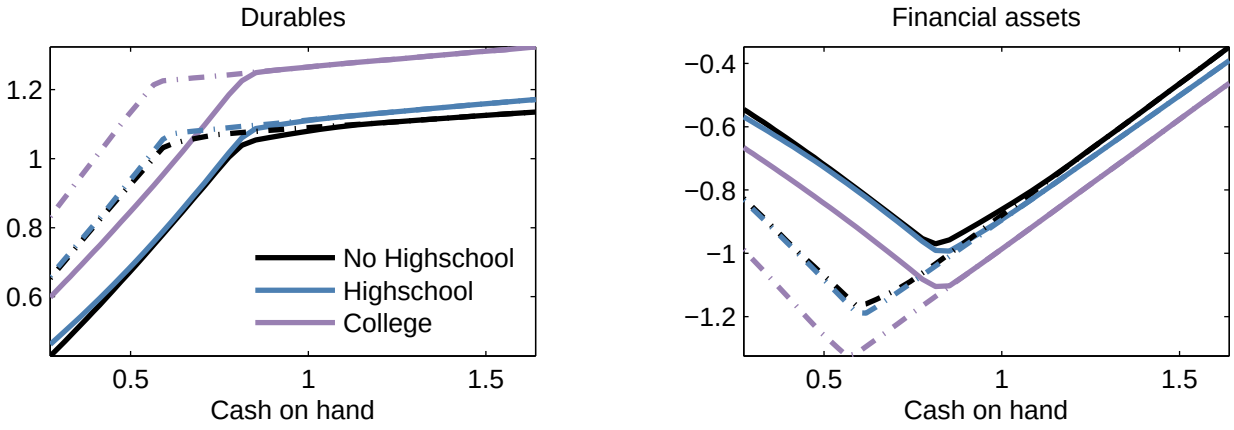
Figure 4
POLICY FUNCTIONS ACROSS AGE-EDUCATION COHORTS



Note: the policy functions are plotted conditional on a durable level of 25% of permanent income.

Figure 5

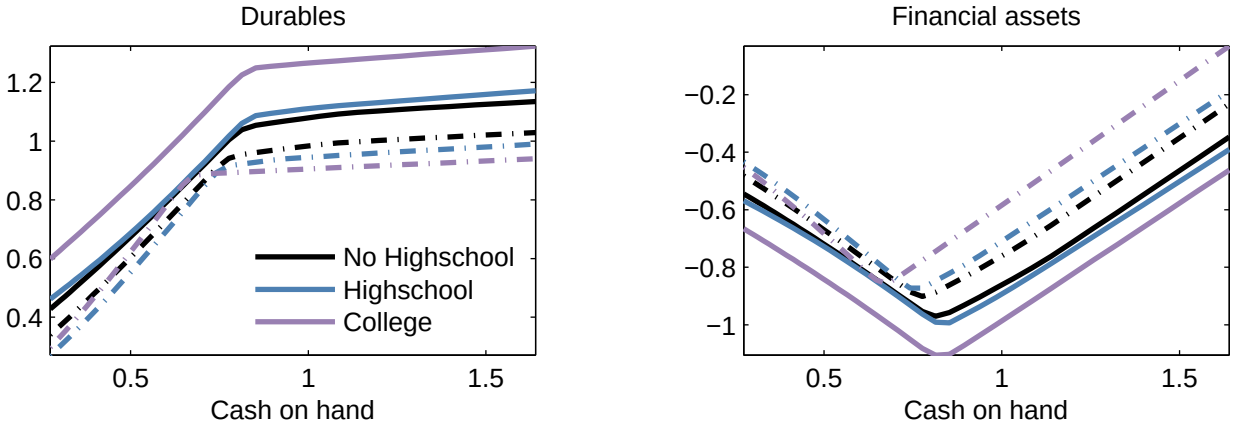
Policy functions under alternative collateral regimes



Note: the dotted line corresponds to the case $\mu_d = 0.95$, i.e. an exogenous increase in the loan-to-value ratio. Policy functions are plotted for an agent of age 40, conditional on a durable level of 25% of permanent income.

Figure 6

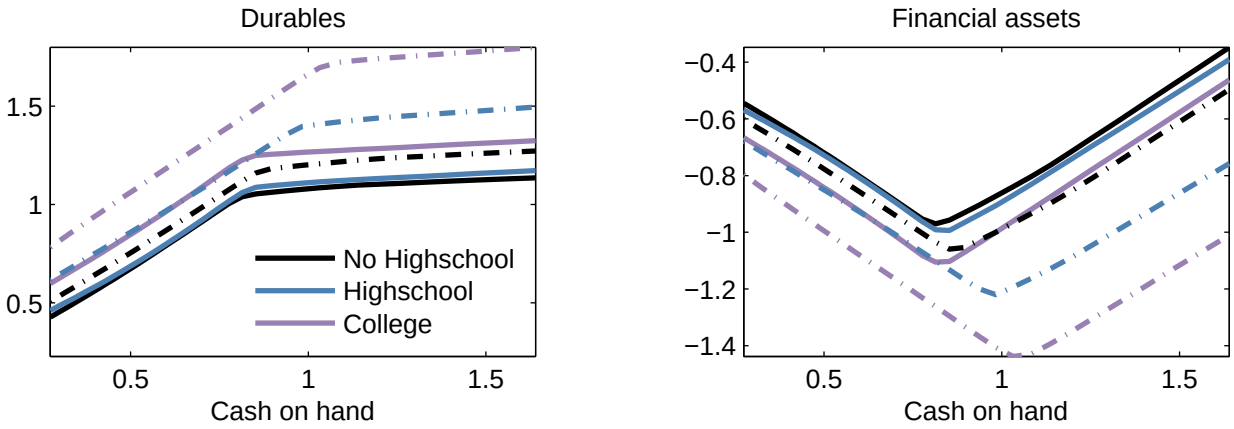
Policy functions under alternative degrees of social status concerns



Note: the dotted line corresponds to the case $\eta = 0$, i.e. no utility weight on social status.

Figure 7

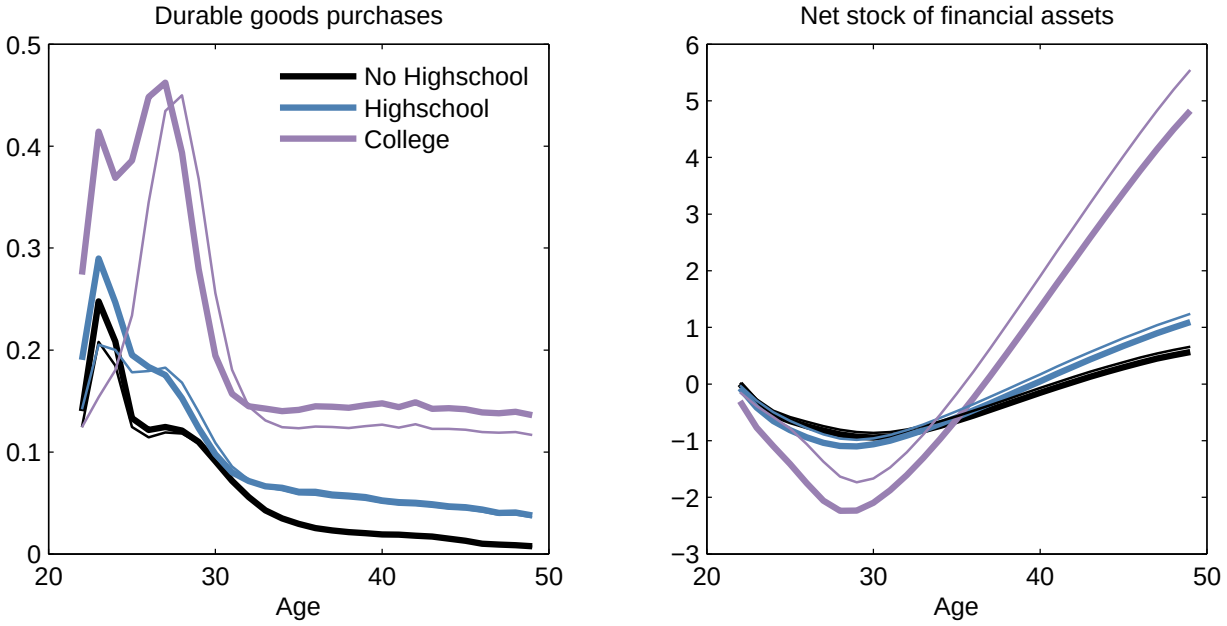
POLICY FUNCTIONS UNDER ALTERNATIVE SOCIAL REFERENCE LEVELS



Note: the dotted line corresponds to an increase of the durable reference levels by a factor of 2.0.

Figure 8

LIFE CYCLE EFFECTS OF THE QUEST FOR SOCIAL STATUS



Note: the thin line corresponds to the case $\eta = 0$, i.e. no utility weight on social status.

Figure 9

SENSITIVITY TO FINANCIAL CONDITIONS: THE ROLE OF SOCIAL STATUS

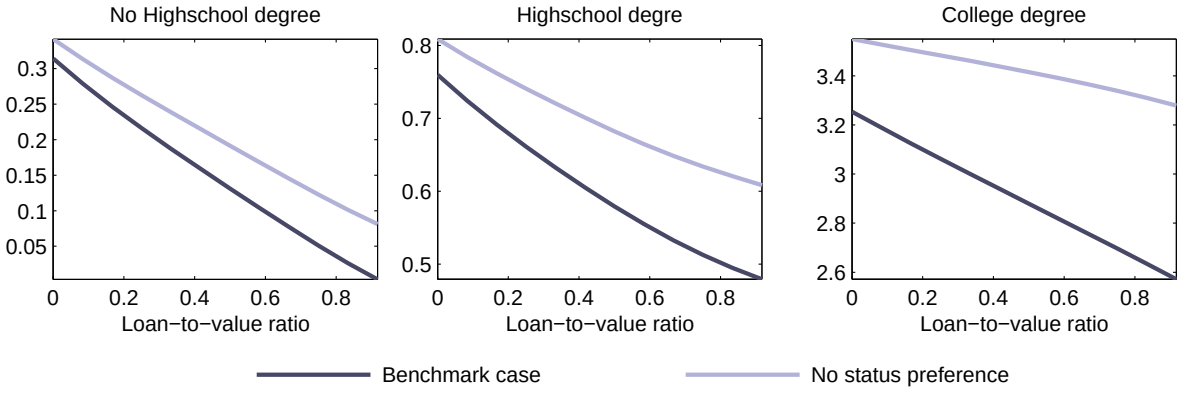


Figure 10

SENSITIVITY TO SOCIAL REFERENCE LEVELS: THE EFFECT OF THE DEPRECIATION RATE

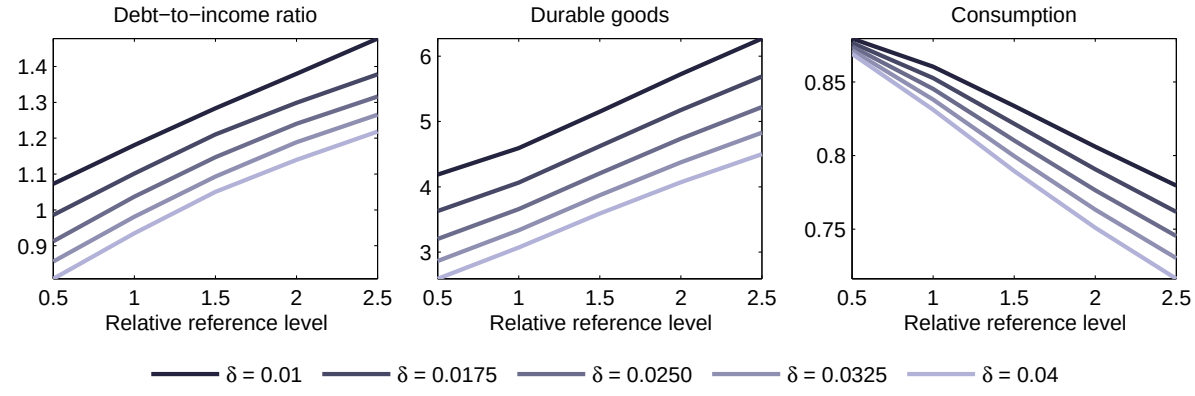


Figure 11

Sensitivity to social reference levels: the effect of collateral constraints