Disability in Retirement, Home Production, and Informal Insurance Between Spouses [†]

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Abstract

How does the potential informal insurance from a spouse - i.e. the fact that a healthy spouse might "take care" of a disabled one - impact the life-cycle decisions of the elderly? In other words, is this insurance strong enough to affect their dissavings behaviours? To answer this question, I build a life-cycle model of retired households in which couples are modelled explicitly and in which the above informal insurance channel is introduced through the presence of home production. Quantitatively, the model replicates the main patterns of savings and informal insurance observed in the data. Shutting down this informal insurance has only a minor influence on the wealth patterns of retired couples, casting doubt on the idea that it provides a strong protection against disability-related expenditures in old age. The positive correlation of disability risk between partners and the high risk of being widowed while disabled are key to this result.

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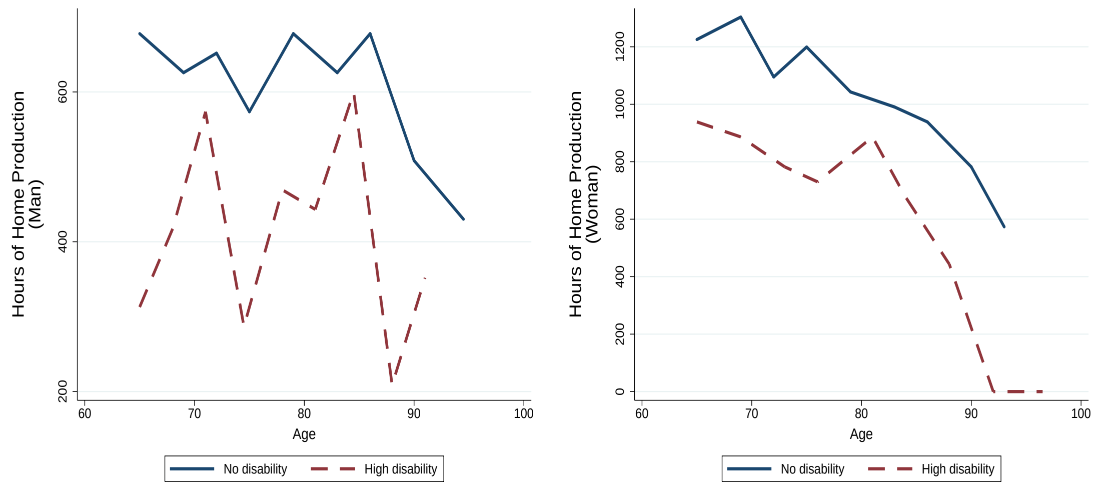

Figure 1: Hours of home production as a function of age and disability

Introduction

Retired individuals face a significant risk of becoming disabled as they age. This usually translates in higher spending on home care or nursing homes. For couples, an alternative for higher spending exists if one of the partners becomes disabled. Indeed, a healthy spouse can, in principle, "take care" of a sick spouse. While such an insurance mechanism has been well documented in different fields, little (if any) is known on its impact on savings behaviours. This is however crucial to assess whether the strength of this informal insurance mechanism is strong or not. Indeed, if strong, shutting it down should lead to substantially lower dissavings when both members of a couple are healthy and to higher dissavings when one of them is disabled. Said differently, removing this insurance should lead to much more precautious dissavings behaviours. This paper tries to understand whether this is the case or not.

To tackle this question, we need three elements: (i) a measure of the needs when disabled, (ii) which can allow for intertemporal comparisons, and (iii) for which we observe an insurance-like channel within couples. A good candidate, satisfying these three conditions, is home production.

First, as someone faces disability he or she is likely to have more difficulty performing home production tasks. Following Becker (1965), to maintain effective consumption, a household experiencing a fall in home production hours should spend more on goods and services which can substitute for them. Hence, the extent of the fall in hours of home production can inform on how much more would need to be spent to maintain a given level of consumption. Figure 1, which plots hours of home production of men and women as a function of disability and age, confirms these intuitions. Disability generates a large reduction in home production hours: for instance, healthy retired women up to 80 years-old spend about 1,100 hours annually (at the median) on home production, and this number falls to less than 200 for highly disabled women around 90 years-old[1]. The timing of the fall in home production

[1]All the data are from the US and are from the Health and Retirement Study (HRS) and the Consumption and Activities Mail Survey(CAMS).

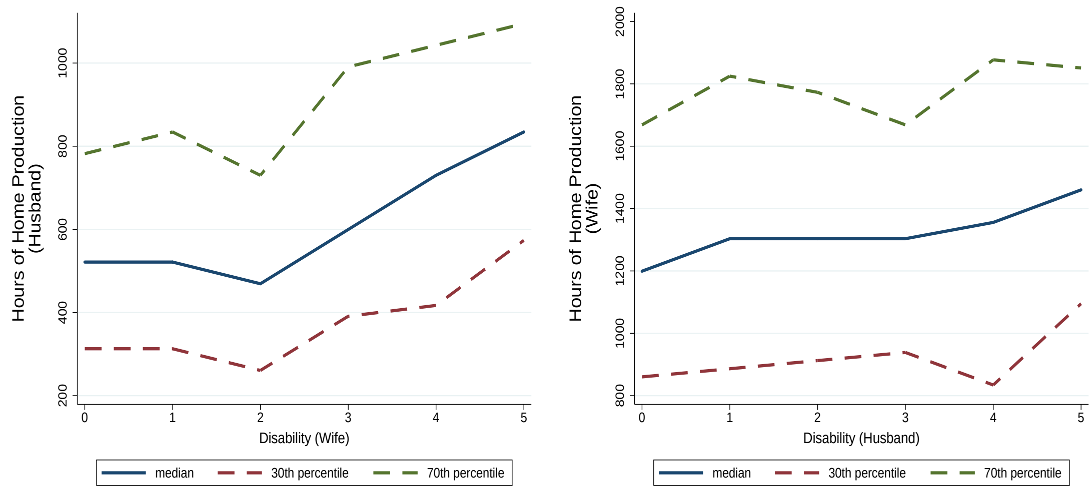

Figure 2: Hours of home production as a function of disability of the spouse

hours (in particular for women at older ages) is about the same as the large rise in out-of-pocket medical expenditures (in great part due to long-term care expenditures) documented in De Nardi et al. (2010). Moreover, home production, being done in a similar way across time can *a priori* be used for intertemporal comparisons.

Finally, and in particular for households not receiving help from the family and without a long-term care insurance (LTCI), we observe insurance-like mechanisms within couples as shown in figure 2. Indeed, we clearly see that men increase their hours of home production as their wives get disabled. A similar pattern is observed for women. Once again, the magnitude of these variations is large with men increasing hours of home production by about 250 hours, or about 45%, at the median when their wives go from no disability to high disability.

However, to understand if the above mechanism provides a strong insurance against old age contingencies, it is not sufficient to look only at the static picture. Indeed, its provision might be uncertain as disability can occur at the same time for both spouses or can occur when one of the spouses have died. A natural way to assess the importance of this insurance channel is then to look at how it affects savings behaviours, as it should act as a substitute for disability-related spendings.

To do so, I build a rich structural life-cycle model augmented with home production in which couples are modelled explicitly. Individuals (and hence, households) face longevity, disability, and medical expenditure risks. In particular, the model includes a correlation of disability risk between partners and a risk of widowhood similar to those in the data, which is crucial to assess the strength of the informal insurance within couples. The model is matched to the data using a method of simulated moments. Quantitatively, it replicates well the patterns for home production hours and wealth observed in the data. Importantly, it generates the same sort of informal insurance observed in figure 2.

It is then used to perform counterfactual experiments. First of all, I show that disability, through its effect on home production, has a large impact on wealth patterns in the model, meaning that this latter attributes a substantial share of dissavings behaviours to the dynamics of home production.

Given this observation, and the fact that the informal insurance within the couple is well reproduced, we would expect this latter to have a large influence of wealth patterns of couples. However, this is not the case. When shutting down this channel, we do find that the intratemporal gains stemming from it are sizeable. However, its provision is so uncertain that dissavings behaviours barely change. Hence, this informal insurance channel does not seem very strong in the sense that it does not alter substantially the needs for precautionary savings of the elderly.

This paper contributes to the life-cycle literature in retirement by introducing a new informal insurance mechanism and by studying how couple households might differ from single households. The life-cycle literature in retirement has so far mainly concentrated on singles as in De Nardi et al. (2010). While some papers do study couples, they usually model them in a very simple manner, for instance through the presence of economies of scale as in Nakajima and Telyukova (2014). While informal insurance might stem from children as in Barczyk and Kredler (2014) or Dobrescu (2015), the informal insurance within the couple has so far been understudied. As we clearly observe insurance-like mechanisms within retired couples, it is of importance to understand if they affect wealth decumulation patterns as it can have further implications for insurance designs and the trade-offs linked to the reforms of the entitlements of the elderly.

The paper is divided in seven sections. First, I discuss the choice of home production in more details and why it is adapted for the purpose of this paper. In the same section, I also discuss the existing literature. As the paper is at the crossroads of many different fields, it is not meant to be exhaustive. It should however give the interested reader a view of some of the main developments which occurred in the related fields and how my work extends the current research. In a second section, I present the intratemporal part of the model. It encompasses some of the main intuitions of the paper. It is a collective model[2] with home production in which the ability to do home production is affected by health condition and age. The third part discusses the database and documents the main empirical patterns regarding home production, linking them to the theoretical model. The fourth section presents the intertemporal part of the model in which households make optimal decisions regarding expenditures and savings, taking into account different sources of risk. The fifth section discusses the estimation. The sixth part presents the outcome of the model and the results from the counterfactual experiments. The last part concludes.

1 Preliminary Discussion

1.1 Why home production

Time spent on home production activities (TSHPA, thereafter) serves two purposes in this work. First of all, it is used as a measure of the needs for higher spending of the elderly. Second, it measures the extent of the informal insurance within the couple.

An issue which needs to be discussed concerns the activities which must be included in home production for the present analysis. Given the life-cycle dimension of the problem under hand, the chosen time measure needs to allow for *intertemporal* comparisons. First of all, I discuss the activities

[2] Though, for the estimation of the structural model, I consider the special unitary case of the collective framework.

included in home production in this paper and show that they arguably allow for these types of comparisons. I then discuss other activities for which time is not well adapted for such comparisons.

As the main measure of TSHPA, I use the sum of time spent on: (i) house cleaning, (ii) washing, ironing, or mending clothes, (iii) yard work or gardening, (iv) shopping or running errands and (v) preparing meals and cleaning-up afterwards. First, let's start by the way the questions are asked in the CAMS. They are all asked in a similar way. For activity (v) it is: "How many hours did you spend last week preparing meals and cleaning up afterwards?".

Consider the case of a single individual healthy in t and disabled in $t+1$ and the activity cooking. The hours h_t done cooking in t are *a priori* comparable to the hours h_{t+1} done cooking in $t+1$. Indeed, cooking done in t is done in a similar manner than cooking done in $t+1$. Cooking a steak when disabled or healthy has no reason to be much different. Thus, intertemporal comparisons do seem possible using this measure. For a couple, the reasoning is similar with an additional requirement: time declared by a given spouse for an activity must reflect her or his effort on this activity. Even, if spouses do cook together, usually each one does a specific task. For instance, the wife might take care of cooking the vegetables, while the husband might cook the meat, or the reverse. If the wife is now disabled and the husband needs to do both activities, we can clearly state that the effort done by the husband on cooking is now higher if his health has not changed. Hence, for the husband, we can compare his effort cooking in t to his effort cooking in $t+1$. Moreover, for the wife, we can link the reduction of the time she spends cooking to a higher effort for a given amount of time spent on this activity (due to the occurrence of disability). Such a logic can easily be applied to activities (i) to (v) as well.

Now let's consider a set of activities which are not considered but which might be associated to the insurance channel studied here: personal grooming and hygiene, such as bathing and dressing. In this case, the CAMS question is similar to the one above: "How many hours did you spend last week [on] personal grooming and hygiene, such as bathing and dressing?". An issue with those activities is that the body of the person helped is an input in the production function. Hence, if the person is helped, even though she or he reduces her or his input in the production function, she or he might not reduce the time spent doing this activity. So, time is not well suited for intertemporal comparisons here, as it does not measure the effort done by a specific person. Hence, the choice not to consider those activities. The above concern is confirmed by regression analysis. Indeed, if we regress time spent on personal grooming on disability, we do not find any evidence of a reduction in time as the level of disability increases.

It should also be noticed that the activities I consider represent a substantial amount of time. In my sample, women spend on average 1,120 hours on home production annually. The median is a bit lower at 991 hours annually. As a matter of comparison, the average of the hours actually worked by a US worker was of 1,799 in 2005 according to the OECD. For men, the figures for home production are lower with a median of 574 hours and a mean of 729 hours. Hence, for men the median represents about 32% of the average time spent working by a US worker. For women, this figure is 55%. I also computed the ratio of time spent on home production over the sum of time spent on home production and time spent on personal grooming and hygiene. For women, the mean of this ratio is 69%, the median is 75% and the 25th percentile is 64%. For men, these numbers are respectively 63%, 69% and 54%. So, for a large majority of retirees, time spent on home production is higher than time spent on personal grooming.

Finally, home production is interesting to study as it is usually not covered by Medicare and thus not well insured by public programs. Indeed, according to the brochure entitled "Medicare and Home Health Care", it is said that Medicare usually covers only skilled nursing care. It is defined as follow: "Any service that could be done safely without a non-medical person (or by yourself) without the supervision of a nurse, isn't skilled nursing care". Moreover, it is explicitly written that 24-hour-a-day care at home, meals delivered at home, homemaker services (shopping, cleaning...) and personal care (dressing or bathing) are usually not covered.

Overall, the fact that the chosen measure of home production allows for intertemporal comparisons of the efforts of individuals and represents a high share of time makes it a good candidate for tackling the questions of interest here. This latter elements backs up the implicit assumption that home production reflects the extent of the overall (non purely medical) needs of the elderly and can measure the extent of the informal insurance within the couple.

In the next subsection, I summarize the related literature.

1.2 Literature Review

The present paper is at the crossroads of several and mostly separate literatures. First of all, several studies have shown that home production, as introduced by Becker (1965), is an important part of consumption. For instance, home production seems to have resolved the so-called retirement consumption puzzle. In particular, Aguiar and Hurst (2005) have shown that the decline in food expenditures upon retirement was met by an increase in time spent cooking. Moreover, they have shown, using detailed food diaries, that actual food consumption did not show any decline despite the fall in spending on this category. Hurd and Rohwedder (2008) reached similar conclusions using the same data I use. Aguiar and Hurst (2007) also showed that data on shopping time and prices imply that the log difference between the opportunity cost of time of a household aged 65-74 and one aged 40-44 is of around -0.25. Moreover, using these results and data on time spent on home production they find an elasticity of substitution between home production and expenditures of 1.8. Stancanelli and Soest (2012) showed also that home production was increasing at retirement for both men and women using French data. Their paper concentrates mostly on couples and they show that retirement of the wife tends also to decrease hours of home production done by the husband. Bonsang and van Soest (2014) find comparable results using German panel data. Finally, in the tradition of the large literature trying to explain life-cycle patterns of expenditures, Aguiar and Hurst (2013) show that most of the differences in expenditure patterns as a function of age are due to categories which are input to market work or amenable to home production. They also show that including home production in a life-cycle model leads to a level of uninsurable permanent income risk which is line with the data, a feature that previous models had difficulty to match. To my knowledge, no recent work in the economics literature has attempted to understand the consequences of the dramatic fall in home production hours shown in the introduction in parallel with the dynamics that are observed inside couples.

The second literature this paper is related to is the extremely large literature on the provision of informal care and its complementarity or substitutability with formal care. Most of this literature has focused on the provision of care from adult children to their elderly parents. Bonsang (2009) - using data from the Survey of Health, Ageing and Retirement in Europe (SHARE) - finds that informal care from children tends to substitute for formal care at relatively low levels of disability but that this substitutability tends to vanish as disability increases. Bolin et al. (2008) find somehow comparable results. They find that formal and informal care are substitutes while informal care is complement to doctor and hospital visits. Van Houtven and Norton (2004) using data from the HRS and AHEAD find that informal care by adult children reduces home health care use and delays nursing home entry. Lo Sasso and Johnson (2002) using AHEAD data find that help from children reduces the probability of nursing home use. Johnson and Lo Sasso (2006) found that women who spent time helping their parents cut back their paid work hours by about 367 hours annually which lead on average to foregone wages of $7,000 per year in 1998 dollars. Pezzin et al. (1996) found limited substitutability between formal and informal care. Overall, some of these papers seem to indicate a certain degree of substitutability between formal and informal care, with substitutability tending to be more limited at higher levels of disability. The results in the present paper are globally in line with those results.

The provision of care can also stem from other relatives (other than children) like friends or neighbours as show in Kalwij et al. (2012). Also, a strand of the literature has attempted to understand the reason behind time and money transfers between children and parents. Contrary to the idea that care stems from altruism (as in Becker, 1974), several studies point to exchange motives behind such transfers (see Bernheim et al., 1985 and Cox, 1987). A detailed review of the literature on the subject can be found in Alessie et al. (2014) which show results in line with the exchange motive. Thus, this strand of the literature suggests that informal care from children might not be free of costs for the elderly parents.

To my knowledge, only two recent papers about retirement have attempted to introduce informal types of arrangements within dynamic life-cycle models. Barczyk and Kredler (2014) build a dynamic framework where the provision of care from children to their elderly parent is the result of complex dynamics which can stem from altruistic reasons or exchange motives. This setting allows to study long-term care policy taking into account the endogenous reaction of care. In particular, they find that formal-care subsidy can be financed at almost zero cost to taxpayers, mainly because there is an effect on the labour force which increases tax revenues. My work differs from theirs in three ways. First, I focus on spousal insurance. Second, the framework I use is collaborative in the sense that households make Pareto efficient choices. Third, I do not consider the help stemming from children. The second difference is linked to the fact that the Pareto efficient setting is more plausible in an intrahousehold setting than it is in their framework where informal mechanisms are between different households. The third difference is mainly done for simplicity and in the paper I try as much as possible to consider households which do not benefit from the help of their children. I believe, however, that considering both intrahousehold and interhousehold mechanisms of informal care might be a fruitful extension of the existing research. Dobrescu (2015) also allows for informal insurance within a dynamic life-cycle model. In her framework, households can self-insure or use insurance contracts. There are two types of insurance contracts: formal and informal. The latter depend on social ties and bequeathable wealth. In particular, she is able to allow for differing social ties using the cross-country differences from SHARE.

The present paper is also related to the work by Kotlikoff and Spivak (1981) in which they show that the family by pooling income and mortality risk can substitute for annuities. The key difference between my paper and theirs is that I am interested in the insurance role of spouses regarding disability. This interest stems from the fact that previous works such as Palumbo (1999) and De Nardi et al. (2010) have highlighted that medical risk, and mostly long-term care risk, is one of the main, if not the main, reasons behind savings behaviours in old age. Given that the presence of a spouse might substitute partly for long-term care expenditures, it is arguably of interest to study such spousal insurance and its influence of savings behaviours. Moreover, the insurance channel described here is different and stems from a channel of labour supply[3]. Lakdawalla and Philipson (2002) are in many ways related to the paper here. In particular, they argue that the reduction of the gap between the longevity of men and women may reduce the needs for long-term care. The model here is, in a way, richer and its quantitative component can assess the importance of spousal insurance on savings behaviours. Finally, Goda et al. (2013) show that out-of-pocket medical spending, mainly from nursing home stays, are increasing upon widowhood.

On top of the works by Palumbo (1999) and De Nardi et al. (2010), the life-cycle literature in retirement has experienced several interesting developments. For instance, Nakajima and Telyukova (2012, 2014) study the importance of housing in explaining observed savings behaviours. Ameriks et al. (2011) and Lockwood (2013) look more closely at the importance of bequest motives. Early attempts to empirically assess the importance of bequest motives can be found in Hurd (1987, 1989). His results are in contrast to some more recent work such as the one in Kopczuk and Lupton (2007). A key innovation in Ameriks et al. (2011) is to use survey data to discriminate between bequest motives and public care aversion. They find that the latter decreases substantially the demand for life annuities. Lockwood (2013) argues that the low dissavings rate of retired households in combination with the low demand for long-term care insurance constitutes evidences of large bequest motives over which individuals are not very risk-averse. In Lockwood (2012), he also argues that bequest motives may explain why so little retirees purchase life annuities. Hubbard et al. (1995) find that means-tested insurance programs can crowd-out savings. Similarly, Brown and Finkelstein (2008) show that Medicaid can crowd-out LTCI demand for an important share of the elderly population. De Nardi et al. (2014) extend their 2010 work and study more in-depth the effect of Medicaid on savings behaviours and show that high lifetime income households often value Medicaid the most. Scholz et al. (2006) using a model featuring realistic earnings and medical risk argue that most Americans do save enough for retirement.

This paper is also related to the literature on collective models of households as introduced by Chiappori (1988, 1992) and Apps and Rees (1988). This literature is very active and some noticeable recent examples of applications of this approach include Browning and Gø rtz (2012), Browning et al. (2013) or Cherchye et al. (2012). Mazzocco (2007) is one application of such a framework to the study of life-cycle behaviours. His key contribution is to allow for the absence of commitment in such a framework. This implies that Pareto weights are endogenous and, in particular, depend on the outside option (for instance divorce). His estimation procedure is an extension of the approach trying to estimate Euler equations. In this work, I assume that Pareto weights are not changing overtime as is done in Hong and Ríos-Rull (2007, 2012) which estimate a dynamic household model using data on life-insurance holdings.

[3]In the sense that individuals can adjust the time they spend on home production, which is a type of labour.

2 The intratemporal problem

Consider a household aged t, where t is the age of the husband and Δt is the age of the husband minus the age of his wife, which has a utility function of the form:

$$u^{hh}\left(c_{f,t}, c_{m,t}, h_{f,t}, h_{m,t} | \mathbf{s}_t = \left(\mathbf{s}_{f,t}, \mathbf{s}_{m,t}\right), t\right) = \phi\left(\frac{c_{f,t}^{1-\gamma}}{1-\gamma} - A_f\left(\mathbf{s}_{f,t}, t-\Delta t\right)\frac{h_{f,t}^{1+\eta}}{1+\eta}\right)$$
$$+\left(1-\phi\right)\left(\frac{c_{m,t}^{1-\gamma}}{1-\gamma} - A_m\left(\mathbf{s}_{m,t}, t\right)\frac{h_{m,t}^{1+\eta}}{1+\eta}\right)$$

The first term in bracket is the utility of the wife in the couple. While the second term is the utility of the husband. The utility of the wife is weighted by ϕ, while the one of the husband is weighted by $1-\phi$. I thus assume that the allocation inside the household is Pareto efficient. If ϕ depends on relative pensions, relative education, price variations, we are in the case of the collaborative model. If ϕ is independent of such factors, the model is the special unitary case of the collective framework. In the intertemporal model the weights will be constant over time. This is similar to what is done in Hong and Ríos-Rull (2007, 2012). While, it might be interesting to have a model without commitment in which Pareto weights are endogenous as in Mazzocco (2007), this would raise several issues. Most of these issues are exposed in Hong and Ríos-Rull (2012, p. 3703) and I will repeat or add a few ones. First of all, adding participation constraints would make the problem computationally intensive and would require to make assumptions about any additive term that would stem from becoming single, in the case of the standard assumption that the outside option is the utility from divorce. Second, divorce rates among retirees are lower than in the rest of the population. Despite a rise from 1.79% in 1990 to 4.84% in 2010 for the 65+, it is still much lower than the divorce rate of the 50-64 which was at 13.05% in 2010 (Brown and Lin, 2012). The divorce rate among individuals younger than 44 is even higher, above 20% (Brown et al., 2014). Hence, it appears that divorce, usually considered as the outside option, is not that often exercised among retirees. This suggests a higher cost of divorce for retirees than for the rest of the population. So, the fact that I do not consider changing Pareto weights might have minor costs. Moreover, in the regression analysis I control for different factors which might affect Pareto weights and I find that the main patterns regarding home production are not changed once adding those controls.

$c_{f,t}$ ($c_{m,t}$) is the amount of good c_t allocated to the wife (husband). $h_{f,t}$ ($h_{m,t}$) is the time spent by the wife (husband) on home production activities (HPA). An increase in $h_{f,t}$ ($h_{m,t}$) typically reduces her (his) utility. $A_f\left(\mathbf{s}_{f,t}, t-\Delta t\right)$ ($A_m\left(\mathbf{s}_{m,t}, t\right)$) is a number which drives her (his) disutility relative to TSHPA. It depends on her (his) age $t-\Delta t$ (t) and on a vector of observables describing health condition $\mathbf{s}_{f,t}$ ($\mathbf{s}_{m,t}$). In the application, it will be a vector of dummies indicating her (his) level of disability. Notice that $A_f\left(\mathbf{s}_{f,t}, t-\Delta t\right)$ and $A_m\left(\mathbf{s}_{m,t}, t\right)$ are the only elements differing in the respective utility functions of the wife and the husband. γ and η are standard parameters.

$c_t = c_{f,t} + c_{m,t}$ is a good which is produced by mixing time and expenditures. I assume that it is the only good available. The model can easily be modified to include the possibility of a non home-produced good. However, my interest here focuses on the overall relationship between savings and time spent on home production rather than on the reallocation of expenditures. I thus opted for this simpler structure which also avoids the problem of the classification of expenditures which can always be subject to debate. Denoting by $h_t = h_{f,t} + h_{m,t}$ the overall time spent on home production by the household, the production technology is assumed to have a constant elasticity of substitution (CES) with an elasticity of substitution ϵ. It is of the same form as in Aguiar and Hurst (2007):

$$c_t = \left(h_t^\rho + \psi q_t^\rho\right)^{1/\rho}$$

where $\rho = 1 - \frac{1}{\epsilon}$ and $q_t = \chi x_t$. ψ measures the weight of q_t relative to h_t in the production of the good c_t. x_t measures the amount of expenditures spent by the household at time t and $\chi \geq 1$ is a parameter which affects the extent of the economies of scale of a couple relative to a single household. x_t is an exogenous variable from the intratemporal problem point of view. Hence, the intratemporal problem consists in finding the optimal amounts for the other variables conditional on the level of x_t. The intertemporal problem will consist in the allocation of x_t across time.

To summarize the problem is to maximize utility under the above constraints. So the problem that the household faces at age t is:

$$\max_{\{c_t, c_{f,t}, c_{m,t}, h_t, h_{f,t}, h_{m,t}, q_t\}} u^{hh}\left(c_{f,t}, c_{m,t}, h_{f,t}, h_{m,t} | \mathbf{s}_t = \left(\mathbf{s}_{f,t}, \mathbf{s}_{m,t}\right), t\right)$$

subject to:

$$h_t = h_{f,t} + h_{m,t}$$

$$c_t = \left(h_t^\rho + \psi q_t^\rho\right)^{1/\rho}$$

$$c_t = c_{f,t} + c_{m,t}$$

$$q_t = \chi x_t$$

To simplify notations, I put $A_f \equiv A_f\left(\mathbf{s}_{f,t}, t - \Delta t\right)$ and $A_m \equiv A_m\left(\mathbf{s}_{m,t}, t\right)$.

From the above optimization problem we obtain the following relation:

$$h_t^{\rho-\eta-1}\left(h_t^\rho + \psi q_t^\rho\right)^{(1-\gamma-\rho)/\rho} = \left(\left(\phi A_f\right)^{-1/\eta} + \left(\left(1-\phi\right) A_m\right)^{-1/\eta}\right)^{-\eta} \Phi^{-1} \tag{1}$$

where $\Phi = \phi\left(1 + \left(\frac{1-\phi}{\phi}\right)^{1/\gamma}\right)^{\gamma-1} + (1-\phi)\left(1 + \left(\frac{\phi}{1-\phi}\right)^{1/\gamma}\right)^{\gamma-1}$.

This relation implies that a sufficient and necessary condition for time spent on home production and expenditures to be substitute is:

$$\frac{1}{\gamma + \rho - 1}\left(-\left(\eta + \gamma\right) h_t^\rho + \left(\rho - \eta - 1\right) \psi q_t^\rho\right) < 0$$

The second term in brackets is negative as long as:

$$\rho - \eta - 1 < 0 \Leftrightarrow -\frac{1}{\epsilon} - \eta < 0$$

which is always true. So a sufficient condition is:

$$\gamma+\rho-1>0 \Leftrightarrow \gamma>\frac{1}{\epsilon}$$

As a consequence, time spent on home production and expenditures are substitute if the curvature of the utility function and the elasticity of substitution between time and expenditures are high enough. I assume in the rest of the exposition that this condition is always satisfied. Assuming that $dq = 0$, it is interesting to see how variations in A (the parameter driving the disutility of performing HPA) affect differently TSHPA for couples and for singles. For couples, we have:

$$\begin{aligned} \left((\rho-\eta-1)+(1-\gamma-\rho)\frac{h_t^\rho}{h_t^\rho+\psi q_t^\rho}\right)\frac{dh_t}{h_t} &= \\ \frac{(\phi A_f)^{-1/\eta}}{(\phi A_f)^{-1/\eta}+((1-\phi)A_m)^{-1/\eta}}\frac{dA_f}{A_f} &+ \frac{((1-\phi)A_m)^{-1/\eta}}{(\phi A_f)^{-1/\eta}+((1-\phi)A_m)^{-1/\eta}}\frac{dA_m}{A_m} \end{aligned} \tag{2}$$

For a single agent, the relation is[4]:

$$\left((\rho-\eta-1)+(1-\gamma-\rho)\frac{h_t^\rho}{h_t^\rho+\psi q_t^\rho}\right)\frac{dh_t}{h_t}=\frac{dA}{A} \tag{3}$$

As $\frac{(\phi A_f)^{-1/\eta}}{(\phi A_f)^{-1/\eta}+((1-\phi)A_m)^{-1/\eta}}<1$ and $\frac{((1-\phi)A_m)^{-1/\eta}}{(\phi A_f)^{-1/\eta}+((1-\phi)A_m)^{-1/\eta}}<1$, a percentage increase in A will lead to a lower percentage fall of h_t in the case of a couple than in the case of a single household if one starts at a similar ratio h_t/q_t. This comes from the fact that A_f and A_m may not be perfectly correlated. If $\frac{dA_f}{A_f}=\frac{dA_m}{A_m}$, then equation (2) becomes similar to equation (3). This result conveys the idea that informal insurance between spouses stems from the fact that health shocks may not be perfectly correlated among them. However, the likely correlation between A_m and A_f makes it an imperfect insurance mechanism.

One interesting question is whether or not h_m increases following a rise in A_f if A_m and q_t are constant. That is, does a husband increases the time he spends on home production if his wife gets in worse health and if effective expenditures remain constant? h_m is determined by the following optimality condition:

$$h_{m,t}^\eta=\frac{\Phi}{(1-\phi)A_m}h_t^{\rho-1}\left(h_t^\rho+\psi q_t^\rho\right)^{(1-\gamma-\rho)/\rho} \tag{4}$$

If q_t stays constant a fall in h_t leads to a rise in $h_{m,t}$ through the term $h_t^{\rho-1}$ as long as the elasticity of substitution ϵ is greater than 1. The term $\left(h_t^\rho+\psi q_t^\rho\right)^{(1-\gamma-\rho)/\rho}$ increases as well following a fall in h_t under the condition $\gamma > 1/\epsilon$. Thus $h_{m,t}$ tends to rise following a rise in A_f. The reason for this is intuitive. If q_t stays constant, the fall in h_t driven by the fact that the wife is in worse health leads to a reduction in c_t, the quantity of the home-produced good. This reduction in c_t increases the marginal utility of consuming this good. Thus the husband, who does not experience any change in A_m, optimally responds by increasing the marginal disutility of time spent on HPA as, roughly, it should equalize the marginal utility of consumption c_t. This is done by increasing $h_{m,t}$.

An alternative for the household would be, of course, to increase q_t. However, if it is unable to

[4] The problem of a single agent is in appendix. It is a straightforward modification of the above problem.

increase it enough so as to maintain c_t at a high enough level, then the occurrence of disability of one member will tend to increase the time spent on home production of the other member. This feature is of course absent in a model with only one agent. Thus, the above model produces some sort of intrahousehold insurance, a mechanism of adjustment which is absent in a single-agent model.

From a life-cycle perspective, it is important to understand whether or not the above intrahousehold insurance affects the marginal utility out of expenditures, as ultimately this latter affects savings behaviours. In the above model, this can be seen by studying the marginal utility of x_t or q_t. Let's consider the marginal utility u'_q relative to q_t:

$$u'_q = \Phi\psi q_t^{\rho-1}\left(h_t^{\rho} + \psi q_t^{\rho}\right)^{(1-\gamma-\rho)/\rho} > 0 \tag{5}$$

The cross derivative u'_{qh} relative to h is given by:

$$u'_{qh} = \Phi\psi\left(1-\gamma-\rho\right) q_t^{\rho-1} h_t^{\rho-1}\left(h_t^{\rho} + \psi q_t^{\rho}\right)^{(1-\gamma-2\rho)/\rho} \tag{6}$$

Under the previous assumptions, this cross-derivative is negative so that a fall in h_t will lead to a rise in the marginal utility of expenses q_t. Combining this expression with equation (4) shows that the presence of a spouse may limit the marginal utility out of expenditures. Indeed, a healthy spouse limits the extent of the fall in TSHPA for a given level of q_t. This, in turns, limits the rise in the marginal utility from q_t.

Finally, the model leads to the following log-linear equation:

$$\ln h_{m,t} - \ln h_{f,t} = \frac{1}{\eta}\ln\left(\frac{\phi}{1-\phi}\right) + \frac{1}{\eta}\left(\ln A_f - \ln A_m\right) \tag{7}$$

This equation simply tells that the ratio $h_{m,t}/h_{f,t}$, should be negatively related to the ratio A_f/A_m. Thus, if we can come up with objective factors likely to affect directly A_m and A_f, then we should observe a change in the log of the ratio $h_{m,t}/h_{f,t}$ (which I will call the *log ratio* in the reminding of the text for simplicity). An advantage of this equation is that it should not be sensitive on whether or not the household receives help from the outside as it does not depend on q_t or h_t, aside from elements potentially affecting the intercept through changes in the relative Pareto weights. Moreover, the fact that the relative household members' weights enter in a linear way in the above equation imply that it is possible to control for factors potentially affecting them by adding simple linear controls to this equation. Finally, the estimation of the previous equation gives the coefficients on the objective factors affecting A_m and A_f up to the scale factor η (except for the constants, see below). This is informative on the shocks to A_m and A_f . As a matter of fact, a slightly modified version of equation (7) will be given as a part of the moments to match for the estimation of the model[5]. All this can be seen from the derivations below.

For the structural model, I will assume that $A_f\left(\mathbf{s}_{f,t}, t-\Delta t\right) = \exp\left(\delta_f^o + \left(\mathbf{s}'_{f,t}, t-\Delta t, (t-\Delta t)^2\right)\delta_f\right)$

[5]Notice that (7) depends only on the fact that the disutility from doing HPA is additive, takes the above rather standard functional form and that η is the same for both spouses. It does not depend on the production function or the utility function.

and $A_m(\mathbf{s}_{m,t},t) = \exp\left(\delta_m^o + \left(\mathbf{s}'_{m,t},t,t^2\right)\delta_m\right)$. δ_f^o and δ_m^o are constants. δ_f and δ_m are vectors of coefficients associated with the different health states and age. Equation (7) can then be rewritten:

$$\ln h_{m,t} - \ln h_{f,t} = \frac{1}{\eta}\ln\left(\frac{\phi}{1-\phi}\right) + \frac{1}{\eta}\left(\delta_f^o - \delta_m^o\right) + \frac{1}{\eta}\left(\mathbf{s}'_{f,t}, t-\Delta t, (t-\Delta t)^2\right)\delta_f - \frac{1}{\eta}\left(\mathbf{s}'_{m,t},t,t^2\right)\delta_m \quad (8)$$

While in the estimation of the life-cycle model I consider that ϕ is similar for all couples, it is possible to relax this assumption here. Let's assume that $\phi = \frac{\exp\left(\Lambda_0 + \mathbf{Z}'\mathbf{\Lambda}^{\mathbf{Z}}\right)}{1+\exp\left(\Lambda'_0 + \mathbf{Z}'\mathbf{\Lambda}^{\mathbf{Z}}\right)}$ as in Browning et al. (2013). $\mathbf{Z}$ is a vector of controls and $\mathbf{\Lambda}^{\mathbf{Z}}$ is the associated vector of coefficients. Λ_0 is a constant. In this case (8) rewrites:

$$\ln h_{m,t} - \ln h_{f,t} = \frac{1}{\eta}\left(\Lambda_0 + \mathbf{Z}'\mathbf{\Lambda}^{\mathbf{Z}}\right) + \frac{1}{\eta}\left(\delta_f^o - \delta_m^o\right) + \frac{1}{\eta}\left(\mathbf{s}'_{f,t}, t-\Delta t, (t-\Delta t)^2\right)\delta_f - \frac{1}{\eta}\left(\mathbf{s}'_{m,t},t,t^2\right)\delta_m \quad (9)$$

Under the assumption A1 that any element in $\left(\mathbf{s}'_{f,t}, t-\Delta t\right)$ or $\left(\mathbf{s}'_{m,t},t\right)$ is not included in $\mathbf{Z}$, this leads to the following econometric specification:

$$\ln h_{m,t} - \ln h_{f,t} = \alpha_0 + \mathbf{Z}'\alpha^{\mathbf{Z}} + \left(\mathbf{s}'_{f,t}, t-\Delta t, (t-\Delta t)^2\right)\alpha_f + \left(\mathbf{s}'_{m,t},t,t^2\right)\alpha_m + \varepsilon \quad (10)$$

where $\alpha_0 = \frac{1}{\eta}\Lambda_0 + \frac{1}{\eta}\left(\delta_f^o - \delta_m^o\right)$, $\alpha^{\mathbf{Z}} = \frac{1}{\eta}\mathbf{\Lambda}^{\mathbf{Z}}$, $\alpha_f = \frac{1}{\eta}\delta_f$, $\alpha_m = \frac{1}{\eta}\delta_m$ and ε is an error term. Hence under A1, the disutility stemming from changes in health condition is perfectly identified from (10) up to a scale factor η.

Notice that A1 might not be perfectly true in reality. However, if we think that disability of the wife reduces both her ability to perform home production and her weight in the household decision making, then the coefficients on the variables affecting the ability of the wife to perform HPA will be biased downward. So it will tend to understate the effect of these variables on the ability to perform HPA. The same is true for men. A1 will however be a working assumption in the remaining of the paper.

In the next section, I show that (10) is valid empirically. I also discuss the database used and document econometrically the main patterns in the data. The results in this part are very robust empirically. For the sake of not overcharging the paper, many additional tables for robustness can be found in the appendix.

3 Empirical Patterns

3.1 Data

The data for home production come from the Consumption and Activities Mail Survey (CAMS). Covariates usually come from the Health and Retirement Study[6] (HRS). The CAMS is a questionnaire asked to a random subsample of HRS respondents. It asks, in particular, questions about the time spent by individuals on activities linked to home production. As a core measure of home production I consider (i) house cleaning, (ii) washing, ironing, or mending clothes, (iii) yard work or gardening,

[6] I use mainly the RAND version of the HRS except when I use data which are not in it but can be found in the HRS.

(iv) shopping or running errands and (v) preparing meals and cleaning-up afterwards. All the data are converted in hours per year. The core measure of home production sums up activities (i) to (v). I considered different measures for home production as well and the main results appeared to be very robust. Some of these robustness checks are in appendix.

As the HRS, the CAMS is a biannual survey. It is asked during the fall. While the HRS is completed during even years, the CAMS is completed during odd years. I thus link a given wave of the CAMS (for instance the CAMS of year 2005) to the previous wave of the HRS (i.e. the one of 2004). The CAMS has been introduced in 2003. I use data from 2005 onwards as the CAMS started to ask questions about activities of both spouses then. Moreover, the questionnaire is almost exactly the same for the waves 2005, 2007, 2009, 2011 and 2013 while some changes (mainly about expenditures) occur between 2003 and 2005. So, to summarize, for data on home production, I use the CAMS waves for 2005, 2007, 2009, 2011 and 2013 and respectively link them to the HRS waves for 2004, 2006, 2008, 2010 and 2012 using household and personal identification numbers. In all the study I consider only retired individuals above 63 and below 100.[7]

I construct two separate datasets from the HRS and CAMS data whose constructions are detailed in the appendix. The first dataset use HRS data from 1998 onwards and is used to compute transition matrices, mortality risk and to study wealth patterns. The second dataset is used to study home production patterns and is constructed from the HRS and the CAMS. This sample is mechanically smaller as the CAMS is more recent and asked only to a subsample of the HRS respondents.

From the HRS, I take demographic variables such as age as well as indices of disability (or health)[8]. The disability variable I use comes from the RAND version of the HRS and is called "mobila". In the HRS, individuals are asked whether or not they had difficulties (i) walking several blocks, (ii) walking one block, (iii) walking across the room, (iv) climbing several flight of stairs and (v) climbing one flight of stairs. The index is equal to the number of difficulties people declare to have. So if an individual answers no for each potential difficulty (i) to (v) mobila will be equal to 0, while, if an individual answers yes for each one, mobila will be equal to 5. I transform this measure in 5 dummies for each spouse denoted $mobij$ with $i = 1, ..., 5$ and $j = f, m$ (f for female, m for male). $mobij$ is equal to 1 if spouse j has $mobila = i$ and to 0 otherwise. So if $mob1f = 1$, the wife in the couple has $mobila = 1$. As an alternative to mobila, I also experimented with other measures and in particular with the often used measure of self-reported health. The results with self-reported health were very similar. The choice of mobila is mainly driven by the fact that it is more objective than the measure of self-reported health and that it does not suffer the potential endogeneity bias of measures such as instrumental activities of daily living. I also take from the HRS variables such as income[9] of the spouses, total household wealth and several other covariates.

Table 1 presents some summary statistics of the dataset used for home production. We clearly see that men do less hours of home production than women whether we consider the median or the mean. Notice that men which are in a couple do less hours of home production than single men. The reverse

[7]I define as retired individuals those declaring 0 earnings as in Lockwood (2013). For individuals in a couple, I also impose that the spouse has 0 earnings. The construction of the sample is described in details in the appendix.

[8]Notice that I will use disability or bad health interchangeably.

[9]Income in all the reminder is the sum of an individual's employer pension and annuity, social security disability and supplemental security income, income from social security retirement, veterans benefits, welfare and foodstamps. De Nardi et al. (2010) use a similar measure. All dollar measures in the paper are expressed in 1998 dollars using the price index for personal consumption expenditures for major types of products from the Bureau of Economic Analysis.

Table 1: Summary Statistics

	Median	Mean
Home Production Men	574	729
Home Production Men (Couple)	521	687
Home Production Men (Single)	730	850
Home Production Men (Single and Widower)	677	790
Home Production Women	991	1120
Home Production Women (Couple)	1199	1337
Home Production Women (Single)	782	929
Home Production Women (Single and Widowed)	782	900
Home Production Wife minus Home Production Husband	600	650
Disability Men	0	1.04
Disability Women	1	1.39
Disability Wife minus Disability Husband	0	.20
Age Men	75	75.9
Age Women	75	75.6
Age Wife minus Age Husband	-2	-2.7
LTCI	0	.17
Help from family or friends	0	.09
Number of households	5988	
Number of couple households	2409	

These figures are computed using the dataset for home production. The variable "LTCI" is equal to 1 if the household has some long-term care insurance and to 0 otherwise. "Help from family or friends" is equal to 1 if the household receives some help from family or friends and to 0 otherwise.

is true for women. This pattern is present if we consider all singles or only those which are widows or widowers. It is also robust when controlling for health and age. This pattern will actually help to set the parameter ϕ in the model. We also see that women have on average a higher level of disability than men and that women are 2 to 2.7 years younger than their husbands whether we consider the median or the mean. About 17% of households have some form of long-term care insurance (LTCI) and about 9% receive some help from family or friends.

3.2 Home production inside couples

This subsection has two aims. The first one is to assess the empirical validity of equation (10). The second is to understand under which conditions the patterns in figure 2 are actually present.

To estimate equation (10), we face one difficulty which is the treatment of zeros. Indeed, $\ln h_{m,t} - \ln h_{f,t}$ (that I call the *log ratio*) cannot be computed if either $h_{m,t}$ or $h_{f,t}$ is zero. The case where $h_{m,t} = h_{f,t} = 0$ is not of much interest for this relation and applies to only 9 couples. It thus can be disregarded. However, 230 couples have one of the two members declaring zero hour of home production, which is about 9.5% of my sample. The theoretical model does not allow for zero hour of home production as the marginal disutility of doing 1 hour of home production at zero hour is zero. It can however allow for an arbitrary low positive number of hours of home production.

Thus, one solution is to replace entries for which we observe 0 by some small number $\underline{h}$ when only one of the two spouses does zero hour of home production. It is natural to think that those declaring zero hour might do some home production but very little, so that they effectively declare zero when filling the survey. Bottomcoding in such a way is highly problematic when using OLS. Indeed, the choice of $\underline{h}$ will affect greatly the estimates in particular as the logarithm function is very steep at low values. This is much less of a problem when using median regressions under two conditions[10]. The first is that $\underline{h}$ should be low enough. The second is that the *new* median should not be located in the area where changes are made. The first condition is easy to understand. Most of the zeros actually occur when an individual is disabled, which is intuitive. If, for instance, we set $h_{m,t}$ to a large number when $h_{m,t} = 0$, we will actually move the median up when individuals are disabled so that we will find that people have less disutility from doing home production when considering the zeros than when we do not consider them. This goes clearly against the data which show that individuals have much more probability to declare zero hour when disabled.

The second condition is maybe more difficult to understand. I illustrate it in figure 3. Consider that before bottomcoding we are only dealing with points A to E, where A represents the highest value for the variable considered and E the lowest. The median of this sample is located at point C. On the one hand, imagine that by bottomcoding, we have two more observations represented by F and G. In this case, the median is shifted down and is now at point D. We clearly see that, as long as F and G are lower than D, whatever the value of F and G the median will be the same. On the other hand, if by bottomcoding we add observations represented by F to K, the new median will be located where our bottomcoding is done. As a consequence, the value given when bottomcoding will affect the median in an arbitrary way. At best, we may bottom code at E and get an upper bound for the median.

It is easy to check that this second condition is verified when bottomcoding here. Table 2 shows a

[10]Notice that the logic described here could be applied to other percentiles of the distribution.

Table 2: Log difference of hours of home production of husbands and wives

	I	II	III	IV	V
mob1f	0.0997	0.0488	0.0488	0.0488	0.0488
	(0.0735)	(0.0814)	(0.0814)	(0.0804)	(0.0794)
mob1m	-0.223***	-0.254***	-0.254***	-0.254***	-0.254***
	(0.0765)	(0.0796)	(0.0796)	(0.0784)	(0.0787)
mob2f	0.167*	0.166*	0.166*	0.182**	0.182**
	(0.0853)	(0.0926)	(0.0926)	(0.0894)	(0.0898)
mob2m	-0.179**	-0.310***	-0.310***	-0.320***	-0.310***
	(0.0818)	(0.103)	(0.103)	(0.111)	(0.101)
mob3f	0.565***	0.588***	0.588***	0.588***	0.588***
	(0.0939)	(0.122)	(0.122)	(0.122)	(0.116)
mob3m	-0.128	-0.442**	-0.442**	-0.396**	-0.396**
	(0.120)	(0.176)	(0.176)	(0.159)	(0.156)
mob4f	0.756***	0.895***	0.895***	0.895***	0.872***
	(0.120)	(0.124)	(0.124)	(0.123)	(0.123)
mob4m	-0.377**	-0.801***	-0.821***	-0.821***	-0.799***
	(0.167)	(0.201)	(0.201)	(0.197)	(0.185)
mob5f	0.749***	1.835***	1.855***	1.856***	1.833***
	(0.195)	(0.416)	(0.416)	(0.457)	(0.448)
mob5m	-0.411**	-1.912***	-1.912***	-1.828***	-1.651***
	(0.195)	(0.501)	(0.501)	(0.470)	(0.289)
Constant	-0.821***	-0.811***	-0.811***	-0.811***	-0.811***
	(0.0436)	(0.0439)	(0.0439)	(0.0444)	(0.0439)
Observations	2170	2400	2400	2400	2400
R^2	0.054	0.105	0.118	0.115	0.113

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Median regressions. The dependent variable is the log ratio. Column I is without bottomcoding. In column II, III, IV, and V, I bottomcode with .00001, 10, 24, and 40 hours respectively.

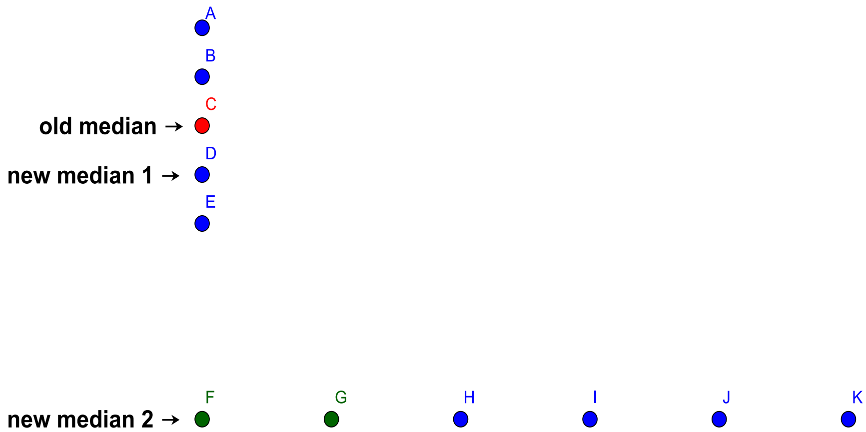

Figure 3: Bottomcoding and its effect on the median

median regression of $\ln h_{m,t} - \ln h_{f,t}$ on the disability dummies[11]. In column I, I do not bottomcode. Even when not bottomcoding, we see that equation (10) obtained directly from the theoretical framework appears valid empirically. As disability increases, the disutility from doing home production appears to increase. To grasp the magnitude of the effect, we see that the median of $\ln h_{m,t} - \ln h_{f,t}$ when both spouses have no disability is -0.821 which implies that $h_{m,t}/h_{f,t}$ is equal to .44. So a man spends about half the time his wife spends on home production. If his wife has now the highest level of disability, $h_{m,t}/h_{f,t} = \exp(-0.821 + .749) \simeq 0.93$. The magnitude of the time reallocation on HPA is thus large even when not bottomcoding.

In column II, I replace the zeros by .00001. In this case, the magnitude of the coefficients is usually higher. When both spouses are healthy $h_{m,t}/h_{f,t}$ is estimated to be approximately .44 as before. When the wife has now the highest level of disability $h_{m,t}/h_{f,t}$ is estimated to be 2.8. Hence, the reallocation appears even much larger in this case. The man, before his wife was disabled, was doing less than half of what she was doing. When she is highly disabled, he does about 3 times the amount of home production his wife does.

In column III to V, I bottomcode respectively by 10, 24 and 40 hours. A first indication that the second condition is verified under the bottomcoding procedure in column II is that there is almost no difference (or very minor ones) with column III. Another evidence is presented in figure 4. I plot in this graph the distribution of $\ln h_{m,t} - \ln h_{f,t}$ (the log ratio) for bottomcoded values when the value $\underline{h}$ is set to .00001 as in column II of table 2. The values at the left of the graph correspond to those where $h_{m,t}$ is zero, while those on the right correspond to those where $h_{f,t}$ is zero. We see that the log ratio is in absolute value usually greater than 15 and in any case greater than 10. Would a median be located where the bottomcoding is done, we should obtain an estimated value for the log ratio of more than 10 in absolute value. The highest median we get in absolute value is 0.811+1.912 which is 2.723, hence much lower than 10.

As we increase the value of $\underline{h}$, the histogram shows that some of the values are located around the median. However, even when bottomcoding to 40, the very large majority (about 77%) of the values

[11] I do not consider the age and age-square components here to ease the interpretation. Results of this regression with those components are in appendix.

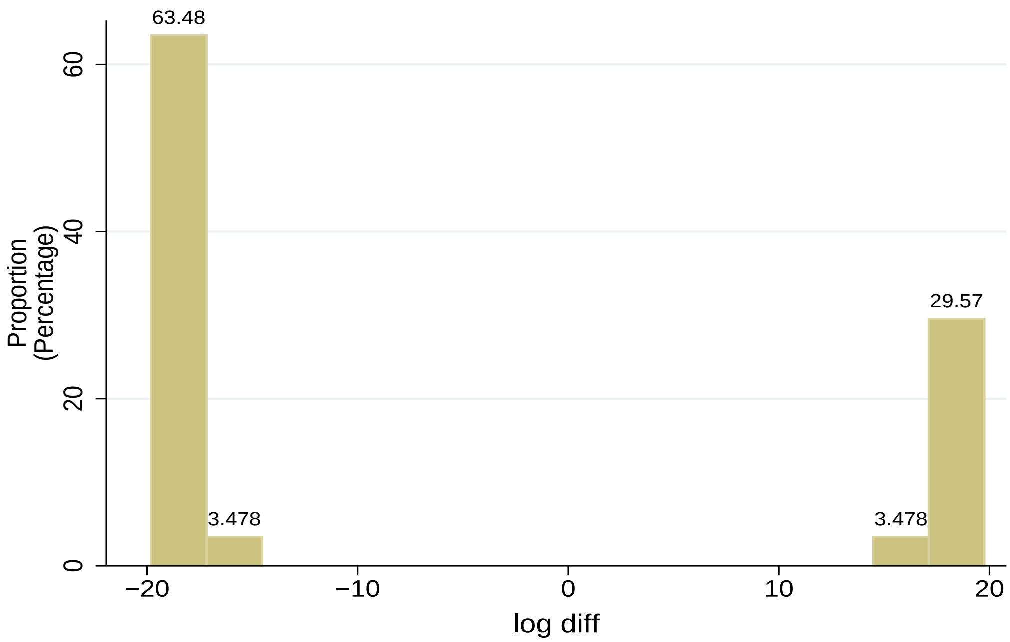

Figure 4: Distribution of the log ratio for bottomcoded observations in column II of table 2

for the log ratio is above 2.723. When bottomcoding to 24, about 88% of the values for the log ratio are above 2.723 in absolute value. This explains why there is relatively little difference through column II to V. We can thus conclude that the value chosen to bottomcode has only a very minor effect on the estimated coefficients of the structural equation (10) when using median regressions. In the appendix, I assess the robustness of this relation and also discuss the OLS case.

There exist two potential channels for the change in the log ratio observed. Typically, if the ratio of TSHPA done by a man over the one done by his wife increases when the wife becomes disabled, it can be driven by a reduction in hours done by the woman, an increase in hours done by the man, or both. Table 3 shows the results from median regressions of hours done by either men or women in a couple on the disability dummies of the different household members. In column I to III, I consider hours done by men in a couple. Column I considers as regressors only the disability dummies. Not very surprisingly, we see that men in a couple decrease time spent on home production when they become disabled. More interestingly, we clearly see that husbands, when controlling for their own healths, increase time spent on home production when their wives get disabled. The increase is actually substantial. A man with no disability spends 521 hours annually when his wife has no disability as well. However, if his wife has mobila equal to 5, the hours done by the same man are estimated to be 913, an increase of 75%. This feature holds true if we control for whether or not the household receives some help from the family or friends, or whether or not it has some form of LTCI (column II). It also holds true if we consider only the sample of households without LTCI and not receiving help from the family or friends.

In column IV to VI, I consider hours done by women in a couple. Column IV is similar to column I. Once again, we clearly see that women decrease the hours of home production they do when they

Table 3: Home production of husbands and wives

	I	II	III	IV	V	VI
$mob1f$	52.14*	52.14*	-1.29e-12	-78.21	-104.3**	-130.4**
	(27.18)	(28.00)	(41.29)	(52.61)	(48.14)	(57.23)
$mob1m$	-52.14*	-52.14*	-104.3***	104.3*	104.3**	156.4**
	(29.20)	(29.97)	(38.73)	(57.60)	(51.10)	(64.35)
$mob2f$	52.14*	52.14*	-3.23e-12	-104.3	-52.14	-78.21
	(28.13)	(29.61)	(39.30)	(70.17)	(63.84)	(75.04)
$mob2m$	-156.4***	-156.4***	-156.4***	156.4**	156.4**	156.4**
	(29.01)	(30.10)	(46.26)	(61.83)	(62.73)	(66.27)
$mob3f$	156.4***	156.4***	104.3	-260.7***	-260.7***	-312.9***
	(55.07)	(57.72)	(71.90)	(68.91)	(65.40)	(66.62)
$mob3m$	-104.3*	-104.3*	-156.4**	182.5*	208.6**	208.6**
	(62.92)	(63.00)	(77.61)	(107.1)	(84.46)	(91.48)
$mob4f$	260.7***	260.7***	208.6***	-495.4***	-469.3***	-469.3***
	(46.00)	(47.45)	(59.22)	(84.04)	(78.50)	(90.56)
$mob4m$	-260.7***	-234.6***	-208.6**	234.6**	208.6**	260.7**
	(56.03)	(70.71)	(97.43)	(107.8)	(91.76)	(124.9)
$mob5f$	391.1***	391.1***	312.9***	-886.4***	-730.0***	-573.6***
	(88.08)	(88.18)	(106.0)	(246.7)	(123.1)	(206.2)
$mob5m$	-469.3***	-469.3***	-365.0***	78.21	156.4	391.1**
	(36.06)	(39.61)	(105.0)	(192.3)	(110.4)	(153.0)
has some LTCI		-1.31e-14			-156.4***	
		(23.17)			(42.95)	
receives help from		-52.14			-573.6***	
family or friends		(58.78)			(115.1)	
Constant	521.4***	521.4***	573.6***	1251.4***	1303.6***	1303.6***
	(15.59)	(17.13)	(21.29)	(33.70)	(36.83)	(38.00)
Observations	2409	2372	1742	2409	2372	1742
R^2	0.032	0.033	0.024	0.045	0.050	0.033

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Median regressions. In column I to III the depend variable is hours done by husbands. In column IV to VI, the dependent variable is hours done by wives. In column III and VI, I remove households having a LTCI and/or receiving help from the family or from friends.

become disabled. We also see that they increase their hours of home production when their husbands get disabled, even though at the highest level of disability this effect is not significant and smaller than at more moderate levels of disability. When controlling for LTCI and help from the family or friends (column V), the effect at the highest level of disability is now large, though still not significant. Interestingly, having a LTCI is associated with lower hours of home production for women. This suggests that LTCI might partly cover the types of activities considered in this paper. Receiving help from the family has a strong negative effect. It is however clearly an endogenous variable as help from the family is more likely as disability is high. However, it suggests that help from the family might be important to consider as argued for instance in Barczyk and Kredler (2014). Including this family dimension in the framework studied here might prove to be very interesting but is left for future research. In column VI, I remove households receiving some help from the family or having some form of LTCI. In this case, we see that women increase substantially hours of home production as their husbands get disabled. In this case, a woman with no disability spends 1,304 hours annually on home production when her husband has no disability as well. However, if her husband has mobila equal to 5, the hours done by the same woman are estimated to be 1,697, an increase of 30%. For the simulated model, I will consider only households with no LTCI and not receiving help from the family or friends to concentrate exclusively on the insurance channel which is the focus of this paper.

One alternative would have been to remove all households with children. Unfortunately, about 98% of the sample of couples for which I have data on home production have children. The proportions for single women and single men are respectively 88% and 82%. For single women, the number of observations does allow for some comparisons but I did not find any difference regarding home production between single women with and without children once controlling for disability, either using OLS or median regressions.

Overall, we can conclude that the movements in the log ratio are driven by a decrease in TSHPA when one gets disabled and by an increase in TSHPA when one's spouse gets disabled. In particular, the second mechanism appears to provide some sort of insurance and its magnitude can be considered to be large. The robustness of these results is assessed further in the appendix.

3.3 Other patterns for home production

In this subsection, I document some general patterns regarding home production including also single individuals. In table 4, I regress hours of home production done by men on the disability dummies for men, and on a dummy equal to 1 if the man is in a couple and to 0 otherwise. In columns I to III, I use OLS while in columns IV to VI I use median regressions. In column I (resp. IV), I use the full sample of men for which home production is observed. In column II (resp. V), I remove single men which are not widowers. On top of this, in column III (resp. VI), I remove all men in households receiving some help from the family or friends.

From this table, we clearly see that men in couples spend less time on home production than single men. This is true if we consider only widowers and when controlling for health. Controlling for age and its square (results not displayed) does not alter those conclusions. Also, the results when interacting the disability dummies with the couple dummy are very similar. Such a regression (using OLS on the full sample of men) predicts, for instance, that men in couples spend 196 (vs 182 in table 4) hours less on home production than single men, all else equal.

Table 4: Home production of men - general patterns

	I	II	III	IV	V	VI
mob1m	-89.58***	-87.77***	-89.98***	-52.14	-52.14*	-52.14*
	(31.03)	(32.51)	(32.75)	(37.63)	(27.28)	(27.10)
mob2m	-62.29	-70.76	-59.86	-104.3*	-104.3***	-104.3***
	(42.16)	(43.56)	(44.77)	(55.62)	(31.69)	(34.77)
mob3m	-143.4***	-163.8***	-193.5***	-130.4**	-156.4***	-182.5***
	(50.97)	(52.91)	(52.15)	(59.15)	(53.57)	(58.81)
mob4m	-178.6***	-125.7*	-68.53	-260.7***	-234.6***	-156.4***
	(67.84)	(73.95)	(81.84)	(76.40)	(58.31)	(58.71)
mob5m	-415.9***	-432.4***	-381.8***	-495.4***	-521.4***	-365.0***
	(57.47)	(56.64)	(63.47)	(33.70)	(30.16)	(79.11)
in a couple	-181.9***	-129.5***	-156.0***	-234.6***	-156.4***	-208.6***
	(34.69)	(41.85)	(43.84)	(33.67)	(32.67)	(36.78)
Constant	923.8***	871.1***	893.5***	808.2***	730.0***	782.1***
	(33.78)	(42.02)	(43.63)	(32.67)	(32.87)	(36.93)
Observations	3234	2854	2712	3234	2854	2712
R^2	0.032	0.024	0.021	0.030	0.022	0.018

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Column I to III OLS. Column IV to VI median regressions. The dependent variable is hours of home production done by a man. In column, I and IV, I consider the full sample of men for which home production is observed. In column II and V, I remove single men which are not widowers. In column III and VI, I remove also all men in a household receiving help from the family or friends.

Table 5 is similar but here I regress hours of home production done by women. Here, we observe the reverse pattern than the one for men: women in a couple spend roughly 363 to 417 hours more on home production annually than single women. This is true considering only widows, adding age and its square or interacting terms. Using OLS on the full sample adding interaction terms as well as age and its square, we still find that women in couple spend about 306 hours more annually on home production than single women.

The fact that men spend less time on home production when in a couple and women more actually will influence the value of ϕ in the simulated model if η is given. To see this, observe the first two terms in equation (8). The first term is directly influenced by ϕ, while the second term is, roughly speaking, the disutility to do home production of a woman minus the one of a man when both are healthy. δ_f^o and δ_m^o are actually matched by fitting the hours of home production of single men and single women. ϕ then adjusts to fit hours done by men and women in a couple.

Table 5: Home production of women - general patterns

	I	II	III	IV	V	VI
$mob1f$	-77.59**	-79.05**	-63.29*	-91.25***	-104.3***	-78.21**
	(30.52)	(32.78)	(32.94)	(27.45)	(29.98)	(30.91)
$mob2f$	-135.5***	-123.1***	-95.04**	-104.3***	-104.3***	-39.11
	(36.44)	(39.19)	(40.38)	(34.80)	(39.65)	(40.83)
$mob3f$	-228.8***	-231.8***	-166.8***	-247.7***	-208.6***	-182.5***
	(44.13)	(48.69)	(52.30)	(38.83)	(45.68)	(50.63)
$mob4f$	-293.8***	-324.4***	-279.2***	-352.0***	-391.1***	-299.8***
	(51.23)	(55.81)	(61.83)	(51.95)	(60.35)	(77.48)
$mob5f$	-677.5***	-680.1***	-566.0***	-873.4***	-886.4***	-651.8***
	(55.07)	(60.76)	(79.62)	(26.57)	(29.72)	(93.81)
in a couple	362.5***	389.6***	364.3***	378.0***	417.1***	378.0***
	(29.30)	(30.68)	(31.64)	(23.98)	(25.93)	(27.07)
Constant	1070.2***	1044.1***	1061.8***	925.5***	886.4***	912.5***
	(25.85)	(28.83)	(29.20)	(19.51)	(21.08)	(20.34)
Observations	5163	4493	4111	5163	4493	4111
R^2	0.106	0.115	0.079	0.104	0.113	0.079

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Column I to III OLS. Column IV to VI median regressions. The dependent variable is hours of home production done by a woman. In column, I and IV, I consider the full sample of women for which home production is observed. In column II and V, I remove single women which are not widows. In column III and VI, I remove also all women in households receiving help from the family or friends.

3.4 Wealth decumulation

In table 6, I show that disability is associated with lower wealth. I perform a median regression of the wealth of couples on the disability of their members[12]. In each regression, I control for age of the household, its square, cohort and wave effects. In column I (resp. II, III and IV), I consider households in the fourth (resp. third, second, first) income quartile. Those regressions suffer an evident bias as individuals with worse health might have exited the labour market earlier and thus may have lower wealth. Hence, it might be mainly a pattern stemming from before retirement. The regressions here should thus be interpreted only as correlations. The simulated model will correct for this bias by featuring a realistic initial distribution of wealth which will be a function of disability.

Table 6: Wealth as a function of disability - couple households

	I	II	III	IV
$mob1m$	-70187.7***	-26197.9*	-42041.6***	-14125.8
	(18534.7)	(13586.9)	(13288.0)	(15556.8)
$mob2m$	-102745.0***	-50095.8***	-54228.5***	-43757.7***
	(22195.8)	(15561.3)	(19803.8)	(14709.0)
$mob3m$	-123747.3***	-53474.9**	-89031.1***	-60172.8***
	(28793.9)	(22250.3)	(14557.3)	(13944.5)
$mob4m$	-120550.1***	-41053.4*	-108163.1***	-60719.3***
	(29544.5)	(21373.4)	(14742.0)	(11902.1)
$mob5m$	-245229.7***	-91519.1***	-94895.0***	-91208.0***
	(25420.8)	(25316.7)	(21283.2)	(13586.5)
$mob1f$	-5397.0	-30904.2**	-9465.4	-23708.9
	(20252.8)	(14124.9)	(14745.6)	(14632.5)
$mob2f$	-92081.8***	-73695.9***	-79812.0***	-57606.3***
	(19851.3)	(16184.4)	(14650.9)	(12656.1)
$mob3f$	-98662.0***	-90318.5***	-87136.3***	-48751.4***
	(27843.2)	(17344.5)	(16347.6)	(14656.5)
$mob4f$	-31091.1	-111677.0***	-99258.3***	-63851.3***
	(28083.1)	(16726.1)	(15206.6)	(14436.2)
$mob5f$	-140475.9***	-120782.4***	-134272.8***	-89157.2***
	(38642.1)	(25499.7)	(19560.9)	(15873.0)
Observations	2231	2543	2506	1779
R^2	0.039	0.042	0.059	0.041

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Median regressions. The dependent variable is total wealth. In each regression, I control for age of the household, its square, cohort and wave effects. In column I to IV I consider respectively couple households in the fourth to first income quartile.

[12] The sample used for this regression is the one used when simulating the model. More details can be found in the appendix.

4 The intertemporal problem

The resolution of the problem is in two steps. First, we need to solve for the intratemporal problem presented in section 2. This gives three objects $u^{hh}(x, \mathbf{s}_t, t)$ (for couple households), $u^{sf}(x, \mathbf{s}_{f,t}, t)$ (for single female) and $u^{sm}(x, \mathbf{s}_{m,t}, t)$ (for single men). The utility of a couple depends on the age and health status of both spouses. In the application, I assume that the husband is two years older than the wife which is the median in the sample. The utility of singles for a given level of x is derived from a problem similar to the one in section 2 but with only one agent and no economies of scale (i.e. $\chi = 1$). The derivation of this problem can be found in appendix.

The above objects are taken as given for the exposition of the intertemporal problem below, which is the second step of the problem. I first start by the timing of the model. The maximum age T is set to 100 for both men and women. Each household is assumed to enter retirement when the man is aged 65 or when the woman is aged 63. First, a household draws a state S_t. This state is a function of $\mathbf{s}_t$ and whether household members are still living or not. The probability to draw a given S_t depends on the previous state S_{t-1} and on age $t-1$. As a matter of fact, given the standard assumption that health status follows a Markovian process, the current transition probability matrix is a function of health state. Roughly speaking, the probability of disability or death is higher for the disabled than for the non disabled. On top of this, each state is associated with a different mean of log medical expenditures $\mu(S_t, t)$. In a second time, the household draws a shock $\varepsilon_t \sim \mathcal{N}(0, \sigma_\varepsilon^2)$. This latter and the mean of log medical expenditures define the level of medical expenditures m_t of the household in t:

$$m_t = \exp\{\mu(S_t, t) + \varepsilon_t\} \tag{11}$$

This allows for a skewed distribution of medical expenditures. In a third time, the household decides upon how much to spend today (x_t) on goods and services given its intertemporal budget constraint. This constraint further depends on the level of initial wealth b_t and and on pension income $y(S_t)$. In the application, pension income depends on whether the household is a couple or a single household, and not on the level of disability. Given the gross rate of interest R, the budget constraint is given by:

$$Rb_t + y(S_t) - m_t = x_t + b_{t+1} \tag{12}$$

The constraint can be rewritten as a function of cash-on-hand w_t:

$$w_t = Rb_t + y(S_t) - m_t = x_t + b_{t+1} \tag{13}$$

$$w_{t+1} = R(w_t - x_t) + y(S_{t+1}) - m_{t+1} = x_{t+1} + b_{t+2} \tag{14}$$

As is standard, a non-borrowing constraint is assumed:

$$x_t \leq w_t \tag{15}$$

I also assume a minimum level of cash-on-hand $w_{min}(S_t)$, so that cash-on-hand should be replace in equations (13), (14) and (15) by:

$$w_t = \max\left(w_{min}\left(S_t\right), Rb_t + y\left(S_t\right) - m_t\right) \tag{16}$$

w_{min} is a short way to represent Medicaid. Concerning, Medicare the brochure entitled "Medicare and Home Health Care" explicitly states that Medicare covers skilled care but does not usually cover unskilled care. It says that "any service that could be done safely by a non-medical person (or by yourself) without the supervision of a nurse isn't skilled nursing care". This clearly does not include the type of activities which are considered here. Moreover, it is explicitly said in the brochure that the types of activities I consider here are usually not covered by Medicare. As a consequence, I do not model Medicare[13].

Given the above constraints the household solves for x_t which maximizes its expected utility. There are three types of problems: one for those still in a couple, one for single women and one for single men. I start by the exposition of the problem for couples. In its recursive form the problem is[14]:

$$\begin{aligned} v_t^{hh}\left(w_t, S_t\right) = \max_{x_t} u^{hh}\left(x_t, S_t, t\right) &+ p_t^f\left(S_t\right) p_t^m\left(S_t\right) \beta E_t\left[v_{t+1}^{hh}\left(w_{t+1}, S_{t+1}\right) \mid S_t\right] \\ &+ p_t^f\left(S_t\right)\left(1 - p_t^m\left(S_t\right)\right) \beta E_t\left[v_{t+1}^{hhsf}\left(W_{t+1}, S_{t+1}\right) \mid S_t\right] \\ &+ \left(1 - p_t^f\left(S_t\right)\right) p_t^m\left(S_t\right) \beta E_t\left[v_{t+1}^{hhsm}\left(W_{t+1}, S_{t+1}\right) \mid S_t\right] \\ &+ \left(1 - p_t^f\left(S_t\right)\right)\left(1 - p_t^m\left(S_t\right)\right) \beta\left(\phi v_F\left(w_{t+1}\right) + (1-\phi) v_M\left(w_{t+1}\right)\right) \end{aligned} \tag{17}$$

$v_t^{hh}(.)$ is the value function of a household aged t. It depends on five objects. First, it depends on the utility flow $u^{hh}(.)$ the household gets in t by consuming x_t given its current state S_t and its age t. Second, it depends on the expected value in $t+1$ if the household remains a couple $v_{t+1}^{hh}(.)$. It is weighted by the respective survival probabilities of the woman and her husband $p_t^f(S_t)$ and $p_t^m(S_t)$, and by the discount factor β assumed to be the same for husbands and wives. The third element is the expected value the household obtains if the wife becomes widowed. Would there not be any bequest motive, this would correspond to the expected value function of a single woman weighted by ϕ. The fourth object is similar but corresponds to the case where only the husband survives. The fifth object is the value from bequest if both spouses die. Notice that in this case $w_{t+1} = Rb_{t+1}$.

The case for a single woman and a single man are similar so I only expose the one for a single woman. It takes the form:

$$\begin{aligned} v_t^{sf}\left(w_t, S_t\right) = \max_{x_t} u^{sf}\left(x_t, S_t, t\right) &+ p_t^f\left(S_t\right) \beta E_t\left[v_{t+1}^{sf}\left(w_{t+1}, S_{t+1}\right) \mid S_t\right] \\ &+ \left(1 - p_t^f\left(S_t\right)\right) \beta v_f\left(w_{t+1}\right) \end{aligned}$$

In this case, the value function depends on the current utility flow of the single woman, on her value

[13] Medicare enters however in the coverage of medical expenditures. Out-of-pocket medical expenditures are net of Medicare reimbursements and exogenous in the model

[14] I assume constant Pareto weights and that a dead spouse has no influence on the decision making of the surviving spouse.

in the next period if she survives and on her value from leaving a bequest. Slightly more complicated is the value that a couple household obtains if the single woman has cash-on-hand w_t in state S_t. Denoting with stars the level of variables chosen by the single woman given her optimal choice, it takes the following recursive form:

$$\begin{aligned} v_t^{hhsf}\left(w_t, S_t\right) = \phi u^{sf}\left(x_t^{\star}, S_t, t\right) + p_t^f\left(S_t\right)\beta E_t\left[v_{t+1}^{hhsf}\left(W_{t+1}^{\star}, S_{t+1}\right) \mid S_t\right] \\ + \left(1 - p_t^f\left(S_t\right)\right)\beta\left(\phi v_f\left(w_{t+1}^{\star}\right) + \left(1-\phi\right) v_m\left(w_{t+1}^{\star}\right)\right) \end{aligned}$$

It depends on the current flow of utility from the single wife given her optimal decision weighted by ϕ, on the expected value that the household gets if the wife survives and on the utility from bequest that *both* members get if the wife is not alive next period. It is this latter part that implies that $v_t^{hhsf}\left(w_t, S_t\right) \neq \phi v_t^{sf}\left(w_t, S_t\right)$. Here, I assume that bequest motives are similar for men and women and take the following functional form:

$$v_f\left(w\right) = v_m\left(w\right) = \zeta \frac{\left(c_b + w\right)^{1-\gamma}}{1-\gamma}$$

This functional form is standard. ζ drives the strength of the bequest motive, while $c_b > 0$ is a parameter driving the extent to which bequests are luxury goods.

5 Model's estimation

The population is split in four income quartiles. I compute different income quartiles for couples, single women and single men. I assume that a woman in a couple belonging to the Xth quartile of the income distribution of couples will, when single, belong to the Xth quartile of single women. A similar assumption is made for men. For the simulations, I do not consider households with some LTCI or receiving help from the family or friends. The latter is done as the model does not include help from the family or friends though, as mentioned before, it might be an interesting extension.

5.1 First stage estimation

5.1.1 Mortality and health status

I regroup disability levels so as to have three possible levels of disability. Typically, I regroup people with *mobila* equal to 0 or 1 in a same group ($mob01 = 1$). I do the same for people with *mobila* equal to 2 or 3 ($mob23 = 1$) and 4 or 5 ($mob45 = 1$). This assumption is made so as to limit the computational burden. Given these three levels of disability and death, a household can be in $4 \times 4 = 16$ states, which implies already a transition matrix of size $16 \times 16 = 256$. I then compute the probability to transit between states using a multinomial logit regression[15]. For singles[16], the dependent variables are a cubic in age, current health state, health state interacted with age, income quartile, income

[15]This can be considered as a standard approach. De Nardi et al. (2010) also use logit regressions to estimate transition probabilities.

[16]All singles considered from now on are widows or widowers.

Table 7: Life Expectancy

	Men (at age 65)	Women (at age 63)
Simulated Sample	16.7	21.2
US life tables	17.7	21.9
Income Quartile		
First	15.1	19.9
Second	16.0	20.9
Third	17.3	21.6
Fourth	18.1	22.4

The figures for US life tables are taken from the 2011 period life table for the Social Security area population from the Social Security Association. All other statistics are computed on the simulated sample used to fit the data. All figures are in years.

quartile interacted with age, whether the person is in a couple, whether the person is a single woman. In addition, this two latter are also interacted with age. Finally, for those in a couple I also allow the disability of the spouse to affect one's health. This allows for the correlation between health states of spouses which is essential to assess the value of spousal insurance. Ultimately, we would think that this correlation is linked to the intrahousehold insurance at play here. Building this into the model is possible but would require defining an additional state variable, I thus abstract from this channel. Any analysis performed hereafter should be understood as conditional on an invariant transition probability matrix. This is by far the norm in the literature. For men, I found that having a spouse with *mobila* greater or equal to 2 has a significant positive impact on the probability to have disability issues or to die. The bi-annual transition matrix is then converted to annual.

From table 7, we see that the implied longevity using the estimated transition matrix is very close to what is found in US life tables[17]. For men, I compute life expectancy at age 65 and for women life expectancy at 63. This corresponds to the ages at which I start the simulations. Men live 1 year less in my simulated sample than what is found in life tables and women live half a year less. We also see that individuals in higher income quartiles are expected to live longer. For instance, a man in the first income quartile is expected to live 3 years less than a man in the fourth income quartile.

In table 8, I show that the patterns of disability and marital status at age 90+ observed in the data are usually well reproduced in my simulated sample. In particular, the figures for women are very close to their data counterparts. For instance, a woman age 90 or more in the data has 42.2% of chances to have mobila equal to 4 or 5. In the simulated sample, this number is 42.0%. For men, the patterns are a bit less well reproduced, certainly reflecting the fact that men are less numerous, which implies that the estimation of transition probabilities is less precise. However, the results are

[17] I discuss the initial distribution for the simulations afterwards.

Table 8: Statistics about disability and marital status, Model vs Data

	Model	Data
Women in couple at age 90+	5.6	4.8
Women in couple at age 90+ and with mobila equal to 4 or 5	5.2	5.0
Men in couple at age 90+	32.4	43.8
Men in couple at age 90+ and with mobila equal to 4 or 5	32.9	44.3
Women with mobila equal to 0 or 1 at age 90+	29.5	29.3
Women with mobila equal to 2 or 3 at age 90+	28.5	28.5
Women with mobila equal to 4 or 5 at age 90+	42.0	42.2
Men with mobila equal to 0 or 1 at age 90+	34.4	42.0
Men with mobila equal to 2 or 3 at age 90+	29.0	27.2
Men with mobila equal to 4 or 5 at age 90+	36.5	30.8

Statistics from the model are those obtained on the simulated sample. Statistics from the data are obtained from the sample used to estimate the transition matrix. The table reads as follow. "Women in couple at age 90+" is the proportion of women aged 90 or more which are in a couple. "Women with mobila equal to 0 or 1 at age 90+" is the proportion of women aged 90 or more which have mobila equal to 4 or 5. All figures are in percentage.

still quite close to the data.

One important thing to notice is that women with high disability have a large probability to be single past aged 90. I find that about 95% of them are single which will have an important influence on the results.

5.1.2 Medical expense risk

As all dollar values, out-of-pocket medical expenditures are expressed in 1998 dollars. The log of two-year medical expenditures of the household is estimated as a function of a cubic in age, disability, disability interacted with age, disability of a spouse, whether in couple, whether a single woman, income quartile and income quartile interacted with age. I use OLS rather than fixed-effects as a fixed-effect estimation might be imprecise to estimate the transition from couple to single. I then compute the standard deviation of the error term. Under the assumption of normality, I compute the corresponding mean expenditures over two years. Using the transition probability matrix and a realistic initial distribution (described below) of the population along the different states, I compute the corresponding annual mean medical expenditures. To reflect the fact that medical expenditures are more volatile at annual frequencies I multiply the standard deviation on two year medical expenditures by 1.4 and adjust the log mean accordingly. I consider only households in which the respondent has no long-term care insurance and for which no member has been in a nursing home in the past two years.

The latter two assumptions are important for identification. The model above conveys the idea that part of medical expenditures are exogenous. However, some of what is recorded as out-of-pocket medical expenditures might be substitutable by a spouse. In particular, it is the part of nursing home which comprises services such as cleaning, cooking... The identification of the weight of hours of home production in the home production function (the parameter ψ) will thus stem from the part of asset decumulation (computed on the sample which includes those facing nursing home stays) which is not explained by the *exogenous* part of medical expenses (which does not use nursing home respondents). The model will thus associate most of the additional costs when spending some time in nursing home to the fall in home production.

5.1.3 Income

The log of pension income is computed as an OLS regression on income quartile. I perform such a regression separately for couple households, single men and single women.

5.1.4 Initial distribution of states and wealth

To compute the initial distribution of marital status and health status, I classify each household along the 15 possible states (i.e. the combination of the three disability status and death minus the case where both spouses are dead). I do so for those aged less than 70, without any LTCI and not receiving help from the family. For each income quartile separately, I use the distribution of households along these different types to build the initial distribution of households in the model.

For initial wealth, I perform a median regression for households less than 70 on the disability status of husbands and wives and on the three possible marital status. I do so separately for each income quartile and consider a similar sample to the one for the initial distribution of state. To allow for heterogeneity in wealth conditional on these covariates I compute the distribution of the error term. I then allocate randomly an additional term to each household from this distribution.

To estimate annual medical expenditures, I simulate 1,000,000 household histories using the transition between states described in earlier. I assume that single men start aged 65, single women start aged 63, and couples start with the wife aged 63 and the husband aged 65. For the estimation of the model and the results presented below, I simulate 20,000 household histories.

5.2 Second stage estimation

Some parameters are initially fixed. I set β to 0.97 and R to 1.03. I also fix γ to 4. γ can be interpreted as the relative risk aversion over a "pure" consumption good. The parameter χ is set to 1.198 which corresponds to Mc Clements' scale for a couple without children (i.e. a childless couple is equivalent to 1.67 adults) used by Attanasio et al. (2008).

I set x_{min} to be \$5,280, \$5,280 and \$20,000 for single individuals with respectively $mob01 = 1$, $mob23 = 1$ and $mob45 = 1$. I assume the same floor for no disability and moderate disability as the Medicare brochure suggests that the program is not very generous. Moreover, Medicaid is likely not to pay for small services when people are not heavily impaired. The value of \$5,280 corresponds to the pension income of single women in the first wealth quartile. For high disability, I assume a floor of \$20,000. This represents about two fifths of the annual cost for a nursing home (see Ameriks et al., 2011). Given that nursing homes also include medical services, this is a reasonable figure. In previous versions, I used a lower floor and did not find that results changed significantly. For a couple, I assume that x_{min} is the sum of the x_{min}s that each of the spouses would receive if they were singles given their health states. I further divide this number by χ assuming that the government takes into account household economies of scales. As an example, a couple with the wife having $mob01 = 1$ and the husband having $mob45 = 1$, would have $x_{min} = (5,280 + 20,000)/1.198 = \$21,102$.

To avoid some numerical problems which could occur when dividing by low values, I re-express, when solving the model, all dollar values in 10,000 of dollars and all hour measures in 1,000 of hours. However, when displaying the results, I re-express all measures in their initial units.

As a baseline, I assume that:

$$A_m = \exp\left(\delta_m^o + \delta_m^{age}(t-63) + \delta_m^{age^2}(t-63)^2 + \delta_m^{mob23} mob23m + \delta_m^{mob45} mob45m\right)$$

$$A_f = \exp\left(\delta_f^o + \delta_f^{age}(t-\Delta t-63) + \delta_f^{age^2}(t-\Delta t-63)^2 + \delta_f^{mob23} mob23f + \delta_f^{mob45} mob45f\right)$$

This means that the disability to do home production depends on a component depending on the individual's age (minus 63) and its square and on her or his disability state. The parameters which will be set matching our moments are thus:

$$\left(\delta_m^o, \delta_m^{age}, \delta_m^{age^2}, \delta_m^{mob23}, \delta_m^{mob45}, \delta_f^o, \delta_f^{age}, \delta_f^{age^2}, \delta_f^{mob23}, \delta_f^{mob45}, \phi, \eta, \epsilon, \psi, \zeta, c_b\right)$$

$\left(\delta_m^{mob23}, \delta_m^{mob45}, \delta_f^{mob23}, \delta_f^{mob45}\right)$ are obtained by matching the median of the log ratio as a function of disability. $\left(\delta_m^o, \delta_f^o\right)$ are set to match the hours of home production done by single men and single women. $\left(\delta_m^{age}, \delta_m^{age^2}, \delta_f^{age}, \delta_f^{age^2}\right)$ help to match the overall pattern of home production as a function of age. ϕ helps to reproduce the fact that men do more home production when singles, while it is the reverse for women. ψ measures the importance of home production in consumption. If it is infinite then home production does not influence wealth patterns at all. η helps to reproduce the insurance channel as it drives the response of the supply of home production. If it is infinite home production would barely move. ϵ helps measures the degree of substitution between hours of home production and expenditures and helps to match the way wealth reacts when disability occurs. ζ and c_b help to reproduce the wealth distribution at older ages.

To set those parameters and assess how well the model can reproduce the patterns observed in the data I use the following moments. The first set of moments (M1) is the median of hours of home production done by woman with $mob01 = 1$ as a function of age where age is represented by 6 dummies (63-69, 70-74, 75-79, 80-84, 85-89, 90+). M2 and M3 are similar but for women with respectively $mob23 = 1$ and $mob45 = 1$. M4 to M6 are the same as M1 to M3 but for men. M7 is the median of hours of home production done by single women as a function of age. M8 is the median of hours of home production done by women in couple as a function of age. M9 and M10 are similar to M7 and M8 but for men. ϕ will help to capture the differences between M7 and M8, and M9 and M10. M11 is the median of the log ratio as a function of the disability of the wife in a couple. M12 is the median of the log ratio as a function of the disability of a husband in a couple. M13 represents the hours of home production done by married men as a function of the disability of their wives. M14 is similar but now the x-axis represents the health of those men. M15 and M16 are similar to M13 and M14 but here the "dependent" variable is hours done by married women. M17 to M20 plot total household wealth as a function of age[18] for income quartiles going from the highest to the lowest. M21 to M24 are similar but with the x-axis being the disability of the woman in the household (if a woman is present). M25 to M28 are similar but with disability of the man as the x-axis. As a total, we are dealing with 126 moments. The different parameters are set to minimize the distance between the data and the model. More details on the computation of the moments and the distance can be found in the appendix.

In the next section, I describe the model's fit and describe the results from some counterfactual experiments.

6 Model's behaviours

6.1 Comparison of the model and the data

In this subsection, I describe the outcome relative to the data of three different versions of the model. The calibrated parameters for these models can be found in table 9. First of all, I will describe the outcome of the model with bequest motives.

Figure 5 shows the outcome of this version of the model relative to the data. This model can reproduce most of the observed patterns in the data. It replicates the fact that home production falls as women get disabled (M1 to M3). It also can replicate the decline of home production as a function of age. For men, the model is also able to replicate the fall of TSHPA as they get disabled (M4 to M6). Moreover, it reproduces well the fact that TSHPA for women in a couple is higher than TSHPA for single women (M7-M8). It also replicates well the fact that men in a couple spend less time on HPA than single men (M8-M9). For both men and women, these differences are close to those in the data. For instance, in the data, a woman between 63 and 69 spends about 950 hours on home production if single and 1,250 hours if in a couple. These figures are respectively around 1,000 and 1,300 in the model. Moreover, the model reproduces fairly well the insurance mechanism described before. Typically, we see that the model can generate an increase in time spent on home production by men if their wives get disabled (M13). A similar pattern is observed for women, though the increase is much smaller both in the model and the data. The reason why this increase is not as strong as the one in table 3 is that I do not control for the health of the woman here. It occurs that not controlling for health of the woman, in a regression of TSHPA by a woman on disability of her husband, makes the coefficients on disability of the man very small. It reflects the correlation of disability risk between spouses.

Wealth patterns are globally well reproduced and in particular we see that the model can generate little dissavings as in the data for the second to the fourth income quartile (M17 to M19). The model is less successful in replicating the fact that households in the first income quartile do not decumulate. Part of this might lie in the fact that other small sources of risk, not covered by public insurance, may play a role. For wealth, patterns as a function of disability, the model is also able to replicate well the patterns observed for the second to the fourth income quartile. As a consequence, we see that

[18] Here age is age of the household. It is defined as the age of the husband in the case of a couple household. For single households, it is the age of the individual. It is converted in similar age dummies than before.

Table 9: Calibrated Parameters

	(I)	(II)	(III)
Parameters	Bequest	No Bequest	No Bequest + Tail
η	2.02	3.15	2.17
ψ	0.089	0.090	0.197
ϵ	2.96	3.36	3.19
ϕ	0.43	0.27	0.29
δ_m^o	0.43	0.53	-0.34
δ_f^o	-0.89	-0.74	-1.24
δ_m^{mob23}	0.46	0.87	0.49
δ_m^{mob45}	1.38	3.01	1.36
δ_f^{mob23}	0.46	0.45	0.45
δ_f^{mob45}	1.73	3.27	1.73
δ_m^{age}	-0.021	-0.017	-0.020
$\delta_m^{age^2}$	0.0032	0.0042	0.0031
δ_f^{age}	-0.021	-0.018	-0.020
$\delta_f^{age^2}$	0.029	0.0032	0.027
ζ	10.3		
c_b	1.00		

Calibrated parameters for different versions of the model. All parameters are set to minimize the distance between the data and the model.

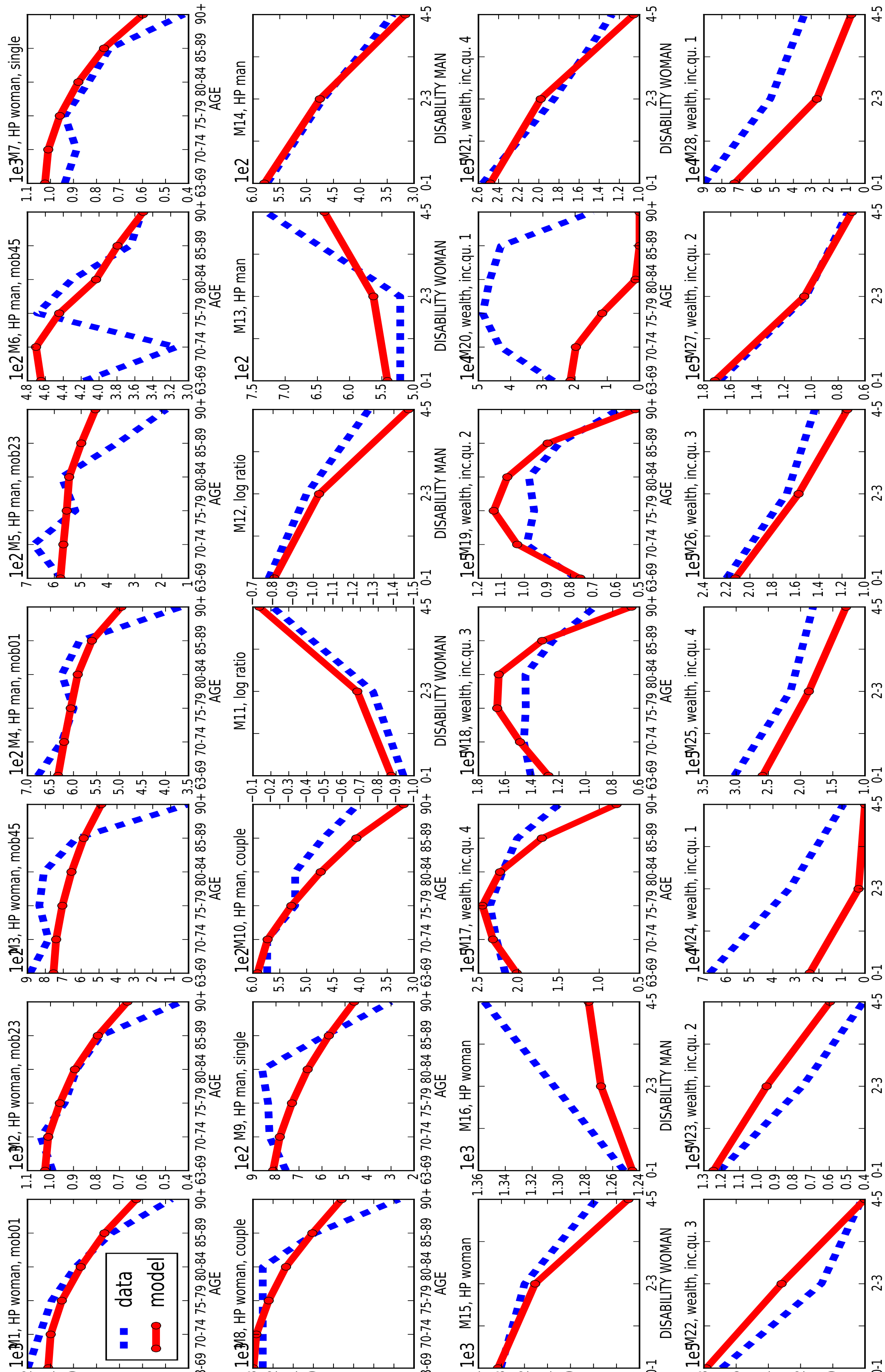

Figure 5: Model vs Data: Model with Bequest

the theoretical model presented here is successful in replicating most of the observed patterns of home production and wealth decumulation observed in the data.

The model estimated without bequest motives is displayed in figure 6. Overall, the patterns are quite similar to those in the model without bequest, reflecting the fact that it is hard to disentangle what stems from bequest motives and precautionary motives in a model with bequest motives. This is a general problem in the literature (see for instance De Nardi et al., 2010). The rise in home production hours done by men, when their wives get disabled is a bit less well reproduced than in the previous model, which is reflected in the higher value found for η. Overall, for this version model as was the case for the former one, we can see that the patterns in the data are quite well reproduced.

However, both do not reproduce very well the fact that hours of home production done by disabled women at age 90+ fall close to zero. Given that about 42% of women at this age have mobila equal to 4 or 5, it is an important dimension to consider as it represents a significant “tail risk”. To take into account this fact, I set the disutility from doing home production of a woman aged 90+ and with mobila equal to 4 or 5 to a large value so that she does approximately 0 hour of home production[19]. The model is otherwise similar and the values for the other parameters in this setting without bequest motives can be found in the third column of table 9.

The comparison of the model and the data can be found in figure 7. In this case, we see that the model reproduces (by construction) the very large fall in time spent on home production for women aged more than 90 and with mobila equal to 4 or 5. The other patterns of home production are still well reproduced, though the increase in TSHPA by men when their wives get disabled is a bit lower than before. This stems partly from the fact that ψ is now higher. ψ is naturally higher in this case as we increase the potential fall on TSHPA. As a matter of consequence, the value of ψ must rise in order not to generate too much precautionary motive.

Concerning wealth decumulation, this version of the model generates wealth decumulation patterns for households in the fourth wealth quartile in line with the data. It generates however too much precautionary behaviour for households in the second and third wealth quartile.

6.2 The effects of disability and age

A first question we may ask is: to which extent does disability, through its effect on home production, affect savings behaviours? This question can easily be answered in the case of the above model, as we just need to set some parameters to 0. The overall effect is quite similar from one version of the model to another so I will concentrate on the outcome from the model with bequest.

First of all, I set $\delta_m^{mob45} = \delta_f^{mob45} = 0$. All other parameters as well as the risk of longevity and medical expenditures are the same as before. The only modification in this case is that being disabled does not increase the disutility from performing HPA. Thus, I can clearly see the effect of disability on the model's behaviours. Figure 8 compares the original model with bequest to the one in which disability is shut down.

First of all, we see that hours of home production of men and women with mobila equal to 4 or 5 increases when we shut down the disability channel. This translates in a slight rise of median hours

[19]Remember that the model cannot generate 0 hour of home production but that as A become very large it can get to values tending to 0.

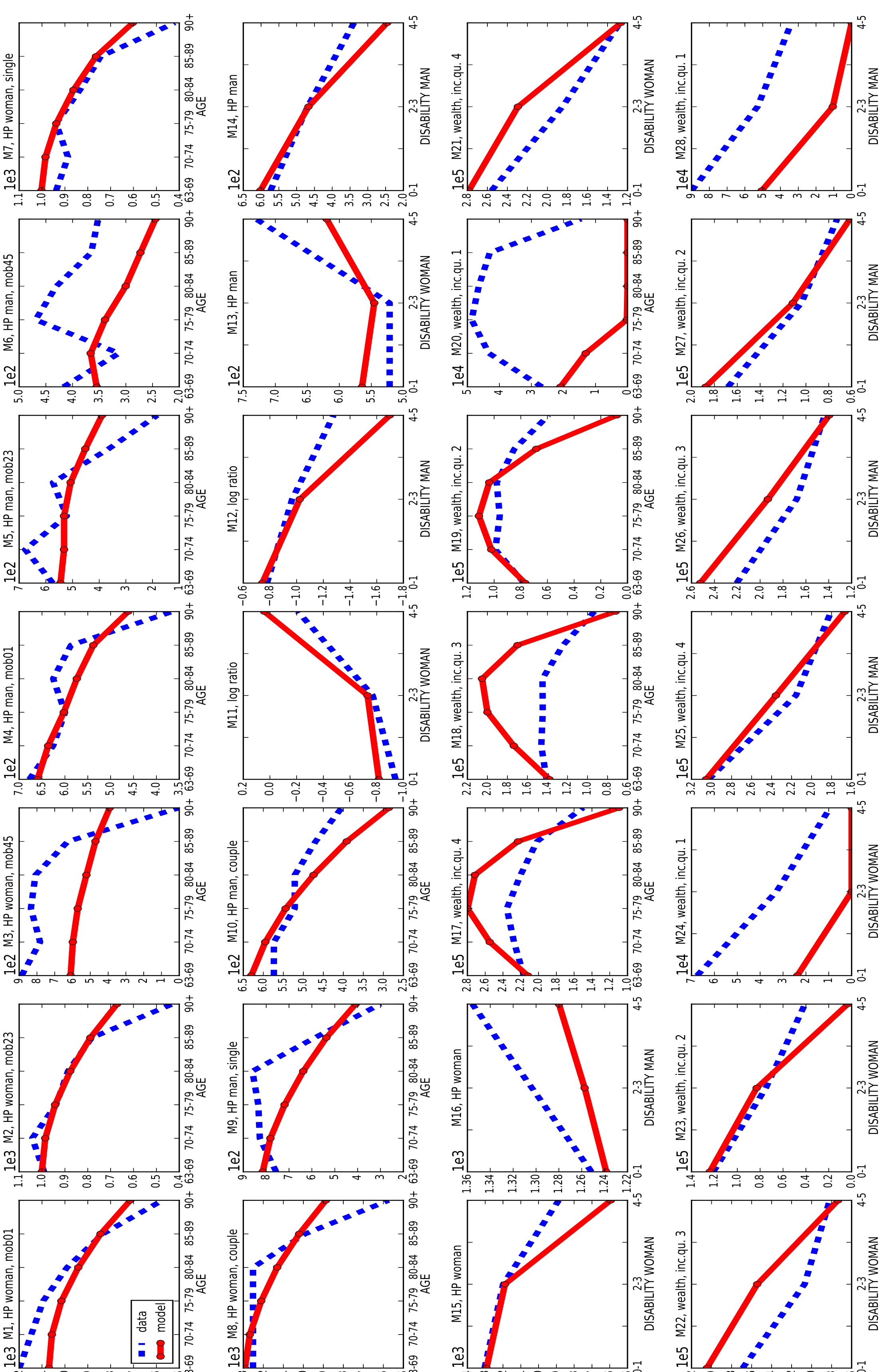

Figure 6: Model vs Data: Model without Bequest

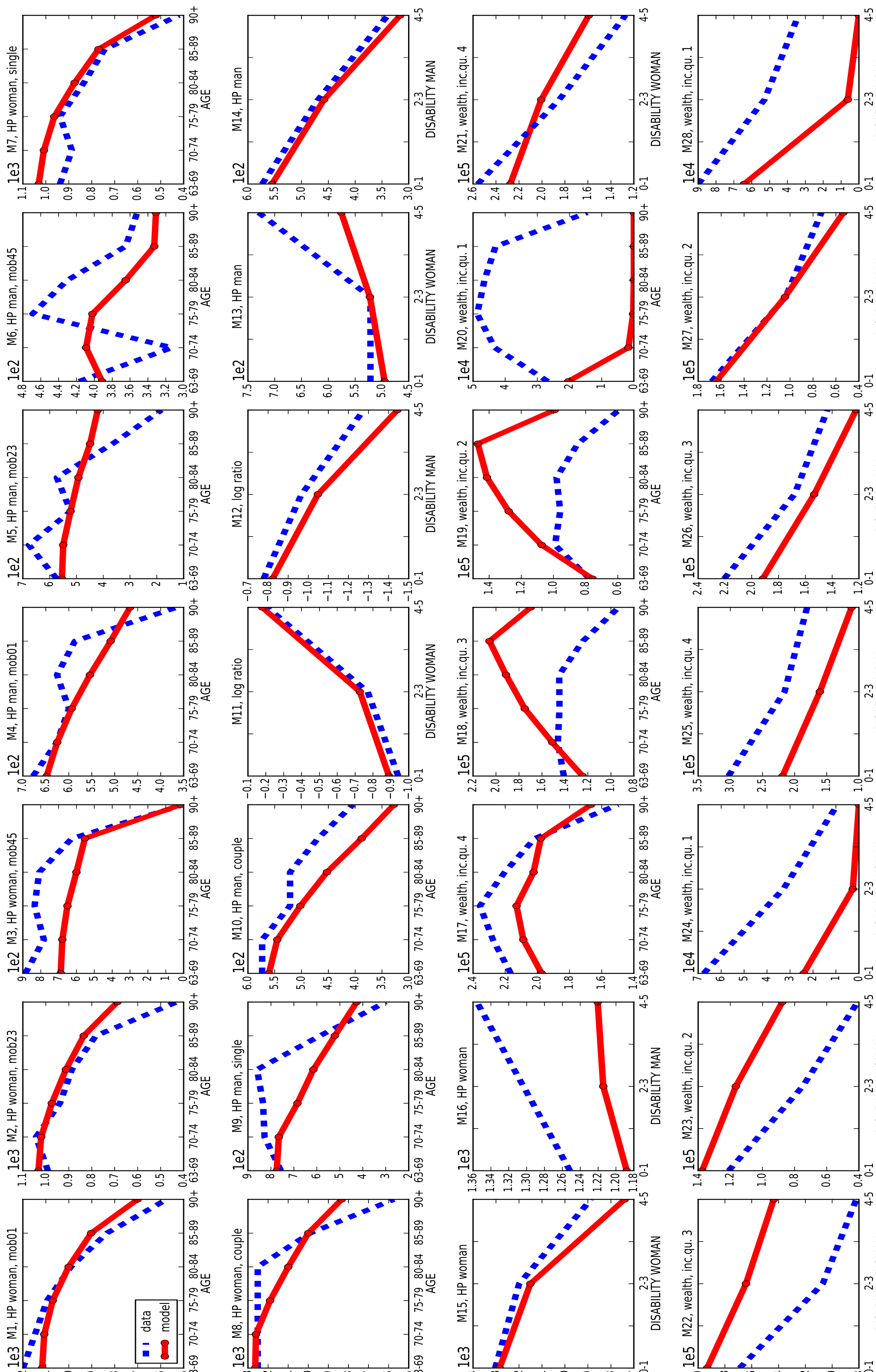

Figure 7: Model vs Data: Model without Bequest but with “Tail Risk”

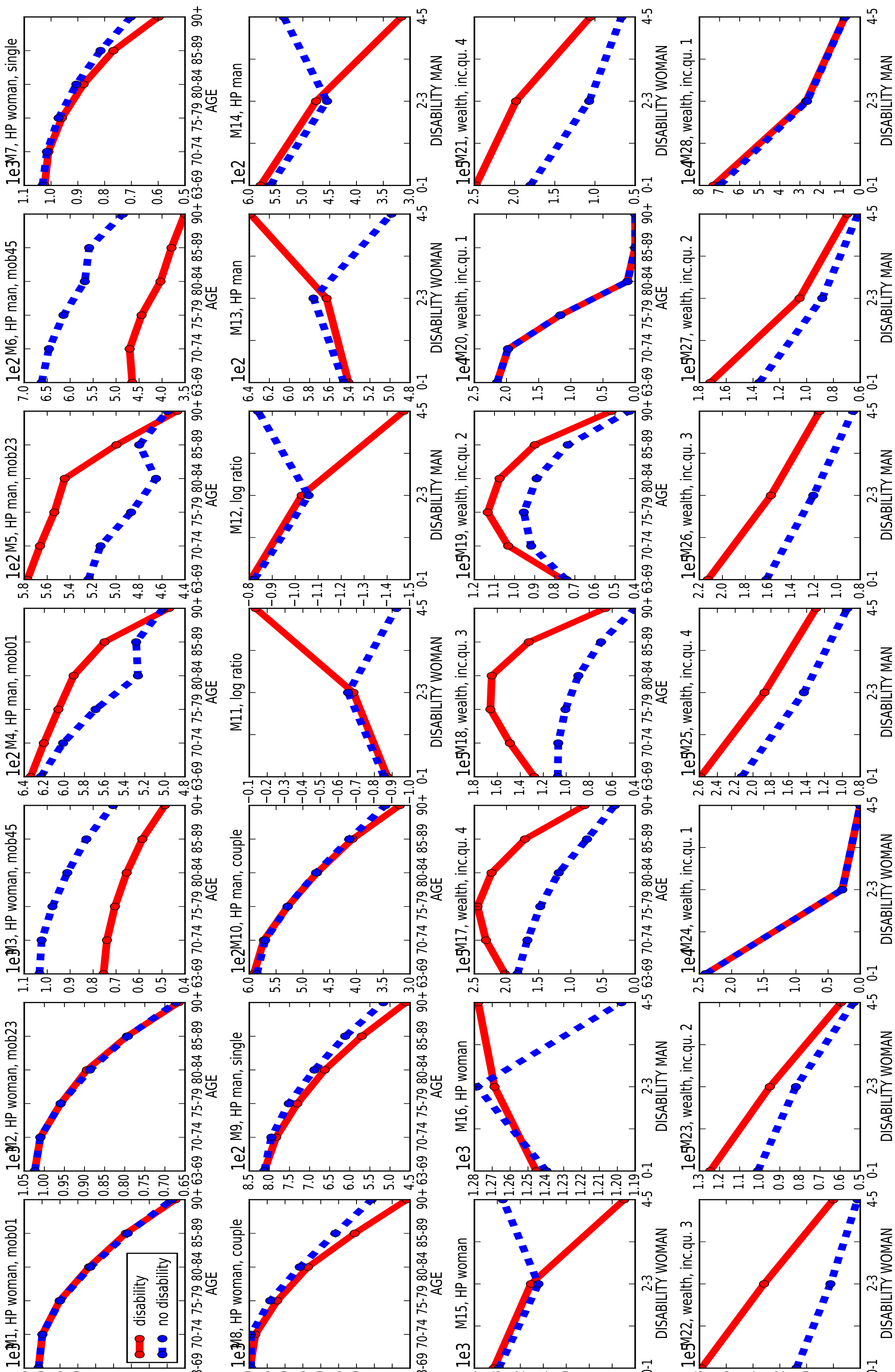

Figure 8: The Effect of Disability: Model with Bequest

of home production done by women at older ages, whether single or in a couple. This reflects the fact that older women have a high risk of being disabled. The insurance channel provided by men disappears (M13). In particular, we see that hours of home production done by men fall when their wives are "disabled" which reflects mainly the fact that households spend more due to a lower expected lifetime[20].

Second, we see that disability has a high impact on savings behaviours for the second to the fourth income quartile (M17 to M19). Thus, it appears that disability generates a strong precautionary motive. In the model with tail risk, the disability at age 90+ is actually the key driver of savings behaviours with an impact even larger than what we observe here (figure not displayed). This would be in line with De Nardi et al. (2010) in which savings behaviours are driven by the rise in average medical expenses observed after age 90 (see figure 3 in their paper).

I then assess the effect of age. As we can see from figure 5, there is a strong decline of home production hours with age at every level of disability. In figure 9, I compare the model with bequest in the previous subsection to the same model in which $\delta_m^{age} = \delta_m^{age^2} = \delta_f^{age} = \delta_f^{age^2}$. We clearly see that home production of women for a given level of disability is now constant. The fact that we see an increase with age for men (M4 to M7) reflects the fact that more of them become single. The insurance channel is here amplified as the age effect was applying mainly to elderly individuals, thus those more likely to have a sick spouse. As a consequence, it was more costly for them to provide the insurance with this age effect.

Clearly, age in the model has a large impact on wealth. This is true in all versions of the model, even the one with tail risk. This suggests that the fact that the ability to perform HPA is expected to deteriorate with age at every declared level of disability affects also importantly savings behaviours.

Overall, we see that the model under hand is able to replicate most of the observed patterns in the data and attributes a lot of importance to disability and age. In the next subsection, I study how the insurance channel highlighted before affects the model.

6.3 The value of spousal insurance

As seen above, the model reproduces fairly well the fact that men increase the hours of home production they do when their wives become disabled, what I called spousal insurance. To evaluate the importance of such an insurance on life-cycle behaviours, I now shut it down. To do so, denote by $h^{\star}_{m,t}\left(x_t, \mathbf{s}_{m,t}, t\right)$ the optimal hours of home production, from the problem in section 2, done by a man in state $\mathbf{s}_{m,t}$ at age t when the household is spending x_t and when the wife is in *good health*, i.e. when mobila is equal to 0 or 1.

Now assume that the household problem is similar to the one in section 2 but with the additional constraint:

$$h_{m,t} = h^{\star}_{m,t}\left(x_t, \mathbf{s}_{m,t}, t\right),\ \forall\left(\mathbf{s}_{f,t}, \mathbf{s}_{m,t}\right),\ \forall t,\ \forall x_t$$

This constraint in fact imposes that hours of home production done by a man are always set to those normally done when his wife is in good health. That is, the man cannot increase hours spent

[20] Remember that longevity has not been affected in the above procedure.

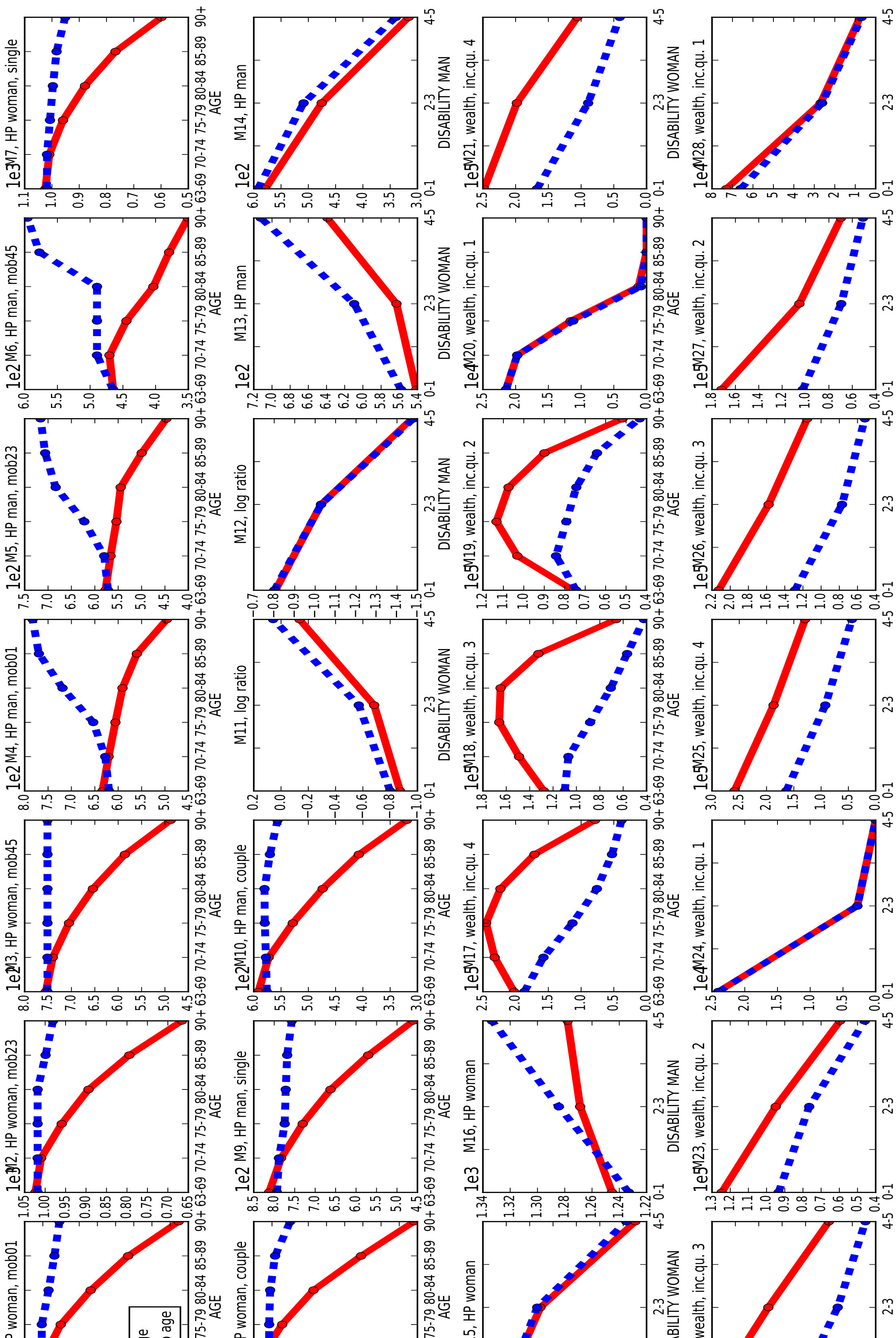

Figure 9: The Effect of Age: Model with Bequest

on home production if his wife gets sick. The insurance channel in this case is thus shut down. The utility fiction under this constraint can be written as:

$$u^{hh}\left(c_{f,t}, c_{m,t}, h_{f,t}, h_{m,t} | \mathbf{s}_t = (\mathbf{s}_{f,t}, \mathbf{s}_{m,t}), t\right) = \phi\left(\frac{c_{f,t}^{1-\gamma}}{1-\gamma} - A_f\left(\mathbf{s}_{f,t}, t-\Delta t\right)\frac{h_{f,t}^{1+\eta}}{1+\eta}\right)$$
$$+(1-\phi)\left(\frac{c_{m,t}^{1-\gamma}}{1-\gamma} - A_m\left(\mathbf{s}_{m,t}, t\right)\frac{\left(h_{m,t}^{\star}\left(x_t, \mathbf{s}_{m,t}, t\right)\right)^{1+\eta}}{1+\eta}\right)$$

The constraints that apply in this case are:

$$h_t = h_{f,t} + h_{m,t}^{\star}\left(x_t, \mathbf{s}_{m,t}, t\right)$$
$$c_t = \left(h_t^{\rho} + \psi q_t^{\rho}\right)^{1/\rho}$$
$$c_t = c_{f,t} + c_{m,t}$$
$$q_t = \chi x_t$$

This problem can be solved in a very similar way to the one in section 2 except that now the hours done by the men are exogenously set. The value of spousal insurance can then be evaluated in two ways. First of all, I consider the value of spousal insurance from an intratemporal point of view.

Recall that $u^{hh}\left(x, \mathbf{s}_t, t\right)$ denoted the utility level stemming from the resolution of the problem in section 2 as a function of x, $\mathbf{s}_t$ and t. Let's denote the solution from the problem just above, in which the insurance from the husband has been removed, by $\tilde{u}^{hh}\left(x, \mathbf{s}_t, t\right)$. It is then possible to evaluate the value of spousal insurance at different vectors $\left(x, \mathbf{s}_t, t\right)$ by solving for Δx in the equation:

$$u^{hh}\left(x, \mathbf{s}_t, t\right) = \tilde{u}^{hh}\left(x + \Delta x, \mathbf{s}_t, t\right) \tag{18}$$

$\Delta x\left(x, \mathbf{s}_t, t\right)$ is the additional dollar amount that a household currently benefiting from spousal insurance would require to give up this spousal insurance in a one-period setting. This is a natural way in the theoretical framework of this paper to evaluate the benefits stemming from this insurance channel. In table 10, I show the value of this intratemporal insurance at different values of x and for different ages of the wife. I consider in each case that the man is healthy and that his wife has mobila equal to 4 or 5. This is arguably the case in which the insurance channel is the strongest. The results (i.e. the value of Δx) are in dollars.

First of all, we see that these numbers are usually not small. Hence, the fact that men can increase hours of home production when their wives are disabled provides large welfare gains intratemporally. For the first two versions of the model, we see however that those gains are falling with age. This reflects the fact that disability is increasing with age, and hence that it becomes more difficult for the husband, as he ages, to provide this insurance.

Gains in the third version of the model are smaller before at age 70 and 80, but higher after age 90. Remember that, in this version of the model, ψ is higher in order not to generate extremely large precautionary behaviours. Hence, gains from spousal insurance are usually lower. However, when the wife is aged 90, the level of home production she can do falls close to zero if mobila is equal to 4 or

Table 10: The intratemporal value of spousal insurance

	Bequest	No Bequest	No Bequest + Tail
Age 70			
$x =$ \$20,000	\$11,003	\$13,786	\$4,507
$x =$ \$30,000	\$10,654	\$13,248	\$3,501
$x =$ \$60,000	\$11,766	\$13,966	\$3,349
Age 80			
$x =$ \$20,000	\$10,113	\$12,558	\$4,202
$x =$ \$30,000	\$9,663	\$11,929	\$3,166
$x =$ \$60,000	\$10,690	\$12,503	\$2,990
Age 90			
$x =$ \$20,000	\$8,556	\$10,315	\$28,538
$x =$ \$30,000	\$7,966	\$9,591	\$26,325
$x =$ \$60,000	\$8,681	\$9,911	\$21,971

Value of Δx in equation (18) at different ages for the wife and different values of expenditures x.

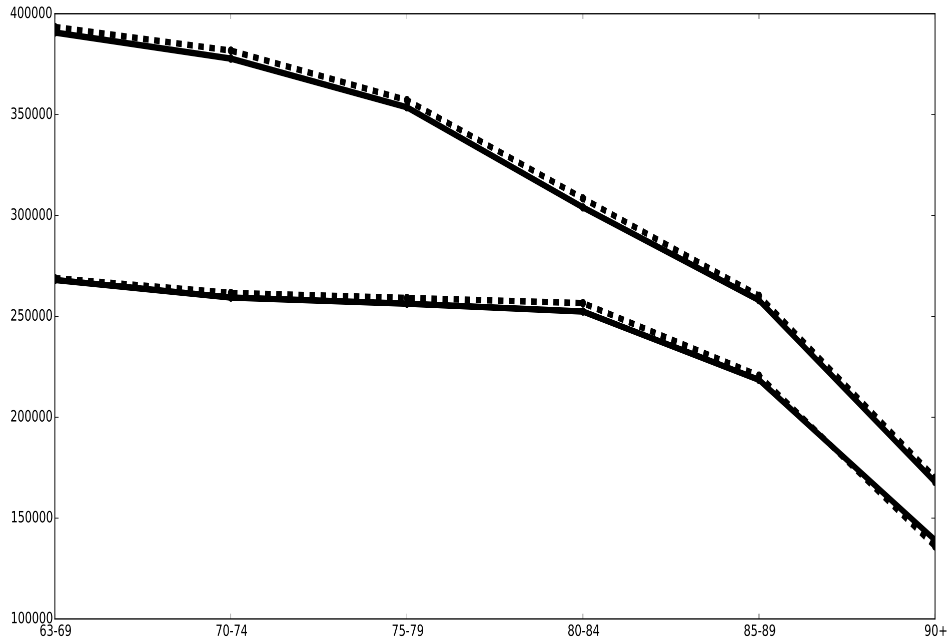

Figure 10: The effect of spousal insurance on wealth patterns

The y-axis is wealth and the x-axis is age. I use calibration (I) of table 9. The continuous lines represent wealth patterns of couple households in the third and fourth income quartiles in the model with insurance. The dotted lines are similar but for the model without insurance.

5. This feature was not well reproduced in the other two versions and that is why we see such large gains after age 90 in this version of the model.

However, studying the intratemporal case is not sufficient for our purpose. Indeed, the intratemporal case does not take into account the probability to provide this insurance, and hence cannot help us to understand the effect of this insurance on life-cycle savings. In figure 10, I show how wealth patterns differ for couples in the third and fourth income quartiles if the insurance channel is removed[21]. I use calibration (I) of table 9 which is the one which fits the data the best and which also reproduces well this insurance channel. Results do not differ qualitatively in the other versions. I show the results for calibration (III) of table 9 in appendix.

We see that removing this insurance channel has only minor effects on life-cycle behaviours. Even though wealth tends to rise when this insurance channel is removed, the change in wealth patterns is fairly small. The reason for this result is that, despite the large intratemporal gains from spousal insurance, its provision is very uncertain. This is evident from table 7 which shows that a woman aged 90 and disabled has only 5.2% chances of being in a couple. I found similar patterns in the other two versions of the model.

However, it is important to notice that spousal insurance does not only stem from the fact that

[21]Removing the insurance channel consists only in replacing u^{hh} by $\tilde{u}^{hh}$ in the intertemporal problem.

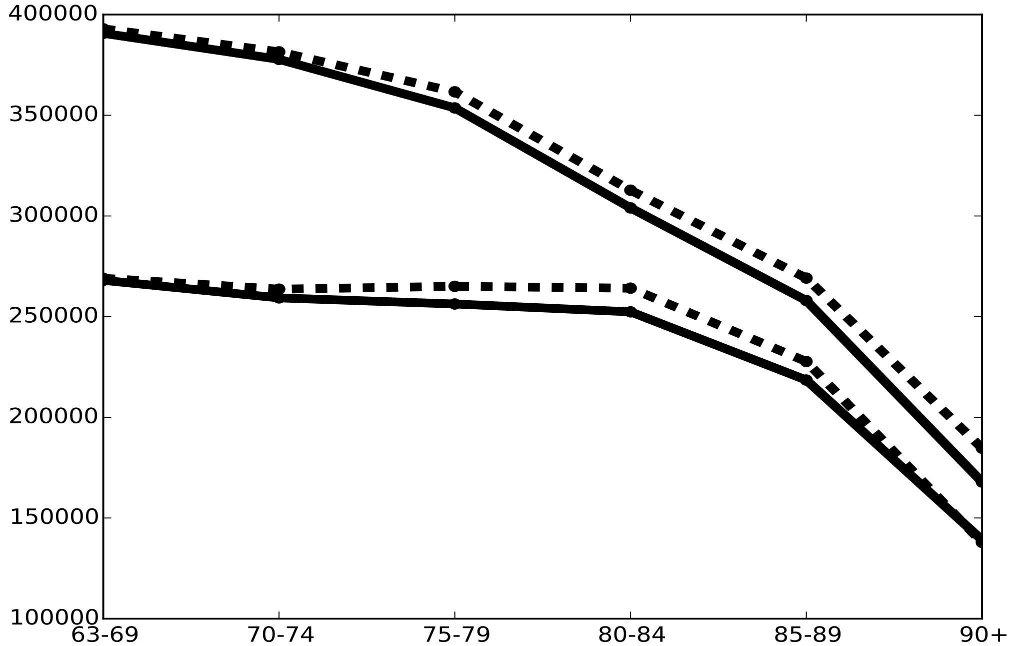

Figure 11: The effect of not perfectly correlated disability risk

The y-axis is wealth and the x-axis is age. I use calibration (I) of table 9. The continuous lines represent wealth patterns of couple households in the third and fourth income quartiles. The dotted lines are similar but for a model in which $A_m = A_f \exp\left(\delta_m^o - \delta_f^o\right)$.

spouses can increase the time they spend on home production when their spouses are disabled, but also from the fact that there is an imperfect correlation of risk. Said differently, if a spouse has a negative shock to her ability to do home production, the other has a positive probability not to be impaired at the same time. This means that hours of home production of this other spouse are maintained. I now compare the model under the calibration of column (I) of table 9 to a similar model but in which $A_m = A_f \exp\left(\delta_m^o - \delta_f^o\right)$. It means that I do not modify any of the transition probabilities but that when the wife has a negative shock to do home production, the husband faces a similar shock. I then compare dissavings behaviours of couples in the third and fourth income quartiles. The results from this exercise are displayed in figure 11. We see that changes in dissavings patterns are larger here. This suggests that the fact that risk is not perfectly correlated between spouses and that men face a lower risk of disability than their wives might affect more life-cycle savings. However, the change is fairly small. Hence, it appears that the spousal insurance at play here has much less effect on life-cycle behaviours than if we were to remove disability risk (see figure 8).

Finally, following the argument in Lakdawalla and Philipson (2002), I try to assess what would be the effect of having men facing similar longevity and disability risks than women. Remember that to estimate the transition probability matrix, I used logit regressions with dummies equal to 1 if the person was a woman, and to 0 otherwise. To perform, this exercise I keep the same estimates but

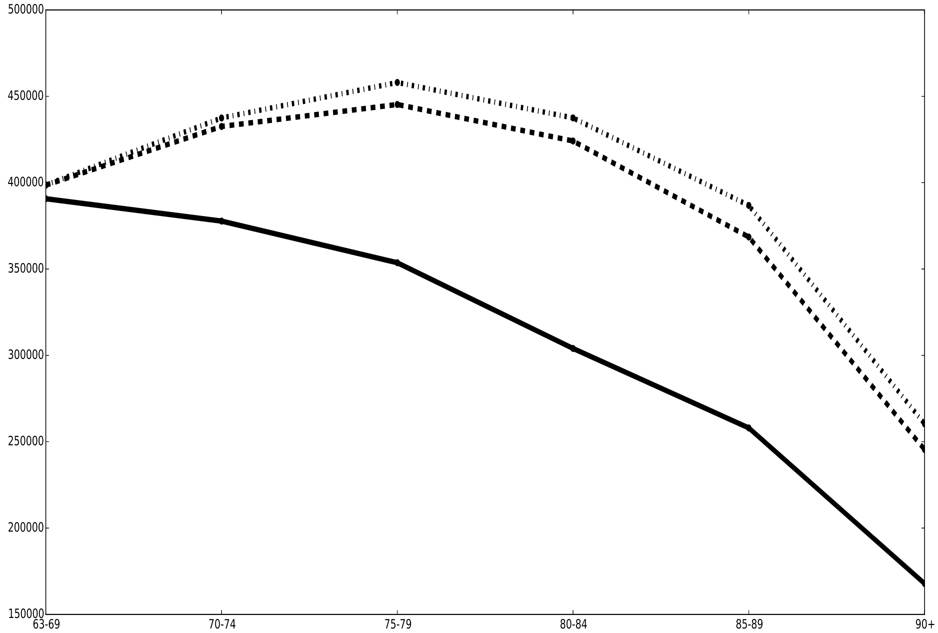

Figure 12: The effect of longevity

The y-axis is wealth and the x-axis is age. I use calibration (I) of table 9. The continuous line represents wealth patterns of couple households in the fourth income quartile with the original transition matrix. The dotted line is similar but with a transition matrix similar for men and women. The dotted-dashed line uses this latter transition matrix, and on top of this I assume that $A_m = A_f \exp\left(\delta_m^o - \delta_f^o\right)$.

assume that men are women, in the sense that I set these dummies to 1 for men as well when computing the transition matrix. I then simulate the model with this change. Once again, I use the calibration in column (I) of table 9. The results from this exercise for couples in the fourth income quartile are displayed in figure 12.

We clearly see that savings would increase if we make this change. It is simply due to the fact that higher longevity and a higher risk of disability for men increases the need for precautionary savings. Hence, if the rise in longevity for men leads to similar patterns of disability than for women, the need for savings would rise and not fall. So, it is not obvious that higher longevity of men would reduce savings by increasing the provision of informal insurance. Indeed, in the model here we find that savings would rise quite importantly. If we further assume that men have the same shocks to home production than their wives, then the needs for savings would increase even more.

Overall, we see that spousal insurance seems to have a fairly small effect on life-cycle savings despite non-trivial intratemporal gains from this insurance. Hence, it appears that having a spouse provides some insurance but that the correlation of risk, the fact that one might be single when disabled and that it is costly in terms of utility to increase hours of home production, all make this insurance a relatively weak one.

7 Conclusion

In this paper, I showed that a model with home production can reproduce well the main patterns in the data regarding home production and decumulation. In particular, I show that such a model can reproduce well the insurance-like mechanisms that take place within couples. However, I find that these mechanisms affect little dissavings behaviours as there is a high correlation of risk between spouses and as the chances for the wife to be widowed when disabled are large. This suggests that the potential insurance brought out by a spouse should not be over-evaluated in the design of entitlement reforms. Moreover, it suggests that the insurance brought out by a spouse has little chance to crowd-out the demand for other insurance products such as long-term care insurance.

This paper is one of the first attempts to study how retired couples might differ from retired singles, and to introduce informal insurance mechanisms within a life-cycle model. Definitely more research is needed within this area. In the paper, I showed that help from children seemed to influence home production hours done by women. Studying this channel further is on the agenda.

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A Robustness of the regressions

A.1 Home Production inside couples

In table 11, I show that using OLS the choice of $\underline{h}$ in the bottomcoding procedure in table 2 generates very different estimates[22]. Once again in column I, I do not bottomcode. In columns II to V, I bottomcode using respectively .0001, 10, 24 and 40. We clearly see that the choice of $\underline{h}$ affects greatly the magnitude of the estimated coefficients. This confirms that when using such a procedure median regressions are better suited.

Table 11: Log difference of hours of home production of husbands and wives

	I	II	III	IV	V
mob1f	0.159**	-0.256	0.0734	0.0943	0.106
	(0.0645)	(0.290)	(0.0910)	(0.0814)	(0.0765)
mob1m	-0.192***	-0.670**	-0.301***	-0.277***	-0.264***
	(0.0688)	(0.261)	(0.0893)	(0.0816)	(0.0777)
mob2f	0.191**	0.243	0.237**	0.236**	0.236**
	(0.0831)	(0.362)	(0.113)	(0.101)	(0.0953)
mob2m	-0.240***	-1.544***	-0.516***	-0.451***	-0.413***
	(0.0863)	(0.382)	(0.122)	(0.109)	(0.103)
mob3f	0.485***	1.542***	0.734***	0.682***	0.652***
	(0.107)	(0.488)	(0.159)	(0.142)	(0.133)
mob3m	-0.204*	-2.742***	-0.772***	-0.647***	-0.575***
	(0.118)	(0.652)	(0.178)	(0.153)	(0.140)
mob4f	0.797***	1.871***	1.052***	1.000***	0.970***
	(0.148)	(0.711)	(0.226)	(0.200)	(0.186)
mob4m	-0.370**	-3.333***	-1.009***	-0.861***	-0.775***
	(0.165)	(0.804)	(0.228)	(0.198)	(0.182)
mob5f	1.112***	7.979***	2.737***	2.404***	2.211***
	(0.211)	(1.130)	(0.317)	(0.272)	(0.248)
mob5m	-0.543***	-6.569***	-1.643***	-1.331***	-1.149***
	(0.207)	(1.498)	(0.354)	(0.291)	(0.256)
Constant	-0.864***	-0.968***	-0.876***	-0.870***	-0.867***
	(0.0462)	(0.156)	(0.0572)	(0.0530)	(0.0508)
Observations	2170	2400	2400	2400	2400
R^2	0.058	0.115	0.127	0.124	0.120

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

OLS. The dependent variable is the log ratio. Column I is without bottomcoding. In column II, III, IV, and V, I bottomcode with .00001, 10, 24, and 40 hours respectively.

In table 12, I bottomcode $\underline{h}$ to .00001 and perform the same median regression as in column II of table 2 but add controls. I increase the set of controls going from column I to column V. In column I, I just control for the age and age-square of both the husband and wife. In column II, I also add cohort effects. In column III, I also add wave fixed-effects. In column IV, I also add controls for income quartile, wealth quartile and relative pension of the two spouses. In column V, I finally add as

[22] All standard errors in the OLS regressions are robust and clustered at the household level.

a regressor whether a given spouse declares to have some memory difficulty[23].

We first see that the coefficients on the disability dummies are very robust across the different specifications. So the results presented in the main text regarding the log ratio are robust to the inclusions of a large set of different controls. Second, we can see that the presence of memory difficulties also affect the log ratio. I do not include this dimension in the simulated model in order not to increase the state space[24], but it could be included in future works.

Table 13 is similar to table 12. The same bottomcoding is use and the same sets of controls. However, I include also home maintenance and car maintenance. None of the conclusions are changed. I do not include home maintenance and car maintenance in the main measure of home production as those two activities can be considered as some sort of investment and as the model does not feature durable goods.

Table 14 is exactly similar to table 3 in the main text except that I use OLS rather than fixed effects. The patterns are very similar to those obtained with median regressions.

Table 15 is similar to table 3. However, in this case, I control for age, its square, cohort effects, wave fixed effects, income quartile, wealth quartile and the ratio of income between husbands and wives. Adding all these controls does not modify the any of the conclusions of the main text.

Finally, table 16 is similar to 15 but I use as a measure of home production the core measure plus home maintenance and car maintenance. Results are similar.

B Data Selection

Here, I describe here the procedure to construct the database. I mention the names of the files used. Though, they are not publicly available, they are intended to be if this work gets published in the future.

B.1 Restrictions which apply to both samples

File used: DATA_SELECTION.DO and the other cleaned files. The base file is the RAND HRS database which is at the individual level. I drop observations for which we do not have the couple/single variable. Retired individuals are considered to be those between 63 and 100 declaring 0 earnings. For couples, I also impose that the spouse must have 0 earnings. I drop observations for which the cohort is unknown (if fact 0 observation deleted). All dollar measures are converted in 1998 dollars using the price index for personal consumption expenditures for major types of products from the Bureau of Economic Analysis (BEA). I consider households from 4 cohorts : AHEAD (born before 1924), CODA (born between 1924 and 1930), HRS (born between 1931 and 1941) and war babies (born between 1942 and 1947).

[23] In later waves, this variable has been replaced by a question about Alzheimer. For those answering that they have Alzheimer in later waves I set that they have memory issues. For the others, I assume that they have no memory problems.

[24] We would need in this case to multiply by 2 each dimension of the transition matrix.

Table 12: Log difference of hours of home production of husbands and wives

	I	II	III	IV	V
$mob1f$	0.0484	0.0425	0.0584	0.0470	0.0310
	(0.0804)	(0.0818)	(0.0841)	(0.0797)	(0.0811)
$mob1m$	-0.219***	-0.226***	-0.264***	-0.220***	-0.250***
	(0.0786)	(0.0841)	(0.0769)	(0.0808)	(0.0834)
$mob2f$	0.159*	0.140	0.126	0.122	0.140
	(0.0940)	(0.0953)	(0.0995)	(0.0993)	(0.103)
$mob2m$	-0.359***	-0.359***	-0.375***	-0.312***	-0.335***
	(0.0972)	(0.0998)	(0.107)	(0.110)	(0.112)
$mob3f$	0.596***	0.590***	0.576***	0.644***	0.644***
	(0.119)	(0.123)	(0.111)	(0.123)	(0.134)
$mob3m$	-0.378**	-0.357**	-0.421**	-0.311*	-0.367**
	(0.173)	(0.160)	(0.183)	(0.159)	(0.173)
$mob4f$	0.865***	0.869***	0.839***	0.917***	0.938***
	(0.130)	(0.128)	(0.129)	(0.160)	(0.157)
$mob4m$	-0.701***	-0.700***	-0.694***	-0.640***	-0.753***
	(0.190)	(0.191)	(0.175)	(0.188)	(0.193)
$mob5f$	1.718***	1.699***	1.710***	1.712***	1.736***
	(0.411)	(0.412)	(0.356)	(0.485)	(0.498)
$mob5m$	-1.793***	-1.786***	-1.821***	-1.764***	-1.830***
	(0.405)	(0.414)	(0.416)	(0.646)	(0.606)
age of the wife	-0.374***	-0.397**	-0.403**	-0.465**	-0.397*
	(0.121)	(0.199)	(0.192)	(0.196)	(0.209)
age of the husband	0.265*	0.273	0.217	0.198	0.169
	(0.153)	(0.215)	(0.212)	(0.226)	(0.235)
age of the wife squared	0.00265***	0.00282**	0.00290**	0.00334**	0.00286**
	(0.000818)	(0.00138)	(0.00133)	(0.00136)	(0.00145)
age of the husband squared	-0.00185*	-0.00192	-0.00158	-0.00147	-0.00123
	(0.00100)	(0.00144)	(0.00143)	(0.00154)	(0.00159)
husband has memory difficulties					-0.945***
					(0.294)
wife has memory difficulties					1.320***
					(0.435)
Constant	2.853	3.487	5.860	8.542	7.089
	(5.209)	(6.462)	(6.255)	(6.498)	(6.388)
Observations	2400	2400	2400	2367	2339
R^2	0.107	0.107	0.110	0.109	0.153

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Median Regressions. The dependent variable is the log ratio with $\underline{h}$ set to .00001. I increase the set of controls going from column I to column V. In column I, I just control for the age and age-square of both the husband and wife. In column II, I also add cohort effects. In column III, I also add wave fixed-effects. In column IV, I also add controls for income quartile, wealth quartile and relative pension of the two spouses. In column V, I finally add as a regressor whether a given spouse declares to have some memory difficulty

Table 13: Log difference of hours of home production of husbands and wives

	I	II	III	IV	V
$mob1f$	0.0172	0.0158	0.0728	0.0861	0.0643
	(0.0750)	(0.0745)	(0.0777)	(0.0789)	(0.0793)
$mob1m$	-0.179**	-0.181**	-0.214***	-0.216***	-0.225***
	(0.0698)	(0.0724)	(0.0738)	(0.0726)	(0.0750)
$mob2f$	0.115	0.106	0.125	0.162	0.158
	(0.0918)	(0.0927)	(0.0900)	(0.101)	(0.102)
$mob2m$	-0.299***	-0.313***	-0.272***	-0.326***	-0.340**
	(0.104)	(0.106)	(0.101)	(0.127)	(0.133)
$mob3f$	0.591***	0.579***	0.555***	0.639***	0.669***
	(0.102)	(0.105)	(0.107)	(0.108)	(0.117)
$mob3m$	-0.391**	-0.396**	-0.391**	-0.405**	-0.488**
	(0.161)	(0.159)	(0.184)	(0.191)	(0.194)
$mob4f$	0.742***	0.738***	0.759***	0.800***	0.799***
	(0.127)	(0.141)	(0.136)	(0.141)	(0.157)
$mob4m$	-0.621***	-0.630***	-0.662***	-0.670***	-0.801***
	(0.196)	(0.197)	(0.184)	(0.175)	(0.220)
$mob5f$	1.476***	1.475***	1.460***	1.591***	1.487***
	(0.405)	(0.358)	(0.345)	(0.362)	(0.388)
$mob5m$	-1.712***	-1.714***	-1.712***	-1.581***	-1.520**
	(0.603)	(0.608)	(0.603)	(0.490)	(0.617)
age of the wife	-0.374***	-0.416**	-0.409**	-0.447**	-0.383
	(0.124)	(0.194)	(0.187)	(0.200)	(0.238)
age of the husband	0.344**	0.374*	0.274	0.329	0.274
	(0.163)	(0.223)	(0.200)	(0.227)	(0.251)
age of the wife squared	0.00266***	0.00297**	0.00299**	0.00326**	0.00281*
	(0.000842)	(0.00136)	(0.00129)	(0.00138)	(0.00165)
age of the husband squared	-0.00240**	-0.00260*	-0.00190	-0.00229	-0.00190
	(0.00107)	(0.00150)	(0.00135)	(0.00152)	(0.00169)
husband has memory difficulties					-1.024***
					(0.356)
wife has memory difficulties					1.742
					(1.173)
Constant	0.0760	0.373	3.606	2.746	2.457
	(5.836)	(6.998)	(5.931)	(7.073)	(6.304)
Observations	2349	2349	2349	2319	2291
R^2	0.109	0.108	0.111	0.117	0.169

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Median Regressions. The dependent variable is the log ratio with $\underline{h}$ set to .00001. I use as hours of home production the core measure plus time spent on home maintenance and car maintenance. I increase the set of controls going from column I to column V. In column I, I just control for the age and age-square of both the husband and wife. In column II, I also add cohort effects. In column III, I also add wave fixed-effects. In column IV, I also add controls for income quartile, wealth quartile and relative pension of the two spouses. In column V, I finally add as a regressor whether a given spouse declares to have some memory difficulty

Table 14: Home production of husbands and wives

	I	II	III	IV	V	VI
mob1f	56.49	56.60	45.80	-50.91	-49.43	-82.85
	(36.12)	(36.51)	(43.53)	(47.04)	(47.46)	(53.02)
mob1m	-98.81***	-98.18***	-126.4***	81.89	85.90*	117.1**
	(34.71)	(35.15)	(41.16)	(50.60)	(51.17)	(59.25)
mob2f	70.69	83.97*	27.03	-120.3**	-101.5*	-118.9*
	(43.76)	(44.83)	(51.65)	(59.89)	(60.50)	(70.91)
mob2m	-105.8**	-98.67**	-101.6*	124.0**	136.5**	124.4*
	(46.45)	(47.55)	(55.98)	(60.13)	(60.26)	(68.05)
mob3f	199.3***	210.2***	217.8***	-251.4***	-249.4***	-268.1***
	(65.70)	(67.35)	(84.03)	(73.76)	(74.81)	(84.40)
mob3m	-179.8***	-170.7***	-200.5***	115.6	134.9*	98.41
	(56.76)	(57.82)	(66.51)	(76.37)	(77.63)	(82.96)
mob4f	251.7***	266.2***	205.9***	-437.3***	-417.0***	-434.3***
	(67.24)	(68.82)	(74.19)	(83.92)	(84.31)	(89.17)
mob4m	-159.0*	-151.2*	-99.62	180.4*	186.9**	177.8*
	(86.31)	(86.59)	(99.56)	(93.38)	(92.13)	(100.5)
mob5f	375.2***	397.0***	297.9***	-783.8***	-726.1***	-647.0***
	(83.64)	(84.25)	(101.5)	(108.5)	(110.2)	(145.1)
mob5m	-438.5***	-416.8***	-371.4***	1.089	70.12	187.2
	(66.31)	(68.50)	(83.16)	(129.5)	(123.9)	(157.8)
Constant	684.4***	686.5***	707.3***	1391.4***	1419.8***	1424.8***
	(26.79)	(30.03)	(32.71)	(34.46)	(37.20)	(39.70)
Observations	2409	2372	1742	2409	2372	1742
R^2	0.036	0.038	0.029	0.045	0.053	0.037

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

OLS regressions. In column I to III the depend variable is hours done by husbands. In column IV to VI, the dependent variable is hours done by wives. In column III and VI, I remove households having a LTCI and/or receiving help from the family or from friends.

Table 15: Home production of husbands and wives

	I	II	III	IV	V	VI
mob1f	60.17**	53.15*	56.76	-85.78	-85.83*	-161.4**
	(30.07)	(30.28)	(40.71)	(52.64)	(50.50)	(64.58)
mob1m	-75.65**	-77.94**	-91.98**	85.47	118.7**	183.0**
	(32.02)	(31.49)	(40.99)	(53.30)	(52.12)	(72.35)
mob2f	56.17	76.11**	-1.403	-137.5**	-58.96	-124.6
	(34.40)	(33.59)	(39.12)	(67.65)	(63.79)	(77.35)
mob2m	-130.0***	-117.4***	-100.9**	159.3**	153.5***	170.3**
	(37.74)	(37.84)	(49.30)	(65.01)	(58.38)	(80.83)
mob3f	156.6**	150.7**	116.9	-280.3***	-275.1***	-289.2***
	(66.77)	(58.69)	(87.01)	(79.80)	(84.26)	(90.71)
mob3m	-109.5	-107.3	-118.4*	167.3**	208.6**	180.0**
	(70.12)	(70.02)	(63.66)	(79.80)	(90.21)	(91.30)
mob4f	281.9***	264.2***	250.4***	-448.8***	-436.0***	-505.6***
	(61.47)	(53.13)	(63.67)	(86.73)	(84.46)	(96.51)
mob4m	-222.0***	-222.5***	-146.0*	223.0**	222.0**	216.3*
	(81.64)	(58.78)	(75.29)	(108.1)	(99.32)	(113.0)
mob5f	390.3***	377.3***	336.6***	-767.0***	-601.3***	-660.0***
	(87.20)	(73.79)	(109.7)	(127.4)	(100.4)	(198.7)
mob5m	-431.2***	-415.6***	-288.4**	104.6	194.1	369.1**
	(59.09)	(63.81)	(128.3)	(165.8)	(122.1)	(155.7)
has some LTCI		-34.29			-149.9***	
		(28.12)			(44.62)	
receives help		-109.5			-428.2***	
from the family or friends		(87.64)			(110.4)	
Constant	-2882.7	-1768.9	-1163.1	-6099.3*	-7156.9**	-5107.0
	(2462.6)	(2576.1)	(3375.1)	(3469.0)	(3398.0)	(5350.6)
Observations	2375	2338	1715	2375	2338	1715
R^2	0.040	0.043	0.038	0.057	0.061	0.051

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Median regressions. In column I to III the depend variable is hours done by husbands. In column IV to VI, the dependent variable is hours done by wives. In column III and VI, I remove households having a LTCI and/or receiving help from the family or from friends. All regressions control for age, its square, cohort fixed effects, wave fixed effects, income quartile, wealth quartile and the ratio of income between husband and wives.

Table 16: Home production of husbands and wives

	I	II	III	IV	V	VI
$mob1f$	60.17**	53.15*	56.76	-85.78	-85.83*	-161.4**
	(30.07)	(30.28)	(40.71)	(52.64)	(50.50)	(64.58)
$mob1m$	-75.65**	-77.94**	-91.98**	85.47	118.7**	183.0**
	(32.02)	(31.49)	(40.99)	(53.30)	(52.12)	(72.35)
$mob2f$	56.17	76.11**	-1.403	-137.5**	-58.96	-124.6
	(34.40)	(33.59)	(39.12)	(67.65)	(63.79)	(77.35)
$mob2m$	-130.0***	-117.4***	-100.9**	159.3**	153.5***	170.3**
	(37.74)	(37.84)	(49.30)	(65.01)	(58.38)	(80.83)
$mob3f$	156.6**	150.7**	116.9	-280.3***	-275.1***	-289.2***
	(66.77)	(58.69)	(87.01)	(79.80)	(84.26)	(90.71)
$mob3m$	-109.5	-107.3	-118.4*	167.3**	208.6**	180.0**
	(70.12)	(70.02)	(63.66)	(79.80)	(90.21)	(91.30)
$mob4f$	281.9***	264.2***	250.4***	-448.8***	-436.0***	-505.6***
	(61.47)	(53.13)	(63.67)	(86.73)	(84.46)	(96.51)
$mob4m$	-222.0***	-222.5***	-146.0*	223.0**	222.0**	216.3*
	(81.64)	(58.78)	(75.29)	(108.1)	(99.32)	(113.0)
$mob5f$	390.3***	377.3***	336.6***	-767.0***	-601.3***	-660.0***
	(87.20)	(73.79)	(109.7)	(127.4)	(100.4)	(198.7)
$mob5m$	-431.2***	-415.6***	-288.4**	104.6	194.1	369.1**
	(59.09)	(63.81)	(128.3)	(165.8)	(122.1)	(155.7)
has some LTCI		-34.29			-149.9***	
		(28.12)			(44.62)	
receives help		-109.5			-428.2***	
from the family or friends		(87.64)			(110.4)	
Constant	-2882.7	-1768.9	-1163.1	-6099.3*	-7156.9**	-5107.0
	(2462.6)	(2576.1)	(3375.1)	(3469.0)	(3398.0)	(5350.6)
Observations	2375	2338	1715	2375	2338	1715
R^2	0.040	0.043	0.038	0.057	0.061	0.051

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Median regressions. In column I to III the depend variable is hours done by husbands. In column IV to VI, the dependent variable is hours done by wives. Home production is the core measure plus home maintenance and car maintenance. In column III and VI, I remove households having a LTCI and/or receiving help from the family or from friends. All regressions control for age, its square, cohort fixed effects, wave fixed effects, income quartile, wealth quartile and the ratio of income between husband and wives.

B.2 Restrictions for home production database

Order to use the files:

1. run *data_for_hh_reg.do*, this file keeps only the individuals for which we observe home production
2. then reorganize the database at the household level using *hh_file.py*
3. then run *data_for_hh_reg2.do*, this file keeps only the individuals for which we observe home production. This file generates the database used for the regression analysis (see below)
4. then run *hh_reg.do*. This file generates the results from the regression analysis and, at the end, generate the sample used for the structural estimation (see below)
5. then run *moment_computations_hp.do*. This file generates the database necessary for the moment computations in Python. In particular, it generates the data moments and the variance of the data moments.

B.2.1 For regression analysis

I drop all observations for which home production is not observed or for which home production is larger than 365*12. Using the python file hh_file.py I reorganize the database at the household level using household identification number. I keep only couples for which home production is known for both. I drop household for which couple variable is equal to zero for both. I drop also "couples" for which couple variable is not equal to 1 for both. I also remove couple households with more than 2 members and single households with more than 1 member.

B.2.2 For structural estimation

On top of the previous selection. I drop all household receiving help from family or friends. I also drop all households with some form of LTCI.

B.3 Estimation for transition probabilities and health

For this part I use data from 1998 onwards. I use as much data as possible.
The file used is *income_quartiles_transition_matrices_and_med.do*.

B.3.1 Income quartiles

I use the dataset generated by *DATA_SELECTION.DO*. I use the whole dataset to compute a measure of income quartiles. Income is pension income and its definition is similar to the one in De Nardi et al. (2010). It is the sum of social security benefits, defined-pension benefits, annuities, veteran's benefits, welfare and food stamps. Notice that the database used is at the individual level and not at the household level. I drop the households above the 95 percentile of the wealth distribution. And I drop also households for which income is higher than the 99 percentile.

For couples, I take all men (remember the data are at the individual level) in a couple and add their income to the one of their spouse. I then compute the different thresholds for income quartiles using this dataset for men. For singles the procedure is straightforward. The correlation between income quartile and its lag is about 66%.

B.3.2 Transition probability

I estimate two year transition probabilities at the individual level using a multinomial logit. There exists four different outcomes in $t+1$: i) being in mob01, ii) being in mob23, iii) being in mob45, iv) being dead.Hence I create a variable called dependent equal to 1,2,3 and 4 respectively. The regressors are:

- a cubic in age
- mob23 and mob45
- mob23*age and mob45*age
- income quartile * age
- whether a woman
- whether in couple
- income quartile dummies
- whether a woman * age
- whether in couple * age
- mob23 of the spouse (if any) * couple (if single this dummy is zero)
- mob45 of the spouse (if any) * couple (if single this dummy is zero)

The pseudo R^2 of this regression is about 22%.

B.3.3 Medical expense risk

I want to have a measure out-of-pocket medical expense risk which removes the highest share of what may be substituted by informal care. For singles, I consider only those not in nursing homes, without LTCI, and widowed. For couples I consider only those in which no member is in nursing home, in which none of the spouses have some form of LTCI. The log of out-of-pocket medical expenditures is regressed on:

- a cubic in age
- mob23 and mob45
- mob23*age and mob45*age
- mob23 of the spouse (if any) * couple (if single this dummy is zero)

- mob45 of the spouse (if any) * couple (if single this dummy is zero)
- whether in couple
- income quartile
- income quartile * age

The R^2 is about 11%. I then generate the error term and compute its standard deviation.

B.3.4 Notes on usage

income_quartiles_transition_matrices_and_med.do generates a database which is used to generate the final database for the estimation. After having run this program, run:

- *hh_file.py* from the same folder
- then run *generate_db_for_python.do:* I keep only couples for which wealth and income are known. I drop households for which the couple variable is equal to zero for both. Drop also "couples" for which the couple variable is not equal to 1 for both. I also remove couple households with more than 2 members and single households with more than 1 member. I drop all households receiving help from the family and having a LTCI.
- I then perform a series of task on this sample (see next section)

B.4 Estimation for income, initial distribution and initial wealth

B.4.1 Income

In the same program I compute mean income by income quartile using an OLS regression. I regress total household income on income quartile. I do it separately for single men, single women and couples. The R^2 for those regressions is higher than 65%.

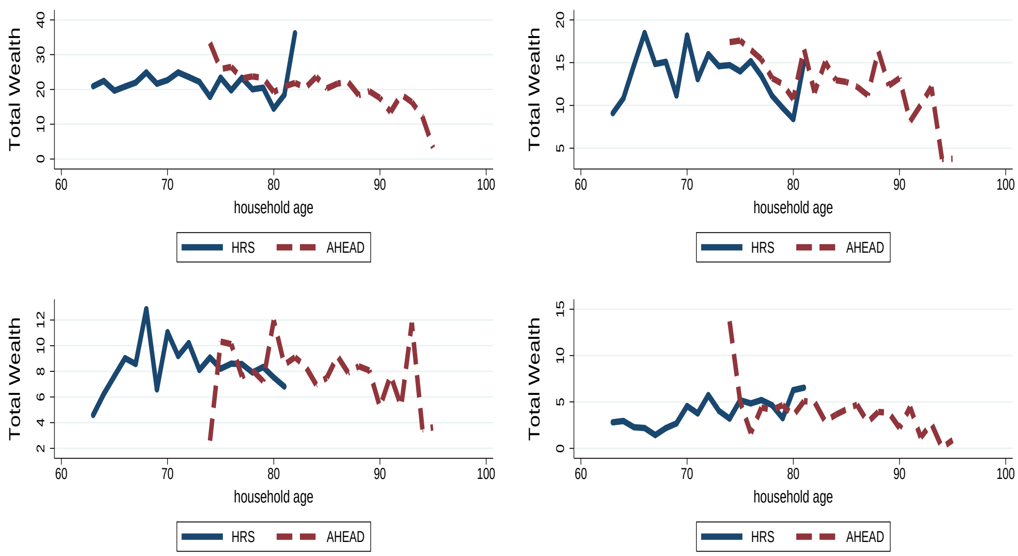
B.4.2 Initial states

In the same program, I compute the distribution of states (15 states remember) for those less than 70. I do so separately for each income quartile.

B.4.3 Wealth and cohort effects

There might be some issues with cohort effects in particular for wealth. However, cohort differences at similar ages seem small. To see this, I plot median wealth as a function of age separately for the HRS and AHEAD cohort for each income quartiles. The differences between the two curves at similar ages do not appear very important. In any case, they are of a comparable order. This is the main reason why I do not control for cohort differences.

Figure 13: Cohort effects for wealth



B.4.4 Initial wealth

I perform a median regression of wealth for those less than 70 on the 15 state dummies. I do so separately for each income quartile. This gives the median of wealth for each state. I then compute the error term and generate the percentiles of the distribution of error terms (once again, for each income quartiles separately). Each household initially will then draw randomly a state from the realistic initial distribution of states. Its wealth will then be equal to the median in its income quartile and state + a random draw from the distribution of error terms corresponding to its income quartile.

C Moments

In order to compute the moments I use a method similar to the one in De Nardi et al. (2010). I use data medians with the unit of analysis being a household. Each moment consists in the median of a variable X for households in a certain group. This group of households is characterized by a vector of dummy variables $\left(d^1, ..., d^N\right)$ with each equal to 1. Imagine that we are considering the median of wealth for households aged 63-69 in the fourth income quartile. In this case, we have X which is wealth. d_1 is the variable equal to 1 if the household is aged 63-69 and 0 otherwise. And d_2 is the variable equal to 1 if the household belongs to the fourth income quartile. Finally, notice that the sample considers only observed households.

Let $\bar{X}_{d^1,...,d^N}$ be the median of X for households in my *simulated* dataset with $\left(d^1, ..., d^N\right) = (1, ..., 1)$. Let X_i be the value of X for the ith household observation in my *original* dataset. In this case, the unconditional moment is:

$$\mathbb{E}_i\left[\left(1\left\{X_i \le \bar{X}_{d^1,...,d^N}\right\} - \frac{1}{2}\right) \times \prod_{j=1}^{N} d_i^j\right] = 0$$

with $1\left\{X_i \le \bar{X}_{d^1,...,d^N}\right\}$ an indicator variable equal to 1 if $X_i \le \bar{X}_{d_1,...,d_N}$ and 0 otherwise. For some households X_i is not observed, but these are households for which at least of the elements $\left(d^1, ..., d^N\right)$ is zero. In this case, the term inside the expectation will be zero. This is the case for instance when X is hours of home production of a woman and that the household considered is a single man.

Practically, the median is computed on the *simulated* data. I then compute the indicator variable and multiply it with the set of dummies for *real* households. And I then take the expectation.

For the computation of the variance, I use the median in the *original* dataset denoted $\hat{X}_{d_1,...,d_N}$. The variance for a given moment is then:

$$\begin{aligned} V\left(\hat{X}_{d^1,...,d^N}\right) = \mathbb{E}_k[(&\left(1\left\{X_k \le \hat{X}_{d^1,...,d^N}\right\} - \frac{1}{2}\right) \times \prod_{j=1}^{N} d_k^j - \\ &\mathbb{E}_i\left[\left(1\left\{X_i \le \hat{X}_{d^1,...,d^N}\right\} - \frac{1}{2}\right) \times \prod_{j=1}^{N} d_i^j\right])^2] \end{aligned} \tag{19}$$

Which can be simplified as by definition $\mathbb{E}_i\left[\left(1\left\{X_i \le \hat{X}_{d^1,...,d^N}\right\} - \frac{1}{2}\right) \times \prod_{j=1}^{N} d_i^j\right] = 0$:

$$V\left(\hat{X}_{d^1,...,d^N}\right) = \mathbb{E}_k\left\{\left(\left(1\left\{X_k \le \hat{X}_{d^1,...,d^N}\right\} - \frac{1}{2}\right)^2 \times \prod_{j=1}^{N} d_k^j\right)^2\right\}$$

D Derivation of the model

D.1 The problem of a single agent

The utility function of a single individual $i = f, m$ age t is:

$$u^i\left(c_{i,t}, h_{i,t}|\mathbf{s}_{i,t}, t\right) = \frac{c_{i,t}^{1-\gamma}}{1-\gamma} - A_i\left(\mathbf{s}_{i,t}, t\right)\frac{h_{i,t}^{1+\eta}}{1+\eta}$$

$$\max_{\{c_{i,t}, h_{i,t},\}} u^i\left(c_{i,t}, h_{i,t}|\mathbf{s}_{i,t}, t\right)$$

subject to:

$$c_{i,t} = \left(h_{i,t}^{\rho} + \psi q_t^{\rho}\right)^{1/\rho}$$

$$q_t = x_t$$

The first order condition (FOC) relative to $h_{i,t}$ is:

$$\rho h_{i,t}^{\rho-1}\frac{1-\gamma}{\rho}\frac{\left(h_{i,t}^{\rho}+\psi q_t^{\rho}\right)^{\frac{1-\gamma-\rho}{\rho}}}{1-\gamma}-A_i\left(\mathbf{s}_{i,t},t\right)h_{i,t}^{\eta}=0$$

$$h_{i,t}^{\rho-1-\eta}\left(h_{i,t}^{\rho}+\psi q_t^{\rho}\right)^{\frac{1-\gamma-\rho}{\rho}}=A_i\left(\mathbf{s}_{i,t},t\right) \tag{20}$$

This is a rootfinding problem which can be solved numerically.

I assume that $\gamma>1-\rho$ and $\rho>0$ as in the text. For each $A_i\left(\mathbf{s}_{i,t},t\right)>0$, a solution exists. Indeed:

$$\lim_{h_{i,t}\to 0^+} h_{i,t}^{\rho-1-\eta}\left(h_{i,t}^{\rho}+\psi q_t^{\rho}\right)^{\frac{1-\gamma-\rho}{\rho}}=+\infty$$

$$\lim_{h_{i,t}\to +\infty} h_{i,t}^{\rho-1-\eta}\left(h_{i,t}^{\rho}+\psi q_t^{\rho}\right)^{\frac{1-\gamma-\rho}{\rho}}=0$$

The solution is moreover unique. Indeed, differentiating we obtain:

$$(\rho-1-\eta)\,h_{i,t}^{\rho-2-\eta}\left(h_{i,t}^{\rho}+\psi q_t^{\rho}\right)^{\frac{1-\gamma-\rho}{\rho}}+(1-\gamma-\rho)\,h_{i,t}^{2\rho-2-\eta}\left(h_{i,t}^{\rho}+\psi q_t^{\rho}\right)^{\frac{1-\gamma-2\rho}{\rho}}<0$$

Practically speaking, I create a sparse grid for h. For each of those h, I compute $|h_{i,t}^{\rho-1-\eta}\left(h_{i,t}^{\rho}+\psi q_t^{\rho}\right)^{\frac{1-\gamma-\rho}{\rho}}-A_i\left(\mathbf{s}_{i,t},t\right)|$. I then pick the h which minimizes this absolute difference. Then from this h I use a Newton algorithm to approximate for the solution of 20.

It is then straightforward to compute consumption and utility.

D.2 The problem of a couple

From the text we know that:

$$\begin{aligned}u^{hh}\left(c_{f,t},c_{m,t},h_{f,t},h_{m,t}|\mathbf{s}_t=\left(\mathbf{s}_{f,t},\mathbf{s}_{m,t}\right),t\right)=\phi&\left(\frac{c_{f,t}^{1-\gamma}}{1-\gamma}-A_f\left(\mathbf{s}_{f,t},t-\Delta t\right)\frac{h_{f,t}^{1+\eta}}{1+\eta}\right)\\&+(1-\phi)\left(\frac{c_{m,t}^{1-\gamma}}{1-\gamma}-A_m\left(\mathbf{s}_{m,t},t\right)\frac{h_{m,t}^{1+\eta}}{1+\eta}\right)\end{aligned}$$

And the overall problem is:

$$\max_{\{c_t,c_{f,t},c_{m,t},h_t,h_{f,t},h_{m,t},q_t\}} u^{hh}\left(c_{f,t},c_{m,t},h_{f,t},h_{m,t}|\mathbf{s}_t=\left(\mathbf{s}_{f,t},\mathbf{s}_{m,t}\right),t\right)$$

subject to:

$$h_t=h_{f,t}+h_{m,t}$$

$$c_t=\left(h_t^{\rho}+\psi q_t^{\rho}\right)^{1/\rho}$$

$$c_t=c_{f,t}+c_{m,t}$$

$$q_t=\chi x_t$$

First: we have:

$$\phi\left(...-A_f\frac{h_{f,t}^{1+\eta}}{1+\eta}\right)+(1-\phi)\left(...-A_m\frac{(h_t-h_{f,t})^{1+\eta}}{1+\eta}\right)$$

Taking the derivative and setting it equal to zero gives:

$$\phi A_f h_{f,t}^{\eta}=(1-\phi)\,A_m h_{m,t}^{\eta}$$

Hence:

$$h_{f,t}=\left(\frac{(1-\phi)\,A_m}{\phi A_f}\right)^{1/\eta}h_{m,t}$$

And

$$h_t=h_{f,t}+h_{m,t}=\left[1+\left(\frac{(1-\phi)\,A_m}{\phi A_f}\right)^{1/\eta}\right]h_{m,t}\Rightarrow h_{m,t}=\left[1+\left(\frac{(1-\phi)\,A_m}{\phi A_f}\right)^{1/\eta}\right]^{-1}h_t$$

$$h_t=h_{f,t}+h_{m,t}=\left[1+\left(\frac{\phi A_f}{(1-\phi)\,A_m}\right)^{1/\eta}\right]h_{f,t}\Rightarrow h_{f,t}=\left[1+\left(\frac{\phi A_f}{(1-\phi)\,A_m}\right)^{1/\eta}\right]^{-1}h_t$$

Utility can then be rewritten:

$$\phi\left(...-A_f\frac{h_{f,t}^{1+\eta}}{1+\eta}\right)+(1-\phi)\left(...-A_m\frac{h_{m,t}^{1+\eta}}{1+\eta}\right)$$

$$=\phi\,(...)+(1-\phi)\,(...)-\phi A_f\frac{h_{f,t}^{1+\eta}}{1+\eta}-A_m\,(1-\phi)\,\frac{h_{m,t}^{1+\eta}}{1+\eta}$$

$$=...-\left[\phi A_f\left[1+\left(\frac{\phi A_f}{(1-\phi)\,A_m}\right)^{1/\eta}\right]^{-1-\eta}-(1-\phi)\,A_m\left[1+\left(\frac{(1-\phi)\,A_m}{\phi A_f}\right)^{1/\eta}\right]^{-1-\eta}\right]\frac{h_t^{1+\eta}}{1+\eta}$$

$$=...-\Omega\,(A_m,A_f)\,\frac{h^{1+\eta}}{1+\eta}$$

with

$$\Omega\,(A_m,A_f)=\phi A_f\left[1+\left(\frac{\phi A_f}{(1-\phi)\,A_m}\right)^{1/\eta}\right]^{-1-\eta}+(1-\phi)\,A_m\left[1+\left(\frac{(1-\phi)\,A_m}{\phi A_f}\right)^{1/\eta}\right]^{-1-\eta}$$

$$=\left[(\phi A_f)^{-1/\eta}+((1-\phi)\,A_m)^{-1/\eta}\right]^{-\eta}$$

We can do a similar thing for consumption:

$$\phi\left(\frac{c_{f,t}^{1-\gamma}}{1-\gamma}-...\right)+(1-\phi)\left(\frac{(c_t-c_{f,t})^{1-\gamma}}{1-\gamma}-...\right)$$

which gives:

$$\phi c_{f,t}^{-\gamma}=(1-\phi)\,c_{m,t}^{-\gamma}$$

Which gives:

$$c_{m,t}^{\gamma}=\frac{1-\phi}{\phi}c_{f,t}^{\gamma}$$

$$c_{m,t}=\left(\frac{1-\phi}{\phi}\right)^{1/\gamma}c_{f,t}$$

Leading to:

$$c_t=c_{f,t}+c_{m,t}=\left(1+\left(\frac{1-\phi}{\phi}\right)^{1/\gamma}\right)c_{f,t}\Rightarrow c_{f,t}=\left(1+\left(\frac{1-\phi}{\phi}\right)^{1/\gamma}\right)^{-1}c_t$$

$$c_t=c_{f,t}+c_{m,t}=\left(1+\left(\frac{\phi}{1-\phi}\right)^{1/\gamma}\right)c_{m,t}\Rightarrow c_{m,t}=\left(1+\left(\frac{\phi}{1-\phi}\right)^{1/\gamma}\right)^{-1}c_t$$

So we can rewrite our utility as:

$$\phi\frac{c_{f,t}^{1-\gamma}}{1-\gamma}+(1-\phi)\,\frac{c_{m,t}^{1-\gamma}}{1-\gamma}+...$$

$$=\phi\left(1+\left(\frac{1-\phi}{\phi}\right)^{1/\gamma}\right)^{\gamma-1}\frac{c_t^{1-\gamma}}{1-\gamma}+(1-\phi)\left(1+\left(\frac{\phi}{1-\phi}\right)^{1/\gamma}\right)^{\gamma-1}\frac{c_t^{1-\gamma}}{1-\gamma}+...$$

$$=\left[\phi\left(1+\left(\frac{1-\phi}{\phi}\right)^{1/\gamma}\right)^{\gamma-1}+(1-\phi)\left(1+\left(\frac{\phi}{1-\phi}\right)^{1/\gamma}\right)^{\gamma-1}\right]\frac{c_t^{1-\gamma}}{1-\gamma}+...$$

$$=\Phi\frac{c_t^{1-\gamma}}{1-\gamma}+...$$

with

$$\Phi=\left[\phi\left(1+\left(\frac{1-\phi}{\phi}\right)^{1/\gamma}\right)^{\gamma-1}+(1-\phi)\left(1+\left(\frac{\phi}{1-\phi}\right)^{1/\gamma}\right)^{\gamma-1}\right]$$

The utility function of the household is then:

$$=\Phi\frac{c_t^{1-\gamma}}{1-\gamma}-\Omega\left(A_m,A_f\right)\frac{h^{1+\eta}}{1+\eta}$$

The FOC relative to h is then:

$$\Phi\rho h_t^{\rho-1}\frac{1-\gamma}{\rho}\frac{\left(h_t^\rho+\psi q_t^\rho\right)^{\frac{1-\gamma-\rho}{\rho}}}{1-\gamma}-\Omega\left(A_m,A_f\right)h_t^\eta=0$$

Which gives:

$$h_t^{\rho-\eta-1}\left(h_t^\rho+\psi q_t^\rho\right)^{\frac{1-\gamma-\rho}{\rho}}=\Omega\left(A_m,A_f\right)\Phi^{-1}$$

Which is the FOC in the paper.

The solution method for h is similar to the case for singles.

Once h is solved for, it is easy to compute all the variables of interests.

D.3 The problem of a couple with no insurance

The utility in this case is:

$$u^{hh}\left(c_{f,t},c_{m,t},h_{f,t},h_{m,t}|\mathbf{s}_t=\left(\mathbf{s}_{f,t},\mathbf{s}_{m,t}\right),t\right)=\phi\left(\frac{c_{f,t}^{1-\gamma}}{1-\gamma}-A_f\left(\mathbf{s}_{f,t},t-\Delta t\right)\frac{h_{f,t}^{1+\eta}}{1+\eta}\right)$$

$$+\left(1-\phi\right)\left(\frac{c_{m,t}^{1-\gamma}}{1-\gamma}-A_m\left(\mathbf{s}_{m,t},t\right)\frac{\left(h_{m,t}^\star\left(x_t,\mathbf{s}_{m,t},t\right)\right)^{1+\eta}}{1+\eta}\right)$$

The constraints that apply in this case are:

$$h_t=h_{f,t}+h_{m,t}^\star\left(x_t,\mathbf{s}_{m,t},t\right)$$

$$c_t=\left(h_t^\rho+\psi q_t^\rho\right)^{1/\rho}$$

$$c_t=c_{f,t}+c_{m,t}$$

$$q_t=\chi x_t$$

The problem can be simply rewritten as:

$$\Phi\frac{c_t^{1-\gamma}}{1-\gamma}-\phi A_f\frac{h_{f,t}^{1+\eta}}{1+\eta}-\left(1-\phi\right)A_m\frac{\left(h_{m,t}^\star\left(x_t,\mathbf{s}_{m,t},t\right)\right)^{1+\eta}}{1+\eta}$$

subject to:

$$h_t=h_{f,t}+h_{m,t}^\star\left(x_t,\mathbf{s}_{m,t},t\right)$$

$$c_t=\left(h_t^\rho+\psi q_t^\rho\right)^{1/\rho}$$

$$c_t=c_{f,t}+c_{m,t}$$

$$q_t=\chi x_t$$

Then the optimality condition to find the hours of the woman is:

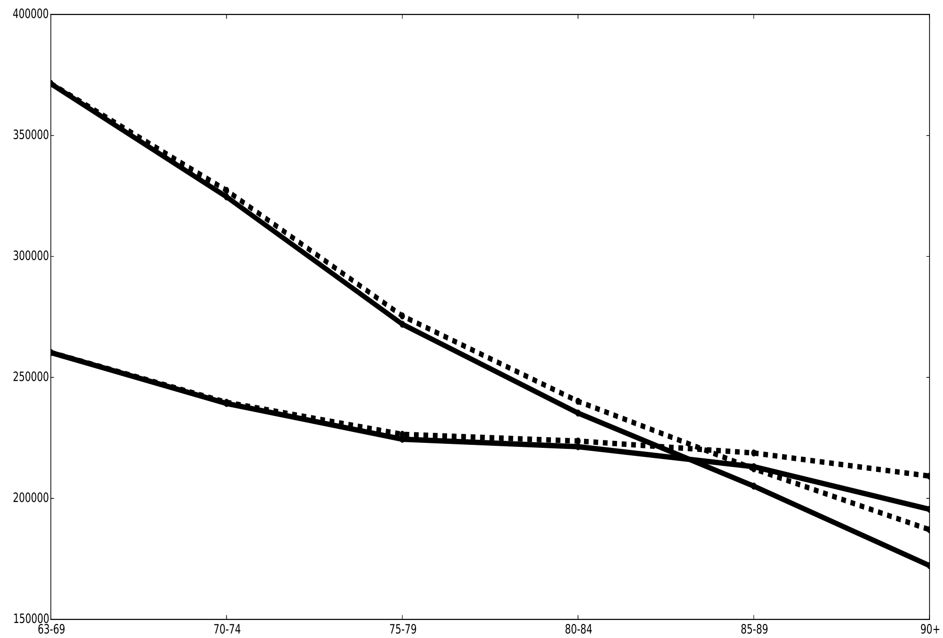


Figure 14: The effect of spousal insurance on wealth patterns

The y-axis is wealth and the x-axis is age. I use calibration (III) of table 9. The continuous lines represent wealth patterns of couple households in the third and fourth income quartiles in the model with insurance. The dotted lines are similar but for the model without insurance.

$$\Phi\left(h_{f,t}+h^{\star}_{m,t}\left(x_t,\mathbf{s}_{m,t},t\right)\right)^{\rho-1}\left(\left(h_{f,t}+h^{\star}_{m,t}\left(x_t,\mathbf{s}_{m,t},t\right)\right)^{\rho}+\psi q_t^{\rho}\right)^{(1-\gamma-\rho)/\rho}=\phi A_f h_{f,t}^{\eta}$$

Then we just need to solve for this root finding problem.

E Robustness Main Results from the Model

Here, I assess the robustness of the results in 6.3 by performing similar experiments but with calibration (III) of table 9.

In figure 14, I show how wealth patterns differ for couples in the third and fourth income quartiles if the insurance channel is removed[25].

We see that removing this insurance channel has only minor effects on life cycle behaviours. Even though wealth tends to rise when this insurance channel is removed, the change in wealth patterns is fairly small[26]. This result is similar to the one in the main text.

[25] Removing the insurance channel consists as in the text to replace u^{hh} by $\tilde{u}^{hh}$ in the intertemporal problem.

[26] The fact that wealth of couples in the third income quartile is higher than wealth of those in the fourth income quartile at advanced ages is mainly due to differences in pension income. As couples in the fourth wealth quartile have higher pension income, they are also better protected against risk.

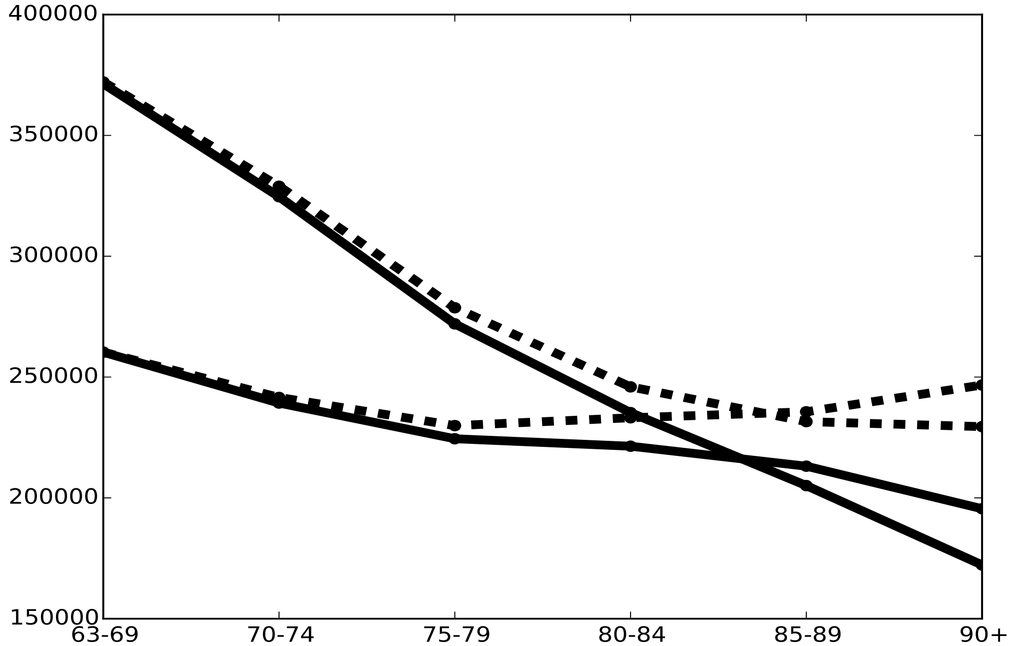


Figure 15: The effect of not perfectly correlated disability risk

The y-axis is wealth and the x-axis is age. I use calibration (III) of table 9. The continuous lines represent wealth patterns of couple households in the third and fourth income quartiles. The dotted lines are similar but for a model in which $A_m = A_f \exp\left(\delta_m^o - \delta_f^o\right)$.

I now compare the model under the calibration of column (III) of table 9 to a similar model but in which $A_m = A_f \exp\left(\delta_m^o - \delta_f^o\right)$. The results from this exercise are displayed in figure 15. We see that changes in dissavings patterns are larger here and slightly larger than what was found in the main text. But the effect is quite moderate until age 85-89.

Finally, I try to assess what would be the effect of having men facing similar longevity and disability risks than women. Figure 16 is similar to figure 12 but with the calibration (III) of table 9. The results are here quite similar to those in the main text.

F Numerical Solution

The solution method is standard. I work with two grids: a grid for cash-on-hand with 30 non-equally spaced grid points in order to have higher density at lower values; and a grid for expenditures with 130 non-equally spaced points in order to have higher density around lower values. The stochastic component of medical expenditures is represented by three grid points. Such grid points and the integration over this dimension follow the Gauss-Hermite quadrature method. For interpolation between grid points on the cash-on-hand grid I use linear interpolation. Increasing the number of grid points did not appear to affect substantially the decision rules. In order to avoid some numerical problems

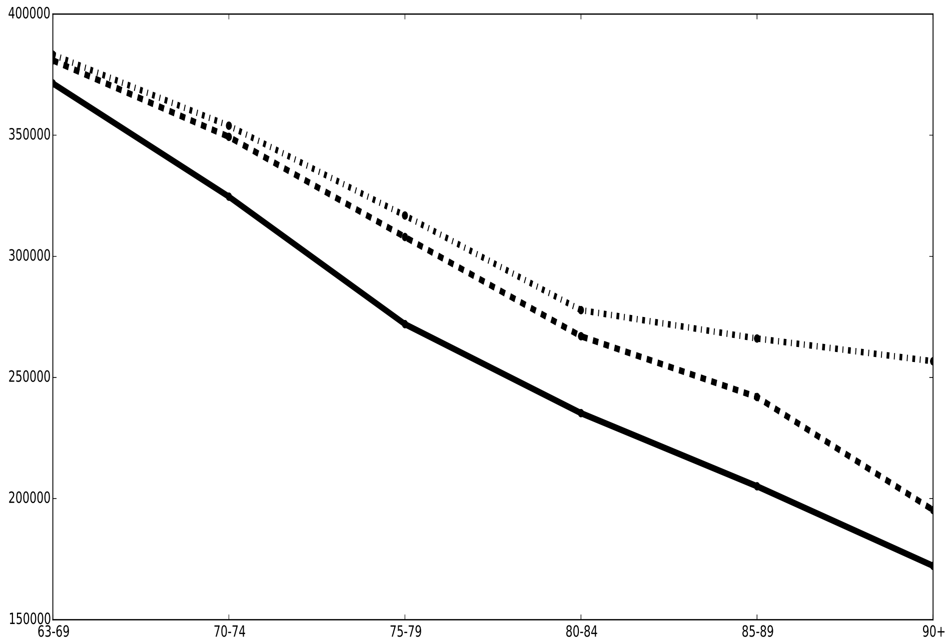


Figure 16: The effect of longevity

The y-axis is wealth and the x-axis is age. I use calibration (III) of table 9. The continuous line represents wealth patterns of couple households in the fourth income quartile with the original transition matrix. The dotted line is similar but with a transition matrix similar for men and women. The dotted-dashed line uses this latter transition matrix, and on top of this I assume that $A_m = A_f \exp\left(\delta_m^o - \delta_f^o\right)$.

stemming from division by large numbers I solve the model expressing h in 1,000 of hours and q in \$10,000.

The model is solved backwards starting from age T. For each level of cash-on-hand on the grid, for each exogenous state and age, I find the decision rules. Those decision rules are then used when simulating the model forward. I first store a set of household histories regarding the different shocks. These simulated histories are then used in all the estimation process. Using the decision rules, I can generate different databases which are used to see if the model fits the data well. For levels of cash-on-hand at the beginning of t which do not lie on the grid, I use linear interpolation to determine the decision rule.

Performing these different steps takes about 40 seconds on a laptop with 16GB of RAM and Core I7 processor. All codes are in Python. For the estimation, I first use a sparse grid for several of the parameters. For some others, I give educated guesses conditional of those parameters. This allows to limit the number of computations. I then pick the set of parameters which give the ten lowest values for the GMM criterion used. From each one of them, I then perform a Nelder-Mead simplex algorithm. I then pick the vector of parameter which gives the lowest value for the GMM criterion.