Long-Term Care and Myopic Couples

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This version: May 2015

Abstract

The paper proposes a theoretical model of LTC issues in the context of two elderly spouses (as opposed to the context of a parent and a child which has most often been analyzed so far) and studies public LTC policy optimal in that case. Spouses are assumed to be myopic about their probabilities of dependence as well as about negative health effects of caregiving burden. This results in a suboptimal outcome, namely, underinsurance and an inefficiently high caregiving effort exerted by the woman, who is the caregiver in the model. While under full information linear insurance subsidies and a linear caregiving tax can easily implement the first-best, it is most likely that in reality the government will not be able to observe the woman's caregiving. Thus, in the second-best, insurance subsidies are used to correct for both types of myopia. Interestingly, myopia about the negative effects of caregiving pushes for a subsidy on the man's but for a tax on the woman's insurance premium. The analysis reveals that, paradoxically, insurance against the woman's LTC risk may be at odds with the protection of her health, which sheds doubts on the popular tendency to emphasize more the importance of LTC insurance for the woman than for the man.

JEL codes: H21, I13, J14.

Keywords: long-term care, insurance, caregiving burden, spouses, myopia, optimal taxation.

Introduction

The ageing societies of today are increasingly becoming concerned by the issue of long-term care (LTC). LTC is the care for people who are dependent on the help of others in performing their basic daily activities (such as dressing, bathing, eating, etc.). The need for this kind of care is highly related with age,[1] which explains the growing concerns in the light of current demographic trends. Indeed, the estimates of the EU indicate that the number of dependent old people might increase by 90% or even 115% from 2007

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[†]I am grateful to my PhD advisors Helmuth Cremer and Jean-Marie Lozachmeur for their support and helpful comments and suggestions. I am also very thankful to Pierre Pestieau for his time and valuable remarks and suggestions.

[1]For instance, around half of all LTC users in the OECD countries are over 80 years old (Colombo et al., 2011).

to 2060, which means that the number of dependent elderly might possibly more than double (European Commission, 2009).[2]

LTC is currently provided and financed by three institutions, namely, the family, the state and the market (Cremer et al., 2012). However, each of these institutions is facing certain problems and challenges which need to be analyzed so that efficient ways to cope with them can be found. A growing body of both theoretical and empirical literature is trying to address these different LTC related issues. Nevertheless, a lot of questions still remain to be explored.

So far, the role of the family in LTC issues has most often been analyzed from the perspective of the parent-child relation and optimal public LTC policy has been studied in the context of single individuals. However, another important familial relation which so far has received less attention in the literature (especially theoretical one) is that of two spouses. Indeed, on average in the OECD countries the percentages of informal caregivers providing care to spouses and to parents are very close (respectively 31.6% and 36.1%) and in some countries the share of spousal caregivers even exceeds the share of those providing care to parents (Colombo et al., 2011). Moreover, the role of spousal caregiving is likely to become even more important due to such trends as an increased mobility of children or an increasing number of childless families. In addition to this, spousal interaction in LTC related issues is not limited to spousal caregiving. For instance, financial decisions which influence the level of wealth (and thus the ability to meet LTC needs) in the case of dependence, such as the purchase of LTC insurance, are usually made jointly by the two spouses and impact the well-being of both spouses as well. It therefore seems important to account for these considerations when public LTC policy is designed. The aim of the present paper is thus to propose a theoretical model of LTC related spousal interaction and to study what public LTC policy would be optimal in this context.

The context of spouses is associated with a number of issues. On one hand, the presence of a spouse to take care of his/her dependent partner can be an important source of help in the case of dependence allowing to reduce the need to rely on costly formal care, especially if the couple does not have children or the children live far away. On the other hand, this help is available only to the spouse who becomes dependent first. The other partner, the one who acted as a caregiver to his/her disabled spouse, cannot expect to receive the same kind of care if later he/she becomes disabled himself/herself since his/her spouse is already dependent, if not yet passed away. Moreover, not only a source of potential aid (i.e. help from the spouse) is absent for this spouse but also few financial resources may be left due to the first partner's LTC expenses. In addition to this, there is substantial evidence that (spousal) caregiving can cause negative effects on the caregiver's health,[3] with a number of these effects persisting even after the care recipient's death (Grant et al., 2002; Robinson-Whelen et al., 2001). Some studies also show that caregiving for a spouse is associated with more serious consequences than caregiving for a parent (Cannuscio et al., 2002; Lee et al., 2003). This constitutes another "hazard" for the spouse whose partner

[2] A 90% increase is predicted assuming that age-specific disability rates will decline in the future, while a 115% increase is expected if these rates remain constant (European Commission, 2009).

[3] See, for instance, Colombo et al. (2011), Mausbach et al. (2007), Sansoni et al. (2004), Shaw et al. (1999).

becomes dependent first. To make things worse, there is also evidence that caregivers tend to neglect their own health when providing care to others (Martinez-Marcos and De la Cuesta-Benjumea, 2014; Stein et al., 2000; Vanderwerker et al., 2005), which suggests that the negative effects of caregiving might be insufficiently taken into account by the caring spouse. Moreover, the caregiving burden seems to be underestimated *ex ante* as well. Despite the existing evidence about the detrimental effects of caregiving on the caregiver's health, many people expect their spouse to become their primary caregiver in case of dependence and also think that they will become primary caregivers of their spouses should this need arise.[4] In addition, there is evidence that people who have some experience with LTC are less likely to believe they can rely on their families if they become dependent than those with no LTC experience (The Associated Press-NORC Center for Public Affairs Research, 2014). This suggests that the real burden of caregiving is hard to realize before actually facing it.

As far as financial LTC consequences are concerned, a way to avoid them could be a purchase of private LTC insurance. Nevertheless, despite potentially large LTC costs[5] and a high probability to become dependent,[6] this insurance is actually bought only by a small fraction of individuals, which is sometimes called the LTC insurance puzzle. Along with other factors potentially contributing to this puzzle,[7] an important explanation seems to be the fact that people tend to be myopic, i.e. to underestimate their likelihood of needing LTC in the future. For instance, a study in the U.S. has revealed that only 35% of people believe they will need LTC whereas even 66% are expected to need some type of LTC after they reach age 65 (Genworth Financial, 2010).[8] While myopia about the probability of dependence has been considered in theoretical papers assuming single individuals (Cremer and Roeder, 2013; De Donder and Leroux, 2013), it seems interesting to look at its implications in the context of spouses as well. This is therefore attempted to do in the present paper.

The low demand for LTC insurance gives rise to various attempts by insurers and financial advisors to educate people in this respect. Interestingly, there seems to be a tendency to put more emphasis on the need to purchase LTC insurance for women than for men. Indeed, it is often stressed that LTC insurance is particularly important for women,[9] and some even advise that couples who cannot afford coverage for both spouses should purchase insurance for the woman only.[10] The reason usually given to explain such advice is the fact that, since women live longer than men and tend to be younger than their partners, they

[4] According to a survey in the U.S., 88% of men and 72% of women expect that if they become disabled, their spouse will be their primary caregiver; 90% of men and 94% of women think that they will become primary caregivers if their spouse loses autonomy (The MetLife Mature Market Institute and AARP Health Care Options, 2004).

[5] For instance, a nursing home stay in the U.S. costs between $40 000 and $70 000 per year, while the average cost in France is around €35 000 per year (Taleyson, 2003).

[6] The estimates of the probability for a 65-year-old person to enter a nursing home at some time before his/her death range between 35% and 49% (Brown and Finkelstein, 2007). Moreover, 66% of people are expected to need some type of LTC after the age of 65 (Genworth Financial, 2010).

[7] For recent surveys on the LTC insurance puzzle, see Cremer et al. (2012), Pestieau and Ponthière (2011), Brown and Finkelstein (2011).

[8] See also Finkelstein and McGarry (2003), Pestieau and Ponthière (2011), Zhou-Richter et al. (2010).

[9] See, for instance, American Council of Life Insurers (2014) and EHB Insurance Group (2010).

[10] Elder Law Answers (2013), Life Resources Group, LLC (2015).

usually provide care if their husbands need LTC, but then are left alone and thus need LTC insurance to pay for formal care.[11] While this reasoning seems to make sense at first sight, it is crucial to note that it does not take into account the negative effects that caregiving to her husband might have on the woman's health. Indeed, prioritizing insurance for the woman leaves the couple with insufficient resources at the time when LTC is needed by the man, which puts more caregiving pressure on his wife and thus deepens the negative impact on her health. Taking these concerns into consideration, the formal analysis in the present paper provides good reason to question the relevance of the above mentioned advice.

The model considers a representative elderly couple which does not have children. There are two periods. Since on average women live longer than men[12] and the female spouse tends to be younger than the male spouse,[13] it is assumed that the woman lives both periods whereas the man lives only one. Furthermore, it is assumed for simplicity that in the first period the woman remains independent with probability 1 whereas the man faces a non-zero probability to become dependent. The woman, however, might become dependent in the second period. While in the reality things are clearly more complex and the situation might differ in different countries, there seem to be reasons to think that the assumed scenario approximates quite well the situation in at least some countries. Firstly, even though the average age difference between spouses is not very big (2-3 years), it nevertheless speaks for the husband being older than the wife, and since the risk of dependence is highly related with age, this increases the chances that the man will become dependent earlier than the woman. Moreover, this scenario seems to be compatible with the statistics in a number of countries which show that at the age when there is a high risk to become dependent (and also among the already disabled elderly), most men still have a living spouse whereas a lot of women are already widowed (which suggests that their partners might have been ill and dependent before).[14] Apart from these reasons, the assumed setting allows to be compatible with the scenario underlying the above mentioned insurance recommendations and thus to better judge their relevance.

Before the beginning of the first period, both spouses are still healthy and consider purchasing private LTC insurance. However, they might underestimate their probabilities to become dependent. If in the first period the man becomes dependent, the couple faces LTC costs which nevertheless can be reduced if

[11] See the references in the two footnotes above.

[12] For instance, life expectancy at birth of women in the EU member states was on average 82.2 years in 2012, compared with 76.1 years for men, which makes the gender gap of 6.1 years. The gender gap in life expectancy at age 65 was on average 3.6 years (OECD, 2014b).

[13] The difference between the man's and the woman's age in industrialized countries tends to be 2-3 years on average (OECD, 2014a).

[14] For instance, in the U.S., 73% of men aged 75–84 were married in 2010, compared with only 38% of women. In contrast, 50% of women were widowed, compared with only 17% of men (Federal Interagency Forum on Aging-Related Statistics, 2012). In addition, a study of nine European countries (Belgium, Czech Republic, Germany, Finland, France, Italy, Netherlands, Portugal and UK) has shown that in 2000, on average in these countries, 69% of disabled men aged 75-84 were married and 21% widowed, while among disabled women in the same age group only 25% were married and even 61% were widowed. The study has also provided a projection for the year 2030 according to which these differences between men and women should decrease but still remain considerable (Gaymu et al., 2008). Some more evidence can be found in the French data according to which 2 out of 3 dependent men had a healthy spouse in 2000, compared with only 1 dependent woman out of 4 (Duée and Rebillard, 2006).

the woman provides care to her husband herself. However, consistently with the evidence presented above, caregiving is associated with negative consequences for the woman's health, and these consequences might be underestimated by the couple. Thus, the spouses might be myopic in two ways: first, about their probabilities of dependence and second, about the negative impact which caregiving has on the woman's health. To the best of my knowledge, the latter type of myopia has not yet been studied in a theoretical paper.

The *laissez-faire* outcome of this economy features a number of inefficiencies coming from the presence of the different types of myopia. While myopia about the negative health effects of caregiving results in the woman's caregiving effort being too high, the underestimation of the spouses' dependence probabilities causes a suboptimal distribution of resources between different states of nature. It is interesting to note that myopia about the probability of the man has consequences not only in the first period when he faces the LTC risk but also in the second period when the woman is left alone: since this myopia causes a suboptimal insurance in the first period, in the case of the man's dependence the couple has fewer resources to be saved for the second period, which results in the woman who had a dependent husband being financially worse-off than the one whose husband was healthy. Therefore, myopia about the man's risk reduces the woman's welfare even when there is no myopia about her own probability of dependence. If, however, this probability is also underestimated by the couple, the second period outcome deviates from optimality even more in the sense that the woman's LTC risk is then also insufficiently insured. A particular attention in that case should be drawn to the second period state of nature where the woman is dependent after having a disabled husband in the first period. A woman who appears in this state is a "victim" of a double suboptimality, that is, a suboptimal level of insurance against both her own and her husband's LTC risk. Thus, myopia about both spouses' dependence probabilities creates a "double hazard" for the woman. This hazard is important to be taken into account given that older women living alone face a particularly high risk of poverty.[15] Moreover, if we also add myopia about the negative impact that caregiving has on the woman's health, we can even talk about a "triple hazard": the (true) negative health effects of an inefficiently high caregiving effort (realized by the woman when it is too late) add to the financial consequences caused by myopia about dependence probabilities. This third source of hazard is also highly important to be considered, especially given the evidence from some studies that women are particularly vulnerable to the caregiving burden (Wang et al., 2014; Yee and Schulz, 2000).

By introducing several corrective instruments, the government can implement the first-best optimal allocation in this economy, but for this it needs to have full information and in particular to be able to observe the amount of care provided by the wife to her husband. The latter condition, however, might be difficult to be fulfilled. Therefore, the paper considers a second-best setting where the woman's caregiving is not observable to the government and studies an optimal linear policy directed at private insurance premiums. It is shown that if the couple is only myopic about the partners' probabilities of

[15] In 2009 in the EU, 29% of older (65+) female single households were at risk of poverty on average, with this risk even being over 50% in some countries (Rodrigues et al., 2012).

dependence (but not about the negative health effects of caregiving), the first-best can be implemented: it is then optimal to subsidize the spouses' insurance premiums at the first-best rates which implement full insurance. On the other hand, if the spouses are not myopic about their dependence probabilities but only underestimate the negative consequences of caregiving, the optimal subsidy rates are not zero as they would be in the first-best. In fact, quite a different treatment of the man's and the woman's insurance premiums is needed in this case: the man's insurance premium has to be subsidized whereas the woman's insurance premium has to be taxed. The reason is that in this case the only inefficiency comes from the woman's caregiving burden being too high, and the woman's caregiving is influenced differently by the insurance of each partner. In particular, insurance against the man's dependence decreases the woman's caregiving since it increases the resources available to the couple in the case of the man's dependence, which in turn implies less need to reduce the LTC costs by relying on the woman's aid. Given that the woman's burden is too high, insurance against the man's dependence has thus to be encouraged. In contrast, insurance against the woman's dependence has an opposite effect. Since it is meant to cover LTC for the woman, it pays no benefit in the case of the man's dependence and thus only represents a cost in that case. This decreases the resources available to the couple and therefore creates more need to reduce the man's LTC expenses by relying on the woman's caregiving. Since this caregiving is already too high, the purchase of insurance should be discouraged so that the decrease in the couple's wealth can be limited.

If the two types of myopia (that about the dependence probabilities and that about the negative effects of caregiving) are considered together, the optimal subsidy rates become more complicated and their signs are in general ambiguous. Nevertheless, it can be clearly seen that the "own probability myopia effect" is positive for both rates: myopia about the probability of the man's (respectively, the woman's) dependence pushes for a higher subsidy on the man's (respectively, the woman's) insurance premium. Moreover, for the man, this effect is reinforced by the correction for myopia about the negative caregiving impact on the woman's health which also calls for a higher subsidy on the man's premium. For the woman, however, the positive "own probability myopia effect" is mitigated by the need to correct for myopia about negative health effects: as explained above, this need pushes for a lower subsidy, if not even a tax, on the woman's insurance premium. The latter result reveals an interesting paradox: in the second-best setting, the protection of the woman's health requires a sacrifice of her insurance coverage or, looking at it the other way round, a purchase of too much insurance for the woman might contribute to her worsened health due to a higher burden of caregiving to her husband.

These are precisely the findings which allow to question the above mentioned tendency to emphasize more the importance of LTC insurance for the woman than for the man. Indeed, in the absence of myopia about dependence probabilities, these findings even suggest that insurance against the man's dependence should on the contrary be encouraged while insurance against the woman's dependence should be discouraged. Certainly, if people are myopic about the woman's probability to become dependent, the need to encourage the woman's insurance arises too, but, as just discussed above, it is still mitigated by the need to correct for myopia about negative health effects. Overall, even though clear-cut conclusions cannot be made, the results of the paper at least give no reason to believe that the woman's insurance should be encouraged more than the man's. Therefore, recommendations to privilege the woman's insurance should be taken with caution. Paradoxical as it may seem, this advice which at first sight seems to be in her favour might in the end appear to be against her if negative effects on her health are taken into account.

The paper is organized as follows. Section 1 describes the model while Section 2 derives the allocation which would be first-best optimal in the analyzed economy. Section 3 then discusses the outcome actually achieved without government intervention (i.e. the *laissez-faire*), whereas Section 4 studies how the first-best allocation can be decentralized under full information. The full information assumption is dropped in Section 5 which analyzes a second-best setting where the woman's caregiving is not observable to the government. Finally, the last section concludes while the Appendix provides some technical details not developed in the text.

1 The model

Consider a representative elderly couple with no children where the husband is indexed by m and the wife is indexed by f. There are 2 periods. For the reasons discussed in the Introduction, it is assumed that the woman lives both periods and the man lives only one. Moreover, it is assumed that in the first period the woman remains independent with probability 1 whereas the man becomes dependent with probability π_m. The woman, however, might become dependent in the second period (with probability π_f).

Just before the beginning of the first period, both spouses are still healthy and consider the possibility to purchase private LTC insurance B_m for the man and B_f for the woman.[16] While making their insurance decisions, the spouses might be myopic about their probabilities to become dependent. In particular, they consider that the probability to become dependent is $\hat{\pi}_m$ for the man and $\hat{\pi}_f$ for the woman, where $\hat{\pi}_m \leq \pi_m$ and $\hat{\pi}_f \leq \pi_f$.

In the beginning of the first period, the risk of the man's dependence either materializes or not. Thus, in the first period, there are two possibilities. First, with probability $1 - \pi_m$, the man remains independent. In that case, the spouses decide how to allocate their wealth between savings s^I for the second period (when the woman will be left alone) and their first period consumptions c_m^I and c_f^I.

Second, with probability π_m, the man becomes dependent. In that case, the couple faces LTC costs L_m. These costs can be reduced if the woman provides some caregiving to her husband herself. In particular, an amount a_f of her caregiving allows to reduce LTC costs by the amount $h(a_f)$, with

[16] Even though the woman never becomes dependent in the first period, it is assumed that she can purchase LTC insurance (for the second period) only before the beginning of the first period and not later. An explanation for this could be that, even though she is still independent, in the first period the woman is already old and thus might be already ineligible for insurance because of her age and/or her health history (e.g. she might have had a stroke, etc).

$h'(a_f) > 0$ and $h''(a_f) < 0$. However, caregiving is associated with negative consequences for the woman's health. These negative consequences are measured by a utility loss $\mu(a_f)$, with $\mu'(a_f) > 0$ and $\mu''(a_f) > 0$. Nevertheless, this negative effect might be underestimated by the couple. To capture this idea, it is assumed that while making their decisions, the spouses consider $\beta\mu(a_f)$ instead of the true impact $\mu(a_f)$ (with $\beta \leq 1$) and realize the true impact only at the end of the first period when it is already too late. Finally, similarly to the case of the man's independence, the couple's wealth has again to be allocated between savings s^D for the second period and the partners' first period consumptions c_m^D and c_f^D.

As mentioned above, it is assumed that after the first period the man dies. Thus, in the second period the woman is left alone. In this period she might also become dependent (with probability π_f). If this happens, she faces LTC costs L_f. In the second period the woman does not make any decisions; her consumption is determined by the choices made in the previous period.

The (true) expected utilities of the two partners can be written as follows:

$$EU_m = (1 - \pi_m)u(c_m^I) + \pi_m u(c_m^D) \tag{1}$$

$$\begin{aligned} EU_f = {} & (1 - \pi_m)\left[u(c_f^I) + (1 - \pi_f)u(d_f^{II}) + \pi_f u(d_f^{ID})\right] + \\ & + \pi_m\left[u(c_f^D) - \mu(a_f) + (1 - \pi_f)u(d_f^{DI}) + \pi_f u(d_f^{DD})\right] \end{aligned} \tag{2}$$

where d_f^{II}, d_f^{ID}, d_f^{DI} and d_f^{DD} denote the woman's consumption in the second period (the first superscript refers to the state of nature which was realized in the first period and the second superscript refers to the state of nature in which the woman is in the second period; e.g. d_f^{ID} denotes the woman's second period consumption when the man was healthy in the first period but she is dependent in the second one). The variables have to satisfy the following budget constraints:

$$c_m^I + c_f^I = W - \pi_m B_m - \pi_f B_f - s^I$$

$$c_m^D + c_f^D = W - \pi_m B_m - \pi_f B_f - L_m + h(a_f) + B_m - s^D$$

$$d_f^{II} = s^I$$

$$d_f^{ID} = s^I - L_f + B_f$$

$$d_f^{DI} = s^D$$

$$d_f^{DD} = s^D - L_f + B_f$$

where W is the couple's initial wealth. LTC insurance is assumed to be actuarially fair; thus, the premiums ($\pi_m B_m$ and $\pi_f B_f$) are equal to the expected benefits.

Decisions in the couple are made by maximizing the sum of the partners' utilities but considering $\hat{\pi}_m$, $\hat{\pi}_f$ and $\beta\mu(a_f)$ instead of π_m, π_f and $\mu(a_f)$.

The timing of the model is as follows:

1. Before the beginning of the first period, the couple chooses the amounts of private LTC insurance B_m and B_f.
2. In the first period, there are two possibilities:
   (a) If the man remains healthy:
      i. First, the couple chooses the amount which will be saved for the second period s^I. This determines the amount which is left for the spouses' first period consumption.
      ii. Then, the couple decides how this amount will be divided between the individual consumptions of the two spouses (c_m^I and c_f^I).

   (b) If the man becomes dependent:
      i. First, it is decided how much LTC the woman will provide to her husband. This determines how much LTC costs L_m will be reduced and thus, together with the initial wealth and (net) insurance benefits, defines the couple's wealth in this period.
      ii. Second, it is decided how much will be saved for the second period, i.e. s^D is chosen. This determines the amount which is left for the partners' first period consumption.
      iii. Finally, it is decided how this amount will be divided between the individual consumptions of the two spouses (c_m^D and c_f^D).
3. In the second period, the man dies and the woman is left alone. She either becomes dependent or remains independent. She does not make any decisions but simply consumes the second period wealth which is determined by the state of nature and by the choices made before.

2 The first-best

Let us now discuss what would be the first-best situation in the above described economy. To do this, let us consider a benevolent (utilitarian) government which has full information and a full control of all the choice variables. While the spouses might underestimate their probabilities to become dependent and the negative effects associated with caregiving, the government is assumed to know the true values and to use them in the maximization of (utilitarian) social welfare. The objective function of the government is thus as follows:

$$SW = (1-\pi_m)\left[u(c_m^I) + u(c_f^I) + (1-\pi_f)u(d_f^{II}) + \pi_f u(d_f^{ID})\right] +$$

$$+\pi_m \left[u(c_m^D) + u(c_f^D) - \mu(a_f) + (1-\pi_f)u(d_f^{DI}) + \pi_f u(d_f^{DD})\right] \tag{3}$$

The resource constraint is the following:

$$(1-\pi_m)c_m^I + \pi_m c_m^D + (1-\pi_m)c_f^I + \pi_m c_f^D + (1-\pi_m)(1-\pi_f)d_f^{II} +$$

$$+(1-\pi_m)\pi_f d_f^{ID} + \pi_m(1-\pi_f)d_f^{DI} + \pi_m \pi_f d_f^{DD} + \pi_m \left[L_m - h(a_f)\right] + \pi_f L_f = W \tag{4}$$

Denoting by λ the Lagrange multiplier associated with the resource constraint, from the FOCs for the consumption levels we get the following equalities:

$$u'(c_m^{I*}) = u'(c_m^{D*}) = u'(c_f^{I*}) = u'(c_f^{D*}) = u'(d_f^{II*}) = u'(d_f^{ID*}) = u'(d_f^{DI*}) = u'(d_f^{DD*}) = \lambda^* \tag{5}$$

where the star denotes the first-best level of the variables. It can thus be seen that all the marginal utilities of consumption are equalized in the first-best. In particular, this means that we have an equality between the marginal utilities of the man and the woman, between the states of nature of each period (i.e. full insurance) and between the two periods.

The socially optimal level of the woman's caregiving is defined by

$$\lambda^* h'(a_f^*) - \mu'(a_f^*) = 0 \tag{6}$$

Thus, the optimal level a_f^* is chosen so as to equalize the marginal benefit and the true marginal cost of caregiving burden.

3 The *laissez-faire*

Having determined the first-best solution, let us now compare it with the outcome which is actually achieved in this economy without government intervention. To derive this *laissez-faire* outcome, we have to respect the timing described in Section 1 and to move backwards. Since no decisions are made in the second period, we can start by considering the two states of nature of the first period.

3.1 The man remains healthy

In the first period state of nature where the man remains healthy, the objective function of the couple can be written as

$$u(c_m^I) + u(c_f^I) + (1-\hat{\pi}_f)u(d_f^{II}) + \hat{\pi}_f u(d_f^{ID}) \tag{7}$$

It has to be maximized subject to the following budget constraints:

$c_m^I + c_f^I = W - \pi_m B_m - \pi_f B_f - s^I$

$d_f^{II} = s^I$

$d_f^{ID} = s^I - L_f + B_f$

Given B_m, B_f and s^I, the amount which is left for the first period consumption is divided between the spouses so as to satisfy the FOC

$$u'(c_m^I) - u'(c_f^I) = 0 \tag{8}$$

This implies that we have

$$u'(c_m^I) = u'(c_f^I) \tag{9}$$

Thus, the marginal utilities of the two spouses are equalized, which is the first-best tradeoff.

Given B_m and B_f, the amount of savings for the second period s^I is chosen so as to satisfy the following FOC:

$$u'(c_m^I)\frac{\partial c_m^I}{\partial s^I} + u'(c_f^I)\frac{\partial c_f^I}{\partial s^I} + (1-\hat{\pi}_f)u'(d_f^{II}) + \hat{\pi}_f u'(d_f^{ID}) = 0 \tag{10}$$

It is shown in Appendix A that $\frac{\partial c_m^I}{\partial s^I} + \frac{\partial c_f^I}{\partial s^I} = -1$. Using this and equality (9), the FOC (10) reduces to

$$(1-\hat{\pi}_f)u'(d_f^{II}) + \hat{\pi}_f u'(d_f^{ID}) - u'(c_m^I) = 0 \tag{11}$$

It can thus be seen that the couple chooses the level of savings by equalizing its marginal cost in terms of both partners' first period consumption and its marginal benefit in terms of the woman's consumption in the two second period states of nature. The "weights" given to each state of nature are however determined by the subjective beliefs about the woman's probability of dependence.

3.2 The man becomes dependent

In the first period state of nature where the man becomes dependent, the objective function of the couple is

$$u(c_m^D) + u(c_f^D) - \beta\mu(a_f) + (1-\hat{\pi}_f)u(d_f^{DI}) + \hat{\pi}_f u(d_f^{DD}) \tag{12}$$

It has to be maximized subject to the following budget constraints:

$c_m^D + c_f^D = W - \pi_m B_m - \pi_f B_f - L_m + h(a_f) + B_m - s^D$

$d_f^{DI} = s^D$

$d_f^{DD} = s^D - L_f + B_f$

Given the amount which can be used for the first period consumption, this amount is divided between the spouses so as to satisfy the FOC

$$u'(c_m^D) - u'(c_f^D) = 0 \tag{13}$$

This implies that we have

$$u'(c_m^D) = u'(c_f^D) \tag{14}$$

Thus, as in the case when the man remains healthy, the partners' marginal utilities are equalized, which is again the first-best tradeoff.

Given the couple's first period wealth equal to $W - \pi_m B_m - \pi_f B_f - L_m + h(a_f) + B_m$, the amount of savings s^D is chosen so as to satisfy the following FOC:

$$u'(c_m^D)\frac{\partial c_m^D}{\partial s^D} + u'(c_f^D)\frac{\partial c_f^D}{\partial s^D} + (1-\hat{\pi}_f)u'(d_f^{DI}) + \hat{\pi}_f u'(d_f^{DD}) = 0 \tag{15}$$

Similarly to the previous case, it can be shown that $\frac{\partial c_m^D}{\partial s^D} + \frac{\partial c_f^D}{\partial s^D} = -1$ (see also Appendix A). Using this and equality (14), the FOC (15) reduces to

$$(1-\hat{\pi}_f)u'(d_f^{DI}) + \hat{\pi}_f u'(d_f^{DD}) - u'(c_m^D) = 0 \tag{16}$$

The amount of the woman's caregiving is chosen knowing that it will influence the first period wealth and in turn will have an effect on savings and consumption. The FOC for a_f writes as follows:

$$u'(c_m^D)\frac{\partial c_m^D}{\partial a_f} + u'(c_f^D)\frac{\partial c_f^D}{\partial a_f} - \beta\mu'(a_f) + \frac{\partial s^D}{\partial a_f}\left[u'(c_m^D)\frac{\partial c_m^D}{\partial s^D} + u'(c_f^D)\frac{\partial c_f^D}{\partial s^D} + (1-\hat{\pi}_f)u'(d_f^{DI}) + \hat{\pi}_f u'(d_f^{DD})\right] = 0 \tag{17}$$

It is shown in Appendix A that $\frac{\partial c_m^D}{\partial a_f} + \frac{\partial c_f^D}{\partial a_f} = h'(a_f)$. Using this, equality (14) and the FOC for s^D, the FOC for a_f reduces to

$$u'(c_m^D)h'(a_f) - \beta\mu'(a_f) = 0 \tag{18}$$

Comparing this to the first-best FOC for a_f (equation (6)), it can be seen that the *laissez-faire* tradeoff is not efficient if $\beta < 1$. In particular, if $\beta < 1$, the negative impact that caregiving has on the woman's health is accounted for insufficiently in the *laissez-faire*, which results in the caregiving effort being higher than socially optimal.

We can now discuss the choice of insurance which takes place before the first period.

3.3 Choice of insurance

For the choice of insurance, the couple's objective function writes as:

$$(1-\hat{\pi}_m)\left[u(c_m^I)+u(c_f^I)+(1-\hat{\pi}_f)u(d_f^{II})+\hat{\pi}_f u(d_f^{ID})\right]+$$

$$+\hat{\pi}_m\left[u(c_m^D)+u(c_f^D)-\beta\mu(a_f)+(1-\hat{\pi}_f)u(d_f^{DI})+\hat{\pi}_f u(d_f^{DD})\right] \tag{19}$$

It has to be maximized subject to the budget constraints

$c_m^I + c_f^I = W - \pi_m B_m - \pi_f B_f - s^I$

$c_m^D + c_f^D = W - \pi_m B_m - \pi_f B_f - L_m + h(a_f) + B_m - s^D$

$d_f^{II} = s^I$

$d_f^{ID} = s^I - L_f + B_f$

$d_f^{DI} = s^D$

$d_f^{DD} = s^D - L_f + B_f$

Focusing on interior solutions and using the envelope theorem, the FOC for B_m can be written as

$$(1-\hat{\pi}_m)u'(c_m^I)\frac{\partial c_m^I}{\partial B_m}+(1-\hat{\pi}_m)u'(c_f^I)\frac{\partial c_f^I}{\partial B_m}+\hat{\pi}_m u'(c_m^D)\frac{\partial c_m^D}{\partial B_m}+\hat{\pi}_m u'(c_f^D)\frac{\partial c_f^D}{\partial B_m}=0 \tag{20}$$

It is shown in Appendix A that $\frac{\partial c_m^I}{\partial B_m}+\frac{\partial c_f^I}{\partial B_m}=-\pi_m$ and $\frac{\partial c_m^D}{\partial B_m}+\frac{\partial c_f^D}{\partial B_m}=1-\pi_m$. Using this and equalities (9) and (14), the FOC for B_m reduces to

$$\hat{\pi}_m(1-\pi_m)u'(c_m^D)-\pi_m(1-\hat{\pi}_m)u'(c_m^I)=0 \tag{21}$$

It can be seen that if $\hat{\pi}_m=\pi_m$, we have $u'(c_m^D)=u'(c_m^I)$, and equivalently, $u'(c_f^D)=u'(c_f^I)$, that is, full insurance against the man's dependence, which is the first-best tradeoff. However, if $\hat{\pi}_m<\pi_m$, full insurance is no longer chosen and in particular, we have $u'(c_m^D)=u'(c_f^D)>u'(c_m^I)=u'(c_f^I)$, i.e. less than full insurance.

Again focusing on interior solutions and using the envelope theorem, the FOC for B_f can be written as

$$(1-\hat{\pi}_m)u'(c_m^I)\frac{\partial c_m^I}{\partial B_f}+(1-\hat{\pi}_m)u'(c_f^I)\frac{\partial c_f^I}{\partial B_f}+(1-\hat{\pi}_m)\hat{\pi}_f u'(d_f^{ID})+$$

$$+\hat{\pi}_m\hat{\pi}_f u'(d_f^{DD})+\hat{\pi}_m u'(c_m^D)\frac{\partial c_m^D}{\partial B_f}+\hat{\pi}_m u'(c_f^D)\frac{\partial c_f^D}{\partial B_f}=0 \tag{22}$$

It is shown in Appendix A that $\frac{\partial c_m^I}{\partial B_f}+\frac{\partial c_f^I}{\partial B_f}=-\pi_f$ and $\frac{\partial c_m^D}{\partial B_f}+\frac{\partial c_f^D}{\partial B_f}=-\pi_f$. Using this and equalities (9) and (14), the FOC for B_f becomes

$$(1-\hat{\pi}_m)\hat{\pi}_f u'(d_f^{ID})+\hat{\pi}_m\hat{\pi}_f u'(d_f^{DD})-(1-\hat{\pi}_m)\pi_f u'(c_m^I)-\hat{\pi}_m\pi_f u'(c_m^D)=0 \tag{23}$$

If $\hat{\pi}_m=\pi_m$ and $\hat{\pi}_f=\pi_f$, using equations (23), (21), (16) and (11), it can be shown that we have the first-best equality $u'(d_f^{II})=u'(d_f^{ID})=u'(d_f^{DI})=u'(d_f^{DD})=u'(c_m^I)=u'(c_m^D)=u'(c_f^I)=u'(c_f^D)$.[17]

If $\hat{\pi}_f=\pi_f$ but $\hat{\pi}_m<\pi_m$, using the same equations, we obtain $u'(d_f^{II})=u'(d_f^{ID})=u'(c_m^I)=u'(c_f^I)<u'(d_f^{DD})=u'(d_f^{DI})=u'(c_m^D)=u'(c_f^D)$. That is, if the couple estimates correctly the probability to become dependent for the woman but is myopic concerning this probability for the man, there will be full insurance against the woman's dependence, but the equality of all second period marginal utilities will not be achieved. In particular, since insurance against the man's dependence in the first period will not be full, the couple will have fewer resources to be saved for the second period in the case when the man is dependent than in the case when he is healthy. Consequently, whether the woman is dependent or not in the second period, her second period wealth and thus consumption will be lower if her husband was dependent in the first period. Therefore, even though there is no myopia about the woman's probability of dependence, her welfare is reduced if there is myopia about this probability for the man.

Finally, if $\hat{\pi}_f<\pi_f$, combining (23) with (16) and (11) and evaluating at $u'(d_f^{II})=u'(d_f^{ID})$ and $u'(d_f^{DD})=u'(d_f^{DI})$, i.e. at full insurance against the woman's dependence, it can be shown that full insurance will no longer be chosen and in particular, less than full insurance will be bought. This means that now we will have $u'(d_f^{ID})>u'(d_f^{II})$ and $u'(d_f^{DD})>u'(d_f^{DI})$. If $\hat{\pi}_m=\pi_m$, full insurance against the man's dependence in the first period will imply $u'(d_f^{ID})=u'(d_f^{DD})>u'(d_f^{II})=u'(d_f^{DI})$.

On the other hand, if $\hat{\pi}_m<\pi_m$, in addition to $u'(d_f^{ID})>u'(d_f^{II})$ and $u'(d_f^{DD})>u'(d_f^{DI})$, we will have $u'(d_f^{ID})<u'(d_f^{DD})$ and $u'(d_f^{II})<u'(d_f^{DI})$. While it is not possible to compare between themselves the intermediate levels of marginal utility $u'(d_f^{ID})$ and $u'(d_f^{DI})$, it is clearly seen that in the second period the woman is best off in the case where neither her husband was nor she is dependent (II) and worst off in the case where he was and she is dependent (DD). This draws attention to the fact that, in the presence of myopia about dependence probabilities, the woman faces a "double hazard": first, myopia about her

[17] This and the following comparisons of marginal utilities are proved in Appendix B.

own dependence probability causes a suboptimal allocation of wealth between the two states of her own autonomy level in the second period; second, myopia about her husband's dependence probability results in a suboptimal allocation of wealth between the two states of his autonomy level in the first period and in turn, in suboptimal levels saved for the second period when the woman will be left alone. Thus, a woman who appears in the state DD is a "victim" of a double suboptimality. Moreover, if we also add myopia about the negative impact that caregiving has on the woman's health, we can even talk about a "triple hazard" for the woman: the underestimation of negative health effects leads to an inefficiently high caregiving burden the true impact of which (realized by the woman when it is too late) adds to the financial consequences caused by myopia about dependence probabilities.

4 Decentralization of the first-best

As it was seen in the previous section, the outcome achieved in the *laissez-faire* is generally not optimal. This raises a question of how the situation could be improved by the intervention of the government. This section tries to answer this question by looking at the benchmark case where the government has full information and can thus decentralize the first-best optimal allocation. The following proposition describes how this can be done.

Proposition 1. *Under full information, the first-best allocation can be decentralized by*
(i) a linear tax of rate $t^* = \frac{(1-\beta)\mu'(a_f^*)}{u'(c_m^{D*})} \geq 0$ *on the woman's caregiving;*
(ii) a linear subsidy of rate $\sigma_m^* = \frac{\pi_m - \hat{\pi}_m}{\pi_m} \geq 0$ *on the man's insurance premium;*
(iii) a linear subsidy of rate $\sigma_f^* = \frac{\pi_f - \hat{\pi}_f}{\pi_f} \geq 0$ *on the woman's insurance premium;*
(iv) lump-sum taxes/transfers (needed to compensate for the linear subsidies/taxes).
Equivalently, subsidies on private insurance premiums can be replaced by a mandatory public insurance scheme which provides full insurance.

To prove this proposition, we first need to introduce a stage 0 in the timing presented in Section 1. In this stage, the government announces its policy consisting of a linear tax on the woman's caregiving, linear subsidies on the man's and the woman's insurance premiums and lump-sum taxes/transfers. Stage 0 is then followed by the stages presented in Section 1.

Let us now revisit the decisions made by the couple in the presence of the public policy. Since there are no instruments targeted at consumption and savings, the FOCs for these variables remain the same as in the *laissez-faire* (while their levels now of course depend on the policy variables). The FOCs for the woman's caregiving and the two spouses' insurance coverage are, however, changed. In particular, the FOC for the woman's caregiving now writes as

$$u'(c_m^D)\,[h'(a_f) - t] - \beta\mu'(a_f) = 0 \tag{24}$$

where t is the rate of the linear caregiving tax. To determine the tax rate which implements the first-best level of the woman's caregiving, we need to combine equation (24) with the first-best FOC (equation (6)). This gives

$$t^* = \frac{(1-\beta)\,\mu'(a_f^*)}{u'(c_m^{D*})} \geq 0 \tag{25}$$

Thus, the optimal tax rate is meant to correct for the couple's myopia about the negative caregiving effects on the woman's health. It is positive whenever $\beta < 1$, i.e. whenever there is some degree of underestimation of these negative effects. Indeed, as it was seen in Section 3, if $\beta < 1$, the *laissez-faire* caregiving effort is too high compared to the social optimum, which implies a need for this effort to be discouraged.

The FOC for the man's insurance coverage is now written as follows:

$$\hat{\pi}_m u'(c_m^D)\,(1+\sigma_m\pi_m-\pi_m)+(1-\hat{\pi}_m)u'(c_m^I)\,(\sigma_m\pi_m-\pi_m)=0 \tag{26}$$

where σ_m is the rate of the linear subsidy on the man's insurance premium. The subsidy rate which implements the first-best level of insurance against the man's dependence can be derived by solving

$$\hat{\pi}_m u'(c_m^D)\,(1+\sigma_m\pi_m-\pi_m)+(1-\hat{\pi}_m)u'(c_m^I)\,(\sigma_m\pi_m-\pi_m)=u'(c_m^{D*})-u'(c_m^{I*}) \tag{27}$$

This gives

$$\sigma_m^* = \frac{\pi_m-\hat{\pi}_m}{\pi_m} \geq 0 \tag{28}$$

It can be seen that the optimal subsidy rate on the man's insurance premium is meant to correct for the couple's myopia about the man's risk to become dependent. Whenever there is some degree of such myopia (i.e. $\hat{\pi}_m < \pi_m$), the subsidy rate is greater than zero. Indeed, since in the *laissez-faire* the underestimation of the man's risk results in underinsurance against his dependence, the purchase of insurance needs to be fostered to achieve the optimal outcome.

The FOC for the woman's insurance coverage now writes as

$$(1-\hat{\pi}_m)\hat{\pi}_f u'(d_f^{ID})+\hat{\pi}_m\hat{\pi}_f u'(d_f^{DD})+(1-\hat{\pi}_m)u'(c_m^I)\,(\sigma_f\pi_f-\pi_f)+\hat{\pi}_m u'(c_m^D)\,(\sigma_f\pi_f-\pi_f)=0 \tag{29}$$

where σ_f is the rate of the linear subsidy on the woman's insurance premium. The subsidy rate which allows to achieve the first-best level of insurance against the woman's dependence can be determined by solving[18]

$$(1-\hat{\pi}_m)\hat{\pi}_f u'(d_f^{ID}) + \hat{\pi}_m\hat{\pi}_f u'(d_f^{DD}) + (1-\hat{\pi}_m)u'(c_m^I)\,(\sigma_f\pi_f - \pi_f) + \hat{\pi}_m u'(c_m^D)\,(\sigma_f\pi_f - \pi_f) =$$

$$= (1-\hat{\pi}_m)\pi_f u'(d_f^{ID*}) + \hat{\pi}_m\pi_f u'(d_f^{DD*}) - (1-\hat{\pi}_m)\pi_f u'(c_m^{I*}) - \hat{\pi}_m\pi_f u'(c_m^{D*}) \tag{30}$$

This gives

$$\sigma_f^* = \frac{\pi_f - \hat{\pi}_f}{\pi_f} \geq 0 \tag{31}$$

Thus, the optimal subsidy rate on the woman's insurance premium corrects for the couple's myopia about the woman's probability to become dependent and is positive whenever $\hat{\pi}_f < \pi_f$. Whenever this is the case, insurance against the woman's dependence needs to be encouraged because otherwise the coverage bought by the couple is too low. It can also be noted at this point that the first-best optimal subsidy rates on both the man's and the woman's insurance premiums depend only on myopia about the risk of the spouse whose insurance is subsidized at the rate in question and are not influenced by myopia about the other partner's risk. As it will be seen in the next section, this is no longer the case in the second-best.

The above discussed linear tax and subsidy rates allow to restore the efficient tradeoffs in the couple's choices. Obviously, to ensure the first-best allocation, these corrective taxes and subsidies need to be compensated in a lump-sum way. Lump-sum taxes or transfers are thus also included in the optimal policy. Finally, it can be noted that subsidies on private insurance premiums can be replaced by a mandatory public insurance scheme which provides full insurance against both the man's and the woman's dependence. In the presence of such insurance, the spouses will be obliged to be fully protected even though, due to myopia, they would not buy full coverage on the market.

This section has thus discussed (first-best) optimal public intervention in the case where the government has full information about the economy. Nevertheless, full information might not always be possible and this might require to rely on second-best optimality. The next section looks at such a case.

5 Second-best: unobservable caregiving

To decentralize the first-best, the government needs to tax the woman's caregiving to make sure that it is not too high due to the couple's myopia about negative health consequences. However, it is likely that in reality the government will not be able to observe (and thus tax) the exact amount of caregiving that a wife provides to her husband. This section therefore considers a second-best setting where the woman's

[18] While it is not straightforward to see it here, it is shown in Appendix C that this subsidy rate indeed implements full insurance against the woman's dependence.

caregiving is not observable to the government and studies an optimal linear policy directed at private insurance premiums.

Consider a policy consisting of a linear subsidy of rate σ_m on the man's insurance premium and a linear subsidy of rate σ_f on the woman's insurance premium financed by a lump-sum tax T paid by the couple before the beginning of the first period. As in the decentralization of the first-best, the government announces the policy in stage 0 of the timing. Let us first discuss the choices made by the couple in the presence of this policy.

5.1 The couple's choices

Given the government's policy, the couple's first period budget constraints in each state of nature become the following:

$$c_m^I + c_f^I = W - T - \pi_m B_m + \sigma_m \pi_m B_m - \pi_f B_f + \sigma_f \pi_f B_f - s^I$$

$$c_m^D + c_f^D = W - T - \pi_m B_m + \sigma_m \pi_m B_m - \pi_f B_f + \sigma_f \pi_f B_f - L_m + h(a_f) + B_m - s^D$$

Since there are no policy instruments directed at consumption, savings and, differently from the decentralization of the first-best, the woman's caregiving, the FOCs for these variables are the same as in the *laissez-faire*, in particular, equations (8), (13), (11), (16) and (18). However, the levels of these variables now of course depend on the policy instruments. The FOCs for the man's and the woman's insurance coverage can be written in the same way as in the decentralization of the first-best, respectively equations (26) and (29). Insurance coverage also obviously depends on the policy variables.

We can now look at the problem of the government and derive its optimal policy in this second-best setting.

5.2 Optimal policy

The problem of the government writes as follows:

$$\max_{\sigma_m, \sigma_f, T} SW$$

$$s.t.\ \sigma_m \pi_m B_m + \sigma_f \pi_f B_f = T$$

where

$$SW = (1-\pi_m)\left[u(c_m^I) + u(c_f^I) + (1-\pi_f)u(d_f^{II}) + \pi_f u(d_f^{ID})\right] +$$

$$+\pi_m\left[u(c_m^D) + u(c_f^D) - \mu(a_f) + (1-\pi_f)u(d_f^{DI}) + \pi_f u(d_f^{DD})\right] \tag{32}$$

The Lagrangean can be written as

$$\mathcal{L} = SW + \phi\left[T - \sigma_m\pi_m B_m - \sigma_f\pi_f B_f\right]$$

The FOCs with respect to σ_m, σ_f and T can be written as follows:

$$\frac{\partial\mathcal{L}}{\partial\sigma_m} = (1-\pi_m)u'(c_m^I)\pi_m B_m + \pi_m u'(c_m^D)\pi_m B_m +$$

$$+\frac{\partial B_m}{\partial\sigma_m}\left[(1-\pi_m)u'(c_m^I)(\sigma_m\pi_m - \pi_m) + \pi_m u'(c_m^D)(1+\sigma_m\pi_m - \pi_m)\right] +$$

$$+(1-\pi_m)\frac{\partial\bar{s}^I}{\partial\sigma_m}\left[(1-\pi_f)u'(d_f^{II}) + \pi_f u'(d_f^{ID}) - u'(c_m^I)\right] +$$

$$+\pi_m\frac{\partial\bar{s}^D}{\partial\sigma_m}\left[(1-\pi_f)u'(d_f^{DI}) + \pi_f u'(d_f^{DD}) - u'(c_m^D)\right] +$$

$$+\pi_m\frac{\partial\bar{a}_f}{\partial\sigma_m}\left[u'(c_m^D)h'(a_f) - \mu'(a_f)\right] +$$

$$+\frac{\partial B_f}{\partial\sigma_m}\left[(1-\pi_m)u'(c_m^I)(\sigma_f\pi_f - \pi_f) + \pi_m u'(c_m^D)(\sigma_f\pi_f - \pi_f) + \pi_m\pi_f u'(d_f^{DD}) + (1-\pi_m)\pi_f u'(d_f^{ID})\right] -$$

$$-\phi\pi_m B_m - \phi\sigma_m\pi_m\frac{\partial B_m}{\partial\sigma_m} - \phi\sigma_f\pi_f\frac{\partial B_f}{\partial\sigma_m} = 0 \tag{33}$$

$$\frac{\partial\mathcal{L}}{\partial\sigma_f} = (1-\pi_m)u'(c_m^I)\pi_f B_f + \pi_m u'(c_m^D)\pi_f B_f +$$

$$+\frac{\partial B_m}{\partial\sigma_f}\left[(1-\pi_m)u'(c_m^I)(\sigma_m\pi_m - \pi_m) + \pi_m u'(c_m^D)(1+\sigma_m\pi_m - \pi_m)\right] +$$

$$+(1-\pi_m)\frac{\partial\bar{s}^I}{\partial\sigma_f}\left[(1-\pi_f)u'(d_f^{II}) + \pi_f u'(d_f^{ID}) - u'(c_m^I)\right] +$$

$$+\pi_m\frac{\partial\bar{s}^D}{\partial\sigma_f}\left[(1-\pi_f)u'(d_f^{DI}) + \pi_f u'(d_f^{DD}) - u'(c_m^D)\right] +$$

$$+\pi_m\frac{\partial\bar{a}_f}{\partial\sigma_f}\left[u'(c_m^D)h'(a_f) - \mu'(a_f)\right] +$$

$$+\frac{\partial B_f}{\partial\sigma_f}\left[(1-\pi_m)u'(c_m^I)(\sigma_f\pi_f - \pi_f) + \pi_m u'(c_m^D)(\sigma_f\pi_f - \pi_f) + \pi_m\pi_f u'(d_f^{DD}) + (1-\pi_m)\pi_f u'(d_f^{ID})\right] -$$

$$-\phi\pi_f B_f - \phi\sigma_m\pi_m\frac{\partial B_m}{\partial\sigma_f} - \phi\sigma_f\pi_f\frac{\partial B_f}{\partial\sigma_f} = 0 \tag{34}$$

$$\frac{\partial\mathcal{L}}{\partial T} = -(1-\pi_m)u'(c_m^I) - \pi_m u'(c_m^D) +$$

$$+\frac{\partial B_m}{\partial T}\left[(1-\pi_m)u'(c_m^I)(\sigma_m\pi_m-\pi_m)+\pi_m u'(c_m^D)(1+\sigma_m\pi_m-\pi_m)\right]+$$

$$+(1-\pi_m)\frac{\partial \bar{s}^I}{\partial T}\left[(1-\pi_f)u'(d_f^{II})+\pi_f u'(d_f^{ID})-u'(c_m^I)\right]+$$

$$+\pi_m\frac{\partial \bar{s}^D}{\partial T}\left[(1-\pi_f)u'(d_f^{DI})+\pi_f u'(d_f^{DD})-u'(c_m^D)\right]+$$

$$+\pi_m\frac{\partial \bar{a}_f}{\partial T}\left[u'(c_m^D)h'(a_f)-\mu'(a_f)\right]+$$

$$+\frac{\partial B_f}{\partial T}\left[(1-\pi_m)u'(c_m^I)(\sigma_f\pi_f-\pi_f)+\pi_m u'(c_m^D)(\sigma_f\pi_f-\pi_f)+\pi_m\pi_f u'(d_f^{DD})+(1-\pi_m)\pi_f u'(d_f^{ID})\right]+$$

$$+\phi-\phi\sigma_m\pi_m\frac{\partial B_m}{\partial T}-\phi\sigma_f\pi_f\frac{\partial B_f}{\partial T}=0 \tag{35}$$

where

$$\frac{\partial \bar{s}^I}{\partial x}=\frac{\partial s^I}{\partial x}+\frac{\partial s^I}{\partial B_m}\frac{\partial B_m}{\partial x}+\frac{\partial s^I}{\partial B_f}\frac{\partial B_f}{\partial x};$$

$$\frac{\partial \bar{s}^D}{\partial x}=\frac{\partial s^D}{\partial x}+\frac{\partial s^D}{\partial B_m}\frac{\partial B_m}{\partial x}+\frac{\partial s^D}{\partial B_f}\frac{\partial B_f}{\partial x}+\frac{\partial s^D}{\partial a_f}\frac{\partial a_f}{\partial x}+\frac{\partial s^D}{\partial a_f}\frac{\partial a_f}{\partial B_m}\frac{\partial B_m}{\partial x}+\frac{\partial s^D}{\partial a_f}\frac{\partial a_f}{\partial B_f}\frac{\partial B_f}{\partial x};$$

$$\frac{\partial \bar{a}_f}{\partial x}=\frac{\partial a_f}{\partial x}+\frac{\partial a_f}{\partial B_m}\frac{\partial B_m}{\partial x}+\frac{\partial a_f}{\partial B_f}\frac{\partial B_f}{\partial x}$$

$$for\ x=\sigma_m,\,\sigma_f,\,T.$$

We can then write these FOCs in compensated terms by defining

$$\frac{\partial \mathcal{L}^C}{\partial \sigma_m}=\frac{\partial \mathcal{L}}{\partial \sigma_m}+\frac{\partial \mathcal{L}}{\partial T}\frac{\partial T}{\partial \sigma_m}=0 \tag{36}$$

and

$$\frac{\partial \mathcal{L}^C}{\partial \sigma_f}=\frac{\partial \mathcal{L}}{\partial \sigma_f}+\frac{\partial \mathcal{L}}{\partial T}\frac{\partial T}{\partial \sigma_f}=0 \tag{37}$$

where $\frac{\partial T}{\partial \sigma_m}=\pi_m B_m$ and $\frac{\partial T}{\partial \sigma_f}=\pi_f B_f$ are derived from the resource constraint.

Also, we can define the following compensated effects:

$$\frac{\partial B_m^C}{\partial \sigma_i}=\frac{\partial B_m}{\partial \sigma_i}+\frac{\partial B_m}{\partial T}\pi_i B_i \tag{38}$$

$$\frac{\partial B_f^C}{\partial \sigma_i}=\frac{\partial B_f}{\partial \sigma_i}+\frac{\partial B_f}{\partial T}\pi_i B_i \tag{39}$$

$$\frac{\partial \bar{s}^{IC}}{\partial \sigma_i} = \frac{\partial \bar{s}^{I}}{\partial \sigma_i} + \frac{\partial \bar{s}^{I}}{\partial T}\pi_i B_i \tag{40}$$

$$\frac{\partial \bar{s}^{DC}}{\partial \sigma_i} = \frac{\partial \bar{s}^{D}}{\partial \sigma_i} + \frac{\partial \bar{s}^{D}}{\partial T}\pi_i B_i \tag{41}$$

$$\frac{\partial \bar{a}_f^{C}}{\partial \sigma_i} = \frac{\partial \bar{a}_f}{\partial \sigma_i} + \frac{\partial \bar{a}_f}{\partial T}\pi_i B_i \tag{42}$$

$$for\ i = m,\ f.$$

Thus, using (33)-(42), we can write

$$\begin{aligned}
\frac{\partial \mathcal{L}^C}{\partial \sigma_m} = \frac{\partial B_m^C}{\partial \sigma_m}\left[(1-\pi_m)u'(c_m^I)(\sigma_m\pi_m - \pi_m) + \pi_m u'(c_m^D)(1+\sigma_m\pi_m - \pi_m)\right] + \\
+(1-\pi_m)\frac{\partial \bar{s}^{IC}}{\partial \sigma_m}\left[(1-\pi_f)u'(d_f^{II}) + \pi_f u'(d_f^{ID}) - u'(c_m^I)\right] + \\
+\pi_m \frac{\partial \bar{s}^{DC}}{\partial \sigma_m}\left[(1-\pi_f)u'(d_f^{DI}) + \pi_f u'(d_f^{DD}) - u'(c_m^D)\right] + \\
+\pi_m \frac{\partial \bar{a}_f^C}{\partial \sigma_m}\left[u'(c_m^D)h'(a_f) - \mu'(a_f)\right] + \\
+\frac{\partial B_f^C}{\partial \sigma_m}\left[(1-\pi_m)u'(c_m^I)(\sigma_f\pi_f - \pi_f) + \pi_m u'(c_m^D)(\sigma_f\pi_f - \pi_f) + \pi_m\pi_f u'(d_f^{DD}) + (1-\pi_m)\pi_f u'(d_f^{ID})\right] - \\
-\phi\sigma_m\pi_m\frac{\partial B_m^C}{\partial \sigma_m} - \phi\sigma_f\pi_f\frac{\partial B_f^C}{\partial \sigma_m} = 0
\end{aligned} \tag{43}$$

and

$$\begin{aligned}
\frac{\partial \mathcal{L}^C}{\partial \sigma_f} = \frac{\partial B_m^C}{\partial \sigma_f}\left[(1-\pi_m)u'(c_m^I)(\sigma_m\pi_m - \pi_m) + \pi_m u'(c_m^D)(1+\sigma_m\pi_m - \pi_m)\right] + \\
+(1-\pi_m)\frac{\partial \bar{s}^{IC}}{\partial \sigma_f}\left[(1-\pi_f)u'(d_f^{II}) + \pi_f u'(d_f^{ID}) - u'(c_m^I)\right] + \\
+\pi_m \frac{\partial \bar{s}^{DC}}{\partial \sigma_f}\left[(1-\pi_f)u'(d_f^{DI}) + \pi_f u'(d_f^{DD}) - u'(c_m^D)\right] + \\
+\pi_m \frac{\partial \bar{a}_f^C}{\partial \sigma_f}\left[u'(c_m^D)h'(a_f) - \mu'(a_f)\right] + \\
+\frac{\partial B_f^C}{\partial \sigma_f}\left[(1-\pi_m)u'(c_m^I)(\sigma_f\pi_f - \pi_f) + \pi_m u'(c_m^D)(\sigma_f\pi_f - \pi_f) + \pi_m\pi_f u'(d_f^{DD}) + (1-\pi_m)\pi_f u'(d_f^{ID})\right] -
\end{aligned}$$

$$-\phi\sigma_m\pi_m\frac{\partial B_m^C}{\partial\sigma_f}-\phi\sigma_f\pi_f\frac{\partial B_f^C}{\partial\sigma_f}=0 \tag{44}$$

Using equations (43) and (44) and also the couple's FOCs, we can get the following expressions for the optimal subsidy rates σ_m and σ_f:

$$\sigma_m=\frac{\frac{\partial B_m^C}{\partial\sigma_m}\left[\pi_m-\hat{\pi}_m\right]\left[u'(c_m^I)(\pi_m-\sigma_m\pi_m)+u'(c_m^D)(1+\sigma_m\pi_m-\pi_m)\right]}{\phi\pi_m\frac{\partial B_m^C}{\partial\sigma_m}}+$$
$$+\frac{\frac{\partial\bar{s}^{IC}}{\partial\sigma_m}\left(1-\pi_m\right)\left[\pi_f-\hat{\pi}_f\right]\left[u'(d_f^{ID})-u'(d_f^{II})\right]}{\phi\pi_m\frac{\partial B_m^C}{\partial\sigma_m}}+$$
$$+\frac{\frac{\partial\bar{s}^{DC}}{\partial\sigma_m}\pi_m\left[\pi_f-\hat{\pi}_f\right]\left[u'(d_f^{DD})-u'(d_f^{DI})\right]}{\phi\pi_m\frac{\partial B_m^C}{\partial\sigma_m}}+$$
$$+\frac{\frac{\partial\bar{a}_f^C}{\partial\sigma_m}\pi_m\left(\beta-1\right)\mu'(a_f)}{\phi\pi_m\frac{\partial B_m^C}{\partial\sigma_m}} \tag{45}$$

and

$$\sigma_f=\frac{\frac{\partial B_f^C}{\partial\sigma_f}\left[\pi_m-\hat{\pi}_m\right]\left(\sigma_f\pi_f-\pi_f\right)\left[u'(c_m^D)-u'(c_m^I)\right]}{\phi\pi_f\frac{\partial B_f^C}{\partial\sigma_f}}+$$
$$+\frac{\frac{\partial B_f^C}{\partial\sigma_f}\left[\pi_m\pi_f-\hat{\pi}_m\hat{\pi}_f\right]\left[u'(d_f^{DD})-u'(d_f^{ID})\right]+\frac{\partial B_f^C}{\partial\sigma_f}\left[\pi_f-\hat{\pi}_f\right]u'(d_f^{ID})}{\phi\pi_f\frac{\partial B_f^C}{\partial\sigma_f}}+$$
$$+\frac{\frac{\partial\bar{s}^{IC}}{\partial\sigma_f}\left(1-\pi_m\right)\left[\pi_f-\hat{\pi}_f\right]\left[u'(d_f^{ID})-u'(d_f^{II})\right]}{\phi\pi_f\frac{\partial B_f^C}{\partial\sigma_f}}+$$
$$+\frac{\frac{\partial\bar{s}^{DC}}{\partial\sigma_f}\pi_m\left[\pi_f-\hat{\pi}_f\right]\left[u'(d_f^{DD})-u'(d_f^{DI})\right]}{\phi\pi_f\frac{\partial B_f^C}{\partial\sigma_f}}+$$
$$+\frac{\frac{\partial\bar{a}_f^C}{\partial\sigma_f}\pi_m\left(\beta-1\right)\mu'(a_f)}{\phi\pi_f\frac{\partial B_f^C}{\partial\sigma_f}} \tag{46}$$

Let us now discuss these optimal subsidy rates. First, it can be shown that the "own subsidy" effect for the man's and for the woman's insurance is positive, i.e. $\frac{\partial B_m^C}{\partial\sigma_m}>0$ and $\frac{\partial B_f^C}{\partial\sigma_f}>0$.[19] Therefore, the

[19] All the relevant comparative statics are derived in Appendix D.

denominators of the two expressions are positive. On the other hand, the numerators of the expressions reflect the considerations of the effects that each subsidy rate has on insurance, savings in each first period state of nature and the woman's caregiving if the man is dependent. It can be noted that the cross effects $\frac{\partial B_m^C}{\partial \sigma_f}$ and $\frac{\partial B_f^C}{\partial \sigma_m}$ do not appear in the expressions since it can be shown that they are both equal to zero.

It can be clearly seen that if there is no myopia, i.e. if $\hat{\pi}_m = \pi_m$, $\hat{\pi}_f = \pi_f$ and $\beta = 1$, both subsidy rates are equal to zero. Indeed, if no myopia is present, the *laissez-faire* outcome is efficient and there is no need for public intervention. On the other hand, if the couple is only myopic about the spouses' probabilities of dependence but not about the negative health effects of caregiving (i.e. $\hat{\pi}_m < \pi_m$, $\hat{\pi}_f < \pi_f$, but $\beta = 1$), public intervention is clearly needed and it can actually restore the first-best. Indeed, it is shown in Appendix E that $\sigma_m = \sigma_m^*$ and $\sigma_f = \sigma_f^*$ which implement full insurance against both partners' dependence are optimal in that case. Obviously, the absence of myopia about negative caregiving consequences implies that there is no need to affect caregiving and its unobservability thus plays no role, which returns us to the first-best setting.

If, however, the partners are not myopic about their dependence probabilities (i.e. $\hat{\pi}_m = \pi_m$ and $\hat{\pi}_f = \pi_f$) but do underestimate the negative health consequences of caregiving (i.e. $\beta < 1$), the optimal insurance subsidy rates will not be equal to zero as they would be in the first-best. In particular, in that case the expressions in (45) and (46) reduce to their last terms which are not zero as long as $\beta < 1$. Interestingly, the sign of the last term (and thus of the optimal subsidy rate) is different for the man and for the woman. Let us first look at the optimal subsidy rate for the man, i.e. equation (45). It can be shown that $\frac{\partial \bar{a}_f^C}{\partial \sigma_m} < 0$, i.e. the woman's caregiving decreases when the subsidy rate on the man's insurance premium increases. The reason for this is that the subsidy on the man's insurance premium encourages the purchase of insurance for the man and this increases the resources available to the couple in the case of the man's dependence; thus, there is less need to reduce the LTC costs by relying on the woman's caregiving. Consequently, it can be seen that the last term of (45) is positive, which means that $\sigma_m > 0$. Indeed, since insurance against the man's dependence decreases the woman's caregiving level which is inefficiently high, this insurance should be encouraged.

In contrast, it can be shown that $\frac{\partial \bar{a}_f^C}{\partial \sigma_f} > 0$, i.e. the woman's caregiving increases with the subsidy rate on her own insurance premium. The reason is that the subsidy on the woman's insurance premium encourages the purchase of insurance for the woman, but, since this insurance is meant to cover LTC for the woman, it pays no benefit in the case of the man's dependence and thus only represents a cost at that time. This decreases the resources available to the couple and therefore implies more need to reduce the man's LTC costs by relying on the woman's caregiving. Consequently, it can be seen that the last term of equation (46) is negative, which means that $\sigma_f < 0$: since the purchase of insurance against the woman's dependence increases the (already inefficiently high) level of the woman's caregiving in the first period, this insurance should be discouraged. Therefore, if the only type of myopia effectively present is that about the negative health consequences of caregiving, the man's insurance premium should be subsidized whereas the woman's insurance premium should be taxed.

While the consideration of only one type of myopia gives clear-cut results (the first-best subsidy rates in the case of myopia about dependence probabilities and a subsidy on the man's and a tax on the woman's insurance premium in the case of myopia about the negative effects of caregiving), things become more complicated if both types of myopia are present at the same time (i.e. if $\hat{\pi}_m < \pi_m$, $\hat{\pi}_f < \pi_f$ and $\beta < 1$). In that case, the optimal subsidy rates σ_m and σ_f are given by the full equations (45) and (46) and their signs are generally ambiguous. Let us now discuss the two subsidy rates in more detail.

The optimal subsidy rate σ_m on the man's insurance premium is given by equation (45). The numerator of the right-hand side of this equation consists of four terms. The first term is the insurance term. As mentioned above, we have $\frac{\partial B_m^C}{\partial \sigma_m} > 0$. Also, focusing on interior solutions for B_m implies that the expression in the second brackets is positive.[20] Therefore, whenever there is myopia about the man's dependence probability (i.e. $\hat{\pi}_m < \pi_m$), the insurance term is positive and calls for a higher subsidy on the man's premium. Indeed, since in the presence of myopia about the man's dependence probability, the couple underinsures against this risk, the purchase of insurance should be encouraged by the government.

The second term takes into account the effect that insurance subsidy has on savings in the first period state of nature when the man is healthy. Contrary to the first term, this term depends on myopia about the woman's, and not the man's, dependence probability. The reason is that myopia about the woman's probability of dependence implies that the choice of savings is made using wrong weights attached to the marginal utilities of the second period. In particular, s^I is chosen so as to satisfy the FOC

$$u'(c_m^I) = (1 - \hat{\pi}_f)u'(d_f^{II}) + \hat{\pi}_f u'(d_f^{ID}) \tag{47}$$

If $\hat{\pi}_f < \pi_f$, then the weight given to $u'(d_f^{ID})$ is too small and the weight given to $u'(d_f^{II})$ is too big. Thus, if $u'(d_f^{ID}) > u'(d_f^{II})$, the right-hand side of (47) is smaller than optimal, which means that the couple saves too little for the second period. It can be shown that $\frac{\partial \bar{s}^{IC}}{\partial \sigma_m} < 0$; thus, if $u'(d_f^{ID}) > u'(d_f^{II})$, the second term is negative and pushes for a lower subsidy on the man's insurance premium. Indeed, since the insurance subsidy discourages savings which are already too small, this subsidy is not desirable. On the other hand, if $u'(d_f^{ID}) < u'(d_f^{II})$, the couple saves too much and thus a higher insurance subsidy is needed to discourage these savings.

The third term takes into account the effect that insurance subsidy has on savings in the first period state when the man is dependent. A similar reasoning can be made as in the discussion of the second term; however, it should be noted that in this case the subsidy on insurance encourages savings, i.e. $\frac{\partial \bar{s}^{DC}}{\partial \sigma_m} > 0$ (the reason is that in this case insurance benefits are received and thus (in net terms) insurance increases the couple's wealth, which allows to save more). Moreover, it should be noted that if we have $u'(d_f^{ID}) > u'(d_f^{II})$, then $u'(d_f^{DD}) > u'(d_f^{DI})$ must hold and vice versa. Thus, the big brackets in the second and the third terms are always positive or negative together, which means that the second and

[20] It can be seen from the couple's FOC for B_m (equation (26)) that an interior solution requires to have $(\sigma_m \pi_m - \pi_m) < 0$ and $(1 + \sigma_m \pi_m - \pi_m) > 0$, which implies that the expression in question is positive.

the third terms push the optimal subsidy into opposite directions.

Finally, as discussed above, the fourth term is meant to correct for myopia about the negative health effects of caregiving. It is positive and pushes for a higher subsidy on the man's insurance premium.

It can be noted that if $\hat{\pi}_f = \pi_f$, then σ_m is clearly positive. When $\hat{\pi}_f < \pi_f$, the sign of σ_m is ambiguous because of a negative savings term.

The optimal subsidy rate σ_f on the woman's insurance premium is given by equation (46). The numerator of the right-hand side of this equation can be divided into six terms. The first three terms are the insurance terms. The situation here is more complicated than in the case of σ_m. In particular, insurance against the man's dependence has a direct impact only in the first period and thus it is directly related only with myopia about the dependence probability of the man. Insurance against the woman's dependence, however, has a direct impact in both periods and thus is directly related with myopia about both partners' probabilities. Therefore, both types of myopia have to be taken into account in the insurance terms. If $\hat{\pi}_m = \pi_m$, the first term disappears and it can be easily verified that the sum of the second and third terms is positive. Thus, if there is only myopia about the woman's dependence probability, the insurance terms clearly call for a higher subsidy on the woman's premium: since myopia causes underinsurance, there is a need to encourage insurance purchases. However, as soon as there is also myopia about the dependence probability of the man, more disbalance arises in the couple's choice of insurance. In particular, similarly to the discussion of savings above, the weights put on the marginal utilities in the FOC for B_f become disbalanced. The impact of this disbalance on the level of insurance depends on the differences between the marginal utilities and cannot be unambiguously determined. The sign of the sum of the three insurance terms is thus undetermined.

The fourth and the fifth terms, similarly to the second and the third terms in the case of σ_m, take into account the effect on savings in each first period state of nature. The reasoning is analogous to the one in the case of σ_m, but the difference here is that both terms go to the same direction. This is because both $\frac{\partial \bar{s}^{IC}}{\partial \sigma_f}$ and $\frac{\partial \bar{s}^{DC}}{\partial \sigma_f}$ are negative: the purchase of insurance for the woman decreases the couple's wealth in both states of nature in the first period and thus savings in both states have to be reduced.

The last term, as discussed above, deals with myopia about the negative health effects of caregiving. It is negative and pushes for a lower subsidy (or even a tax) on the woman's insurance premium.

If $\hat{\pi}_m = \pi_m$, it can be verified that the sum of the insurance and savings terms is positive and calls for a higher subsidy on the woman's premium. The caregiving term, however, is still negative, which leaves the sign of σ_f undetermined. If in addition we have $\hat{\pi}_m < \pi_m$, the sign of the sum of the insurance and savings terms also becomes ambiguous.

While the first-best subsidy rate σ_m^* (respectively, σ_f^*) depends only on myopia about the man's (respectively, the woman's) probability of dependence, the discussion above reveals that the second-best rates take into account myopia about both partners' probabilities. The reason is that the need for the subsidy rates to correct for an additional source of inefficiency (i.e. myopia about the negative health consequences of caregiving) forces a deviation from full insurance, which means that marginal utilities in different states of nature are no longer equalized. This fact creates a need for corrections which are not needed when marginal utilities are equal. See for instance equation (47) which determines the level of savings s^I. As mentioned above, myopia about the woman's probability of dependence implies that the choice of savings is made using wrong weights attached to the marginal utilities of the second period. However, this is a problem only when the marginal utilities of the second period are not equalized. If they are equal, the right-hand side of equation (47) will be the same no matter if $\hat{\pi}_f = \pi_f$ or not. Therefore, a correction of savings is needed only if marginal utilities are not equalized. This illustrates why the second-best rates are subject to additional complications which are not present in the first-best. In other words, the presence of an additional source of inefficiency to be corrected for not only results in additional terms correcting for this particular inefficiency but also complicates the correction for myopia about dependence probabilities.

This complication is mainly responsible for the ambiguity of the signs of the second-best subsidy rates. Nevertheless, it can still be clearly seen that the "own probability myopia effect" is positive for each rate: myopia about the probability of the man's dependence pushes for a higher subsidy on the man's insurance premium (as reflected by the positive first term of (45)) and myopia about the dependence risk for the woman pushes for a higher subsidy on the woman's insurance premium (if $\hat{\pi}_m = \pi_m$, the sum of the terms depending on myopia about the woman's risk is positive in (46)). Moreover, for the man, this effect is reinforced by the correction for myopia about the negative impact of caregiving on the woman's health (the last term of (45)) which also calls for a higher subsidy on the man's premium. For the woman, however, the positive "own probability myopia effect" is mitigated by the need to correct for myopia about negative health effects: the negative last term of (46) pushes for a lower subsidy, if not even a tax, on the woman's insurance premium.

The findings of this section can be summarized in the following proposition.

Proposition 2. *Assume that the government cannot observe the care provided by a wife to her husband and consider a policy consisting of linear subsidies on the man's and the woman's LTC insurance premiums financed by a lump-sum tax. The optimal policy has the following features:*

(i) If the couple is not myopic, the subsidy rates on both spouses' insurance premiums are zero.

(ii) If the couple is only myopic about the spouses' probabilities of dependence but not about the negative health effects of caregiving, the first-best subsidy rates σ_m^* and σ_f^* are optimal.

(iii) If the couple is only myopic about the negative health effects of caregiving but not about the spouses' probabilities of dependence, the man's insurance premium has to be subsidized whereas the woman's insurance premium has to be taxed.

(iv) If the couple is myopic both about the spouses' probabilities of dependence and about the negative health effects of caregiving, the optimal subsidy rates are given by (45) *and* (46)*:*

(a) Differently from the first-best, each partner's subsidy rate depends on myopia about both spouses' probabilities of dependence;

(b) The "own probability myopia effect" is positive for each partner's subsidy rate;

(c) The correction for myopia about the negative health effects of caregiving reinforces the "own probability myopia effect" in the subsidy rate of the man but mitigates it in the rate of the woman.

This section thus reveals interesting results regarding insurance for the woman. It appears that the second-best setting requires a certain tradeoff between the protection of the woman's health and the level of insurance against her LTC risk. While in the first-best it is possible to target the woman's caregiving burden and thus correct for myopia about the negative effects on her health directly, in the second-best this has to be done indirectly, i.e. through the influence on insurance levels. Since, as explained above, insurance against the woman's dependence increases her caregiving burden which is already too high, the need to protect her health requires to reduce the level of this insurance. This suggests that, looking at it the other way round, a purchase of too much insurance for the woman might be "dangerous" for her health. On the other hand, insurance against the man's dependence decreases the woman's caregiving burden and thus contributes to the protection of her health. This being said, the common advice to privilege insurance for the woman mentioned in the Introduction raises serious doubts since it clearly goes against protecting the woman's health. The presence of myopia about the spouses' probabilities of dependence certainly makes things more complicated and prevents from making clear-cut conclusions; however, taking all things together, at least no reason can be found to believe that the woman's insurance should be encouraged more than the man's.

Conclusion

This paper has proposed a theoretical model of family related LTC issues focusing on the context of two elderly spouses (rather than on the parent-child relation as it has most often been done before) and has studied public LTC policy which would be optimal to apply in this context. The model considers a number of issues such as the negative effects that care provision to a dependent partner can have on the caregiving spouse's (who in the model is the wife) health as well as the financial hazard faced by this spouse after the couple has spent a large part of their resources to cover the dependent partner's LTC costs. In the context of these issues, and in line with empirical evidence, the model studies two types of myopia that may prevent the couple from making efficient decisions, namely, myopia about the negative health consequences of caregiving and myopia about the spouses' probabilities to become dependent. The first type of myopia results in the wife's caregiving burden being inefficiently high while the second type causes underinsurance against the partners' dependence.

If the government has full information about the economy, it can implement the first-best optimal allocation by correcting for the two types of myopia using linear subsidies on the man's and the woman's insurance premiums and a linear tax on the woman's caregiving. The need to introduce a tax on informal caregiving might appear somewhat shocking given that most policy recommendations talk on the contrary about subsidizing this care. However, if myopia about the negative health effects of caregiving is considered, it can be clearly seen that it results in the caregiving effort and thus the negative impact on the caregiver's health being too large, which makes it necessary for this effort to be discouraged. While taxation of informal care might be difficult to implement in the reality and while reasons for subsidizing this care might also exist, this finding nevertheless suggests that policy-makers should be cautious with subsidies on informal care in order not to deepen the negative effects on caregivers' health.

Taxing or subsidizing informal care might nonetheless be impossible for the government due to observability reasons. This is why the paper analyzes a second-best setting where the woman's caregiving is not observable to the government and studies an optimal linear policy directed at private insurance premiums. In this setting, corrections for myopia about the negative effects of caregiving can only be made indirectly by influencing the spouses' insurance levels. Interestingly, since the woman's caregiving is affected differently by insurance against her own and her husband's dependence, a different treatment of the two spouses' insurance is needed. If there is no myopia about dependence probabilities, the results are clear-cut: the man's insurance premium has to be subsidized whereas the woman's insurance premium has to be taxed. The presence of myopia about dependence probabilities brings about more ambiguity, but correction for myopia about negative health effects still pushes the two partners' subsidy rates into opposite directions. These findings reveal that, paradoxically, insurance against the woman's LTC risk may be at odds with the protection of her health from inefficiently high caregiving burden. Since the purchase of this insurance decreases the couple's wealth in the case of the man's dependence, the caregiving pressure for the woman is increased as there are fewer resources and thus more need to reduce formal LTC costs. For this reason, the woman's insurance has to be discouraged. On the contrary, the man's insurance has to be encouraged since it reduces the caregiving pressure for his wife.

In addition to providing insights for public policy, these results contribute to the discussion of which spouse should purchase (more) LTC insurance and shed doubts on the popular tendency to put more emphasis on insuring the woman, as discussed in the Introduction. Indeed, considering exactly the scenario put forward in such recommendations, the paper shows that privileging insurance for the woman might turn to be "dangerous" for her health, which invites to take these recommendations with caution.

On the other hand, one can also ask what results we could expect if we considered a more general scenario in which, with a certain probability, the woman could become dependent first and her husband would take care of her. While this would clearly make the model more complicated, one could expect that as far as myopia about negative caregiving effects is concerned, the optimal subsidy rates would then have two terms reflecting corrections for this myopia: in addition to the term accounting for the woman's caregiving in the case of her husband's dependence, there would also be a term accounting for the caregiving of the man in the case when his wife is disabled. This second term would push each subsidy rate into the opposite direction compared to the first term: while insurance against the man's dependence decreases the woman's caregiving burden in the case when her husband is dependent, it would increase the man's caregiving burden in the state of nature where the dependent spouse is the wife, and while insurance against the woman's dependence increases her caregiving burden in the state of her husband's disability, it would decrease the burden of the man in the case of the woman's dependence. The sign of the sum of the two terms would then depend on their relative magnitudes. In turn, these magnitudes would depend on the probability of each state of nature, on the degree of myopia about the negative health effects to each spouse but also on each partner's marginal loss of utility associated with these negative effects. Given that this loss is a convex function of the caregiving burden and considering that women tend to provide more care than men[21] (in the model this could for instance result from assuming the two partners having different abilities to provide care and thus to reduce formal LTC costs), one could expect the woman's marginal loss to be larger than the man's. Moreover, this seems to be even more likely given the evidence from some studies that caregiving burden tends to be more detrimental to the health of women than of men (Wang et al., 2014; Yee and Schulz, 2000). Therefore, even assuming equal probabilities for the two states of nature and the same degree of myopia about the negative impact on each spouse's health, the term accounting for the woman's caregiving would tend to prevail, which would suggest to expect conclusions similar to the ones drawn in this paper.

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Appendix A

In this appendix, the following results obtained in the *laissez-faire* will be proved:

$$\frac{\partial c_m^I}{\partial s^I} + \frac{\partial c_f^I}{\partial s^I} = -1; \quad \frac{\partial c_m^D}{\partial s^D} + \frac{\partial c_f^D}{\partial s^D} = -1; \quad \frac{\partial c_m^D}{\partial a_f} + \frac{\partial c_f^D}{\partial a_f} = h'(a_f);$$

$$\frac{\partial c_m^I}{\partial B_m} + \frac{\partial c_f^I}{\partial B_m} = -\pi_m; \quad \frac{\partial c_m^D}{\partial B_m} + \frac{\partial c_f^D}{\partial B_m} = 1 - \pi_m; \quad \frac{\partial c_m^I}{\partial B_f} + \frac{\partial c_f^I}{\partial B_f} = -\pi_f; \quad \frac{\partial c_m^D}{\partial B_f} + \frac{\partial c_f^D}{\partial B_f} = -\pi_f.$$

To begin, note that the FOC for c_m^j $(j = I,\, D)$ writes as

$$u'(c_m^j) - u'(c_f^j) = 0$$

and the FOC for c_f^j $(j = I,\, D)$ writes as

$$u'(c_f^j) - u'(c_m^j) = 0$$

Then we can derive the following comparative statics:

$$\frac{\partial c_m^j}{\partial s^j} = -\frac{u''(c_f^j)}{u''(c_m^j) + u''(c_f^j)} < 0, \quad for\ j = I,\, D,$$

$$\frac{\partial c_f^j}{\partial s^j} = -\frac{u''(c_m^j)}{u''(c_m^j) + u''(c_f^j)} < 0, \quad for\ j = I,\, D,$$

$$\frac{\partial c_m^D}{\partial a_f} = -\frac{-u''(c_f^D)h'(a_f)}{u''(c_m^D) + u''(c_f^D)} > 0, \quad \frac{\partial c_f^D}{\partial a_f} = -\frac{-u''(c_m^D)h'(a_f)}{u''(c_m^D) + u''(c_f^D)} > 0,$$

$$\frac{\partial c_m^I}{\partial B_m} = -\frac{-u''(c_f^I)(-\pi_m)}{u''(c_m^I) + u''(c_f^I)} < 0, \quad \frac{\partial c_f^I}{\partial B_m} = -\frac{-u''(c_m^I)(-\pi_m)}{u''(c_m^I) + u''(c_f^I)} < 0,$$

$$\frac{\partial c_m^D}{\partial B_m} = -\frac{-u''(c_f^D)(1-\pi_m)}{u''(c_m^D) + u''(c_f^D)} > 0, \quad \frac{\partial c_f^D}{\partial B_m} = -\frac{-u''(c_m^D)(1-\pi_m)}{u''(c_m^D) + u''(c_f^D)} > 0,$$

$$\frac{\partial c_m^I}{\partial B_f} = -\frac{-u''(c_f^I)(-\pi_f)}{u''(c_m^I) + u''(c_f^I)} < 0, \quad \frac{\partial c_f^I}{\partial B_f} = -\frac{-u''(c_m^I)(-\pi_f)}{u''(c_m^I) + u''(c_f^I)} < 0,$$

$$\frac{\partial c_m^D}{\partial B_f} = -\frac{-u''(c_f^D)(-\pi_f)}{u''(c_m^D) + u''(c_f^D)} < 0, \quad \frac{\partial c_f^D}{\partial B_f} = -\frac{-u''(c_m^D)(-\pi_f)}{u''(c_m^D) + u''(c_f^D)} < 0.$$

Using these expressions, the above results can be easily verified.

Appendix B

Let us first show that if $\hat{\pi}_m = \pi_m$ and $\hat{\pi}_f = \pi_f$, we have the first-best equality $u'(d_f^{II}) = u'(d_f^{ID}) = u'(d_f^{DI}) = u'(d_f^{DD}) = u'(c_m^I) = u'(c_m^D) = u'(c_f^I) = u'(c_f^D)$.

To begin, using (11) and (16) in (23), rearranging and using $\hat{\pi}_f = \pi_f$, we get

$$(1-\hat{\pi}_m)\left[u'(d_f^{ID}) - u'(d_f^{II})\right] + \hat{\pi}_m\left[u'(d_f^{DD}) - u'(d_f^{DI})\right] = 0 \tag{48}$$

Looking at the budget constraints for d_f^{II}, d_f^{ID}, d_f^{DI} and d_f^{DD}, it can be seen that if $u'(d_f^{ID}) > u'(d_f^{II})$, we must also have $u'(d_f^{DD}) > u'(d_f^{DI})$ and if $u'(d_f^{ID}) < u'(d_f^{II})$, we must also have $u'(d_f^{DD}) < u'(d_f^{DI})$ (and vice versa). Thus, if inequalities between the marginal utilities are strict, the two brackets in (48) are always positive or negative together. Therefore, the only way for the left-hand side of the equation to be equal to zero is to have $u'(d_f^{ID}) = u'(d_f^{II})$ and $u'(d_f^{DD}) = u'(d_f^{DI})$.

Further, from (21) we have $u'(c_m^I) = u'(c_m^D)$ and from (9) and (14) we obtain $u'(c_m^I) = u'(c_m^D) = u'(c_f^I) = u'(c_f^D)$. Using $u'(c_m^I) = u'(c_m^D)$, we can combine (11) and (16) to obtain

$$(1-\hat{\pi}_f)\left[u'(d_f^{II}) - u'(d_f^{DI})\right] + \hat{\pi}_f\left[u'(d_f^{ID}) - u'(d_f^{DD})\right] = 0 \tag{49}$$

Again looking at the budget constraints for d_f^{II}, d_f^{ID}, d_f^{DI} and d_f^{DD}, it can be seen that if $u'(d_f^{II}) > u'(d_f^{DI})$, we must also have $u'(d_f^{ID}) > u'(d_f^{DD})$ and if $u'(d_f^{II}) < u'(d_f^{DI})$, we must also have $u'(d_f^{ID}) < u'(d_f^{DD})$ (and vice versa). Thus, in order for (49) to hold, it must be that $u'(d_f^{II}) = u'(d_f^{DI})$ and $u'(d_f^{ID}) = u'(d_f^{DD})$.

Finally, using $u'(d_f^{ID}) = u'(d_f^{II})$ in (11) and $u'(d_f^{DD}) = u'(d_f^{DI})$ in (16) implies $u'(c_m^I) = u'(d_f^{ID}) = u'(d_f^{II})$ and $u'(c_m^D) = u'(d_f^{DD}) = u'(d_f^{DI})$.

Taking all these results together, we indeed obtain $u'(d_f^{II}) = u'(d_f^{ID}) = u'(d_f^{DI}) = u'(d_f^{DD}) = u'(c_m^I) = u'(c_m^D) = u'(c_f^I) = u'(c_f^D)$.

Now let us show that if $\hat{\pi}_f = \pi_f$ but $\hat{\pi}_m < \pi_m$, we have $u'(d_f^{II}) = u'(d_f^{ID}) = u'(c_m^I) = u'(c_f^I) < u'(d_f^{DD}) = u'(d_f^{DI}) = u'(c_m^D) = u'(c_f^D)$.

First, we can prove in the same way as above that $u'(d_f^{II}) = u'(d_f^{ID}) = u'(c_m^I) = u'(c_f^I)$ and $u'(d_f^{DD}) = u'(d_f^{DI}) = u'(c_m^D) = u'(c_f^D)$. Then, with $\hat{\pi}_m < \pi_m$, from (21) we have $u'(c_m^I) < u'(c_m^D)$. This therefore implies $u'(d_f^{II}) = u'(d_f^{ID}) = u'(c_m^I) = u'(c_f^I) < u'(d_f^{DD}) = u'(d_f^{DI}) = u'(c_m^D) = u'(c_f^D)$.

Further, let us show that if $\hat{\pi}_f < \pi_f$ and $\hat{\pi}_m = \pi_m$, we have $u'(d_f^{ID}) = u'(d_f^{DD}) > u'(d_f^{II}) = u'(d_f^{DI})$.

First, we are going to verify that $u'(d_f^{II}) = u'(d_f^{ID})$ and $u'(d_f^{DD}) = u'(d_f^{DI})$ no longer hold. To see this, let us combine (23) with (16) and (11) and evaluate at $u'(d_f^{II}) = u'(d_f^{ID})$ and $u'(d_f^{DD}) = u'(d_f^{DI})$. After rearranging, we get

$$\left[(1-\hat{\pi}_m)u'(d_f^{ID}) + \hat{\pi}_m u'(d_f^{DD})\right]\left[\hat{\pi}_f(1-\pi_f) - \pi_f(1-\hat{\pi}_f)\right] < 0 \tag{50}$$

Thus, evaluated at $u'(d_f^{II}) = u'(d_f^{ID})$ and $u'(d_f^{DD}) = u'(d_f^{DI})$, i.e. at full insurance against the woman's dependence, the FOC for B_f is not satisfied and the negative sign of the expression shows that the level of insurance has to be reduced. Therefore, the couple will purchase less than full insurance for the woman, which implies that we will have $u'(d_f^{ID}) > u'(d_f^{II})$ and $u'(d_f^{DD}) > u'(d_f^{DI})$.

Since $\hat{\pi}_m = \pi_m$, we can show in the same way as above that $u'(d_f^{II}) = u'(d_f^{DI})$ and $u'(d_f^{ID}) = u'(d_f^{DD})$. Thus, we indeed have $u'(d_f^{ID}) = u'(d_f^{DD}) > u'(d_f^{II}) = u'(d_f^{DI})$.

Finally, let us show that if $\hat{\pi}_f < \pi_f$ and $\hat{\pi}_m < \pi_m$, we have $u'(d_f^{ID}) > u'(d_f^{II})$, $u'(d_f^{DD}) > u'(d_f^{DI})$, $u'(d_f^{ID}) < u'(d_f^{DD})$ and $u'(d_f^{II}) < u'(d_f^{DI})$.

The first two inequalities, i.e. $u'(d_f^{ID}) > u'(d_f^{II})$ and $u'(d_f^{DD}) > u'(d_f^{DI})$, can be proved in the same way as just shown above. For the second two, we have to combine (11) and (16) noting that with $\hat{\pi}_m < \pi_m$, we have $u'(c_m^I) < u'(c_m^D)$. This gives

$$(1-\hat{\pi}_f)\left[u'(d_f^{II}) - u'(d_f^{DI})\right] + \hat{\pi}_f\left[u'(d_f^{ID}) - u'(d_f^{DD})\right] < 0 \tag{51}$$

It can be seen from the budget constraints for d_f^{II}, d_f^{ID}, d_f^{DI} and d_f^{DD} that the only way for the inequality (51) to hold is to have $u'(d_f^{ID}) < u'(d_f^{DD})$ and $u'(d_f^{II}) < u'(d_f^{DI})$.

Appendix C

In this appendix, it is shown that the subsidy rate $\sigma_f^* = \frac{\pi_f - \hat{\pi}_f}{\pi_f}$ implements full insurance against the woman's dependence. To see this, first note that with this subsidy rate in place, the FOC for B_f becomes

$$(1-\hat{\pi}_m)u'(d_f^{ID}) + \hat{\pi}_m u'(d_f^{DD}) - (1-\hat{\pi}_m)u'(c_m^I) - \hat{\pi}_m u'(c_m^D) = 0 \tag{52}$$

Combining (52) with (11) and (16), simplifying and rearranging gives

$$(1-\hat{\pi}_m)\left[u'(d_f^{ID}) - u'(d_f^{II})\right] + \hat{\pi}_m\left[u'(d_f^{DD}) - u'(d_f^{DI})\right] = 0 \tag{53}$$

As discussed in Appendix B, from the budget constraints for d_f^{II}, d_f^{ID}, d_f^{DI} and d_f^{DD}, it can be seen that the only way for (53) to hold is to have $u'(d_f^{ID}) = u'(d_f^{II})$ and $u'(d_f^{DD}) = u'(d_f^{DI})$, which means full insurance against the woman's dependence.

Appendix D

This appendix derives the comparative statics needed for interpreting equations (45) and (46).

Using (26), we can derive

$$\frac{\partial B_m}{\partial \sigma_m} = -\frac{\left[\hat{\pi}_m u'(c_m^D) + (1-\hat{\pi}_m)u'(c_m^I)\right]\pi_m}{SOC_{B_m}} -$$

$$-\frac{\hat{\pi}_m u''(c_m^D)\frac{\partial c_m^D}{\partial \sigma_m}\left(1+\sigma_m\pi_m-\pi_m\right)+(1-\hat{\pi}_m)u''(c_m^I)\frac{\partial c_m^I}{\partial \sigma_m}\left(\sigma_m\pi_m-\pi_m\right)}{SOC_{B_m}},$$

$$\frac{\partial B_m}{\partial \sigma_f}=-\frac{\hat{\pi}_m u''(c_m^D)\frac{\partial c_m^D}{\partial \sigma_f}\left(1+\sigma_m\pi_m-\pi_m\right)+(1-\hat{\pi}_m)u''(c_m^I)\frac{\partial c_m^I}{\partial \sigma_f}\left(\sigma_m\pi_m-\pi_m\right)}{SOC_{B_m}}$$

and

$$\frac{\partial B_m}{\partial T}=-\frac{\hat{\pi}_m u''(c_m^D)\frac{\partial c_m^D}{\partial T}\left(1+\sigma_m\pi_m-\pi_m\right)+(1-\hat{\pi}_m)u''(c_m^I)\frac{\partial c_m^I}{\partial T}\left(\sigma_m\pi_m-\pi_m\right)}{SOC_{B_m}}$$

where

$$SOC_{B_m}=\hat{\pi}_m u''(c_m^D)\frac{\partial c_m^D}{\partial B_m}\left(1+\sigma_m\pi_m-\pi_m\right)+(1-\hat{\pi}_m)u''(c_m^I)\frac{\partial c_m^I}{\partial B_m}\left(\sigma_m\pi_m-\pi_m\right)<0,$$

$$\frac{\partial c_m^D}{\partial B_m}=\frac{u''(c_f^D)(1+\sigma_m\pi_m-\pi_m)}{u''(c_m^D)+u''(c_f^D)}>0,\ \frac{\partial c_m^I}{\partial B_m}=\frac{u''(c_f^I)(\sigma_m\pi_m-\pi_m)}{u''(c_m^I)+u''(c_f^I)}<0,\ \frac{\partial c_m^D}{\partial T}=\frac{-u''(c_f^D)}{u''(c_m^D)+u''(c_f^D)}<0,$$

$$\frac{\partial c_m^I}{\partial T}=\frac{-u''(c_f^I)}{u''(c_m^I)+u''(c_f^I)}<0,\ \frac{\partial c_m^D}{\partial \sigma_i}=\frac{u''(c_f^D)\pi_i B_i}{u''(c_m^D)+u''(c_f^D)}>0,\ \frac{\partial c_m^I}{\partial \sigma_i}=\frac{u''(c_f^I)\pi_i B_i}{u''(c_m^I)+u''(c_f^I)}>0,\ i=m,\,f.$$

Using definition (38), we can obtain

$$\frac{\partial B_m^C}{\partial \sigma_m}=-\frac{\left[\hat{\pi}_m u'(c_m^D)+(1-\hat{\pi}_m)u'(c_m^I)\right]\pi_m}{SOC_{B_m}}>0$$

and

$$\frac{\partial B_m^C}{\partial \sigma_f}=0.$$

Using (29), we can derive

$$\frac{\partial B_f}{\partial \sigma_m}=-\frac{\hat{\pi}_m u''(c_m^D)\frac{\partial c_m^D}{\partial \sigma_m}\left(\sigma_f\pi_f-\pi_f\right)+(1-\hat{\pi}_m)u''(c_m^I)\frac{\partial c_m^I}{\partial \sigma_m}\left(\sigma_f\pi_f-\pi_f\right)}{SOC_{B_f}},$$

$$\frac{\partial B_f}{\partial \sigma_f}=-\frac{\hat{\pi}_m u''(c_m^D)\frac{\partial c_m^D}{\partial \sigma_f}\left(\sigma_f\pi_f-\pi_f\right)+(1-\hat{\pi}_m)u''(c_m^I)\frac{\partial c_m^I}{\partial \sigma_f}\left(\sigma_f\pi_f-\pi_f\right)}{SOC_{B_f}}-$$

$$-\frac{\left[\hat{\pi}_m u'(c_m^D)+(1-\hat{\pi}_m)u'(c_m^I)\right]\pi_f}{SOC_{B_f}}$$

and

$$\frac{\partial B_f}{\partial T} = -\frac{\hat{\pi}_m u''(c_m^D)\frac{\partial c_m^D}{\partial T}(\sigma_f\pi_f - \pi_f) + (1-\hat{\pi}_m)u''(c_m^I)\frac{\partial c_m^I}{\partial T}(\sigma_f\pi_f - \pi_f)}{SOC_{B_f}}$$

where

$$SOC_{B_f} = \left[\hat{\pi}_m u''(c_m^D)\frac{\partial c_m^D}{\partial B_f} + (1-\hat{\pi}_m)u''(c_m^I)\frac{\partial c_m^I}{\partial B_f}\right](\sigma_f\pi_f - \pi_f) + \hat{\pi}_f\left[(1-\hat{\pi}_m)u''(d_f^{ID}) + \hat{\pi}_m u''(d_f^{DD})\right] < 0,$$

$$\frac{\partial c_m^D}{\partial B_f} = \frac{u''(c_f^D)(\sigma_f\pi_f - \pi_f)}{u''(c_m^D) + u''(c_f^D)} < 0, \quad \frac{\partial c_m^I}{\partial B_f} = \frac{u''(c_f^I)(\sigma_f\pi_f - \pi_f)}{u''(c_m^I) + u''(c_f^I)} < 0.$$

Using definition (39), we can obtain

$$\frac{\partial B_f^C}{\partial \sigma_m} = 0$$

and

$$\frac{\partial B_f^C}{\partial \sigma_f} = -\frac{\left[\hat{\pi}_m u'(c_m^D) + (1-\hat{\pi}_m)u'(c_m^I)\right]\pi_f}{SOC_{B_f}} > 0.$$

Further, using definition (42), we can write

$$\frac{\partial \bar{a}_f^C}{\partial \sigma_m} = \frac{\partial a_f}{\partial \sigma_m} + \frac{\partial a_f}{\partial T}\pi_m B_m + \frac{\partial a_f}{\partial B_m}\frac{\partial B_m^C}{\partial \sigma_m} + \frac{\partial a_f}{\partial B_f}\frac{\partial B_f^C}{\partial \sigma_m}$$

and

$$\frac{\partial \bar{a}_f^C}{\partial \sigma_f} = \frac{\partial a_f}{\partial \sigma_f} + \frac{\partial a_f}{\partial T}\pi_f B_f + \frac{\partial a_f}{\partial B_m}\frac{\partial B_m^C}{\partial \sigma_f} + \frac{\partial a_f}{\partial B_f}\frac{\partial B_f^C}{\partial \sigma_f}.$$

Using (18), we can derive

$$\frac{\partial a_f}{\partial \sigma_i} = -\frac{h'(a_f)u''(c_m^D)\frac{\partial c_m^D}{\partial \sigma_i}}{SOC_{a_f}} < 0, \ for\ i = m,\ f, \quad \frac{\partial a_f}{\partial T} = -\frac{h'(a_f)u''(c_m^D)\frac{\partial c_m^D}{\partial T}}{SOC_{a_f}} > 0,$$

$$\frac{\partial a_f}{\partial B_m} = -\frac{h'(a_f)u''(c_m^D)\frac{\partial c_m^D}{\partial B_m}}{SOC_{a_f}} < 0, \quad \frac{\partial a_f}{\partial B_f} = -\frac{h'(a_f)u''(c_m^D)\frac{\partial c_m^D}{\partial B_f}}{SOC_{a_f}} > 0$$

where $SOC_{a_f} = u'(c_m^D)h''(a_f) + h'(a_f)u''(c_m^D)\frac{\partial c_m^D}{\partial a_f} - \beta\mu''(a_f) < 0$.

This gives

$$\frac{\partial \bar{a}_f^C}{\partial \sigma_m} = \frac{\partial a_f}{\partial B_m}\frac{\partial B_m^C}{\partial \sigma_m} < 0$$

and

$$\frac{\partial \bar{a}_f^C}{\partial \sigma_f} = \frac{\partial a_f}{\partial B_f}\frac{\partial B_f^C}{\partial \sigma_f} > 0.$$

In a similar way, but using definition (40) and deriving equation (11), we can obtain

$$\frac{\partial \bar{s}^{IC}}{\partial \sigma_m} = \frac{\partial s^I}{\partial B_m} \frac{\partial B_m^C}{\partial \sigma_m} < 0$$

and

$$\frac{\partial \bar{s}^{IC}}{\partial \sigma_f} = \frac{\partial s^I}{\partial B_f} \frac{\partial B_f^C}{\partial \sigma_f} < 0$$

where

$$\frac{\partial s^I}{\partial B_i} = \frac{u''(c_m^I)\frac{\partial c_m^I}{\partial B_i}}{SOC_{s^I}} < 0,\ for\ i = m,\ f$$

with $SOC_{s^I} = (1 - \hat{\pi}_f)u''(d_f^{II}) + \hat{\pi}_f u''(d_f^{ID}) - u''(c_m^I)\frac{\partial c_m^I}{\partial s^I} < 0$.

Finally, using definition (41) and deriving equation (16), we can obtain

$$\frac{\partial \bar{s}^{DC}}{\partial \sigma_m} = \frac{\partial B_m^C}{\partial \sigma_m}\left[\frac{\partial s^D}{\partial B_m} + \frac{\partial s^D}{\partial a_f}\frac{\partial a_f}{\partial B_m}\right] = \frac{\partial B_m^C}{\partial \sigma_m}\frac{\partial s^D}{\partial B_m}\left[1 - \frac{h'(a_f)u''(c_m^D)\frac{\partial c_m^D}{\partial a_f}}{SOC_{a_f}}\right] > 0$$

and

$$\frac{\partial \bar{s}^{DC}}{\partial \sigma_f} = \frac{\partial B_f^C}{\partial \sigma_f}\left[\frac{\partial s^D}{\partial B_f} + \frac{\partial s^D}{\partial a_f}\frac{\partial a_f}{\partial B_f}\right] = \frac{\partial B_f^C}{\partial \sigma_f}\frac{\partial s^D}{\partial B_f}\left[1 - \frac{h'(a_f)u''(c_m^D)\frac{\partial c_m^D}{\partial a_f}}{SOC_{a_f}}\right] < 0$$

where

$$\frac{\partial s^D}{\partial B_m} = \frac{u''(c_m^D)\frac{\partial c_m^D}{\partial B_m}}{SOC_{s^D}} > 0,\ \frac{\partial s^D}{\partial B_f} = \frac{u''(c_m^D)\frac{\partial c_m^D}{\partial B_f}}{SOC_{s^D}} < 0,\ \frac{\partial s^D}{\partial a_f} = \frac{u''(c_m^D)\frac{\partial c_m^D}{\partial a_f}}{SOC_{s^D}} > 0$$

with $SOC_{s^D} = (1 - \hat{\pi}_f)u''(d_f^{DI}) + \hat{\pi}_f u''(d_f^{DD}) - u''(c_m^D)\frac{\partial c_m^D}{\partial s^D} < 0$.

Appendix E

This appendix shows that in the case where $\hat{\pi}_m < \pi_m$, $\hat{\pi}_f < \pi_f$, but $\beta = 1$, the first-best subsidy rates $\sigma_m^* = \frac{\pi_m - \hat{\pi}_m}{\pi_m}$ and $\sigma_f^* = \frac{\pi_f - \hat{\pi}_f}{\pi_f}$ are optimal in the second-best as well. To see this, let us evaluate equations (45) and (46) at σ_m^* and σ_f^*. Noting that σ_m^* and σ_f^* implement full insurance against both spouses' dependence, we obtain

$$\sigma_m^* = \frac{[\pi_m - \hat{\pi}_m]\, u'(c_m^{I*})}{\phi^* \pi_m} \tag{54}$$

and

$$\sigma_f^* = \frac{[\pi_f - \hat{\pi}_f]\, u'(d_f^{ID*})}{\phi^* \pi_f} \tag{55}$$

where ϕ^* denotes ϕ evaluated at σ_m^* and σ_f^*. Expressing ϕ from (35) and evaluating it at σ_m^* and σ_f^*, it can be seen that $\phi^* = u'(c_m^{I*}) = u'(d_f^{ID*})$, which implies that (54) and (55) become $\sigma_m^* = \frac{\pi_m - \hat{\pi}_m}{\pi_m} = \sigma_m^*$ and $\sigma_f^* = \frac{\pi_f - \hat{\pi}_f}{\pi_f} = \sigma_f^*$. This proves that (σ_m^*, σ_f^*) is indeed optimal in the second-best.