Asymmetric information and optimal policy to support home care

Marcello Montefiori[a] · Lucia Leporatti[b]

[a)] Marcello Montefiori
University of Genoa
Department of Economics and Business Studies
Via Vivaldi 5 – 16126 Genova - Italy
Email: montefiori@unige.it

[b)] Lucia Leporatti
University of Genoa
Department of Economics and Business Studies
Via Vivaldi 5,16126, Genoa, Italy
tel. +39 010 2095207
e-mail: lucia.leporatti@unige.it

Abstract

The increasing life expectancy poses challenges on the future sustainability of long term care services that today strongly depend on informal care provided within the family by working age children. Ongoing social changes are likely to weaken the informal provision of care. The paper derives optimal policies to help the policy-maker to choose innovative and sustainable solutions to support family care. Optimal policies are derived in the case of complete and incomplete information, taking into account the severity of health condition and the different opportunity costs of informal carers. Drawing inspiration from real world policies and considering all aspects of the family decision-making process, the suitable policy to attain a second best outcome combines lump-sum transfers with paid permissions from work and in-kind provisions. In the context of information asymmetry, the implementation of the second-best outcome requires a recipient's level of care to be forced towards certain targets to avoid adverse selection. Interestingly, there are circumstances in which the transfer can move from lower income households to higher income households.

JEL Codes: D82, H42, I18, J14
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1. Introduction

Life expectancy is increasing in most industrialized countries and the number of people in need for day-to-day help is destined to rise in coming years boosting the demand for long term care (LTC)[1]. According to European Commission (2015), the number of people in need for LTC is expected to grow from 27 million in 2013 to 35 million by year 2060 becoming a major challenge for policy-makers. Despite its social relevance, compared to other social insurance services, in most western countries, the public support for LTC is not very generous and it is estimated that approximately two thirds of LTC are still provided by informal caregivers such as household members, relatives and friends (Klimaviciute and Pestieau, 2018). According to the most recent OECD estimates, on average in the OECD30 countries, public spending on LTC represents 1.4 % of GDP but this percentage varies considerably within the countries, ranging from 4.3% of GDP in the Netherlands to percentages close to 0 % in Greece and Slovak Republic[2]. These differences reflect large disparities within the OECD countries in the forms of financing and providing (formally versus informally) LTC services (Kraus et al., 2010). At the same time, the development of private LTC insurance market is very limited due to substantial market failures (Cremer and Roeder, 2013) and most of the LTC expenditure risk is uninsured and borne by private individuals (Brown and Finkelstein, 2007) increasing the probability of impoverishment of low-income individuals (del Pozo-Rubio et al., 2019).

As a consequence, governments are committed to finding sustainable solutions to respond to the expected increase in frail people's needs and most of the attention is posed on how to finance (Colombo and Mercier, 2012; Costa-font et al., 2015; Wouterse, and Smid, 2017) and organize (Costa-Font et al., 2017) the provision of LTC services. One important issue that should be taken into account is that the vast majority of older people receive help at home[3]. In the OECD30, less than 4% of people older than 65 receive long term care in institutions, whereas those receiving care at home represent more than 9%[4]. To this respect, it should be noted that a relevant part of the home care received by disabled elderly is often informal and offered within the family by household members (Colombo et al., 2011; Paraponaris et al., 2012). Government policies are generally oriented at maintaining the elderly in need of care in their own homes as long as possible

[1] By long-term care, we mean services to support the activities of daily living through formal (i.e. care purchased on the market) or informal (i.e. care offered within the family) care over an extended period of time.

[2] Source: OECD Health Statistics, year 2014

[3] When referring to home care, we mean the care provided in the home by informal carers, such as household members, relatives, friends, and other volunteers or by external carers offering their services at market prices.

[4] Source: OECD Health Data 2016

since this is associated to positive consequences for individual emotional well-being and to a reduction in LTC expenditure (Mosca et al., 2017)[5]. According to Kok et al. (2015) residential care for elderly people is between €8,350 and €11,350 per year more expensive than home care. However, most of western countries are experiencing social changes that are likely to weaken the informal provision of care, particularly the rapid increase in female labor force participation, the declining family size and the increased retirement age. Today, adult children who provide care to their frail parents are the most common type of care providers and the vast majority of them are still of working age (Van Houtven et al., 2013). Consequently, the time devoted by children to care is subtracted from work and this implies the presence of an opportunity cost (Johnson and Wiener, 2006). These issues are pushing public decision-makers to pay increasing attention to policy intended to support informal care and reconcile it with employment (Fujisawa and Colombo, 2009). Several countries are introducing instruments to support and stimulate the work of informal carers in the forms of cash benefits, paid or unpaid leave from work, in-kind services, home support devices and adaptations, counselling and training services (Mosca et al., 2017). The setting of a proper combination of these instruments is complicated by fiscal pressures, demographic change and by the intrinsic complexity and uncertainty associated to LTC systems (Heller and Hauner, 2006). Indeed, governments should balance the need to accommodate patients' preference for staying at home with the need to mitigate externalities of informal care on caregivers' health and employment.

The present study aims at deriving optimal policies to help the policy-maker to choose a tax-funded transfer to support households with family members in need of care when caregivers show different opportunity costs of caring. The finding of a proper equilibrium is complicated by the presence of asymmetric information. Time spent on caring is indeed affected by the severity of physical or mental conditions but in many circumstances this is private information (Kuhn and Nuscheler, 2011), which creates favourable conditions for adverse selection and poses challenges for planners who are intent on social welfare maximization (OECD, 2005). Such an analysis is of particular relevance given the fact that LTC policies are still at an early stage of development in several countries, particularly in the European Union, and evidence in support of different policies are still limited (Courtin et al., 2014). As will be showed and better discussed along the paper, the implementation of policies in support of home care (particularly in the form of cash transfers and of paid permission from work) may lead to unexpected and counter-intuitive distortive outcomes both for low and high income households.

The main innovation of the paper, compared to existing literature, is the simultaneous inclusion in the model of three factors: the different opportunity costs of informal carers; the

[5] However, it cannot be taken for granted that home care is less expensive than care in hospitals or in other institutions; the cost of home care depends on the proportion between informal and market care and it generally rises when the people are in severe needs and receive formal home care (Miur, 2017).

parent's severity (considered alternatively, when it is a public or private information); the costs and productivity of different home caring possibilities (family vs market care).

Using this setting, we derive optimal policies under perfect and imperfect information. Results show that in some circumstances, benefits can favour higher rather lower income individuals and high income carers may be forced to provide a higher than optimal level of informal care. Such situations are particularly relevant in the light of the policies implemented at the moment in some countries (Courtin et al., 2014).

The rest of the paper is organized as follows. In Section 2, the model is presented. In Section 3, the scenario of perfect information is investigated and the first-best outcome is provided. In Section 4 asymmetry of information is examined. Finally, in Section 6, some concluding remarks are presented.

2. The model

A very general setting is adopted in order to consider all the aspects that inform the family decision-making process and, thus, we obtain 'not case-specific' results. The model considers households aiming at utility maximization and assumes that a disabled relative belongs to each household and that he requires care because of problems with daily living activities. Even though different forms of care are possible, the analysis focuses only on the care provided to the parent at his own home, ignoring the possibility of using nursing home care. It is assumed that home care can be provided either by the child or by external carers (market care) offering their services at the market price. To simplify the model, we suppose that each household consists of one child and one parent; consequently, we ignore the case in which the spouse no longer in working age can assist the husband/wife. The child is assumed to be the potential carer and he is still of working age involving the presence of an opportunity cost that, differently from Kuhn and Nuscheler (2011) (KN henceforth), can vary among households. It is assumed that each child shares the time at his disposal between two main activities: producing real income and caring for the parent. In this setting, we assume that the leisure time cannot be devoted to care considering a certain amount of leisure inalienable. The parent is the person in need of care. The model distinguishes between two severity types of parents: high *(h)* and low *(l)*. The share of high severity types is denoted by $k \in (0,1)$.

Two goods enter the household utility function: the benefit the parent gets from care (good X) and the composite good Y (in which all real income is spent):

$$U^i(Y,X) = u^i(Y) + v^i(X), i = l,h$$

Standard assumptions for the utility function are adopted: that is, it increases in Y and X and is strictly quasi-concave, as long as all goods are normal[6]. Good X is given by the sum of child (equivalently, family) care (x^f) and market care (x^m):

$$X = x^f + x^m.$$

Each household produces goods x^f and x^m by its own, decreasing return to scale, production function whose only input[7] is the time devoted to the elderly (t); however they depend also on the parameter ϑ which is related to the severity type of the elderly person:

$$x^{ji} = \xi^{ji}(t^{ji}, \vartheta^i);\ i = h, l; j = f, m$$

The following conditions are assumed to hold: $x_t > 0;\ x_\vartheta < 0;$ and $x_{tt}, x_{\vartheta\vartheta}, x_{t\vartheta} \leq 0$, where the condition $\vartheta^h > \vartheta^l$ is assumed[8]. Similarly to KN (2011), we assume that an additional unit of care leads to a higher benefit for those parents having serious problems; this means that $v_x^h(x) \geq v_x^l(x)$. A crucial assumption in this model is that, although x^f and x^m are perfect substitutes for X (Bolin et al., 2008), they show different productivity in terms of variable t, with productivity depending also on patient type (high or low severity). In particular, for any $\bar{t} > 0$, the following condition is met:

$$x_t^f > x_t^m \big|_{t=\bar{t}} \tag{1}$$

This means that the time a child devotes to care is more productive (i.e., produces a greater amount of x) with respect to the same amount of time bought in the market at the market price. Assuming x as a monotonic function, its inverse may be written as:

$$t^{ji} = L^{ji}(x^{ji}, \vartheta^i);\ i = h, l; j = f, m$$

where t^{ji} is the time devoted/purchased for elderly care, which depends on the level of care x^{ji} and on the severity parameter $\vartheta^i, i = h, l$ of the parent. In particular the following assumptions are met: $t_\vartheta, t_x > 0; t_{\vartheta\vartheta}, t_{xx}, t_{x\vartheta} \geq 0$. From Eq. (1), it is possible to derive the condition $t^i_{x^m} > t^i_{x^f}$. These conditions suggest decreasing returns to scale of the time devoted to care; in particular, this effect is amplified when the parent has a high severity level.

A crucial element in our analysis is the fact that children show different wages (ϖ^i) and, consequently, different opportunity costs of providing informal care. Children who earn low wages (or who have poor labour market opportunities) are more inclined to devote more time to care because of their lower opportunity cost; conversely, children who earn higher wages may have a propensity for counting on market care. The virtual expenditure function $\varpi^i t^{fi}$ for elderly

[6] As opposed to KN, in this setting there are no assumptions regarding the way the level of care affects household utility differently. In particular, KN assume different productivity in terms of utility according to severity type.

[7] Modelling informal care using the usual production functions with decreasing returns is tantamount to mimicking a virtual market in which the shadow price of care rises with the amount of care provided. In order to represent the quality of care provided, two family production functions are considered in the model: high and low. Inputs others than time should enter the function for the production of care, including those goods and factors privately purchased by households. However, for the sake of simplicity, it is assumed that the only input which enters the production function is the time devoted to care.

[8] The subscript indicates the variable with respect to which the function has been derived, either at first or second order.

family care (equivalently, the opportunity cost) depends and increases with the household type i wage level (ϖ^i), with the level of care provided (x^i) and with severity (ϑ^i), where the condition $\vartheta^h > \vartheta^l$ is assumed.

The potential income for the household depends on the wage level ϖ^i multiplied by the endowment of time, which is normalized to one. The endowment of time is assumed to be equal among all household types. The budget constraint can then be written as:

$$\varpi^i\left(1 - t^{fi}\right) - \varpi^m t^{mi} = Y^i, i = l, h$$

where ϖ^i describes, on the one hand, the potential household income and, on the other, the child's opportunity cost for providing care, ϖ^m is the market price for care per unit of time purchased, $t^{fi}$and t^{mi} refer to the amount of time for care provided by child and purchased in the market, respectively and Y^i is the quantity of the composite private good purchased at the market price by household *i*. For simplicity, the price for good *Y* is normalized to 1 ($p_y = 1$). The disposable income is allowed to vary across household types by the assumption of a different wage rate between family types[9].

3. The perfect information scenario and the social optimum

In this section, we explore the opportunity of introducing an incentive in the form of a government lump-sum transfer τ to support home care in a context of perfect information. The transfer τ can be zero, positive, or negative, the household budget constraint is then:

$$\varpi^i\left(1 - t^{fi}\right) - \varpi^m t^{mi} + \tau = Y^i;\ i = l, h$$

Social welfare *W* can be written as:

$$W = \kappa U^h + (1 - \kappa) U^l \qquad (2)$$

where κ is the share of high severity households.

The social planner aims to maximize social welfare, assuming that the means at the social planner's disposal to achieve a policy goal consists of a lump-sum transfer, which is equal in amount among all households of the same type:

$$\kappa \tau^h = (1 - \kappa) \tau^l$$

[9] Note that in the KN setting, the wage rate is normalized to one. To this extent, they assume equal disposable income among family types.

As usual, the first order conditions[10] are derived:

$$u_Y^h = u_Y^l \tag{3}$$

$$u_Y^i = \frac{v_X^i X_{t^{fi}}^i}{\varpi^i} = \frac{v_X^i X_{t^{mi}}^i}{\varpi^m} \tag{4}$$

From Condition (4), we obtain

$$(X_{t^{fi}}^i)/(X_{t^{mi}}^i) = \varpi^i/\varpi^m \tag{5}$$

Condition (3) requires equalization of the marginal utility of good *Y* among the different severity types of households (see Fig.1). The social planner transfers money from one type of household to another as long as the marginal utility of *Y* of the receiving household is higher with respect to that of the giver.

Condition (5) provides the well-known condition for efficiency: the *marginal rate of technical substitution* in the production of good *X* has to equal the negative ratio between the prices of inputs. By assumption, the marginal productivity of the time of care provided by the child is greater with respect to the marginal productivity of market care (see Eq. (1)). Therefore, it is possible to assume that[11]:

$$X_{t^{mi}}^i = \mu X_{t^{fi}}^i \tag{6}$$

where $0 < \mu < 1$.

Using Eqs. (5) and (6), the relationship between t^{fi} and t^{mi} can be derived. Particularly, if $\frac{\varpi^i}{\varpi^m} = \frac{1}{\mu}$ then the amount of time devoted to informal care is equal to that purchased on the market ($t^{fi} = t^{mi}$), whereas if $\frac{\varpi^i}{\varpi^m} > \frac{1}{\mu}$, the amount of time devoted to informal care is lower to that purchased on the market ($t^{fi} < t^{mi}$), and if $\frac{\varpi^i}{\varpi^m} < \frac{1}{\mu}$ then $t^{fi} > t^{mi}$.

Using Eqs. (2) and (3), it is straightforward to obtain the following condition:

$$v_X^h X_{t^m}^h = v_X^l X_{t^m}^l \tag{7}$$

that allows us to simply identify the direction of the transfer outlays. $v_X^h X_{t^m}^h > v_X^l X_{t^m}^l$ implies that an increase in market care for the high severity household permits an increase in terms of

[10] These are necessary and sufficient for efficiency, given a concave programming problem.

[11] For simplicity, μ is assumed not to vary among household types. This implies that the productivity ratio (between family care and market care) is equal to $\frac{1}{\mu}$ regardless of the severity type.

utility greater than that which would be attained by the low severity type. For this reason, the transfer has to move from low severity type to high. On the other hand, if $v_X^h X_{tm}^h$ is lower with respect to $v_X^l X_{tm}^l$, then the transfer would have the opposite sign.

Provided that $\vartheta^h > \vartheta^l$ and assuming the same level of care purchased in the market ($t^{mh} = t^{ml}$), then $X_{tm}^h < X_{tm}^l$. This implies that, unless there are striking differences in wage levels ($\varpi^h \ll \varpi^l$), high severity households have to show higher marginal utility for good *X* than low severity households ($X_t^h > X_t^l$) in order to be eligible for subsidies.

Fig. 1: Perfect information, first-best outcome before and after lump-sum transfer

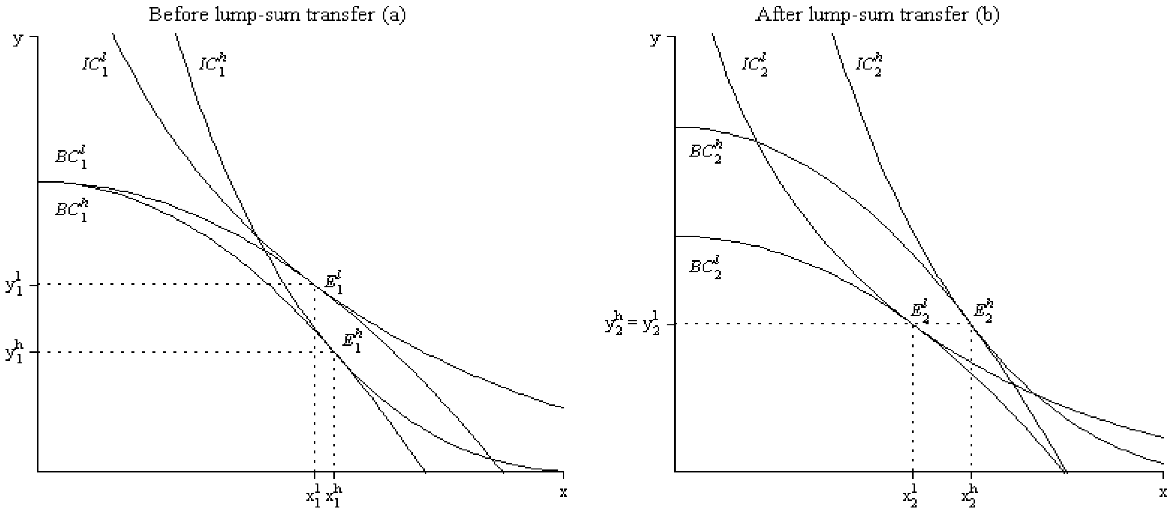


Fig. 1 represents the case in which $\varpi^h = \varpi^l = \varpi^m$ and $v_X^h > v_X^l$. High severity household types are characterized by lower productivity of time ($X_t^h < X_t^l$) because of greater values for ϑ ($\vartheta^h > \vartheta^l$). The lower productivity of time for high severity households might compensate for the difference in terms of marginal utility of *X* and affect the sign of the transfer.

Fig.1a represents the scenario before the lump-sum transfer. E_1^h and E_1^l are the initial equilibrium points for households *h* (high severity) and *l* (low severity), respectively. The BC_1^i represent the initial budget constraints while the IC_1^i lines represent the indifference curves. Before the redistribution, the high severity household shows a lower consumption of good *Y* but a greater *X*.

The assumption underlying the graphical representation of Fig.1 is that, before the lump-sum transfer, the condition $v_X^h X_{tm}^h > v_X^l X_{tm}^l$ is verified. In turn, this implies that the high severity household receives a positive transfer and the low severity household a negative transfer.

The scenario after the redistribution is represented in Fig.2b. We can observe that after the lump-sum transfer, the consumption of good *Y* is the same for both household types. With respect to the initial equilibrium, the high severity household increases its consumption of X whereas the low severity household decreases its consumption of X.

Using Eq. (6) and sticking with the assumption that $\varpi^i = \varpi^m$, it is possible to deduce that $\frac{\varpi^i}{\varpi^m} < \frac{1}{\mu}$ and, consequently, that $t^{fi} > t^{mi}$. Furthermore, knowing that after the redistribution, Condition (7) has to be met, it is possible to infer that $t^{mh} > t^{ml}$. Likewise, the information that $t^h > t^l$ is obtained by using Condition (4).

Note that Fig. 1 refers to a particular case. In general, in our model the direction of the transfer outlays is not defined *a priori*. The result that transfers may flow both from low to high severity household types and vice versa is of some interest when applied to the provision of long-term care, although it is not new per se[12]. Thus, assuming $\varpi^h = \varpi^l$ if the marginal caring effort increases much more steeply in severity than the benefit the family obtains from this (i.e. high severity households face very low productivity of time spent for care and equally low returns in terms of utility), then it may be optimal for transfers to flow from the severe household type to the less severe ($v_X^l X_{t^l}^l > v_X^h X_{t^h}^h$). This is why, given that the (marginal) benefits from care do not vary much with severity from a utilitarian perspective, it is optimal to subsidize production within the lower severity household type.

This counter-intuitive result can arise under two circumstances:

i) Expenditure on care is lower for the more severe type. Intuitively, this implies that severe cases receive less attention from their families (although the latter take full account in their utility of the benefits from caring). These families, in turn, enjoy greater consumption. In this case, it may be that the government seeks to tax away some of the extra consumption of these families. This may be regarded as a somewhat 'artificial case'. In the real world, the problem is that informal carers typically suffer income losses (e.g. Heitmueller and Inglis, 2007) and one would expect such losses to increase with the degree of severity.

ii) The time devoted to care is higher for more severe types and consumption is lower. Furthermore, despite the greater caring input, the benefit from care is lower. This case, which seems to be very plausible, implies that families work hard for their severely-dependent members but cannot really help them. In this case, the counter-intuitive result arises if (and only if) the benefits from care and consumption are substitute goods in the utility function (i.e., if there is a positive cross-derivative). Then, the mechanism behind the result is the following: as low benefits from care are realised for severely-dependent types, this implies low marginal utility of consumption for these families. Therefore, the utilitarian government redistributes income towards the low types[13].

[12] This result is analogous to Huber and Runkel (2006).

[13] This result illustrates the scope for utilitarian welfare functions to generate perverse outcomes and probably does not provide a good basis for policy-making.

However, the optimal transfer outlays τ induce Nash equilibrium characterized by equal marginal utilities for good Y for all households: $u_Y^h = u_Y^l$. In other words, such a Nash equilibrium is a Pareto equilibrium as well, and the economic meaning thereof is that social planners can use lump-sum income transfers for their maximization goals, and in doing so, have simply to control the income marginal utilities of households.

4. Information asymmetry and the optimal transfer

In this section, the incomplete information case is considered. The social planner is aware of the fact that there are low and high severity types but, as already assumed in KN, he is prevented from identifying which is, due to the high costs of case assessment and auditing. The temptation for individuals to lie about the severity and amount of support needed in order to be eligible for higher grants may prevent a first or a second-best outcome from being reached. Even though there are a number of instruments available for policy makers to assess severity (e.g., needs assessment, case management, severity audits), generally these tools are very expensive and lead to a not optimal resolution of information asymmetry [19]. In our setting, the planner has information concerning wages, utility functions, and costs. However, only the expenditure on good Y is directly observable by the planner, while the level of care provided to the elderly is not.

The planner aims at welfare maximization by means of a lump-sum transfer τ that maximizes social welfare when both households may opt to receive the transfer τ (conditional on a given expenditure for Y) or pay the tax (and in so doing avoid being subject to auditing).

Considering by hypothesis the case in which τ is positive, it implies that household l is taxed while household h is subsidized. Note that the social planner cannot offer contracts with the Paretian first-best values because of cheating: the household type which has to pay the transfer could pretend to be the other type.

The social welfare of Eq. (2) is maximized subject to the incentive compatibility constraints that represent the budget constraints faced by the low and high severity types, respectively, when declaring to be the other type. The set of first order conditions (see Appendix A for proofs) allow us to determine the equilibrium in a context of asymmetric information as:

$$u_{Y^h}^h = \Omega\, u_{Y^l}^l \tag{8}$$

where

$$\Omega = \frac{1 + \dfrac{\left[\varpi^m u_{Y^h}^h - v_x^h X_{t^{mh}}^{mh}\right]}{\varpi^m u_{Y^h}^h - v_x^l X_{t^{ml^\circ}}^{ml}}}{1 - \dfrac{\left[\varpi^m u_{Y^h}^h - v_x^h X_{t^{mh}}^{mh}\right]}{\varpi^m u_{Y^h}^h - v_x^l X_{t^{ml^\circ}}^{ml}}} \gtreqless 1 \tag{9}$$

For the taxed household (that corresponds in the present scenario to the low severity type), the first- and second-best conditions coincide. The same does not apply to the subsidized household since a distortion occurs for good *Y*. If we set all the wage levels equal to 1 ($\varpi^l = \varpi^h = \varpi^m = 1$) it emerges that the first-best marginal utility with respect to *Y* for h is lower if compared with the second-best. By denoting $\hat{}$ and $\check{}$ as the first- and second-best variables, respectively, $\hat{u}_Y^h < \check{u}_Y^h$ and $\hat{Y}^h > \check{Y}^h$.

In the present framework, because we have assumed that the transfer moves from low to high severity type, it is implied that $\Omega > 1$. Henceforth, the second-best transfer rule requires the condition $u_{Y^h}^h > u_{Y^l}^l$ and, consequently, $Y^h < Y^l$. The opposite would apply in the case that $\Omega < 1$.

The incentive-compatible constraints have to make allowance for taxed households being indifferent about, on the one hand, paying the tax and freely choosing the optimal amount for *X* and *Y*, and on the other, receiving the transfer conditional on certain expenditure on *Y*.

The incentive-compatible constraint does not permit the condition of equality between the marginal utility with respect to *Y* for the two household types to be met (as it was in the first-best information scenario). The final equilibrium outcome will turn out to be a second-best outcome. The efficient equilibrium outcome, where $u_Y^h = u_Y^l$, is not attainable in the presence of asymmetry of information because this condition creates favourable conditions for the payer to behave strategically by misrepresenting its type. Consequently, the quantity provided by the receiver for both good *Y* and good *X* will be biased with respect to the optimum. By denoting $\hat{}$ and $\check{}$ as the first-best (perfect information) case and the second-best (asymmetric information) case, respectively, we obtain that $\hat{\tau} > \check{\tau}$.

4.1 Distortions in the second-best case

It has been showed that under asymmetric information, distortions arise with reference to the receiver of the lump-sum transfer. In fact, assuming households are autonomous in their spending decisions, lump-sum transfers in the second-best scenario prevent the receiving household from meeting its efficiency conditions (according to Nash behaviour). In particular, under/over-provision of care with respect to the efficiency rule can be observed.

This result is presented in Fig. 2[14], which provides a graphical representation of the distortion incurred by the receiver of the lump-sum transfer. The second-best optimal transfer implies the provision of t_1 and t_3 quantity of market care. The taxed household is indifferent between the two levels because both lie on its indifference curve. However, the efficient provision for the

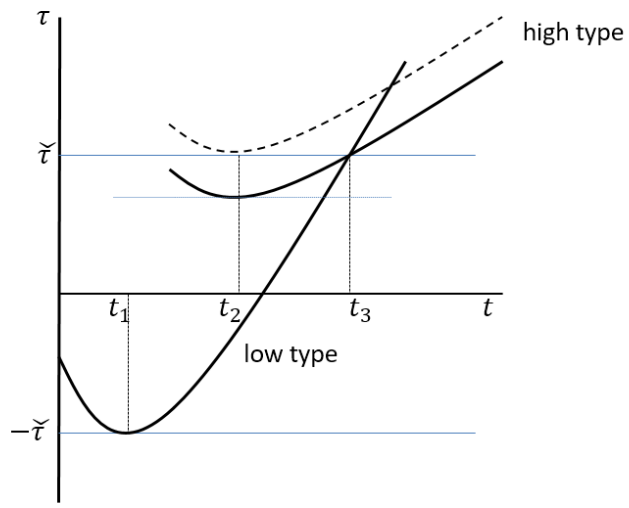
[14] This figure is inspired by one proposed in Huber and Runkel (2006)

receiving household, given the positive transfer $\breve{\tau}$, would equal t_2. Therefore, the planner has to force the receiver to provide t_3 in order to meet the incentive-compatible constraints and to prevent the taxed household from misrepresenting its type.

This result implies that the planner has to change the recipient's attitude to a smaller/larger level of market care, as well as family care, by auditing both the level of market care t^{mi} and family care t^{fi}. However, if it is assumed that only market care is correctly observable by the planner in a scenario characterized by information asymmetry, then even a second-best outcome is not attainable. In fact, the 'contributing' household may find it profitable to misrepresent its severity type in order to be eligible for a positive transfer. In so doing, it would be able to increase its utility by substituting family care with the required utility level for market care.

Therefore, it is possible to state that the Nash behaviour of the receiving household would enable a higher/lower level of care with respect to the social (second-best) optimum, but this would avoid the incentive-compatible constraints to be met. Consequently, a second-best outcome is not attainable by lump-sum transfer if the planner does not observe and audit both family (t^{fi}) and market (t^{mi}) care provided by the recipient household.

Fig. 2: Second-best optimal transfer and distortion at the recipient



4.2 Optimal second-best transfer policy

Section 5.1 shows the distortion which arises for recipients in a second-best scenario when a policy transfer, consisting of a lump sum, is implemented. The deviation from the equilibrium, which occurs when households behave à la Nash, is a crucial feature of our analysis as long as we assume households are autonomous in their spending decisions. It could be argued that this is not a real problem, and in fact, it could be overcome easily by auditing. However, auditing depends on the effective possibility of the planner of observing the variables of interest and it implies additional expenditure, that is, additional taxation.

A second best optimum could be attained if the planner sets two different contracts, one intended for contributors (the *c-contract*) and one intended for recipients (the *r-contract*). If these contracts are set according to the incentive-compatible constraints, no adverse selection occurs.

In previous sections, we show that no distortion arises in contributors' decisions. Their behaviour is coherent with the second-best optimum. For this reason, the *c-contract* still consists of the lump-sum tax ($\check{\tau}$), as defined previously.

On the other hand, problems arise with recipients. In order to enforce a second-best optimum, recipients have to be forced into over-provision of care because incentive-compatible constraints hold. Hence, the *r-contract* has to take into account the market distortions and should be arranged in order to 'induce' households to provide the second-best optimum.

This is possible, assuming that the planner knows (as he actually does) the level of care that the recipient should provide (let us assume, for instance, the recipient to be of the h type). In particular, we define $\check{x}^{fh}$ and $\check{x}^{mh}$ as the second-best optimal levels of family and market care, respectively, which the recipient should provide in order to avoid mimicking behaviour from the other (l) type.

The planner, being aware of each household's production function, can use this information to define the second-best optimal level of inputs, namely, time devoted to family care $\check{t}^{fh}$ and to market care $\check{t}^{mh}$. The planner can then set a new *r-contract*, consisting of:

- (negative) lump-sum transfer T;
- in-kind provision of market care (up to a ceiling of $\check{t}^{mh}$);
- paid leaves from work (up to a ceiling of $\check{t}^{fh}$).

When the household opts for the *r-contract*, it has to pay the (negative) lump-sum tax T which is given by:

$$T = \check{\tau} - \varpi^m \check{t}^{mh} - \varpi^h \check{t}^{fh}$$

The new (negative) lump-sum transfer T entirely covers the costs of the in-kind provision ($\varpi^m \check{t}^{mh}$) and the costs of paid leaves from work ($\varpi^h \check{t}^{fh}$). Then, no further resources or additional taxation are required.

Households are free to choose the contracts they prefer: *c-contract* or *r-contract*. If the household chooses the *c-contract*, then the lump-sum $\check{\tau}$ (where $\check{\tau} < T$) has to be paid and no audit or other duties are levied on it. On the other hand, if the household chooses the *r-contract*, then the lump sum $T > \check{\tau}$ has to be paid. However, the greater taxation T is compensated by in-kind provisions of market care (for instance, by pre-paid vouchers) and paid leave from work. The household is freely able to decide the number of hours required for care, but if the market care demanded exceeds $\check{t}^{mh}$, then the additional hours have to be paid by the household at the market price ϖ^m. In addition, the child can freely choose the amount of time to devote to the care of the elderly person. The child knows that until the ceiling of $\check{t}^{fh}$, his time is paid as if he was working, that is, at his wage level ϖ^h whereas additional hours of informal care will cause him income loss depending on his wage level.

Household *l* (the contributor) is indifferent between the two alternatives (both contracts lie on his indifference curve). On the other hand, household h (the recipient) strictly prefers the contract intended for it. In so doing, its optimal strategy consists of requiring market care up to the amount it can get for free, that is, using all the in-kind transfers it can demand at no cost. It will not exceed this value because the additional hours of market care will cost it ϖ^m and a reduction in the consumption of good *Y* would be the unavoidable consequence. In addition, it would not choose to 'waste' hours of free (market) care because such a decision would negatively affect its utility and would be neutral in terms of real income (i.e. any utility gain is achievable by increasing the consumption of good *Y*). A similar reasoning applied to the use of paid leaves from work.

5 Concluding remarks

The study considered a social planner aiming for social welfare maximization when home care for the elderly can be provided informally by children or purchased on the market at the market price. Assuming that the planner pursues his goal by means of lump-sum transfers, the welfare optimum can be characterized both under perfect and asymmetric information.

In the context of information asymmetry, in which the social planner is unable to observe the parent's severity, we established that implementation of the second-best outcome requires a recipient's level of care to be forced towards certain targets to avoid adverse selection. This is pursued by the setting of contract that, similarly to real world policies adopted, combines lump-sum transfers with paid permissions from work and in-kind provisions. However, distortions emerge in the recipient's decision with regard to elderly care levels. If children receiving benefits show a high opportunity cost of caring, forcing them to provide a specific amount of informal care can be not optimal for them. Another distortion emerges in the direction of the cash transfer that depends on the difference in the opportunity cost of children caring for parents different in severity. There are circumstances in which the transfer can move from lower income households to higher income households.

Similar mechanisms are not artificial, instead they are coherent with the current policies adopted worldwide. Several countries have implemented policies like paying for employed carers and securing permission from work to allow individuals to reconcile work with informal care. These policies are intended to fully or partially compensate for the employment income loss that family carers face while providing informal care. However, when eligibility rules are not dependent on means-testing, these policies are likely to be highly distortive. Consequently, the model proposed offers new informative tools to help policy makers in the setting of new policies and in the reforming of the current LTC systems to reduce inconsistencies and distortions.

References

Bolin, K., Lindgren, B., & Lundborg, P. (2008). Informal and formal care among single-living elderly in Europe. *Health Econ*. 17(3), 393-409.

Brown, J. R., & Finkelstein, A. (2007). Why is the market for long-term care insurance so small? *J Public Econ*. 91(10), 1967-1991.

Colombo, F., & Mercier, J. (2012). Help wanted? Fair and sustainable financing of long-term care services. *Appl Econ Perspect Policy*. 34(2), 316-332.

Colombo, F., Llena-Nozal, A., Mercier, J., & Tjadens, F. (2011). Help Wanted? Providing and paying for long-term care, OECD. http://www.oecd.org. Accessed 20 January 2019

Costa-font, J., Courbage, C., & Swartz, K. (2015). Financing long-term care: ex ante, ex post or both? *Health Econ*. 24, 45-57.

Costa-Font, J., Norton, E. C., & Siciliani, L. (2017). The Challenges of Public Financing and Organisation of Long-Term Care. *Fisc Stud*. 38(3), 365-368.

Courtin, E., Jemiai, N., Mossialos, E. (2014). Mapping support policies for informal carers across the European Union. Health policy. 118(1), 84-94.

Cremer, H., & Roeder, K.: Long-term care policy, myopia and redistribution. (2013). *J Public Econ.* 108, 33-43.

del Pozo-Rubio, R., Mínguez-Salido, R., Pardo-García, I., & Escribano-Sotos, F. (2019). Catastrophic long-term care expenditure: associated socio-demographic and economic factors. Eur J Health Econ. doi: 10.1007/s10198-019-01031-8.

European Commission: The 2015 Ageing Report. Economic and Budgetary Projections for the 28 EU Member States (2013–2060). (2015). European Economy 3. http://ec.europa.eu/economy_finance/publications/ Accessed 20 January 2019

Fujisawa, R., & Colombo F.: The Long-Term Care Workforce: Overview and Strategies to Adapt Supply to a Growing Demand (2009). OECD Health Working Papers, No. 44, OECD Publishing. https://doi.org/10.1787/225350638472

Heitmueller, A. & Inglis, K. (2007). The Earnings of Informal Carers: Wage Differentials and Opportunity Costs. *J. Health Econ*. 26, 821-841.

Heller, P. S., & Hauner, D. (2006). Fiscal policy in the face of long-term expenditure uncertainties. *Int Tax Public Finan*, 13(4), 325-350.

Huber, B., & Runkel, M.: Optimal Design of Intergovernment Grants Under Asymmetric Information. (2006). *Int Tax Public Finan*. 13, 25-41

Johnson, R., & Wiener, J.M. (2006). A Profile of Frail Older Americans and their Caregivers. The Retirement Project: Occasional Paper No. 8, The Urban Institute. https://www.urban.org/research/publication Accessed 20 January 2019.

Klimaviciute, J., & Pestieau, P. (2018). The Public Economics of Long-Term Care. A Survey of Recent Contributions. *Ann. Public Coop. Econ*. 89(1), 49-63

Kok, L., Berden, C., & Sadiraj, K. (2015). Costs and benefits of home care for the elderly versus residential care: a comparison using propensity scores. *Eur J* Health Econ. 16(2), 119-131.

Kraus, M., Riedel, M., Mot, E., Willeme, P., Röhrling, G., & Czypionka, T. (2010). A Typology of Long-Term Care Systems in Europe. ENEPRI Research report No.91, European Network of Economic Policy Research Institutes (ENEPRI). http://aei.pitt.edu/32248/ Accessed 20 January 2019.

Kuhn, M., & Nuscheler, R. (2011). Optimal Public Provision of Nursing Homes and the Role of Information. *J. Health Econ*. 30, 795-810.

Mosca, I., van der Wees, P. J., Mot, E. S., Wammes, J. J., & Jeurissen, P.P. (2017). Sustainability of long-term care: puzzling tasks ahead for policy-makers. *International Journal of Health Policy and Management*. 6(4), 195.

Muir, T. (2017). Measuring social protection for long-term care. OECD Health Working Papers, No. 93, OECD Publishing, Paris, https://doi.org/10.1787/a411500a-en

OECD (2005). Long-Term Care for Older People. OECD. Paris, https://doi.org/10.1787/9789264015852-en

Paraponaris, A., Davin, B., & Verger, P. (2012). Formal and informal care for disabled elderly living in the community: an appraisal of French care composition and costs. *Eur J* Health Econ. 13(3), 327-336.

Van Houtven, C.H., Coe, N.B., & Skira, M.M. (2013). The Effect of Informal Care on Work and Wages. *J. Health Econ*. 32, 240-252.

Wouterse, B., & Smid, B. (2017). How to Finance the Rising Costs of Long-Term Care: Four Alternatives for the Netherlands. *Fisc Stud*. 38(3), 369-391.

Appendix A – Equilibrium under asymmetric information

The social welfare:

$$W = \kappa U^h + (1-\kappa)U^l \tag{A.1}$$

is maximized subject to the following incentive compatibility (IC) constraints:

$$u^l[\varpi^l(1-t^{fl}) - \varpi^m t^{ml} - \tau^l] + v^l(x^{fl} + x^{ml}) \geq u^l\left[\varpi^l(1-t^{fl^\circ}) - \varpi^m t^{ml^\circ} + \left(\frac{1-k}{k}\right)\tau^l\right] + v^l(x^{fl^\circ} + x^{ml^\circ})$$

(A.2)

$$u^h\left[\varpi^h(1-t^{fh}) - \varpi^m t^{mh} + \left(\frac{1-k}{k}\right)\tau^l\right] + v^h(x^{fh} + x^{mh}) \geq u^h[\varpi^h(1-t^{fh^\circ}) - \varpi^m t^{mh^\circ} - \tau^l] + v^h(x^{fh^\circ} + x^{mh^\circ})$$

(A.3)

$$\varpi^l(1-t^{fl^\circ}) - \varpi^h(1-t^{fh}) \geq \varpi^m[\![(t)]\!]^{ml^\circ} - t^{mh}) \tag{A.4}$$

$$\varpi^h(1-t^{fh^\circ}) - \varpi^l(1-t^{fl}) \geq \varpi^m[\![(t)]\!]^{mh^\circ} - t^{ml}) \tag{A.5}$$

where t^{fi° and $t^{mi^\circ}$are the i type care provided by the child and the market, respectively, when cheating, that is, when claiming to be the other severity type.

Constraints (A.2) and (A.3) represent the budget constraints faced by the low and high severity types, respectively, when declaring to be the other type. Considering by hypothesis the case in which τ is positive, it implies that household l is taxed while household h is subsidized. By denoting λ_l and λ_h as the Lagrangian multiplier of Constraints (A.2) and (A.3), respectively, and ψ_l and ψ_h as the Lagrangian multiplier of Constraints (A.4) and (A.5), respectively, the assumption that $\tau > 0$ allows us to set λ_h and ψ_h equal to zero. In fact, there are no advantages for the receiving household h to misrepresent its type by declaring to be the other.

The set of first order conditions is the following:

$$\frac{\varpi^h}{\varpi^m} = \frac{X^{fh}_{t^{fh}}}{X^{mh}_{t^{mh}}} \tag{A.6}$$

$$\frac{\varpi^l}{\varpi^m} = \frac{X^{fl}_{t^{fl^\circ}}}{X^{ml}_{t^{ml^\circ}}} \tag{A.7}$$

$$u^l_{Y^l} = \frac{v^l_X X^{fl}_{t^{fl}}}{\varpi^l} = \frac{v^l_X X^{ml}_{t^{ml}}}{\varpi^m}$$

(A.8)

$$\frac{u^h_{Y^h}}{u^l_{Y^l}} = \frac{(1-k)+\lambda^l}{(1-k)-\lambda^l\left(\frac{1-k}{k}\right)} \tag{A.9}$$

where λ is equal to

$$\lambda^l = \frac{k\left[\varpi^m u_{Y^h}^h - v_X^h X_{t^{mh}}^h\right]}{\varpi^m u_{Y^h}^h - v_X^l X_{t^{ml°}}^l} \tag{A.10}$$

Substituting Eq. (A.8) in Eq. (A.9) and solving for $u_{Y^h}^h$

$$u_{Y^h}^h = \frac{-u_{Y^l}^l\left[\gamma + \left(v_X^l X_{t^{ml°}}^l\right)\right]}{\gamma - v_X^l X_{t^{ml}}^l} \tag{A.11}$$

where

$$\gamma = (1-k)\left(v_X^h X_{t^{mh}}^h - v_X^l X_{t^{ml°}}^l\right) \tag{A.12}$$

Condition (A.8) images Condition (4). In other words, for the taxed household (that corresponds in the present scenario to the low severity type), the first- and second-best conditions coincide. The same does not apply to the subsidized household. In fact, Condition (A.11) suggests that a distortion occurs for good *Y*. To see this result, we can set all the wage levels equal to 1 ($\varpi^l = \varpi^h = \varpi^m = 1$) and compare Eqs. (4) and (A.8). It emerges clearly that the first-best marginal utility with respect to *Y* for h is lower if compared with the second-best. By denoting $\hat{}$ and $\check{}$ as the first- and second-best variables, respectively, $\hat{u}_Y^h < \check{u}_Y^h$ and $\hat{Y}^h > \check{Y}^h$. The same information can be grasped by assuming that the share of high severity is equal to that of low severity ($k = 1/2$) and looking at Eqs. (A.9) and (A.10).

$$u_{Y^h}^h = \Omega\, u_{Y^l}^l \tag{A.13}$$

$$\Omega = \frac{1 + \frac{\left[\varpi^m u_{Y^h}^h - v_X^h X_{t^{mh}}^{mh}\right]}{\varpi^m u_{Y^h}^h - v_X^l X_{t^{ml°}}^{ml}}}{1 - \frac{\left[\varpi^m u_{Y^h}^h - v_X^h X_{t^{mh}}^{mh}\right]}{\varpi^m u_{Y^h}^h - v_X^l X_{t^{ml°}}^{ml}}} \gtreqless 1 \tag{A.14}$$

For the receiving household, the first-best condition, which requires $u_{Y^h}^h = \frac{v_X^h X_{t^{fh}}^h}{\varpi^h} = \frac{v_X^h X_{t^{mh}}^h}{\varpi^m}$, cannot be met (compare Eqs. (4) and (A.11)). In fact, this emerges clearly when noting that the γ parameter (Eq. (A.12)) includes the term $v_X^h X_{t^{mh}}^h$ which should be equal to $\varpi^h u_{Y^h}^h$ in a first-best scenario. By comparing the outcome of the first-best scenario with the case in this section characterized by a lack of information, it is possible to note that the marginal utility for the receiver, with respect to both good *X* and good *Y*, differs from that of the complete information.