Laboratoire d'Economie de Dauphine

DAUPHINE UNIVERSITÉ PARIS | LEDa LEGOS EA 4404

WP n°3/2014

Document de travail

Can formal home care reduce the burden of informal care for elderly dependents? Evidence from France.

Louis Arnault
Andreas Goltz

Pôle Laboratoire d'Economie et de Gestion des Organisations de Santé (LEGOS)
Place du Maréchal de Lattre de Tassigny 75775 Paris Cedex 16
Tél (33) 01 44 05 44 46 Fax (33) 01 44 05 40 67
Site : www.legos.daupine.fr

Can formal home care reduce the burden of informal care for elderly dependents? Evidence from France.

Louis Arnault[a,*], Andreas Goltz[b]

[a] *PSL University of Paris-Dauphine, LEDa-LEGOS, Place du Maréchal de Lattre de Tassigny, 75016 Paris, France*
[b] *Tivoligasse 21/4, 1120 Vienna, Austria*

Abstract

This paper focuses on the trade-off between formal and informal care for elderly dependents living at home in France. Using the French 2008 household Disability - Healthcare data and a newly built indicator of formal home-care prices in each French Council District, we wonder if financial incentives to use more formal home care could relieve informal caregivers. We estimate a bivariate Tobit model to account for both the censor and the endogeneity of our formal home-care variable. Our results confirm that the volume of informal care provided would decrease if the elderly dependents were faced with lower formal home-care prices. Moreover, informal caregivers are shown to be much more sensitive to public subsidizes for skilled formal home care than for the low-skilled one. Subsidizing for skilled formal home care would make informal caregivers more efficient to perform lighter low-skilled tasks. Eventually, acting on formal home care prices could help French public administrators sustain the well-being of both care receivers and informal caregivers.

JEL classification: C34, I12, J14

Keywords: Long-term Care, Informal Care, Formal Care, Elderly

1. Introduction

In France, as well as in most developed countries, a large proportion of the population is aging: this trend will continue in the decades to come. According to the French National Institute of Statistics (INSEE), the proportion of persons aged 65 years or older shifted from 13.9% in 1990 to 16.6% in 2008. In 2025, the elderly are projected to constitute 21.7% of the French population, and this figure is expected to rise to 26.2% in 2050. Although healthy aging is now possible, this population's aging could increase the number of dependent elderly individuals. Given the state of the global economy, governments rely on families to care for elderly dependents. In the next few years, however, the number of potential informal caregivers per elderly dependent is expected to decrease (Lécroart (2011), Marbot and Roy (2012)). In addition to demographic trends, the greater number of active seniors will make children less available to help their elderly dependent parents (Filatriau (2011), Bonnet et al. (2011)). The smaller number of siblings and the growing physical distance between parents and children may also explain this phenomenon (Joël (2007)).

Moreover, if most caregivers provide care gladly and feel positive about their role, those who have heavier caregiving commitments are more likely to take it badly. Zarit et al. (1980)

*Corresponding author. Tel.: +33 1 44 05 44 46; fax: +33 1 44 05 40 67.
Email addresses: louis.arnault@live.fr (Louis Arnault), goltz.andreas@gmail.com (Andreas Goltz)

were among the first researchers to focus on predictors of the heavy burden potentially placed on informal caregivers involved. Existing literature on this topic suggests that providing informal care increases symptoms of depression and incidence of health conditions (see Coe and Van Houtven (2009) for instance). Many answers have been proposed to solve this problem, especially in France. In 2002, the French government introduced the "Allocation Personnalisée d'Autonomie" (APA), a benefit helping elderly dependents to pay for formal or informal care. But restrictive criteria devoted to protect the 'solidarity' principle between husbands and wives prevent spouses or partners from being paid. In 2004 and 2007, other steps were also taken to adjust informal caregivers' working time. But, once again, several restrictive criteria have made them inefficient in practice. In the United States, in-home respite care is sometimes asked for. It consists in providing a short-term break for the family caregivers and relieving them from the demanding responsibility associated with care. Nevertheless, the evidence to support respite having a long-term positive effect on caregivers' burden remains limited and weak (Shaw et al. (2009)). Yet, everyone would benefit from efficient measures devoted to relieve informal caregivers. Their utility would increase and they could possibly re-enter the labor market (Fontaine (2011)). Lifting weight off informal caregivers could also delay the nursing home entry of their relatives (see Mittelman et al. (2006) in cases of elderly suffering from Alzheimer's disease or Spillman and Long (2009)). Such a delay would preserve both families and French public administrators from important costs.

In light of the above-mentioned inefficiency of measures taken so far, formal home care could be another instrument to consider in order to take weight off informal caregivers. Beyond a simple analysis of the determinants, the study of the relationship between formal and informal care could help public administrators answer an especially important public health-policy issue: would a greater public subsidy for formal home care offer respite to informal caregivers? In this article, we try to answer this question by distinguishing between skilled and low-skilled formal home care. Informal caregivers can find it difficult to perform skilled tasks, for which they are not trained. So we suppose that subsidizing for skilled formal home care could lift weight off informal caregivers. On the contrary, we do not expect a significant respite for informal caregivers if low-skilled formal home-care use is encouraged. These hypotheses are tested in the article.

We finally find that the burden of informal care (in terms of hours of care provided) decreases if the elderly dependents are faced with lower formal home-care prices. Moreover, reducing prices of skilled formal home care would give a greater respite to informal caregivers than lowering prices of low-skilled formal home care. Eventually, acting on formal home care prices would relieve informal caregivers and potentially allow them to return to work. It could also delay the nursing home entry of their relatives.

2. Survey

Although studies have been published on the subject for approximately thirty years, the question of whether informal and formal care act as substitute "goods" or not has not been decisively answered. The most studied effect in the recent literature is that of informal care on the use of formal care. Most of the existing results indicate that informal care substitutes for formal care, after controlling for endogeneity. An older study by Greene (1983) controls for endogeneity and concludes that informal care reduces the use of formal care, but the data in the study are drawn from only one American state. Lo Sasso and Johnson (2002) and Charles and Sevak (2005) conclude that informal care reduces the risk of entrance into a nursing home and thus can be seen as a substitute for institutionalization. Using instrumental-variable techniques, Van Houtven and Norton (2004) find that informal care substitute for formal long-term care (nursing homes and home-based care) as well as for health care (hospital and doctor visits). Bolin et al. (2008) explore the same topic using European data and the strategy used

by Van Houtven and Norton (2004), employing child characteristics as instruments of informal care. They find that informal care substitutes for formal home care but complements doctor and hospital visits. Bonsang (2009) also uses instrumental variables but distinguishes between skilled (nursing care) and low-skilled (paid domestic help) formal home care. Using data from the first wave of the Survey of Health, Ageing and Retirement in Europe (SHARE) in a two-part utilization model, he finds that informal care substitutes for low-skilled home care but not for skilled home care in Europe.

We are more concerned about the effect of formal home-care use on informal care for elderly dependents living at home in France. Three existing studies on French data have examined the effect of the APA ("Allocation Personnalisée d'Autonomie") on family involvement, with mixed results. First, Petite and Weber (2006) compare informal care before and after the introduction of the APA in a sample of 2164 APA recipients using data collected by the French Directorate of Demographic and Social Statistics (DREES). They conclude that informal caregivers maintain their level of care; however, the elderly dependents retrospectively declared the amounts of care received. According to the authors, individuals are likely to underestimate the changes in care hours received. Moreover, their needs could have increased by the time they benefitted from the APA; thus the treatment effect of the APA is difficult to identify. Rapp et al. (2011) uses a cross-sectional sample of 1131 French elderly dependents affected by Alzheimer's disease and find that receiving the APA would be associated with an increase in the total number of care hours and a lower ratio of informal to formal care, but not with a decrease in the total number of informal-care hours. Rapp's study has several limitations. First, the results apply to a specific population affected by Alzheimer's disease using informal care. Additionally, the authors consider only the hours of informal care provided by primary informal caregivers. Fontaine (2012) extends the existing French literature on this topic by using matched sampling to compare the care received by APA recipients and the care received by a control group of non-recipients. He aims to estimate both the direct beneficial effect of the APA on formal home-care use and the indirect effect on informal-care provision and finds that publicly funded formal home care partially replaces informal care, especially for slightly disabled individuals whose informal caregivers are partners. Nevertheless, similar to the previous authors, he considers only APA benefits. As publicly funded formal home-care plans provided through the APA differ significantly among individuals, it is impossible to compute elasticities capable of quantifying the aforementioned impacts on the demand for informal care. Additionally, he adds that "the use of the APA is neither random nor exogenous" and the matching procedure that generated his results is questionable. First, his procedure is based on a unidimensional propensity score, which is problematic because several individuals are matched despite having different observable characteristics. Second, the results that he presents do not account for the potential presence of unobserved heterogeneity.

Several past studies focused on the same topic using American or European data have also provided mixed results. Neither Christianson (1988), studying national long-term care in the United States in the 1980's (the Channeling), nor Motel-Klingebiel et al. (2005), using data from four European countries and Israel, find any significant relief for informal caregivers. Pezzin et al. (1996) also use data from the Channeling experiment and find that the effect of an increase in the publicly provided home-care hours on the informal-care hours is limited, after controlling for the living arrangements of the elderly dependent. By contrast, Viitanen (2007) finds a significant crowding-out of informal caregivers living outside the household after an increase in long-term care expenditures using panel data from twelve European countries, including France. Similarly, Stabile et al. (2006) find that an increased availability of public home care is associated with a decline in informal care in Canada. They use instrumental variables correlated with the generosity of the public home-care program in each province. Golberstein et al. (2009) note that the data used by Stabile et al. (2006) are limited in only having information on whether

informal care is delivered. Moreover, the strength and true exogeneity of their instrument regarding formal care, i.e., the generosity of the public home-care program per province, is questionable. Using longitudinal data from the AHEAD and HRS surveys, Golberstein et al. (2009) find that informal care increases for individuals exposed to more restrictive payment caps on Medicare home health care.

Although it could have major implications for future public policy, the effect of formal home care on informal care for elderly dependents living at home has not been studied as often as the reverse. To the best of our knowledge, Stabile et al. (2006), using Canadian data, produced the only cross-sectional study suggesting an instrumental variable model. Theoretically justified instrumental variables of formal home care, however, are difficult to identify and are often subject to controversy. In this study, we extend the previous findings in several different directions. First, we study the effect of formal home care on informal care using the French 2008 household Disability - Healthcare data (*Handicap Santé Ménages* - HSM 2008). Second, we extend the classical two-part model into a bivariate Tobit model to account for the censorship of our formal home-care variable. Third, we have at our disposal a newly built variable of formal home-care prices throughout the whole French country.

3. Background and conceptual framework

3.1. Relationship between formal home care and informal care

Theoretical models related to the utilization of formal and informal care among the elderly are mainly based on family decision-making and health production, in which formal home care and informal care are regarded as two factors of production. The model described by Van Houtven and Norton (2004) is an extension of the classic Grossman (1972) model of health demand that has been altered to include formal and informal care. The relationship between informal and formal care depends on the sign of the derivative of the marginal product of formal care (in the production of health) with respect to informal care. According to Bolin et al. (2008) and Bonsang (2009), complementarity or substitution between formal home care and informal care is an empirical issue. The decision to provide informal care to an elderly dependent parent and the dependent's decision to ask for formal care are simultaneously determined. In this article, we focus only on the effect of formal home care on informal care, which is closely related to our question of interest and has been little studied before now.

Two main hypotheses are tested in this article (cf. Van Houtven and Norton (2004)). First, we examine the effect of incentives to use formal home care on the effective burden placed on informal caregivers. It drives us to look into the nature of the empirical relationship between formal and informal care. This relationship is not straightforward. Contrary to expectations, formal home care and informal care are not necessarily substitutes. They may be independent if, for example, formal home care is essentially required for tasks that informal caregivers will never perform alone. Several normative or emotional considerations can also have an impact on the degree of participation by family members. An informal caregiver may say, for example: "I help 1 hour a day, whatever the other quantities of care my parent receives". Such an arrangement would imply an absence of substitution between formal and informal care. We then test whether the effect of incentives to use more formal home care on informal care is likely to differ according to the type of formal home care considered. In the manner of Bonsang (2009), we isolate skilled (or personal) formal home care (such as bathing) from low-skilled formal home care, which is more related to supervision or helping out with household chores and administrative processes. We expect the respite given to informal caregivers to be higher with skilled than with low-skilled formal home care. Indeed, informal caregivers are often unable or embarrassed to help their elderly dependent relatives in performing such personal tasks.

3.2. Specificities of the French case

In France, formal home care can be provided to elderly dependents in several ways, including using service providers of formal home care that hire and pay employees to care for elderly dependents. As service providers engage in a regulated activity, they are subject to agreements provided by French public agencies. We can distinguish service providers agreed to by the French District Councils from those agreed to by the French Regional Offices for Labor. The former cannot choose their prices, while the latter have more flexibility as long as their prices do not vary dramatically from one year to another. An elderly dependent can also pay the care provider directly by recruiting over the counter. The spectrum of formal home care providers is thus very different from one French district to another. Moreover, visiting nurses and housekeepers can practice anywhere in France. As a result, there is a significant imbalance between districts in terms of supply. In addition, in France as in many European countries, the out-of-pocket expenses for an elderly dependent receiving formal home care are reduced thanks to the "Allocation Personnalisée d'Autonomie" (APA). Since 2002, this benefit has been allotted by the French District Councils. To benefit from the APA, an application must be completed. Each district has its own application, with varying levels of complexity and numbers of supporting documents. Out-of-pocket expenses for the formal home care of elderly dependents can vary widely from one district to another.

To sum up, there is substantial variability among French districts in terms of access to formal home care or formal home-care providers and in terms of out-of-pocket expenses for elderly dependents (Gramain and Neuberg (2009)). These differences should have an impact on individual demands for formal home care, and thus we must take them into account to build a theoretically justified instrumental variable for formal home care.

4. Estimation strategy: A bivariate Tobit model

The aim of this work is to analyze the effect of incentives to use more formal home care on the burden of informal care for elderly dependents. The most appropriate variable of interest to be considered in this study would be a measure of the effective burden of informal care. Nevertheless, such a variable is not available in the HSM survey, which essentially focuses on the elderly dependents themselves. That is why we consider the weekly hours of informal care received by the elderly dependent, as a proxy variable of the burden borne by the informal caregivers. To test the two hypotheses mentioned in Subsection 3.1, we estimate a bivariate Tobit model, which resembles the well-known IV Tobit model, except that our formal-care variable is censored in the structural equation. The first (structural) equation has the form of a Tobit model that predicts the (logged) hours of informal care received (y), which is censored at 0. The second (instrumental) equation takes the form of a Tobit model explaining the (logged) hours of formal home care received (fc, censored at 0) by exogenous variables as well as an exclusion variable (z, also named instrument). The two error terms follow a bivariate normal distribution, whose expectation is $\begin{pmatrix} 0 \\ 0 \end{pmatrix}$ and whose variance-covariance matrix is Σ : $\begin{pmatrix} \sigma_{ic}^2 & \rho\sigma_{ic}\sigma_{fc} \\ \rho\sigma_{ic}\sigma_{fc} & \sigma_{fc}^2 \end{pmatrix}$. The quantity of informal care used (y) is a function of formal home care (fc) and of a vector of exogenous characteristics of the individual (X). The subscript i represents the individual. Our bivariate Tobit model can be written as follows:

$$\begin{cases} y_i^* = \gamma_0 + \gamma_{fc} \ln(1 + fc_i) + \gamma_X' X_i + u_{i,1} \\ fc_i^* = \delta_0 + \delta_z' z_i + \delta_X' X_i + u_{i,2} \end{cases}$$

$$\text{with:} \quad \ln(1+y_i) = \begin{cases} y_i^*, & \text{if } y_i^* > 0 \\ 0, & \text{else.} \end{cases}$$

$$\text{and:} \quad \ln(1+fc_i) = \begin{cases} fc_i^*, & \text{if } fc_i^* > 0 \\ 0, & \text{else.} \end{cases}$$

where y^* and fc^* are latent variables (only observed when they take positive values) related to informal care and formal home care, respectively, and γ_0, γ_{fc}, γ_X, δ_0, δ_z, δ_X are the parameters (or vectors of parameters) to be estimated.

Because the formal home-care and informal-care variables (fc and y) are skewed, we use the log in our model. This bivariate Tobit model is simultaneously estimated with Stata using maximum-likelihood techniques. The log-likelihood is easily calculated following Amemiya (1974), Lollivier (2006) and Fontaine (2011). The explicit version of the log-likelihood is available upon request.

A two-part IV model could also be fitted to answer the question (cf. Van Houtven and Norton (2004) and Bonsang (2009)). In our bivariate Tobit model, however, the endogenous formal home-care variable (fc_i) is censored as there is a large number of individuals (more than 31 % of our population of interest) for whom this variable equals 0. This variable has a large mass point in 0, and the two-part IV model does not take it into account. Moreover, the probability of receiving informal care and the amount of informal care received are treated as independent in the two-part IV model: this very strong assumption should be relaxed. These problems shift our focus to the bivariate Tobit model.

5. Data

We use the 2008 household Disability - Healthcare data (*Handicap Santé Ménages* - HSM 2008) of the French National Institute for Statistics and National Studies (INSEE). The aim of this survey was to acquire as much information as possible about care-dependent people in France; it thus includes both information about health status, socio-economic status, living situation and care received. In total, 29,931 individuals answered the questionnaire.

5.1. Sample selection criteria

The aim of our work is to describe how elderly people in France receive care. We define elderly people as those at least 60 years of age and exclude younger care-dependent people.

We also exclude all completely autonomous people. We use a very broad definition of dependence based on the difficulties in the activities of daily living (ADL) or instrumental activities of daily living (IADL). The ADL tasks include fundamental tasks necessary for an individual to live and survive alone. IADL tasks are not necessary to survive but enable the person to live alone. Seven ADL tasks are taken into consideration in the survey: bathing, dressing and undressing, cutting food, eating and drinking, using the toilet, lying down and getting up from bed, and sitting down in and getting up from a chair. Eleven IADL are considered, as follows: shopping, preparing meals, performing common household chores, performing less common chores, completing common administrative processes, taking medication, moving around, leaving home, using transportation, finding a route, and using a telephone. For each ADL or IADL task, the individuals are asked the following question: "Do you have difficulty doing the following activity alone?". People are considered dependent if they answer "yes" for least one ADL or IADL task or if they declare needing help to perform other activities of daily living, which are not mentioned in the survey. They are also considered care-dependent if they suffer from Alzheimer's disease.

Moreover, informal caregivers living with the care recipient often have difficulty declaring the exact amount of time they spend caring for their cohabitant. There is thus a high proportion

of missing values for this particular group of caregivers. The amounts of care declared are also not as robust as the numbers given by informal caregivers who live elsewhere. The distinction between care and regular household duties is sometimes very difficult to make. Many spouses seem to consider any caring tasks as marital duties and consequently report a very small number of care hours, even if they actually help much more. A similar idea is developed by Paraponaris et al. (2012), who posit that caregivers are less likely to be able to correctly evaluate the cost of an hour of care when they provide it to a close relative than to a more distant one. Information on the health status of the spouse is also not available in our data. Assuming that a significant proportion of spouses are themselves in need of care, we cannot distinguish these spouses from those able to help their partner. We thus decide to include only care-dependent people living alone.

We also discard observations with missing or unreliable values for the variables of interest or for the other explanatory variables. Ultimately, 1687 individuals meet all of the criteria.

5.2. Formal home-care and informal-care variables

Our variable of interest is the weekly hours of informal care received by the respondent. In the HSM questionnaire, the following two questions are asked regarding each informal caregiver (named *INF*):

1. "We will now specify the aid given to you by *INF*. *INF* helps you ... (multiple answers possible) : 1. With daily life tasks like bathing, dressing, help with household chores / 2. With financial or practical aid / 3. By giving you moral support."
2. "In all, how many hours does *INF* help you per day / per week / per month ".

We focus on daily life tasks, indicating that financial help and moral support are not taken into account, when dealing with answers to question 1. Question 2 is asked if (and only if) the informal caregiver provides help for daily life tasks, according to question 1. We transform each answer to question 2 into hours per week. The global amount of informal care received is defined as the sum of care hours provided by all informal caregivers per week.

The formal home-care variable consists of the weekly hours of formal home care received by the respondent. In the HSM questionnaire, the following two questions are asked regarding each formal caregiver (named *FOR*):

1. "Who is *FOR* ? 1. A nurse, a nursing service / 2. A nurse's aid / 3. Another paramedical professional (nurse's aid, occupational therapist, physical therapist, speech-language pathologist...) / 4. A home caregiver, a home helper, a personal care assistant, home carer, specialized transportation services for the disabled / 5. A social caregiver (social worker, special educator...) / 6. A psychologist, psychomotrician / 7. Other. "
2. "In all, how many hours does FOR help you per day / per week / per month. "

When treating answers to question 1, we only consider formal home caregivers belonging to categories 1, 2, 4 and 5. Indeed, we do not want to focus on cures but only on care for daily life activities. We believe that the professionals belonging to groups 3, 6 and 7 were more likely to provide rehabilitation services (i.e. cures) for elderly dependents than formal home care in the usual sense. We transform each answer to question 2 into hours per week. As in informal care, the global amount of formal home care received is defined according to the amounts of care provided by each formal caregiver (belonging to groups 1, 2, 4 and 5 according to question 1).

Later in our article, we separate formal home care into two categories. On the one hand is skilled formal home care, which is related to nursing and personal care. On the other hand is low-skilled formal home care, the main example of which is paid domestic help. To distinguish between these types of home care, we use the three following questions concerning each formal home caregiver (named *FOR*):

1. "Who is *FOR* ? 1. A nurse, a nursing service / 2. A nurse's aid / 3. Another paramedical professional (nurse's aid, occupational therapist, physical therapist, speech-language pathologist) / 4. A home caregiver, a home helper, a personal care assistant, home carer, specialized transportation services for the disabled / 5. A social caregiver (social worker, special educator) / 6. A psychologist, psychomotrician / 7. Other. "
2. "*FOR* helps you... (multiple answers possible) / 1. With personal care (bathing, dressing, meals) / 2. With household chores (cleaning, making meals) / 3. To manage your budget, to take care of paperwork and administrative processes / 4. In ensuring you have someone with you, company / 5. By checking what you do / 6. To go to see the doctor, to take care of your health problems / 7. To go shopping, to buy medicine / 8. With other activities (reading for the blind, translation for the deaf...)."
3. "In all, how many hours does *FOR* help you per day / per week / per month. "

To build the personal formal home care variable (skilled formal home care), we take the sum of the amounts of care (in hours per week) provided by a nurse, a nursing service or a nurse's aide (modalities 1 or 2 of question 1) if and only if this professional helps the elderly dependent with personal care (modality 1 of question 3). The low-skilled formal home care variable is more related to household chores, supervision or administrative processes. This variable is built upon the differences between the global amount of formal home care and the value of skilled formal home care received by each elderly dependent.

5.3. The exclusion variable

Thanks to the censorship of our care variables, the parameters of the bivariate Tobit are theoretically identifiable, even without an exclusion variable z in the formal home-care equation. Empirically, it is better if the identifiability does not rest only within the censorship of both care variables (Lollivier (2006)). The success of our estimation hinges on finding a good exclusion variable (or instrument) for formal home care, which means a variable highly correlated with formal home care but not correlated with the error term in the equation of informal care. It is difficult to identify such a variable, as the effect of formal home-care use on informal care provision is not studied as often as the reverse. To our knowledge, only Stabile et al. (2006), using Canadian data, have suggested an instrumental variable model. Their instruments for formal home care are correlated with the generosity of the public home-care program as follows: the proportion of the population aged 65 and older in each province, the level of provincial spending on education in each province and the provincial tax rate as a share of federal taxes in each province. As discussed in Section 1, the strength and exogeneity of these variables are subject to controversy (cf. Golberstein et al. (2009)).

We use a new instrument, which we assume to be more adapted to the French situation to determine any differences among the French Council Districts that might explain the level of formal home care received. Questionnaires were sent to each French Council District to obtain information about formal home-care prices. We use their answers to build a variable related to average out-of-pockets expenses (of individuals) for formal home care by district. The manner by which we proceed is described in detail in Appendix A. The resulting variable is district-level, which means that the same value is attributed to every individual living in the district. We take this point into account when clustering the error term of each model by district.

Later in the paper, we verify the robustness of our estimates by testing another exclusion variable (instrument) with our bivariate Tobit model. This new exclusion variable aims to evaluate the attractiveness of the territory for professional caregivers. Because visiting nurses or housekeepers can practice their job anywhere in France, there is a geographical imbalance among the districts in terms of formal home-care supply. Genet et al. (2012) explain that differences in the density of the home-care network across Europe and within European countries can

influence access to care. In attractive areas, the greater number of formal home caregivers may give better access to formal home care for elderly dependents, thereby increasing their demand.

Moreover, the risk of induced demand effects is greater in attractive areas. The study of Delattre and Dormont (2003) characterizes induced demand as applied to French physicians. A high density of physicians increases competition and thus favors an induced demand. To maintain or increase their incomes despite competition, these physicians advise patients to consume large volumes of health care. The same argument can be posed for formal home care suppliers. If the formal home care supply is greater in attractive territories, then formal home caregivers have to find strategies to attract loyal "customers" to remain competitive. This practice also tends to increase the demand for formal home care through the effect of induced demand.

Although the French benefit for autonomy (APA) is well-known by a large portion of elderly dependents, there are still those people who do not know of its existence, especially in low-income groups. In attractive areas, the global demand for formal home care should be greater, partly because of the induced demand previously mentioned. Elderly dependents living in such areas have more chances to interact with others who use formal home-care services. It is thus easier for an elderly dependent living in an attractive area to access information about formal home-care supply and/or benefits. Better access to information, in return, should increase the use of formal home care in attractive areas.

It would have been interesting to introduce the density of the visiting nurses or housekeepers in each district as another potential instrument for formal home care. This variable would certainly be correlated with the attractiveness of each district. Nevertheless, endogeneity might have been a problem. Indeed, high individual demand for formal home care can have a positive effect on the number of visiting nurses in the district. We introduce the number of self-employed midwives per woman aged between 15 and 50 in each district, which is also correlated with the attractiveness of the area and is exogenous in our context. Empirically, there is no effect of our instrument on either the probability of receiving informal care or on the amount of informal care received when informal care is given. The density of self-employed midwives by French district in 2007 is obtained thanks to data from the French Directorate of Demographic and Social Statistics (DREES).

5.4. Explanatory variables

We group the explanatory variables into several classes. The group of variables related to the elderly person's health and dependence includes Alzheimer's disease status and a dependence score. To calculate our score, we select each of the seven ADL but only six of the IADL tasks, excluding those that are highly correlated with the Alzheimer's variable. For each ADL or IADL, the score is increased by one if the individual reports having "some difficulty" in executing it alone, by two if he or she reports having "great difficulty" in executing it alone or by three if he or she cannot execute it alone. Each individual's dependence score is the sum of his or her values for each ADL-IADL. The group of variables related to socio-economic characteristics includes having a diploma and the income group (a categorical variable in five modalities). A third group of variables concerns children as potential informal caregivers. The numbers of daughters and sons are introduced as continuous variables. We could focus only on children living close to their dependent parents, as the probability of their caring for the parent is greater; however, the variable "geographical proximity" is potentially endogenous (cf. Charles and Sevak (2005), Bonsang (2009)). That is, a child may move closer to his or her dependent parent if the number of tasks that he or she has to execute for his or her parent increases. To avoid endogeneity bias, we exclude this variable. Control variables include the age and gender of the elderly dependent. Table 1 gives summary statistics (means) for the entire sample (second column) and for the four subsamples built according to the type of care used

Table 1: Summary statistics (means) for the entire sample and by kind of care used.

Variable	All (N=1687)	All (Wgt) (N=1687)	Non-users (N=333)	FC only (N=687)	IC only (N=300)	Both (N=367)
Age	78.8 (8.5)	79.7 (8.2)	74.0 (8.6)	79.5 (7.7)	77.7 (8.2)	82.6 (7.9)
Being a female	0.81	0.81	0.80	0.82	0.80	0.85
Number of sons	1.11 (1.18)	1.12 (1.17)	1.03 (1.06)	0.99 (1.09)	1.24 (1.28)	1.29 (1.31)
Number of daughters	1.13 (1.25)	1.10 (1.22)	1.07 (1.20)	0.90 (1.07)	1.44 (1.42)	1.36 (1.37)
Dependence score	7.9 (8.3)	6.7 (6.8)	1.7 (3.0)	8.2 (7.7)	6.4 (6.4)	14.0 (9.2)
Alzheimer	0.051	0.039	0.024	0.032	0.043	0.117
Receiving formal care	0.62	0.59				
Receiving skilled formal care	0.11	0.08				
Receiving low-skilled formal care	0.60	0.58				
Receiving informal care	0.40	0.33				

Source: HSM 2008.
Sample: elderly dependents aged 60 or older living alone in metropolitan France.
Standard errors in parenthesis

by the elderly dependents (last four columns). The third column gives summary statistics for our sample when all of the observations are weighted to reflect the general population. These estimates are very close to those obtained without weighting the data, indicating that the sample is representative of the population of elderly dependents aged 60 and over living home alone in France. Henceforth, we focus exclusively on non-weighted estimates. The average age of all of the individuals in our sample is 79 years. While the average age of non-users is only 74, older people are overrepresented in the sample of users of both formal and informal care. At first sight, it is surprising that 82% of the individuals in the data sample are women, but we are only looking at elderly individuals who do not live with a spouse. Because women have a longer life expectancy and tend to be younger than their partners, the proportion of women in our sample is accordingly increased. The individuals have a mean of slightly more than two children, with as many sons as daughters. Individuals with children are overrepresented in the subsamples of people receiving informal care and underrepresented in the subsamples of non-users or of people receiving formal care only. This pattern is even stronger for individuals with a daughter than for those with a son, highlighting the role of children, especially daughters, in providing informal care to their elderly dependent parent living at home without a spouse.

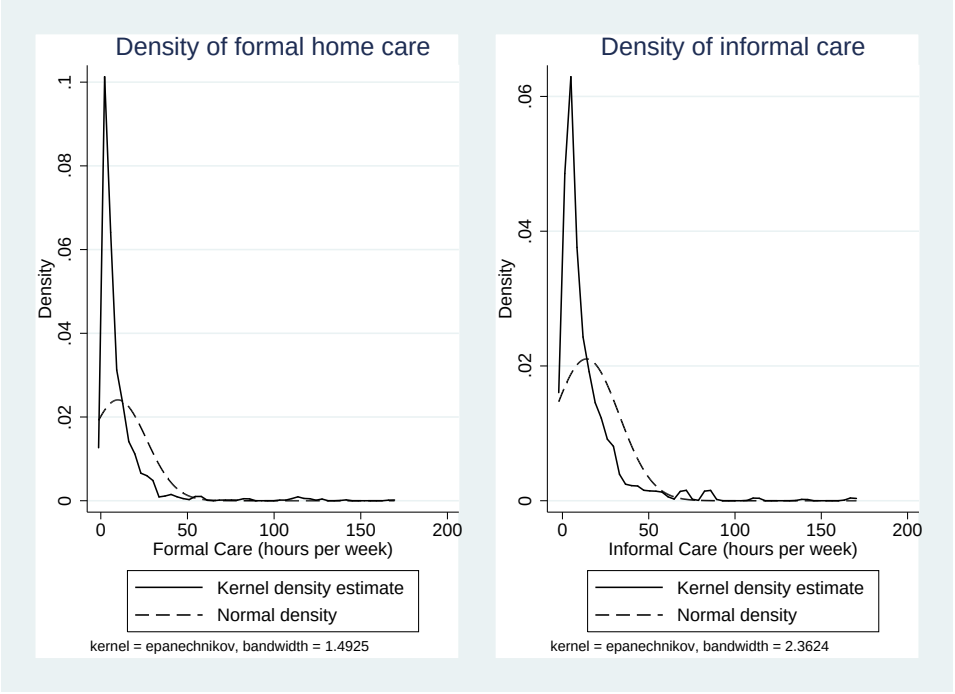
Table 2: Average quantity of care used by care users (in hours per week).

Variable	All care users (N=1354)	Formal only (N=644)	Informal only (N=276)	Both (N=361)
Hours of formal care	7.7 (15.1)	9.0 (15.4)		11.6 (18.3)
Hours of skilled formal care	1.3 (7.1)	1.1 (5.6)		2.8 (11.1)
Hours of low-skilled formal care	6.4 (12.7)	7.9 (14.1)		8.8 (13.6)
Hours of informal care	6.8 (15.0)		12.7 (17.9)	14.9 (19.7)

Source: HSM 2008.
Sample: elderly dependents aged 60 or older living alone in metropolitan France, using formal and/or informal care.
Standard errors in parenthesis

On average, the dependence score is 7.9. On a scale of 39, this value is low. A substantial number of elderly dependents living home alone are not highly care-dependent. As expected, the average dependence score for non-users is very low (1.7) but reaches 14.0 for individuals receiving both types of care. The level of dependence is positively correlated with the use

Figure 1: Kernel density estimation of formal and informal care variables

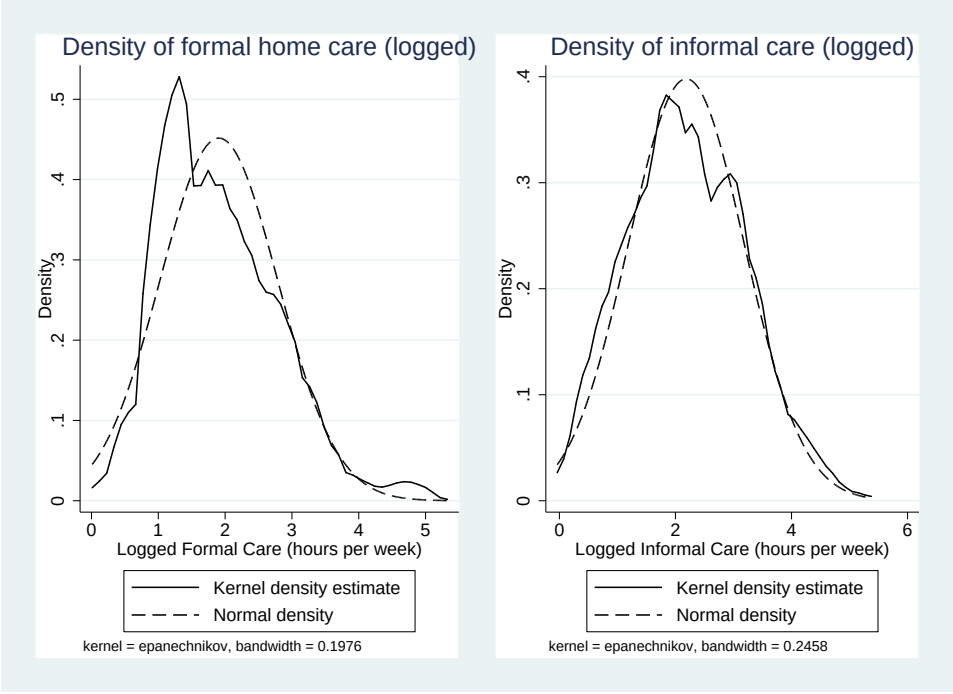


Source: HSM 2008.
Sample: elderly dependents aged 60 or older living alone in metropolitan France and using formal (resp. informal) care.

of care. A total of 5.1% of our sample suffers from Alzheimer's disease, the main cause of mental dependence. These individuals are strongly underrepresented in subsamples of non-users and people receiving only formal home care. People suffering from Alzheimer's disease prefer informal to formal care but are overrepresented in the subsample of people receiving both types of care (11.7%), underlining the major role of both family and professionals in caring for people with mental dependence. The overall proportion of individuals receiving formal home care is greater than that of those receiving informal care (approximately 62% versus 40%). Again, we focus on individuals living without their spouses, who are often the main providers of informal care. The overall proportion of individuals receiving skilled formal home care is much lower than that of individuals receiving low-skilled formal home care (approximately 12% versus 60%).

Table 2 provides the average amounts of care received by all care users (second column) and the amounts for three subsamples according to the type of care used (last three columns). Among the care users, individuals receive on average approximately 7 hours 45 minutes of formal home care per week. Only 16.9% of the global amount of formal home care received consists of skilled formal home care, representing approximately 1 hour 18 minutes per week on average. Individuals receive more than approximately 7 hours of informal care per week. Elderly dependents using both types of care seem to receive on average more formal home care and more informal care than those using one type of care exclusively. These findings are consistent with the previous results (see Table 1) for highly dependent persons, who need more of both formal and informal care. Figure 1 provides the Kernel density estimation of formal and informal care variables (for care users only) using the Epanechnikov Kernel. The estimated formal home-care density function shows that among formal home-care users, a large proportion of individuals receive less than 20 hours a week of care. The density function does not exhibit an upper tail. For informal care users, the number of care hours differs widely among individuals and can be

Figure 2: Kernel density estimation of logged formal and informal care variables



Source: HSM 2008.
Sample: elderly dependents aged 60 or older living alone in metropolitan France and using formal (resp. informal) care.

very large. Consequently, the informal-care density function exhibits a large upper tail. If both estimated density functions are far from being normally distributed, the density function of their logs approaches that of the Gaussian distribution (see Figure 2). We thus prefer working with the logs of both care variables in our models.

The association between both care variables provides us with an initial sense of the nature of the relationship between formal and informal care in our sample. By far the most familiar measure of association (dependence) is the Bravais-Pearson's linear correlation between two variables Y_1 and Y_2. This indicator is only powerful when the link between Y_1 and Y_2 is linear. An alternative measure of non-linear association is the rank correlation, one main indicator of which is Spearman's correlation coefficient (ρ), defined as the Pearson's correlation coefficient of the ranked Y_1 and the ranked Y_2. Similar to the linear correlation coefficient, its values vary between -1 and 1, with 1 indicating perfect concordance. The Spearman's rank correlation coefficient is less sensitive to outliers than the Pearson correlation.
These coefficients are calculated for both care variables in Table 3. In the global sample, the Spearman's correlation coefficient ρ is not significantly negative at a 5% level and very close to 0 (-0.03). Without controlling for the level of dependence, the highly dependent individuals are most likely to receive large quantities of formal home care and are highly likely to receive substantial informal care. Thus, the Spearman's correlation coefficient tends to be positive, or at least close to zero. As expected, after controlling for the level of dependence[1], the Spearman's correlation coefficient is strongly negative and significant (at a 1% level). Formal home care

[1]We use our score of dependence related to limitations in activities of daily living and instrumental activities of daily living. We recode this score into four groups, based on its quartiles : "being weakly dependent" (i.e. belonging to the first quartile), "being moderately dependent" (i.e. belonging to the second quartile), "being highly dependent" (i.e. belonging to the third quartile), and "being very highly dependent" (i.e. belonging to the fourth quartile).

and informal care are thus negatively associated after controlling for the level of dependence.

Table 3: Spearman's correlation coefficient between formal and informal care variables

	Total sample	**By level of dependence (Score of dependence)**			
		Weak	**Moderate**	**High**	**Very High**
ρ	-0.03	-0.21***	-0.30***	-0.35***	-0.19***

Source: HSM 2008.
Sample: elderly dependents aged 60 or older living alone in metropolitan France.
* $p < .1$, ** $p < .05$, *** $p < .01$

6. Results and interpretation

In this section, we present the results of the bivariate Tobit model and then estimate it, distinguishing between skilled and low-skilled formal home care. Eventually, we check the robustness of our estimates, modifying the exclusion variables.

6.1. The bivariate Tobit model

The estimates of the bivariate Tobit model can be found in Table 4. Our exclusion variable, the average out-of-pocket expenses for formal home care by district, is negatively correlated with the hours of formal home care received by each elderly dependent and is significant at a 1% level. The less expensive formal home care, the more formal home care the elderly dependent uses. We attempt to include our exclusion variable in the informal-care equation, even if the model is then identified only by the censor of both dependent variables. As expected, the coefficient is not significant at a 10% level, indicating that our instrument is not correlated with informal care. Formal and informal care are both positively influenced by the level of dependence. Parameters associated with the dependence score, Alzheimer's disease status and age group are significant at the 5% level, even if Alzheimer's disease has a significant impact only on informal care. People suffering from early-stage Alzheimer's disease must be over-represented in our sample of Alzheimer's patients living alone at home. These patients may not require help beyond familial support, or their families may believe this to be the case. People suffering from Alzheimer's disease may also find it difficult to collect the necessary paperwork to benefit from formal home care. The characteristic of having a diploma has a positive and significant impact on formal home-care use: educated individuals may find obtaining information about the formal home-care market easier and have easier access to it. Moreover, the characteristic of having a diploma can be considered a proxy variable for social class. Individuals belonging to higher social classes have more of an opportunity to hire a housekeeper to perform domestic tasks. This effect is consistent with estimates from several studies, such as those from Van Houtven and Norton (2004). The use of informal care increases with the number of children, consistent with intuition and the literature on the subject (Bolin et al. (2008), Charles and Sevak (2005)) because children are the main informal-care providers for elderly dependents living without a partner.
The formal home care variable has a significant negative effect on the hours of informal care received in the bivariate Tobit model. Receiving more formal home care reduces the probability of receiving informal care and/or the quantity of informal care received when informal care is given. The model predicts that a decrease in the price of formal home care would relieve informal caregivers. It confirms the hypothesis of a substitution effect between formal and informal care.

Table 4: Bivariate Tobit model with formal home care

	Formal care	Informal care
Hours of formal care		-0.666*** (0.197)
Dependence score	0.102*** (0.00426)	0.138*** (0.0189)
Alzheimer (Ref: No)	0.109 (0.139)	0.846*** (0.288)
Has a diploma (Ref: No)	0.152** (0.0765)	-0.142 (0.132)
Income (Ref: Less than 600 €)		
600 €- 1000 €	0.201** (0.0984)	-0.219 (0.201)
1000 €- 1500 €	0.294** (0.126)	-0.647*** (0.216)
1500 € and +	0.203** (0.101)	-0.127 (0.188)
Missing	0.0772 (0.145)	-0.312 (0.217)
Living area (Ref: Big city (100 000 inh. and +))		
Rural area	0.0926 (0.112)	-0.428* (0.229)
Small size city (- than 20 000 inh.)	0.00168 (0.0974)	0.0915 (0.205)
Mid-size city (20 000 to 100 000 inh.)	0.185* (0.0993)	-0.160 (0.215)
Number of sons	-0.0110 (0.0274)	0.120*** (0.0425)
Number of daughters	-0.0814** (0.0349)	0.303*** (0.0489)
Is a female (Ref: No)	-0.0142 (0.0814)	-0.433*** (0.159)
Age group (Ref: 60-64)		
65-69	0.239 (0.217)	0.530** (0.258)
70-74	0.541*** (0.190)	0.641** (0.265)
75-79	0.805*** (0.150)	0.911*** (0.255)
80-84	1.019*** (0.181)	1.121*** (0.270)
85-89	0.898*** (0.152)	1.294*** (0.277)
90+	0.935*** (0.251)	1.808*** (0.304)
Out-of-pocket expenses	-0.125*** (0.0328)	
Intercept	0.0524 (0.335)	-1.473*** (0.351)
σ	1.316*** (0.0550)	2.143*** (0.0741)
ρ	-0.0632 (0.0828)	
Observations	1687	

Source: HSM 2008.
Sample: elderly dependents aged 60 or older living alone in metropolitan France.
Standard errors in parenthesis
* $p < .1$, ** $p < .05$, *** $p < .01$

6.2. Marginal effect of the out-of-pocket expenses for formal home care

In Subsection 6.1 we show that the bivariate Tobit model confirms the existence of an effect of formal home care prices on informal caregivers. To quantify this effect, we simulate the one of a one Euro decrease in the average out-of-pocket expenses for formal home care on formal home-care use (Δ_{FC}). We estimate the effect of the same increase on informal-care use (Δ_{IC}) and divide these two effects (Δ_{IC} / Δ_{FC}) to characterize the response of informal caregivers to an increase in formal home-care use. These effects are obtained with the use of a Monte-Carlo simulation and are presented in the first line of Table 5. The manner in which we simulate these effects is described in Appendix B. First, a one Euro decrease in the average out-of-pocket expenses would increase by 1 hour 06 minutes the average quantity of formal home care used each week. Then, if the quantity of formal home care increased by X minutes (hours), the

amount of informal care used would decrease by 2.0 times X minutes (respectively hours). In other words, for a given increase in the amount of formal home care used, the decrease in the quantity of informal care provided would be 2.0 times greater. An increase in formal home care hours received seems to give the opportunity for informal caregivers to help less. The point now is to try to understand how this effect changes if we distinguish between skilled and low-skilled formal home care. Inspired by Bonsang (2009), we isolate skilled (or personal) formal home care

Table 5: Simulated marginal effects of a one Euro decrease in the average out-of-pocket expenses for formal home care

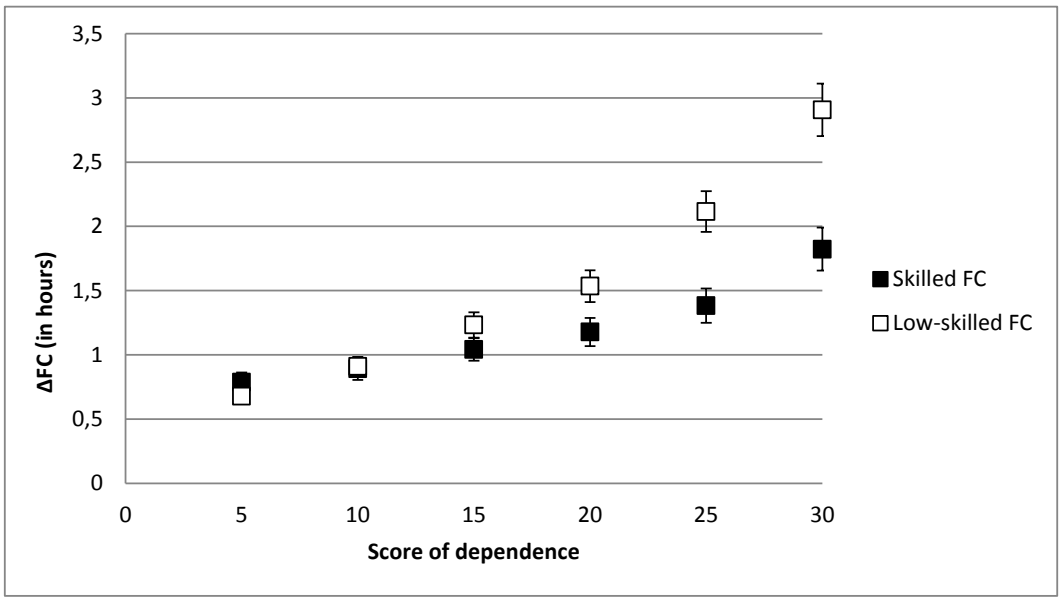
Kind of formal care considered	**Simulated ME on formal home-care use (Δ_{FC}) [95% C.I.]**	**Δ_{IC} / Δ_{FC} ratio [95% C.I.]**
Total FC	+1 h 06 [+1 h 01, +1 h 11]	-2.0 [-2.2, -1.8]
Low-skilled FC alone	+58 min [+52 min, 1 h 02]	-1.5 [-1.7, -1.2]
Skilled FC alone	+ 52 min [+ 46 min, + 57 min]	-3.5 [-3.9, -3.1]

Source: HSM 2008.
Sample: elderly dependents aged 60 or older living alone in metropolitan France.

(such as bathing) from low-skilled formal home care, which is more related to supervision or help in household chores and administrative processes. In Appendix C, Table C.7 (Table C.8), we re-estimate the bivariate Tobit model according to the hours of skilled (respectively low-skilled) formal home care replacing the total hours of formal home care. For each model, we simulate the effect of a one Euro decrease in the average out-of-pocket expenses for formal home care on formal home-care use (Δ_{FC}). We then estimate the effect of the same increase on informal-care use (Δ_{IC}) and divide these two effects (Δ_{IC} / Δ_{FC}) to characterize the response of informal caregivers to an increase in formal home-care use. These effects for skilled and low-skilled formal home care are computed and presented in the second and third lines of Table 5. First, a one Euro decrease in the average out-of-pocket expenses would increase by 58 minutes the quantity of low-skilled formal home care used, on average, against only 52 minutes for skilled formal home care. The price elasticity of skilled formal home-care demand appears to be a little bit lower than that of low-skilled formal home-care demand. Moreover, the decrease in the quantity of informal care provided would be 3.5 times greater than a given increase in the amount of skilled formal home care used, compared to only 1.5 times greater for low-skilled formal home care. As expected, subsidizing for skilled formal home care lifts off stronger weight from informal caregivers than subsidizing for low-skilled formal home care. The effect of formal home-care use on informal care is greater for personal/nursing formal home care than for domestic formal home care. Several explanations can be suggested to explain this result. First, informal caregivers are not suited for personal care or are less ready to take on some of these tasks, such as bathing their parent. As a consequence, they would easily renounce the necessity of performing such tasks if a professional caregiver was available to do it. Second, the difference of efficiency between formal and informal caregivers may be greater for personal formal home care than for low-skilled formal home care. Informal caregivers may spend a great amount of time bathing their elderly dependent parents due to their lack of technique and ability. This circumstance could easily explain why an additional hour of personal formal home care would strongly decrease the number of hours of informal care provided. Third, even if we control for the level of dependence in our model, the elderly receiving personal formal home care are generally more dependent than those receiving low-skilled formal home care only. Skilled formal home care is mainly provided to highly dependent individuals as their informal caregivers would then have more of a chance to be overburdened. Such differences in terms of the crowding out of informal caregivers could highlight, in fact, differences in the terms of the level of dependence of the elderly.

To invalidate this last hypothesis, we allow the level of dependence to vary and observe how the simulated effects change. For both skilled and low-skilled formal home care, the effect of an

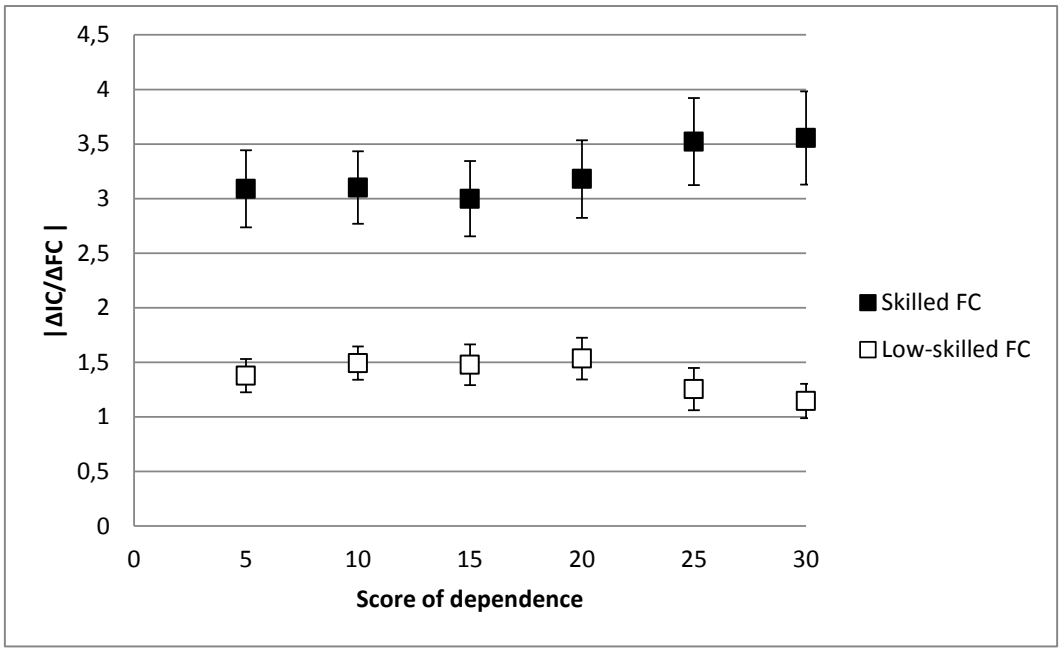
Figure 3: Simulated effect of a one Euro decrease in the average out-of-pocket expenses for formal home care on its use, given the level of dependence and the kind of formal home care impacted.



Source: HSM 2008.
Sample: elderly dependents aged 60 or older living alone in metropolitan France and using formal (resp. informal) care.

rise in out-of-pocket expenses on formal home-care use increases with the level of dependence (Figure 3). As far as the level of dependence increases, the effect of an increase in out-of-pocket expenses on low-skilled formal home-care use becomes greater than the one on skilled formal home-care use. The price elasticity of skilled formal home care demand seems to become lower than the price elasticity of low-skilled formal home care demand. This result is consistent with our expectations as skilled formal home-care use is less influenced by its cost than low-skilled formal home-care demand due to the many informal caregivers reluctant or unable to perform skilled tasks (such as personal care). In Figure 4, we study how the Δ_{IC}/Δ_{FC} ratio changes when the level of dependence varies. First, regardless of the level of dependence, the ratio is greater for skilled formal home care than for low-skilled formal home care. This outcome confirms the results obtained in Table 5. Subsidizing for skilled formal home care would lift off strong weight from informal caregivers. On the contrary, the respite for informal caregivers would remains low if low-skilled formal home-care use was encouraged. We then observe that the ratio is close to remaining constant with the level of dependence after increases in the out-of-pocket expenses for skilled or low-skilled formal home care are observed. For high levels of dependence, however, the relationship between the strength of the crowding out of informal caregivers and the level of dependence seems to become negative for low-skilled formal home care. Conversely, such a relationship seems to become positive when we consider an increase in skilled formal home-care use. These opposite trends may be the consequences of the care receiver's needs being no longer fully satisfied. In that case, we can imagine that informal caregivers renounce to be crowded out for low-skilled tasks but are increasingly happy to allow formal home caregivers to perform rough skilled tasks, often responsible for their burden.

Figure 4: Simulated effect of a one Euro decrease in the average out-of-pocket expenses for formal home care on the Δ_{IC}/Δ_{FC} ratio, given the level of dependence and the kind of formal home care impacted.



Source: HSM 2008.
Sample: elderly dependents aged 60 or older living alone in metropolitan France and using formal (resp. informal) care.

6.3. Sensitivity analysis

To assess the robustness of our model, we estimate our bivariate Tobit model using another exclusion variable (instrument) in the formal home-care equation. This new exclusion variable aims to measure the attractiveness of the territory for professional caregivers. Because visiting nurses or housekeepers can practice their job anywhere in France, there is a geographical imbalance among districts in terms of formal home-care supply. We introduce the number of self-employed midwives per woman aged between 15 and 50 in each district, which is also correlated with the attractiveness of the area and is exogenous in our context. The estimates of the bivariate Tobit model with skilled formal home care using such an exclusion variable appear in Appendix D, Table D.9. Our instrument is a strong predictor of skilled formal home care because its coefficient is positively significant at a 1% level. Nevertheless, this does not have a significant impact on the informal care use at the 10% level. The estimates of the bivariate Tobit model with low-skilled formal home care and total formal home care using this new exclusion variable are available upon request. The simulated effects of a one unit increase in the average density of self-employed midwives on care uses can be computed thanks to the Monte-Carlo technique (see Appendix B for more details). These values can be found in Table 6. First,

Table 6: Simulated effects of a one unit increase in the average density of self-employed midwives

Kind of formal care considered	**Simulated ME on formal home-care use (Δ_{FC}) [95% C.I.]**	**Δ_{IC} / Δ_{FC} ratio [95% C.I.]**
Total FC	+27 min [+21 min , +34 min]	-2.7 [-3.0, -2.3]
Low-skilled FC alone	+20 min [+18 min, +22 min]	-1.8 [-2.0, -1.6]
Skilled FC alone	+2 h 33 [+2 h 20, +2 h 45]	-3.0 [-3.3, -2.6]

Source: HSM 2008.
Sample: elderly dependents aged 60 or older living alone in metropolitan France.

this new exclusion variable seems to have a greater impact on skilled formal home-care demand than on low-skilled formal home-care use (+2 hours 33 minutes versus only + 20 minutes). Nevertheless, the estimated ratios Δ_{IC}/Δ_{FC} are very close to those obtained after decrease in out-pocket-expenses (see Table 5). The relief of informal caregivers is greater after a given increase (X) in hours of skilled formal home care than after the same increase (X) in hours of low-skilled formal home care (-3.0 times X against -1.8 times X).

7. Conclusion

A simple empirical model is estimated in order to know whether or not incentives to use more formal home care would relieve informal caregivers. Three main results can be highlighted in this study.

First, the care arrangements of French elderly dependents differ according to the type of dependence with which they are subjected to. French elderly individuals living at home and suffering from physical dependence do not seem to rest upon a unique type of care. On average, they use more formal home care and more informal care when they become physically dependent. Conversely, the subjects suffering from mental dependence, such as Alzheimer's disease, receive more informal care than formal home care. We tried to highlight several potential explanations for this phenomenon, but further studies are required to better understand such a result. In any case, mentally and physically dependent individuals do not only suffer from different limitations but are also cared for differently.

Second, the burden of informal care (in terms of hours of care provided) would decrease if the elderly dependents were faced with lower formal home-care prices. Thus, financial incentives to use more formal home care would relieve informal caregivers. Informal caregivers often have to bear the cost of care on their own, although this cost can be very high. More generous public subsidies, through the French benefit for autonomy (APA) for instance, would help them make up for the financial loss of caring for their elderly dependent relatives. If relieving informal caregivers allows them to feel better and return to work (cf. Fontaine (2011)), then there is a social value in sharing or mutualizing the risks. Lifting weight off informal caregivers could also delay the nursing home entry of their relatives (see Mittelman et al. (2006) or Spillman and Long (2009)). On top of pleasing the elderly dependents, such a delay would make both the families and the public administrators save money.

Third, lowering prices of skilled formal home care would give a greater respite to informal caregivers than reducing prices of low-skilled formal home care. Informal caregivers are often unable or embarrassed to perform skilled personal tasks. They would easily renounce skilled tasks if a professional caregiver was available to perform them. In this article, we show that acting on prices of skilled formal home care would relieve informal caregivers from heavy tasks requiring abilities, without them renouncing low-skilled tasks that they usually take up for.

Acknowledgements

We gratefully acknowledge financial support from the Université Paris-Dauphine. We thank the professors from LEDa-LEGOS for their helpful comments during seminars. We are especially grateful to Jérôme Wittwer, Andreas Goltz, Agnès Gramain, Eve Caroli, Roméo Fontaine, Eric Delattre and Céline Pilorge as well as to the participants in the JMA 2012, the LEDa-LEGOS seminars, the JESF 2012, the congress of AFSE 2013 and the congress of the European Economic Association 2013 for their useful comments and suggestions. The author alone is responsible for the analysis and interpretation in this paper.

References

Amemiya, T., 1974. Multivariate regression and simultaneous equation models when the dependent variables are truncated normal. Econometrica: Journal of the Econometric Society, 999–1012.

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

Bonnet, C., Cambois, E., Cases, C., Gaymu, J., 2011. La dépendance : aujourd'hui l'affaire des femmes, demain davantage celle des hommes ? Population et Sociétés (483).

Bonsang, E., 2009. Does informal care from children to their elderly parents substitute for formal care in Europe? Journal of Health Economics 28 (1), 143–154.

Cameron, A., Trivedi, P., 2009. Microeconometrics using stata. Vol. 5. Stata Press College Station, TX.

Charles, K., Sevak, P., 2005. Can family caregiving substitute for nursing home care? Journal of Health Economics 24 (6), 1174–1190.

Christianson, J., 1988. The evaluation of the national long term care demonstration. The effect of channeling on informal caregiving. Health Services Research 23 (1), 99.

Coe, N., Van Houtven, C., 2009. Caring for mom and neglecting yourself? The health effects of caring for an elderly parent. Health economics 18 (9), 991–1010.

Delattre, E., Dormont, B., 2003. Fixed fees and physician-induced demand: A panel data study on french physicians. Health Economics 12 (9), 741–754.

DiCiccio, T., Efron, B., 1996. Bootstrap confidence intervals. Statistical Science, 189–212.

Filatriau, O., 2011. Projections à l'horizon 2060 : des actifs plus nombreux et plus âgés. INSEE Première 1345.

Fontaine, R., 2011. The trade-off between informal care and work in Europe. Le soutien familial aux personnes âgées dépendantes, PhD Thesis, Université Paris Dauphine, 109–164.

Fontaine, R., 2012. The effect of public subsidies for formal care on the care provision for disabled elderly people in france. Economie publique/Public economics (28-29), 271–304.

Genet, N., Boerma, W., Kroneman, M., Hutchinson, M., Saltman, R., 2012. Home care across europe. European Observatory of Health Systems and Policies - Observatory Studies Series (27), 61–62.

Golberstein, E., Grabowski, D., Langa, K., Chernew, M., 2009. The effect of medicare home health care payment on informal care. Inquiry: a journal of medical care organization, provision and financing 46 (1), 58.

Gramain, A., Neuberg, S., 2009. Réagencements territoriaux et conduites des politiques sociales à l'échelle locale. Travail et emploi 3 (119), 77–87.

Greene, V., 1983. Substitution between formally and informally provided care for the impaired elderly in the community. Medical Care, 609–619.

Grossman, M., 1972. On the concept of health capital and the demand for health. The Journal of Political Economy 80 (2), 223–255.

Joël, M., 2007. Solidarités familiales. In T. Barnay et C. Sermet (Eds.). Le vieillissement en Europe : aspects biologiques, économiques et sociaux, 113–125.

Lécroart, A., 2011. Projections du nombre de bénéficiaires de l'APA en france à l'horizon 2040-2060. Série sources et méthodes - DREES (23).

Lo Sasso, A., Johnson, R., 2002. Does informal care from adult children reduce nursing home admissions for the elderly? Inquiry 39 (3), 279–297.

Lollivier, S., 2006. Econométrie avancée des variables qualitatives. Economie et statistiques avancées. Economica.

Marbot, C., Roy, D., 2012. Projections du coût de l'APA et des caractéristiques de ses bénéficiaires à l'horizon 2040 à l'aide du modèle Destinie. Document de Travail - INSEE, 24–40.

Marquier, R., 2010. Les activités des aides à domicile en 2008. Etudes et résultats DREES (Paris),(octobre 2010) 741, 1–8.

Mittelman, M., Haley, W., Clay, O., Roth, D., 2006. Improving caregiver well-being delays nursing home placement of patients with Alzheimer's disease. Neurology 67 (9), 1592–1599.

Motel-Klingebiel, A., Tesch-Roemer, C., Von Kondratowitz, H., 2005. Welfare states do not crowd out the family: evidence for mixed responsibility from comparative analyses. Ageing and Society 25 (06), 863–882.

Paraponaris, A., d'Alessandro, E., Davin, B., Protière, C., Tache, G., 2012. L'utilisation de l'évaluation contingente pour valoriser l'aide informelle apportée aux personnes souffrant de handicap ou en perte d'autonomie : quelle intelligibilté dans le cadre d'enquêtes en population générale (QUALIMEC)? Rapport final pour la MiRe-DREES et la CNSA.

Petite, S., Weber, A., 2006. Les effets de l'allocation personnalisée d'autonomie sur l'aide dispensée aux personnes âgées. Etudes et résultats - DREES (459).

Pezzin, L., Kemper, P., Reschovsky, J., 1996. Does publicly provided home care substitute for family care? Experimental evidence with endogenous living arrangements. Journal of Human Resources, 650–676.

Rapp, T., Grand, A., Cantet, C., Andrieu, S., Coley, N., Portet, F., Vellas, B., 2011. Public financial support receipt and non-medical resource utilization in alzheimers disease results from the PLASA study. Social Science & Medicine 72 (8), 1310–1316.

Shaw, C., McNamara, R., Abrams, K., Cannings-John, R., Hood, K., Longo, M., Myles, S., O'Mahony, S., Roe, B., Williams, K., et al., 2009. Systematic review of respite care in the frail elderly.

Spillman, B., Long, S., 2009. Does high caregiver stress predict nursing home entry? Inquiry 46 (2), 140–161.
Stabile, M., Laporte, A., Coyte, P., 2006. Household responses to public home care programs. Journal of Health Economics 25 (4), 674–701.
Van Houtven, C., Norton, E., 2004. Informal care and health care use of older adults. Journal of health economics 23 (6), 1159–1180.
Viitanen, T., 2007. Informal and formal care in Europe. IZA Discussion Paper No. 2648.
Zarit, S., Reever, K., Bach-Peterson, J., 1980. Relatives of the impaired elderly: correlates of feelings of burden. The Gerontologist 20 (6), 649–655.

Appendices

Appendix A. Out-of-pocket expenses for formal home care by district

The success of the estimation of our bivariate Tobit model hinges on finding a good exclusion variable (or instrument) for formal home care, which means a variable highly correlated with formal home care but not correlated with the error term in the equation of informal care. We use a new instrument, which is assumed to be more adapted to the French situation, aiming to assess differences between French Council Districts, which can explain the level of formal home care received by each individual. Questionnaires were sent (by Agnès Gramain) to each of the French Council Districts to get information about formal home-care prices. We use their answers to build a variable related to average out-of-pockets expenses (of individuals) for formal home care by district.

In 2002, the French government introduced the "Allocation Personnalisée d'Autonomie" (APA), a benefit to help elderly dependents pay for formal home care. To benefit from the APA, citizens fill out an application. Each district has its own application, with varying levels of complexity and numbers of supporting documents. The out-of-pocket expenses for formal home care of elderly dependents benefiting from the APA can vary widely from one district to another. A special rate (which can be called "solvency rate") is fixed by each French General Council District regarding the type of formal home-care provider of a given elderly dependent. For an hour of formal home care brought by a given service provider, the out-of-pocket expenses of the elderly dependent are equal to a percentage of the solvency rate varying from 0 to 90% according to his/her income (0% for a low-income individual to 90% for a high-income individual). Nevertheless, the invoice price of such an hour of care is potentially higher than its solvency rate. The difference between these two values is entirely supported by the elderly dependent himself/herself and increases his/her out-of-pocket expenses.

As service providers engage in a regulated activity, they are subject to agreements provided by French public agencies. We can highlight two main types of service providers: those agreed to by the French District Councils and those agreed to by the French Regional Offices for Labor. The former are either fee-based or not. Fee-based service providers agreed to by the French District Councils cannot set their invoice prices: the invoice price of an hour of care equals its solvency rate (fixed by each French District Council). The out-of-pocket expenses of an elderly dependent using such a service provider are easy to evaluate. Conversely, non-fee-based service providers agreed to by the French District Councils and service providers agreed to by the French Regional Offices for Labor can set higher invoice prices than the solvency rates. In these cases, the out-of-pocket expenses of an elderly dependent are difficult to evaluate because we only obtain information about solvency rates (but not about invoice prices) with the questionnaires. Using the answers of such questionnaires, the following steps are taken to build our variable of average out-of-pocket expenses for formal home care by district:

1. For each French District Council, we attempt to calculate the solvency rate of the biggest formal home-care provider among fee-based service providers agreed to by French District Councils. For this group of providers, the invoice price is equal to the solvency rate. Out-of-pocket expenses can then be easily calculated.
2. Several French District Councils submit fee-based service providers agreed to by the French District Councils to two solvency rates: one for skilled formal home care (such as personal care) and another for low-skilled formal home care (such as domestic tasks). According to Marquier (2010), approximately two-thirds of the total amount of formal home care provided to elderly adults in 2008 concerns low-skilled formal home care compared to one-third for skilled formal home care. For these districts, we compute the weighted mean

of the two available rates. At this stage, we are able to estimate the average out-of-pocket expenses for 55 districts.

3. The solvency rate of the biggest formal home-care provider (among fee-based service providers agreed to by French District Councils) is not filled out in two questionnaires. We estimate it by calculating the mean of the lowest and highest solvency rates among those of fee-based service providers agreed to by French District Councils. At this stage, we possess all of the information to estimate the average out-of-pocket expenses for 57 districts.
4. Several French District Councils do not set invoice prices for formal home care providers. In such districts, there are no fee-based service providers agreed to by the French District Councils, but only non-fee-based service providers agreed to by the French District Councils or service providers agreed to by the French Regional Offices for Labor. In these cases, the out-of-pocket expenses of an elderly dependent are difficult to evaluate because we only possess information about solvency rates (but not about invoice prices) in the questionnaires. For these districts, we estimate the invoice prices using the nearest neighbor imputation. The idea behind such an imputation is very simple. First, a distance between districts is built starting from several exogenous variables. Then, the missing value of a given district is substituted by the mean value of the three nearest districts, according to the distance function previously built. In our case, we consider six variables for each district: the proportion of individuals aged 65 and older in 2009 (X_1), the number of individuals benefiting from the APA in 2008 (X_2), the GDP per capita in 2005 (X_3), the proportion of individuals living in rural areas in 2007 (X_4), the number of nursing homes per 1000 individuals aged 75 and older in 2008 (X_5) and the density of general practioners in 2008 (X_6). We use the following L1-distance function between two districts i and j:

$$D_{ij} = \sum_{k=1}^{6} \frac{|X_{ik} - X_{jk}|}{\sigma_k}$$

, where σ_k is the standard error of the variable X_k. After this imputation, we are able to estimate the average out-of-pocket expenses for 71 of the 72 districts, that returned the questionnaire.
5. The last step is to impute values of invoice prices and solvency rates for the 24 districts, that did not return the questionnaire. We estimate both invoice prices and solvency rates for these districts using the same nearest neighbor imputation technique. Eventually, we are able to estimate the average out-of-pocket expenses for 95 districts of metropolitan France.

In each district, we consider a reference individual with an income such that he or she has to bear 33% of the solvency rate per hour of formal home care used. This individual is rather poor because the participation of a given elderly dependent varies from 0 to 90% of the solvency rate, based on his or her income. This threshold of 33% was arbitrarily chosen. A quick sensitivity analysis shows that the main results are not impacted by a change in this threshold. For a given district i, the average out-of-pocket expenses for an hour of formal home care (OPE_i) can be calculated as follows:

$$OPE_i = 33\% \cdot SR_i + (IP_i - SR_i)$$

, where SR_i is the solvency rate of an hour of formal home care in district i and IP_i is the invoice price of an hour of formal home care in district i.

Appendix B. Simulating the effect of discrete shocks on care variables using the Monte-Carlo technique

In this article, we are interested in estimating the effect of discrete shocks of exogenous variables on formal and informal-care variables. The natural way of approaching this could be to compute marginal effects and to bootstrap this effect with N replicates to obtain confidence intervals. Cameron and Trivedi (2009) and DiCiccio and Efron (1996) provide the details of computing bootstrapped bias-corrected confidence intervals. Nevertheless, calculating the explicit form of such marginal effects in our model is very cumbersome, which is why we simulate these effects using the Monte-Carlo simulation technique. For example, how do we proceed if we want to simulate the effect of an increase in out-of-pocket expenses on both formal and informal-care use? First, we define a reference individual. Selecting only individuals of our sample receiving both informal and formal home care, the reference individual takes the average value of each continuous variable and the mode of each discrete variable entering the model. We then repeat the following steps 1000 times (with k varying from 1 to 1000):

1. We simulate a couple of observations (u_{1k}, u_{2k}) following a truncated bivariate normal distribution, whose expectation is $\begin{pmatrix}0\\0\end{pmatrix}$ and whose variance-covariance matrix is $\Sigma = \begin{pmatrix}\widehat{\sigma_{ic}}^2 & \widehat{\rho\sigma_{ic}\sigma_{fc}}\\ \widehat{\rho\sigma_{ic}\sigma_{fc}} & \widehat{\sigma_{fc}}^2\end{pmatrix}$. $\widehat{\rho}$, $\widehat{\sigma_{ic}}$ and $\widehat{\sigma_{fc}}$ are estimated by our model. The distribution of u_{1k} and u_{2k} is truncated to focus on individuals already receiving both informal and formal home care.
2. We then predict $E(y_k|y_k > 1, fc_k > 1, X = \tilde{x}, z = \tilde{z})$ and $E(fc_k|y_k > 1, fc_k > 1, X = \tilde{x}, z = \tilde{z})$, the expectations of both quantities of care received, given that they are greater than an hour a week and that the covariates (including the out-of-pocket expenses Z) are known.
3. We decrease the average out-of-pocket expenses by one Euro ($z = \tilde{z} - 1$) and predict the new expectations: $E(y_k|y_k > 1, fc_k > 1, X = \tilde{x}, z = \tilde{z} - 1)$ and $E(fc_k|y_k > 1, fc_k > 1, X = \tilde{x}, z = \tilde{z} - 1)$.
4. We can now compute our effects for the k^{th} replication:

$$(\Delta_{FC})^{(k)} = E(fc_k|y_k > 1, fc_k > 1, X = \tilde{x}, z = \tilde{z}-1) - E(fc_k|y_k > 1, fc_k > 1, X = \tilde{x}, z = \tilde{z}-1)$$

$$(\Delta_{IC}/\Delta_{FC})^{(k)} = \frac{E(y_k|y_k > 1, fc_k > 1, X = \tilde{x}, z = \tilde{z} - 1) - E(y_k|y_k > 1, fc_k > 1, X = \tilde{x}, z = \tilde{z})}{E(fc_k|y_k > 1, fc_k > 1, X = \tilde{x}, z = \tilde{z} - 1) - E(fc_k|y_k > 1, fc_k > 1, X = \tilde{x}, z = \tilde{z})}$$

.

We eventually consider the mean of the 1000 replications to obtain our final effects:

$$\Delta_{FC} = \frac{1}{1000}\sum (\Delta_{FC})^{(k)}$$

$$\Delta_{IC}/\Delta_{FC} = \frac{1}{1000}\sum (\Delta_{IC}/\Delta_{FC})^{(k)}$$

By the central limit theorem, the mean is asymptotically normally distributed. Confidence intervals can thus be estimated.

Appendix C. Models with skilled and low-skilled formal home care

Inspired by Bonsang (2009), we isolate skilled (or personal) formal home care (such as bathing) from low-skilled formal home care, which is more related to supervision or help in household chores and administrative processes. In Table C.7 (Table C.8), we re-estimate the

Table C.7: Bivariate Tobit model with skilled formal home care

	Skilled formal home care	Informal care
Hours of skilled formal care		-0.799*** (0.255)
Dependence score	0.183*** (0.0122)	0.117*** (0.0127)
Alzheimer (Ref: No)	0.675 (0.526)	0.905*** (0.308)
Has a diploma (Ref: No)	-0.191 (0.262)	-0.222 (0.142)
Income (Ref: Less than 600 €)		
600 €- 1000 €	0.0761 (0.358)	0.111 (0.165)
1000 €- 1500 €	0.420 (0.402)	-0.0170 (0.220)
1500 € and +	0.174 (0.545)	-0.960*** (0.326)
Missing	0.167 (0.413)	-0.296 (0.239)
Living area (Ref: Big city (100 000 inh. and +))		
Rural area	0.266 (0.414)	-0.281 (0.190)
Small size city (- than 20 000 inh.)	0.355 (0.367)	-0.727*** (0.236)
Mid-size city (20 000 to 100 000 inh.)	0.325 (0.442)	-0.228 (0.202)
Number of sons	0.189** (0.0797)	0.143*** (0.0459)
Number of daughters	-0.138 (0.109)	0.331*** (0.0544)
Is a female (Ref: No)	0.378 (0.418)	-0.404** (0.164)
Age group (Ref: 60-64)		
65-69	-0.220 (0.706)	0.476* (0.272)
70-74	0.199 (0.674)	0.490* (0.271)
75-79	0.761 (0.597)	0.684*** (0.241)
80-84	0.930 (0.579)	0.822*** (0.255)
85-89	1.369** (0.575)	1.104*** (0.264)
90+	1.387** (0.693)	1.584*** (0.312)
Out-of-pocket expenses	-0.109 (0.199)	
Intercept	-5.951*** (1.636)	-1.761*** (0.387)
σ	2.718*** (0.179)	2.299*** (0.0783)
ρ	0.295** (0.122)	
Observations	1687	

Source: HSM 2008.
Sample: elderly dependents aged 60 or older living alone in metropolitan France.
Standard errors in parenthesis
* $p < .1$, ** $p < .05$, *** $p < .01$

bivariate Tobit model with hours of skilled (low-skilled) formal home care replacing the total hours of formal home care. In both new models, the coefficients of our exclusion variable, the density of self-employed midwives, remain positive and significant at a 1% level. It is difficult to compare the coefficients of the new models with those of the previous bivariate Tobit model (with total hours of formal home care), but the main explanatory variables remain significant at a 5% level. Dependence-associated variables (dependence score, age and Alzheimer's disease status) significantly explain at least formal or informal-care variables. Having children significantly increases the quantity of informal care received. These results are consistent with those obtained by Bonsang (2009). If the coefficient of education level remains positive and significant at a 10% level for low-skilled formal home care, it no longer explains the quantity of skilled formal home care received. Using formal home care for domestic tasks is more frequent

Table C.8: Bivariate Tobit model with low-skilled formal home care

	low-skilled formal home care	Informal care
Hours of low-skilled formal care		-0.443** (0.225)
Dependence score	0.0878*** (0.00567)	0.114*** (0.0194)
Alzheimer (Ref: No)	0.0131 (0.129)	0.796*** (0.287)
Has a diploma (Ref: No)	0.172* (0.0993)	-0.156 (0.129)
Income (Ref: Less than 600 €)		
600 €- 1000 €	-0.0190 (0.0863)	0.112 (0.156)
1000 €- 1500 €	0.101 (0.117)	-0.0494 (0.190)
1500 € and +	0.0152 (0.145)	-1.016*** (0.325)
Missing	0.0731 (0.148)	-0.313 (0.221)
Living area (Ref: Big city (100 000 inh. and +))		
Rural area	0.204** (0.0989)	-0.254 (0.209)
Small size city (- than 20 000 inh.)	0.332*** (0.123)	-0.653*** (0.238)
Mid-size city (20 000 to 100 000 inh.)	0.239*** (0.0923)	-0.146 (0.203)
Number of sons	-0.0242 (0.0272)	0.116*** (0.0404)
Number of daughters	-0.0845** (0.0332)	0.313*** (0.0535)
Is a female (Ref: No)	-0.0249 (0.0917)	-0.426*** (0.165)
Age group (Ref: 60-64)		
65-69	0.282 (0.239)	0.518** (0.257)
70-74	0.580*** (0.208)	0.602** (0.274)
75-79	0.836*** (0.160)	0.821*** (0.255)
80-84	1.054*** (0.207)	1.003*** (0.295)
85-89	0.880*** (0.163)	1.185*** (0.276)
90+	0.891*** (0.299)	1.670*** (0.318)
Out-of-pocket expenses	-0.108*** (0.0323)	
Intercept	-0.0841 (0.342)	-1.485*** (0.348)
σ	1.373*** (0.0516)	2.172*** (0.0754)
ρ	-0.143* (0.0854)	
Observations	1687	

Source: HSM 2008.
Sample: elderly dependents aged 60 or older living alone in metropolitan France.
Standard errors in parenthesis
* $p < .1$, ** $p < .05$, *** $p < .01$

among highly educated individuals. This is not the case for personal care because most informal caregivers are reluctant to perform such tasks, even among people in poorly educated groups. In each model, the formal home-care variable has a significant negative effect on the informal-care use. Receiving more formal home care reduces the probability of receiving informal care and/or the quantity of informal care received when informal care is provided. Both models predict a crowding out of informal caregivers when the hours of skilled or low-skilled formal home care increase. These models confirm the hypothesis of a substitution effect between formal and informal care, as informal caregivers are crowded out when the quantities of both skilled and low-skilled formal home care are increased. Nevertheless, we are able to observe that the average out-of-pocket expenses for formal home care does not explain significantly the quantity of skilled formal home care used. The price elasticity of skilled formal home-care demand is

low, which is why we decide to test the robustness of our estimates for skilled formal home care using another exclusion variable (see Subsection 6.3 and Appendix D).

Appendix D. Sensitivity analysis model

Table D.9: Bivariate Tobit model with another exclusion variable (density of self-employed midwives) for skilled formal home care

	Skilled formal home care	Informal care
Hours of skilled formal care		-0.752*** (0.221)
Dependence score	0.188*** (0.0126)	0.115*** (0.0126)
Alzheimer (Ref: No)	0.616 (0.490)	0.897*** (0.302)
Has a diploma (Ref: No)	-0.193 (0.269)	-0.222 (0.141)
Income (Ref: Less than 600 €)		
600 €- 1000 €	0.200 (0.361)	0.111 (0.165)
1000 €- 1500 €	0.418 (0.402)	-0.0174 (0.218)
1500 € and +	0.132 (0.557)	-0.958*** (0.326)
Missing	0.265 (0.400)	-0.298 (0.239)
Living area (Ref: Big city (100 000 inh. and +))		
Rural area	0.360 (0.358)	-0.283 (0.190)
Small size city (- than 20 000 inh.)	0.272 (0.331)	-0.726*** (0.235)
Mid-size city (20 000 to 100 000 inh.)	0.497 (0.391)	-0.230 (0.202)
Number of sons	0.185** (0.0783)	0.141*** (0.0455)
Number of daughters	-0.0946 (0.0983)	0.331*** (0.0543)
Is a female (Ref: No)	0.375 (0.412)	-0.405** (0.165)
Age group (Ref: 60-64)		
65-69	-0.333 (0.707)	0.477* (0.271)
70-74	0.209 (0.659)	0.491* (0.270)
75-79	0.733 (0.606)	0.682*** (0.241)
80-84	0.933* (0.562)	0.819*** (0.256)
85-89	1.298** (0.552)	1.097*** (0.266)
90+	1.367** (0.665)	1.577*** (0.312)
Density of midwives	0.294*** (0.0657)	
Intercept	-7.889*** (0.916)	-1.748*** (0.393)
σ	2.666*** (0.179)	2.293*** (0.0796)
ρ	0.277*** (0.106)	
Observations	1687	

Source: HSM 2008.
Sample: elderly dependents aged 60 or older living alone in metropolitan France.
Standard errors in parenthesis
* $p < .1$, ** $p < .05$, *** $p < .01$