TEPP WORKING PAPER

N° 2014 - 6

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www.tepp.eu

TEPP - Institute for Labor Studies and Public Policies
TEPP - Travail, Emploi et Politiques Publiques - FR CNRS 3435

ISSN 2110-5472

Does home care for dependent elderly people improve their mental health?

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Conflict of interest statement
The authors wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

Abstract
We estimate the effects of both informal and formal home care on the mental health of dependent elderly people, measured by depression and a general mental health score (the Mental-Health Inventory, MHI-5). While theoretical models include a health production function of dependent elderly, it has not received much attention in the empirical literature.
Using a sample of 4,067 dependent elderly from the French Disability and Health Survey (2008), we take into account the endogeneity of care with instrumental variables. The results show that informal care significantly reduces the risk of depression of dependent elderly while an additional formal care hour increases their general mental health by 2 points on a 0-100 scale. If the objective of public policies is simply to reduce the risk of depression, informal care should be encouraged. By contrast, formal care should be considered as particularly relevant to ensure the mental well-being of dependent elderly.

Key words: long-term care; health production; informal care; formal care; depression; mental health.
JEL: D130; I120; J140; C360.

1. Introduction

The aging of baby-boomers, coupled with the increase in life expectancy, leads to a greater risk of old-age dependence in France. The number of dependent elderly is expected to double by 2060, reaching 2.3 million people. More generally, between 2000 and 2060, the proportion aged 75 and over will increase from 8% to 16% (French National Institute of Statistics and Economic Studies). The increase in the ratio of elderly to working-age people will generate high social costs (e.g., insuring the Pay-As-You Go System's equilibrium). Moreover, total French public spending on long-term care represented 24 billion Euros in 2010 (1.2% of GDP), including 14 billion for health expenditures, 7.5 billion for long-term care and 2 billion for accommodation.

Beyond this volume effect, the quality of life for older people, particularly their mental health, is a key variable in understanding their healthcare expenditures and how to respond in the best way to their needs. In addition, maintaining the mental health of older people is important, because a bad mental health status may accelerate the disability[1]. Indeed, the effect of pathology on impairments and the effect of functional limitations on disability are higher for depressed individuals than for non-depressed ones (Van Gool *et al.*, 2005). Otherwise, mental health is a major political concern, as underlined in the Comprehensive mental health action plan 2013-2020 (WHO) and in the European Pact for Mental Health and Well-being launched in 2008. This latter initiative makes the mental health of older people one of its five priority areas and invites policy makers and stakeholders to "*provide measures to promote mental health and well-being among older people receiving care (medical and/or social) in both community and institutional settings*". At the French level, the law on the adaptation of society to the aging of the population, adopted by the National Assembly in September 2014,

[1] The disability model (Verbrugge and Jette, 1994) involves four consecutive phases: pathology, impairment, functional limitation and disability.

highlights the role of preventing suicide among elderly persons. Indeed, in 2010, people aged 65 and over accounted for 28% of suicides and these suicides were often the result of an undiagnosed and untreated depression.

Support of elderly people in France is based mainly on a family model and informal caregivers. Thus, the French High Family Council estimates that 3.6 million elderly people live in ordinary households and receive care due to health problems; 48% of them receive only informal care, 20% only formal care and 32% are helped by both formal and informal care. Care hours provided by family caregivers are estimated at over one billion hours, which would represent 77% of the total hours of care.

Several theoretical models include a health production function which has two inputs: formal and informal care. However, to the best of our knowledge, this function has not received much attention in the empirical literature. Our goal is to estimate from French data the effects of both formal home care (provided by professional workers) and informal care (provided by the family and other relatives) on the mental health of dependent elderly living at home. For this, we use two mental health indicators: depression and the Mental-Health Inventory (MHI-5). We take into account the potential endogeneity of care using an instrumental variables analysis. From a public policy perspective, this study identifies the most effective care arrangements in terms of mental health. It informs policy makers about the relative benefits of financing informal care or formal care in the current context of population aging and financial constraints.

The article is organized as follows: section 2 offers a summary of the existing literature; section 3 presents the data and methodology used; section 4 provides some descriptive

statistics, the results of the estimations and robustness tests. Finally, the last section is devoted to discussion and the conclusion.

2. Background

While the literature suggests that informal care may have both positive[2] and negative effects[3] on the emotional well-being of the elderly (see for example Fast *et al.*, 1999, for a literature review), the economic literature sees formal and informal care as inputs in an elderly person's health production function. A first type of theoretical model of long-term care arrangements considers a unique utility function for the entire family. Hoerger *et al.* (1996) are interested in the effect of public subsidies on the living arrangements of a dependent elderly person (living alone, living with a child or moving into a nursing home). They assume that the family utility increases with informal and formal care and that the marginal utility of care increases with the severity of the disability, but they do not formalize a health production mechanism. Pezzin *et al.* (1996) also study the impact of a public program on living arrangements and define a health production function. The production of a disabled elderly person's functioning, conditional on the level of disability, requires formal or informal care. Stabile *et al.* (2006) study the ability of dependent elderly to perform ADLs (activities of daily living). This level of ability is determined by a production function, which depends positively on informal and formal care for a given health status.

Other models examine the decisions of two individuals – a disabled parent and a child – who have different utility functions. Pezzin and Schone (1999) consider informal care and the labour supply of a daughter who has a dependent parent, as well as their living arrangements. A parent's physical health or well-being, conditional on functional or cognitive disability, is defined as a public good whose production depends on formal care (purchased in the market

[2] Elderly people cared for by their children report that they are less restless, lonely, bored and unhappy in comparison with other older people.

[3] Loss of personal control in their lives, stress, tension between needing care and not wanting to be a burden, restricted future outlook, lower psychological morale.

by the parent) and informal care (provided by the daughter). More recently, Thiébaut *et al.* (2012) build a theoretical model to study the impact of a French reform which would consist of recovering public contributions paid to dependent elderly from part of their estate after their death. They consider a quality of life production function with two inputs: formal and informal care. They assume that informal care is preferred to formal care by the parent and that the marginal productivity of formal care is constant (possible turnover of professional workers), while the marginal productivity of informal care is decreasing (informal caregivers tire more easily).

Finally, some models allow for the presence of multiple potential informal caregivers. Van Houtven and Norton (2004) define the parent's health status as a function (adapted from Grossman, 1972) of the aggregate level of informal care (from all children), of formal medical care and of human capital. Byrne *et al.* (2009) specify a game-theoretic model of family decisions in which children allocate time for work, leisure, informal care and they allocate money for consumption and formal care. The elderly individual(s) (it may be a couple) allocate time for informal care and leisure and they allocate money to consumption and formal care. The health quality of the elderly – which is defined as an *"aggregate measure of true health […] and accommodations made for health problems"* – depends on informal care, formal care and on a set of demographic characteristics. In the latter two references, children are altruistic in the sense that their utility depends on the parent's health.

To the best of our knowledge, only Stabile *et al.* (*op. cit.)* and Byrne *et al.* (*op. cit.)* provide empirical results on the health effects of formal and informal care on the care recipient[4]. The first study uses Canadian data and shows that greater generosity of public home care programs (at the provincial level) leads to a higher probability of reporting good self-assessed

[4] By contrast, the recent economic literature has been more interested in estimating health effects of informal care on the caregivers (see for example Coe and Van Houtven, 2009; Do *et al.*, 2015; Van den Berg *et al.*, 2014).

health. When it takes into account the potential endogeneity of public generosity, the effect becomes insignificant. Nevertheless, this work does not estimate the effect of informal care.

Byrne *et al.* (*op. cit.*) use US data and find that formal care and informal care – especially care provided by a spouse – have only small positive effects on the parent's health quality[5]. Furthermore, they show that informal care provided by a child is more effective than formal care; an additional hour of informal care implies a 0.12 % increase in the health quality of parents. Finally, Rice *et al.* (2009) do not directly study health, but show that more hours of care decrease the probability of unmet needs for assistance in daily life activities. However, this study cannot be easily generalized, since it only concerns the very frail elderly (Medicare and Medicaid dually enrolled elderly) in six states of the US.

3. Method

3.1. Data

In order to estimate the health production function, we use the Ordinary Households section of the French Disability and Health Survey (*Enquête Handicap Santé Ménage*), which was carried out in 2008 among non-institutionalized people by the French Institute of Statistics and the Ministry of Health. This survey provides information on the socioeconomic and socio-demographic characteristics of 29,931 individuals, as well as on their family situation. Furthermore, it gives details on individual deficiencies, functional limitations, activity restrictions and health problems.

We select a sample of 4,067 dependent elderly persons aged 65 and over based on activity restrictions. An individual is considered dependent if he reports difficulties in performing alone at least one ADL or one instrumental activity of daily living (IADL). ADLs are the most basic activities of daily life and refer to personal care and functional mobility: bathing, dressing and undressing, eating and drinking, using the bathroom, lying down in and getting

[5] Since there is no direct measure for health quality of parents available in the data, the authors observe it indirectly through its effect on utility (which is measured by a dummy variable indicating if the elderly person was happy during the past week).

up from bed, sitting down in and getting up from a chair. IADLs support an independent life style: shopping, cooking, doing common and less common household chores, doing administrative tasks, managing medication, moving around in all of the rooms of a floor, leaving home, using transportation, finding your way, using a telephone.

3.2. Variables of interest

We are interested in the effects of informal and formal home care on two mental-health variables: depression and the Mental-Health Inventory. The depression variable has a value of 1 if the individual has suffered from depression in the twelve months prior to the survey, and 0 otherwise[6]. A disadvantage of this variable is that it refers to a specific disease. Therefore, we also use a general mental health measure: the Mental-Health Inventory (MHI-5). This indicator is built from five questions of the Short Form Health Survey (SF-36), which was included in a mail-back questionnaire left for the surveyed individuals. The questions are the following: "*Over the past four weeks, were there times when you… i) felt very anxious; ii) felt so discouraged that nothing could make you feel better; iii) felt calm and relaxed; iv) felt sad and demoralized; and v) felt happy.*" For each question, five response categories are possible (always, often, sometimes, rarely, never) scored from 1 to 5. The total score is then transformed to a 0-100 scale, 100 being the best possible health. The MHI-5 is a validated and reliable general mental health measure, but there exists no determined cut-off point that can be used to screen for depressive symptoms (Kelly *et al.*, 2008). Similarly, Hoeymans *et al.* (2004) stress the need for a valid and internationally comparable cut-off point[7]. For these reasons, and because we are interested in a very particular population, we will use the MHI-5 as a general mental health score and not try to screen for specific symptoms. The estimations

[6] The survey question is *"have you had chronic depression in the past 12 months?"*.

[7] The commonly used cut-off point is 52, but many other limits exist (Thorsen *et al.*, 2013).

of the effect of care on the MHI-5 will focus on the 2,117 individuals who have completed the paper questionnaire[8].

The main explanatory variables are informal care (IC) and formal care hours (FCH). The informal care variable is equal to 1 if the dependent elderly receives help from family members or other relatives, and 0 otherwise. We use a binary care variable because of missing values (27%) in informal care hours received, especially when the caregiver and the dependent elderly are co-residents. In contrast, we are well-informed about formal care hours (only 3.5% of missing values). From information on the frequency of formal care (daily, weekly or monthly) and care hours received per unit of time, we build a unique variable which gives formal care hours received per week. Finally, it should be mentioned that the care being considered here is aid with daily life tasks activities: i) personal care (bathing, dressing, meals); ii) household chores (cleaning, making meals); iii) managing the budget, paperwork and administrative processes; iv) ensuring company; v) ensuring supervision; vi) taking care of health problems; vii) shopping or viii) other activities.

3.3. Econometric model

The equation of interest (see below) estimates the effect of informal care (IC) and formal care hours (FCH) on mental health. X_i is a set of characteristics of the dependent elderly and the family. We control for activity restrictions and functional limitations (moderate and severe ADL restrictions; moderate and severe IADL restrictions; and motor, sensory and cognitive limitations), for demographic variables (age and gender), socioeconomic variables (education level, monthly income, urban area) and family characteristics (living with a partner, having children, recent widowhood, seeing the family less than once a month). We also take into account if individuals answer the survey for themselves or if a third party helps them answer

[8] We take into account the potential selection bias in the robustness tests of section 4.

or responds for them (in other words, we control for proxy respondents). All variables are described in table 1 below.

$$MH_i = \alpha_1 IC_i + \alpha_2 FCH_i + X_i\alpha_3 + \epsilon_i$$

We estimate this equation first treating formal and informal care as exogenous. We use a linear probability model for depression[9] and a standard linear regression for the mental health score.

However, this naïve model may be biased due to the potential endogeneity of care variables. First, health measurement errors may exist. We try to limit this bias by introducing two mental health measures. Second, a bad mental health status may increase the probability of receiving formal or informal care and the intensity of the help (*reverse causality*). The empirical literature has mainly highlighted the positive effect of activity restrictions on the probability of receiving formal care (Bonsang, 2009), informal care (Fontaine *et al.*, 2007; Haberkern and Szydlik, 2010) and on informal care hours (Golberstein *et al.*, 2009). Furthermore, some chronic diseases (hypertension, diabetes, stroke, dementia, cancer) increase the probability and the intensity of informal care (Golberstein *et al.*, 2009). Moreover, a bad or very bad self-assessed health increases the use of informal care (Bonsang, 2007) and the probability of formal care (Stabile *et al., op. cit.*). Finally, some research has highlighted "*significant influences of emotional and mental disabilities […] on long-term care utilization*" (Portrait *et al.*, 2000).

Third, there exist unobserved factors influencing the elderly's mental health that are correlated with formal and informal care. For example, children's health plays a role in the provision of informal care and may impact parents' mental health. Similarly, family history of mental health problems may change the elderly's attitude toward formal care; it also may

[9] We use a linear probability model in order to compare these estimations with the model treating care variables as endogenous.

increase awareness amongst potential informal caregivers. Furthermore, the medicalization of the health of the elderly facilitates the diagnosis of depression and may increase informal care due to information or guilt put on family members by medical institutions (Weber, 2010).

In order to address this potential endogeneity, we estimate instrumental variables models using two-stage least squares[10]. We estimate two models – one with a binary dependent variable (depression) and one with a continuous dependent variable (the mental health score) – with two endogenous regressors – one binary (informal care) and one continuous (formal care hours). We choose to consider depression and informal care as continuous variables, so that instrumental variables can easily be implemented. In addition, the literature acknowledges that the linear probability model gives good estimates of marginal effects, particularly for mean values of the covariates (Angrist and Pischke, 2009, p. 107; Wooldridge, 2002, p. 465). Finally, in the robustness subsection (4.3), we test whether our results remain stable when we take into account the fact that depression and informal care are binary variables, using simultaneous equations models.

3.4. Instruments

Since we have two endogenous regressors, we need to find at least two instruments (vector Z_i) that are correlated with formal and informal care, $corr(IC_i, Z_i) \neq 0$ and $corr(FCH_i, Z_i) \neq 0$, but orthogonal to the error term in the mental health equation, $corr(\epsilon_i, Z_i) = 0$. On the one hand, the empirical literature dealing with the effects of informal care on formal care utilization provides good instruments for informal care based on family variables. Van Houtven and Norton (*op. cit.*) instrument informal care by the number of children of the elderly and whether or not the eldest child is a daughter; Charles and Sevak (2005) use a set of instruments combining the gender of the children, their marital status and

[10] ivreg2 command in Stata, developed by Baum *et al.*, 2007.

their location; Bolin *et al.* (2008) use the number of children and whether or not the oldest child lives more than 100 kilometers away; and Bonsang (2009) chooses the geographical distance and the proportion of daughters. In our study, we consider four instruments for informal care: i) the proportion of daughters, ii) having at least one child who has no child, iii) having at least one child who has no partner, and iv) having at least one child who lives nearby (same building, same town or same department[11]). We assume: i) that daughters have a higher propensity to provide care; that a child who has no child (ii) or no partner (iii) can allocate more time to informal care; and iv) that the opportunity cost of informal care is lower when children live close to the elderly. The exogeneity of where children are located has been challenged in the literature (e.g., children with sick parents may live closer). We nevertheless choose to consider this variable, because it has passed overidentification tests in empirical works (Bolin *et al.*, *op. cit.*; Bonsang, 2009) and it has been shown that the effect of child distance on care arrangements is very large (Stern, 1995).

On the other hand, instruments are much less developed for formal care. To the best of our knowledge, only Stabile *et al.* (*op. cit*) have discussed this issue. They study the effect of public home care generosity – measured by the spending by province and year per individual aged 65 and older – on home care utilization, informal caregiving and health. They instrument public home care generosity by the share of the population aged 65 and older by province, the level of provincial spending on education and the provincial tax rate. They find that the exogeneity of public home care generosity could not be rejected. In the present work, the instrument for formal care is the proportion of individuals aged 75 and over who received the Personal Autonomy Allowance (PAA, *Allocation Personnalisée d'Autonomie*) at the

[11] French departments are equivalent to UK counties.

departmental level in 2008[12]. The amount of aid depends on the level of dependence (which was assessed by a medico-social team during a visit to the elderly's home), and the beneficiary pays a contribution based on income. We use the proportion of beneficiaries at the departmental level to take into account French disparities in access to PAA[13]. Indeed, the General Councils have set up heterogeneous appraisal and decision-making processes[14]. For instance, application files display varying degrees of complexity and require varying numbers of supporting documents. Moreover, the grid used to assess the level of dependence is very sensitive and likely to lead to departmental inequalities for eligibility to PAA. Finally, the professional profile of medico-social teams and the period of entitlement to PAA may vary between departments.

4. Results

4.1. Descriptive statistics

Table 1 below provides descriptive statistics. They cover both the total sample (4,067 observations), used for estimating depression, and the subsample of individuals (2,117) that have completed the paper questionnaire, used for the estimations of the MHI-5.

As far as our variables of interest are concerned, around 8% of individuals had suffered from depression in the twelve months prior to the survey in both samples. The MHI-5 is characterized by an average of 50 (out of 100) and a standard deviation of 21. A significant proportion of dependent elderly benefits from care. In the total sample, 68% of individuals receive informal care (as compared to 66% in the subsample) and the average number of formal care hours received per week is 6 (as compared to 5 in the subsample). The large

[12] The Personal Autonomy allowance, launched in 2002, is a needs-based national program administered at the departmental level by the General Councils; it covers part of the formal home care received by individuals at least 60 years of age who need help for activities of daily living.

[13] Approximately 30% of these disparities are neither explained by the socio-demographic structure of the departments nor by departmental policies.

[14] This view is supported by several reports from French authorities: the Inspectorate of Social Affairs (2009), the Court of Auditors (2009), the National Assembly (2010).

standard deviation of formal care hours (between 12 and 14 hours) underlines the significant dispersion of formal care intensity in both samples.

These samples have similar demographic and socioeconomic characteristics: the mean age of dependent elderly individuals is 79 years old; a large majority are women (around 70%); three quarters of individuals have a low or medium education level; most individuals (76%) live in an urban area; and the mean proportion of individuals aged 75 and older receiving the Personal Autonomy Allowance at the departmental level is around 15%. They are also comparable in terms of family characteristics: 45% of surveyed individuals live with a partner; 4-5% of elderly are recently widowed; 87% have at least one child; and 13% see their family less than once a month. The majority of individuals (66%) have at least one child who lives nearby; around 40% have one child who has no partner; and 30% have one child who has no child.

By contrast, the two samples are characterized by different levels of dependence. Indeed, in the subsample, the average number of severe restrictions in ADLs is 0.49 and the average number of severe restrictions in IADLs is 2.78, as compared to 0.68 and 3.36, respectively, for the total sample. They are also less frequently limited: 32% report sensory limitations and 31% report cognitive limitations, *versus* 37% and 38%, respectively, for the total sample. This better health status of individuals in the subsample probably explains why they receive less care and why proxy respondents are less present.

Table 1
Descriptive statistics for both samples.

	Total sample		Subsample	
	Mean	Std. dev.	Mean	Std. dev.
Mental health variables				
Depression	0.078	0.268	0.079	0.270
MHI-5	-	-	49.469	20.895
Care variables				
Informal care	0.683	0.465	0.658	0.475
Number of formal care hours per week	6.328	13.569	5.072	11.940
Control variables				
Health controls				
Number of moderate restrictions in ADLs	0.650	1.067	0.603	1.024
Number of severe restrictions in ADLs	0.681	1.506	0.489	1.266
Number of moderate restrictions in IADLs	1.312	1.539	1.347	1.507
Number of severe restrictions in IADLs	3.356	3.422	2.781	3.077
Motor limitation	0.909	0.288	0.891	0.312
Sensory limitation	0.370	0.483	0.321	0.467
Cognitive limitation	0.380	0.486	0.310	0.463
Demographic and socioeconomic controls				
Age	79.194	7.383	78.682	7.194
Female	0.705	0.456	0.729	0.445
Education level				
- Low	0.452	0.498	0.409	0.492
- Medium	0.322	0.467	0.346	0.476
- High	0.226	0.418	0.245	0.431
Monthly income				
- Less than 1000 EUR	0.239	0.427	0.232	0.422
- 1000/1500 EUR	0.253	0.435	0.258	0.438
- 1500/2000 EUR	0.163	0.370	0.169	0.375
- More than 2000 EUR	0.247	0.431	0.251	0.434
- Missing value	0.098	0.297	0.090	0.286
Urban area	0.760	0.427	0.757	0.429
Family controls				
Living with a partner	0.451	0.498	0.452	0.498
Widowhood < 2 years	0.042	0.201	0.048	0.213
Having at least one child	0.870	0.336	0.868	0.339
Seeing the family less than once a month	0.138	0.345	0.131	0.337
Proxy respondent	0.341	0.474	0.264	0.441
Instruments				
Having at least one child who has no partner	0.435	0.496	0.412	0.492
Having at least one child who has no child	0.310	0.463	0.299	0.458
Having at least one child who lives in the same building, town or department	0.658	0.474	0.658	0.474
Proportion of daughters	0.440	0.364	0.440	0.369
Proportion of individuals aged 75+ receiving the PAA at the departmental level (per 1,000 inhabitants)	148.934	74.170	146.644	74.932
Number of observations	4,067	4,067	2,117	2,117

Source: French Disability and Health Survey, 2008.
Field: Dependent individuals, aged 65 and over (1st column: total sample, 2nd column: subsample of individuals that have completed the paper questionnaire).

4.2. Estimation results

Specification tests

Among all possible combinations of two, three, four or five instruments listed in the method section[15], we selected those with the highest first stage *F*-statistics. Finally, we retained i) the proportion of daughters and the proportion of PAA recipients for the depression model; ii) having at least one child who has no partner and the proportion of PAA recipients for the MHI-5 model. In addition, just-identified instrumental variables models[16] are *"median unbiased and therefore unlikely to be subject to a weak-instrument critique"* (Angrist and Pischke, 2009, pp. 209-210).

Table 2 (see below) summarizes, for both depression and the MHI-5, OLS regressions' results, considering formal and informal care as exogenous, and IV models' results, treating care variables as endogenous. In addition, for IV models, we report the first stage coefficients of instruments and several test statistics. Appendices B and C present the complete instrumental variables estimations for depression and the MHI-5. First of all, the null hypothesis of exogeneity[17] of formal and informal care is rejected in both models (p=0.049 for depression and p=0.004 for the MHI-5), indicating that IV models are preferred to OLS.

Concerning the strength of instruments, the proportion of PAA recipients has a positive and significant at the 1% level impact in the first-stage equation for formal care hours. This result confirms the assumption that the departmental proportion of beneficiaries correlates with access to PAA and thus with formal care. In the first-stage for informal care, a positive and significant at the 1% level effect exists for the proportion of daughters (in the depression

[15] The proportion of daughters, having at least one child who has no child, having at least one child who has no partner, having at least one child who lives nearby, the proportion of individuals receiving the PAA.

[16] In our case, two endogenous regressors and two instruments.

[17] In the ivreg2 command in Stata, the endogeneity test is a difference of two Sargan-Hansen statistics: one for the equation treating the regressors as endogenous and one for the equation treating the regressors as exogenous.

model) and having a child who has no partner (in the MHI-5 model). In short, children's availability and propensity to help are good predictors of informal care.

In the depression model, we note that the proportion of PAA recipients is significant in the informal care equation and that the proportion of daughters is a significant predictor of formal care hours. It probably captures the complex relationship between these two types of care. Indeed, the empirical literature shows that informal care substitutes formal home care after controlling for endogeneity (Greene, 1983; Van Houtven and Norton (*op. cit.*); Bolin *et al.* (*op. cit*)), and that this substitution effect tends to disappear as the elderly person's level of disability increases (Bonsang, 2009).

The Angrist-Pischke (AP) multivariate *F*-test (Angrist and Pischke, 2009, pp. 217-218) tests whether one particular endogenous regressor is weakly identified. In our case, AP *F*-statistics are generally higher than the conventional $F=10$ threshold used for single endogenous variables and we can significantly reject the null hypothesis that formal and informal care are weakly identified at the 1% level ($F=12.04$ and $F=13.29$, respectively, for informal and formal care in the depression model; $F=14.83$ and $F=9.67$ in the MHI-5 model; $p<0.01$). In addition, the comparison of the Cragg-Donald Wald *F*-statistic to Stock and Yogo (2005)'s critical values[18] allows testing the identification of the model as a whole. In our case, for both the depression and the MHI-5 models, the maximum Wald test size distortion ranges between 10% and 15%.

Exclusion restrictions cannot be tested in just-identified models. We thus run overidentified models containing three instruments (the proportion of daughters, having a child who has no

[18] Stock and Yogo (2005) tabulate critical values (that depend on the number of endogenous regressors and instruments) that give information on the bias of the IV estimator relative to OLS and on size distortions of the associated Wald statistic. We present results only on size distortions, since the study of the bias requires at least two overidentifying restrictions. The Cragg-Donald Wald *F*-statistic is 5.14 in the depression model and 4.84 in the MHI-5 model. The critical value if we want to restrict the size distortion to 15% (*resp.* 10%) is 4.58 (*resp.* 7.03).

partner, the proportion of PAA recipients) using limited information maximum likelihood (see Appendix A). The AP *F*-statistics are lower than in the just-identified models and the comparison of the Cragg-Donald Wald *F*-statistic to critical values of Stock and Yogo (*op. cit.)* shows that the maximum Wald test size distortion ranges between 10% and 15%. Results are similar to those of just-identified models and the Anderson-Rubin overidentification test cannot reject the null hypothesis that our exclusion restrictions are valid (p=0.583 for depression, p=0.924 for the MHI-5).

Table 2
Effects of formal and informal care on the risk of depression and on the Mental-Health Inventory of the care recipient – OLS and IV estimations.

Dependent variable	Depression		MHI-5	
	OLS	IV	OLS	IV
Informal care	-0.021*** (0.010)	-0.416* (0.215)	0.760 (1.025)	19.950 (17.062)
Formal care hours	0.0001 (0.0003)	-0.005 (0.007)	0.046 (0.041)	1.819** (0.835)
First-stage equation for informal care				
At least one child who has no partner	-	-	-	0.077*** (0.020)
Proportion of daughters	-	0.059*** (0.021)	-	-
Proportion of PAA recipients	-	0.0002** (0.0001)	-	0.0001 (0.0001)
First-stage equation for formal care hours				
At least one child who has no partner	-	-	-	-0.487 (0.517)
Proportion of daughters	-	-1.093* (0.606)	-	-
Proportion of PAA recipients	-	0.009*** (0.003)	-	0.010*** (0.003)
AP *F*-test of instruments for IC	-	12.04***	-	14.83***
AP *F*-test of instruments for FCH	-	13.29***	-	9.67***
Exogeneity test, *p-value*	-	0.049	-	0.004
Number of observations	4,037	4,037	2,117	2,117

Source: French Disability and Health Survey, 2008. Field: Dependent individuals, aged 65 and over.
Note: Regressions include all the control variables listed in table 1. Standard errors are reported in parentheses. For the depression model, the number of observations is 4,037 (while we have a sample of 4,067 dependent elderly persons) because of 30 missing values.
*: significant at the 10% level, **: 5% level, ***: 1% level.

Main results

The comparison of OLS and IV results in table 2 highlights that when care variables are treated as exogenous, their effect on the mental health of the care recipient is underestimated. This is in line with our discussion on reverse causality in the method section: a bad mental health status may increase the probability of receiving care and the intensity of the help. This is also consistent with the existence of unobserved variables that may be positively correlated

with care variables and with the diagnosis of mental health problems (e.g., family history of mental health problems, the medicalization of the health of the elderly).

The IV results show that receiving informal care reduces the risk of depression by 41%, while formal care hours have no significant effect. In contrast, the mental health score is only impacted by formal care. A one-unit increase in formal care hours improves the MHI-5 by 1.8 points on the 0-100 scale. To illustrate this idea, individuals who do not receive formal care have a mean estimated MHI-5 of 44.9, while individuals receiving formal care have a mean MHI-5 of 52.6. Thus, formal care is more effective in maintaining general mental health than in reducing the risk of depression. This may reflect that everyday activities are more closely related to the former health indicator than to the latter. The differential impact of formal and informal care could also be explained by the fact that formal care has an effect in the short run (the MHI-5 is measured over the past four weeks) while informal care has an impact in the longer run (depression is measured in the 12 months prior to the survey).

Concerning the effect of control variables the risk of depression significantly increases with restrictions in IADLs and with motor and cognitive limitations (see table in Appendix B, first column). Otherwise, the mental health score (MHI-5) is significantly deteriorated with severe restrictions in IADLs, moderate and severe restrictions in ADLs, motor limitations and cognitive limitations (see table in Appendix C, first column). Socioeconomic and family variables have no effect on mental health (for both indicators), except for two factors: being recently widowed, which decreases the MHI-5 by 8 points; and the presence of proxy respondents, which increases the probability of reporting depression. Finally, demographic controls stress that the risk of depression is higher for women and lower for older people.

Determinants of formal and informal care

The determinants of formal and informal care in the first-stage equations (see tables in appendices B and C, columns 2 and 3) are generally consistent with the literature. First, activity restrictions have a positive effect on the receipt of informal care and on formal care hours[19]. In contrast, functional limitations do not seem to play a role, except for motor limitations in the informal care equation.

Second, women receive more formal care than men and have a lower probability of receiving informal care. Possible explanations are that women have less potential caregivers than men, or that husbands who have to care for their spouse use formal care more frequently than wives at given level of dependence (Gaymu *et al.*, 2008). The age of the dependent elderly has a negative effect on informal care and a positive effect on formal care hours. In the literature, the effect of age on informal care is rather positive. At first sight, we have good control variables for the health status of the elderly; the age variable thus does not explain a health effect. We can find another explanation by assuming that the elderly's age may be interpreted as a proxy for the age of children: the older the children are, the frailer they are; and thus they are less likely to provide informal care. With regard to socioeconomic variables, the elderly's education level decreases the probability of informal care and increases the number of formal care hours. Indeed, highly educated individuals are more aware and better informed of publicly available formal programs (Stabile *et al.*, *op. cit.*). In addition, elderly education is partially a proxy for children's education. Children with a higher education probably have higher wages in the labor market and thus a higher opportunity cost of informal care. The probability of receiving informal care rises with monthly income. This is in line with the positive link between informal care and the expectation of receiving an inheritance highlighted by Bonsang (2007). However, in accordance with Van Houtven and Norton (*op.*

[19] By contrast, the negative effect of severe restrictions in ADLs on informal care in the depression model may be explained by a substitution effect between informal and formal care for high levels of dependence.

cit.) and Bonsang (2009), income does not influence the intensity of formal care. Finally, family variables play a significant role in the care received. Having a partner has a positive effect on the probability of informal care and a negative effect on formal care hours. Moreover, being recently widowed increases formal care hours, and seeing the family less than once a month diminishes the use of informal care.

4.3. Robustness tests

In this subsection, we test whether our results remain stable when we take into account the fact that depression and informal care are binary variables. Since IV models with binary first-stage and second-stage equations cannot be easily implemented, we use simultaneous equations models. We estimate jointly mental health (equation 1, probit model for depression, linear model for the MHI-5), the receipt of informal care (equation 2, probit model) and formal care hours (equation 3, linear model). We use the same control variables as previously and exclusion variables in equations 2 and 3 correspond to IV analysis' instruments. In these models, error terms of equations (1), (2) and (3) are assumed to follow a multivariate normal distribution. This assumption is a weakness of the model, but less parametric estimations are outside the scope of this robustness test[20].

As outlined above, the subsample used for the MHI-5 model represents only about half of the surveyed individuals (2,117 out of 4,067). If unobserved factors influencing this selection are correlated with the error term in the mental health equation, results are biased (Heckman, 1979). Thus, we add a selection equation (equation 4, probit model) to our simultaneous equations model for the MHI-5. This selection equation includes the same control variables as those previously described, as well as informal care and formal care hours. In order to identify our model, we need an exclusion variable that appears in the selection equation but does not

[20] The parameters of these simultaneous three-equations models are estimated by the maximum-likelihood method (cmp package in Stata; Roodman, 2011).

affect mental health[21]. We use the fact of having voted or not in the 2007 French presidential and legislative elections. Even if we cannot completely rule out the possibility that voting behavior may be influenced by mental health, we think it is above all a good indicator of social participation and of the desire to give an opinion (and, thus, of the probability of returning the questionnaire).

Table 3 below (columns 1 and 2) presents the results of the simultaneous three-equations models for depression and for the MHI-5. The last column provides estimations for the MHI-5 model with selection.

The significant correlation coefficients of residuals between informal care and depression equations (0.52) and between formal care and the MHI-5 equations (-0.72) are consistent with the existence of reverse causality and omitted variables and highlight the need to treat care variables as endogenous. Besides, the negative and significant correlation coefficient between formal and informal care (-0.19) seems to indicate the existence of substitution effects between these two types of care. Finally, the residuals of the selection equation are neither correlated with care equations, nor with the MHI-5 equation, suggesting that selection is not an issue.

The effects of care variables on the mental health of dependent elderly individuals are consistent with those estimated using instrumental variables, although the coefficient of informal care in the depression equation is lower. Informal care significantly decreases the risk of depression by 25% (at the 1% level), as compared to 41% (at the 10% level) in the

[21] The model is technically identified even if the same set of variables appears in the selection equation and in the mental health equation. However, in this case, identification is due to distributional assumptions about the residuals (non-linearity) and may lead to imprecise estimates (Sartori, 2003).

instrumental variables analysis[22]. A one-unit increase in formal care hours improves the MHI-5 by 2 points, and the effect is higher when we adjust for selection bias (2.4 points).

Table 3
Robustness tests – simultaneous equations models.

Dependent variable	Depression	MHI-5	MHI-5 with selection
	Simultaneous 3-equations model	Simultaneous 3-equations model	Simultaneous 4-equations model
(1) Mental health equation			
Informal care	-0.251*** (0.048)	2.411 (5.785)	0.739 (6.357)
Formal care hours	-0.008 (0.009)	1.974** (0.911)	2.387** (1.085)
(2) Informal care equation			
At least one child who has no partner	-	0.071*** (0.020)	0.053*** (0.014)
Proportion of daughters	0.067*** (0.020)	-	-
Proportion of PAA recipients	0.0002** (0.0001)	0.0001 (0.0001)	0.0002* (0.0001)
(3) Equation for formal care hours			
At least one child who has no partner	-	-0.102 (0.397)	0.031 (0.337)
Proportion of daughters	-0.845 (0.646)	-	-
Proportion of PAA recipients	0.009*** (0.003)	0.010*** (0.003)	0.009*** (0.003)
(4) Selection equation			
Has not voted in the 2007 French presidential and legislative elections	-	-	-0.042** (0.019)
Correlation between mental health and IC	0.519*	0.099	0.151
Correlation between mental health and FCH	0.457	-0.723***	-0.820***
Correlation between IC and FCH	-0.186***	-0.186***	-0.187***
Correlation between selection and health	-	-	1.203
Correlation between selection and IC	-	-	0.236
Correlation between selection and FCH	-	-	-0.344
Number of observations	4,037	2,117	4,067

Source: French Disability and Health Survey, 2008. Field: Dependent individuals, aged 65 and over.
Note: Regressions include all the control variables listed in table 1. In the selection, depression and informal care equations, the figures given correspond to marginal effects at mean. Standard errors are reported in parentheses.
*: significant at the 10% level, **: 5% level, ***: 1%.

[22] It is difficult to decide in favor of one model or the other since they both have some drawbacks: the IV linear probability model considers informal care and depression as continuous variables and the simultaneous equations model assumes that the error terms follow a multivariate normal law. The important result is that informal care has a significant and large effect on depression in both specifications. The overidentified IV model in Appendix A, that shows that informal care reduces the risk of depression by 34%, provides an intermediate result.

5. Discussion

Our contribution to the literature is to empirically estimate the effects of both informal and formal care on mental health while controlling for the endogeneity of care. The results show that informal care reduces the risk of depression of dependent elderly while formal care increases their general mental health. The higher effectiveness of formal care in maintaining the general mental health than in reducing depression may reflect the fact that everyday activities are more closely related to the former health indicator than to the latter.

If the objective of policy makers is simply to reduce the risk of depression of dependent elderly people, they should encourage informal support by recognizing the important role played by family caregivers, implementing respite care, reinforcing counseling and training services or reconciling paid employment and informal care. By contrast, formal home care should be considered as particularly relevant if the objective is to ensure the mental well-being of dependent elderly. While it seems difficult to change family behaviors, there are significant levers for increasing the financial accessibility for formal care services. For example, the French National Assembly has increased the Personal Autonomy Allowance in September 2014.

Despite these interesting results, our study has some limitations that must be kept in mind. We use declarative data and subjective measures of mental health, which may result in response biases (recall bias, social desirability bias). More objective measures such as the medical consumption of antidepressants may be interesting, but are not available in the survey. In addition, longitudinal data would allow us to control for unobserved individual heterogeneity, and would enable us to observe the effects of formal care and informal care for the same individual throughout the whole process of dependence.

Future research could investigate whether formal and informal care have heterogeneous effects on the health of the care recipient. For instance, the effectiveness of care may depend on the level of dependence, the gender of the dependent elderly or the relationship between the elderly and informal caregivers. Byrne *et al.* (*op. cit.*) stress that informal care provided to women is significantly less effective than informal care to men and that daughters provide higher quality care than do sons. On the other hand, Van Houtven and Norton (2008) find no gender difference in effectiveness of informal care provided by adult children. It would also be interesting to study the effect of formal and informal care for subgroups of particular interest, such as single elderly women who are at higher risk of nursing home entry.

Appendix A. Overidentified instrumental variables models.

Dependent variable	Depression	MHI-5
	Overidentified IV	Overidentified IV
Informal care	-0.339** (0.145)	20.530 (15.826)
Formal care hours	-0.006 (0.007)	1.787** (0.761)
Equation for informal care		
At least one child who has no partner	0.051*** (0.014)	0.076*** (0.020)
Proportion of daughters	0.057*** (0.021)	0.052* (0.029)
Proportion of PAA recipients	0.0002* (0.0001)	0.0001 (0.0001)
Equation for formal care hours		
At least one child who has no partner	0.072 (0.423)	-0.473 (0.517)
Proportion of daughters	-1.096* (0.606)	-1.158 (0.730)
Proportion of PAA recipients	0.009*** (0.003)	0.010*** (0.003)
AP *F*-test of instruments for IC	12.31***	8.53***
AP *F*-test of instruments for FCH	6.65***	5.75***
Exogeneity test, *p-value*	0.022	0.003
Anderson-Rubin overidentification test, *p-value*	0.583	0.924
Number of observations	4,037	2,117

Source: French Disability and Health Survey, 2008. Field: Dependent individuals, aged 65 and over.
Note: In these overidentified models, we use limited information maximum likelihood rather than two-stage least squares because it is more robust to weak instruments. Regressions include all the control variables listed in table 1. Standard errors are reported in parentheses.
*: significant at the 10% level, **: 5% level, ***: 1%.

Appendix B. Instrumental variables for the risk of depression.

	Depression	First-stage for informal care	First-stage for formal care hours
Intercept	0.547*** (0.168)	0.554*** (0.086)	-13.307** (2.532)
Care variables			
Informal care	-0.416* (0.215)	-	-
Formal care hours	-0.005 (0.007)	-	-
Health controls			
Number of moderate ADL restrictions	0.014 (0.009)	0.019*** (0.007)	0.898*** (0.198)
Number of moderate IADL restrictions	0.023** (0.009)	0.035*** (0.005)	0.432*** (0.147)
Number of severe ADL restrictions	-0.004 (0.017)	-0.020*** (0.006)	2.250*** (0.184)
Number of severe IADL restrictions	0.023** (0.010)	0.039*** (0.003)	0.625***-0.099)
Motor limitation	0.052** (0.026)	0.087*** (0.024)	0.227 (0.701)
Sensory limitation	0.019 (0.012)	0.020 (0.014)	-0.416 (0.424)
Cognitive limitation	0.037** (0.015)	-0.026 (0.016)	0.780 (0.476)
Demographic and socioeconomic controls			
Age	-0.005*** (0.002)	-0.003*** (0.001)	0.165*** (0.029)
Female	0.037* (0.019)	-0.045*** (0.016)	1.550*** (0.462)
Education level			
- Low	-	-	-
- Medium	0.004 (0.015)	-0.026* (0.016)	0.877* (0.465)
- High	-0.030 (0.031)	-0.109*** (0.019)	1.773*** (0.555)
Monthly income			
- Less than 1000 EUR	-	-	-
- 1000/1500 EUR	0.016 (0.015)	0.017 (0.020)	0.177 (0.574)
- 1500/2000 EUR	0.012 (0.020)	0.054** (0.023)	0.745 (0.663)
- More than 2000 EUR	0.021 (0.023)	0.078*** (0.021)	-0.027 (0.629)
Rural area	-0.010 (0.014)	-0.024 (0.016)	0.725 (0.464)
Family controls			
Living with a partner	0.048 (0.035)	0.143*** (0.016)	-1.406*** (0.466)
Widowhood < 2 years	-0.011 (0.041)	-0.050 (0.034)	4.246*** (0.984)
At least one child	0.011 (0.022)	0.020 (0.023)	-1.029 (0.675)
Seeing the family less than once a month	-0.017 (0.031)	-0.122*** (0.020)	-0.073 (0.584)
Proxy respondent	0.065** (0.030)	0.125*** (0.018)	-0.190 (0.526)
Instruments			
Proportion of daughters	-	0.059*** (0.021)	-1.093* (0.606)
Proportion of PAA recipients	-	0.0002** (0.0001)	0.009*** (0.003)
Number of observations	4,037	4,037	4,037

Source: French Disability and Health Survey, 2008. Field: Dependent individuals, aged 65 and over.
Note: Standard errors are reported in parentheses. *: significant at the 10% level, **: 5% level, ***: 1% level.

Appendix C. Instrumental variables for the MHI-5.

	MHI-5	First-stage for informal care	First-stage for formal care hours
Intercept	40.366** (17.139)	0.703*** (0.124)	-13.664*** (3.131)
Care variables			
Informal care	19.950 (17.062)	-	-
Formal care hours	1.819** (0.835)	-	-
Health controls			
Number of moderate ADL restrictions	-3.043*** (0.868)	0.016 (0.010)	0.604** (0.252)
Number of moderate IADL restrictions	-0.968 (0.867)	0.040*** (0.007)	0.151 (0.183)
Number of severe ADL restrictions	-4.916** (2.046)	-0.013 (0.010)	2.280*** (0.255)
Number of severe IADL restrictions	-2.635*** (0.964)	0.042*** (0.005)	0.566*** (0.127)
Motor limitation	-9.174*** (2.784)	0.105*** (0.031)	0.348 (0.786)
Sensory limitation	-1.971 (1.470)	0.027 (0.021)	0.107 (0.532)
Cognitive limitation	-7.224*** (1.766)	-0.019 (0.024)	0.950 (0.596)
Demographic and socioeconomic controls			
Age	0.198 (0.172)	-0.005*** (0.001)	0.151*** (0.036)
Female	-3.776 (2.399)	-0.063** (0.023)	2.090*** (0.571)
Education level			
- Low	-	-	-
- Medium	0.130 (1.555)	-0.021 (0.023)	0.574 (0.571)
- High	0.928 (2.718)	-0.102*** (0.027)	1.649** (0.673)
Monthly income			
- Less than 1000 EUR	-	-	-
- 1000/1500 EUR	0.567 (1.894)	0.012 (0.028)	-0.492 (0.702)
- 1500/2000 EUR	2.126 (2.286)	0.049 (0.032)	-0.202 (0.811)
- More than 2000 EUR	1.572 (2.630)	0.096*** (0.031)	0.051 (0.783)
Rural area	1.584 (1.498)	-0.010 (0.022)	-0.022 (0.566)
Family controls			
Living with a partner	-4.033 (3.168)	0.165*** (0.022)	-1.177** (0.569)
Widowhood < 2 years	-8.159** (3.724)	-0.048 (0.045)	2.558** (1.144)
At least one child	-1.829 (1.933)	-0.016 (0.030)	0.081 (0.772)
Seeing the family less than once a month	-1.388 (2.888)	-0.124*** (0.029)	0.565 (0.732)
Proxy respondent	0.804 (2.478)	0.104*** (0.026)	0.073 (0.658)
Instruments			
At least one child who has no partner	-	0.077*** (0.020)	-0.487 (0.517)
Proportion of PAA recipients	-	0.0001 (0.0001)	0.010*** (0.003)
Number of observations	2,117	2,117	2,117

Source: French Disability and Health Survey, 2008. Field: Dependent individuals, aged 65 and over.
Note: Standard errors are reported in parentheses. *: significant at the 10% level, **: 5% level, ***: 1% level.

Acknowledgements

Sandrine Juin is a PhD student at the iPOPs laboratory of excellence, supported by heSam University, under the reference ANR-10-LABX-0089.

We would like to thank two anonymous reviewers for their constructive comments. We are grateful to Carole Bonnet, Marion Leturcq, Benoît Rapoport, Laurent Gobillon, Emmanuelle Cambois and Chantal Cases from the French Institute for Demographic Studies for their advice. We also thank participants at the LABEX OSE Rencontres d'Aussois – notably Agnès Gramain (University Paris 1 Panthéon-Sorbonne) –, the Health Economists' Study Group (Sheffield), the Disability and Health monthly seminar (Paris), and the monthly seminar on health economics of the University Paris-Est Créteil – notably Yann Videau (University Paris-Est Créteil). The paper has also benefitted from comments by participants at the 63rd annual meeting of the French Economic Association (Lyon), at the Journées Louis-André Gerard-Varet (Aix-en-Provence) – notably Pierre Pestieau (University of Liège) –, at the European Health Economics Association PhD conference – notably Hendrik Schmitz (University of Paderborn) – and at the annual seminar of PhD students of the University Paris-Est – notably Pierre Blanchard (University Paris-Est Créteil) and Thibault Brodaty (University Paris-Est Créteil).

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