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Elsa Perdrix, Quitterie Roquebert. Does an increase in formal care affect informal care? Evidence among the French elderly. 2020. halshs-02370689v2

HAL Id: halshs-02370689

<https://shs.hal.science/halshs-02370689v2>

Preprint submitted on 20 Jan 2020

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WORKING PAPER N° 2019 – 60

**Does an increase in formal care affect informal care?
Evidence among the French elderly**

**Elsa Perdrix
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JEL Codes: I10, J14, I18

Keywords: long term care, informal and formal care, instrumental variable



Does an increase in formal care affect informal care? Evidence among the French elderly*

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January 2020

Abstract

This paper investigates the causal impact of formal care use on informal care among formal care users. We propose an original instrument for formal care use, using local disparities in the price of formal care providers. Using the French survey *CARE*, we implement a two-part model to show the effect of formal care on the extensive and on the intensive margin of informal care. An exogenous increase in formal care is found to slightly decrease the probability to use informal care. Heterogeneity tests show this negative effect is mainly driven by caregiving for daily life activities, provided by women and secondary caregivers. At the intensive margin, however, informal care is not significantly affected by a formal care increase. Reforms extending the generosity of public policies for formal care use can thus be expected to have a limited effect on informal care use, concentrated on specific caregivers.

JEL CODES: I10, J14, I18

KEYWORDS: *long term care, informal and formal care, instrumental variable*

*This work has benefited from valuable feedbacks from the participants of the ILPN (2018), 41e JESF (2019) and from the seminar of the LEDa-LEGOS (Université Paris Dauphine), the group “A ta santé” and the CARE group at DREES. We particularly thank Thomas Renaud for his discussion.

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1 Introduction

As many European countries, France is experiencing the aging of its population and public policies have to cope with an increasing demand for long term care. Long term care, referring to services for individuals suffering from functional limitations, can be provided by professionals (formal care) and non-professional relatives (informal care). Informal care plays a major role in the provision of domestic help and personal care (Colombo et al., 2011), while it has been shown to have detrimental effects on caregivers's health, labor supply and social life (Bauer and Sousa-Poza, 2015). In France, public policies tend both to encourage the use of professional care services and to support informal caregivers. The main program targeted to the disabled elderly, the APA program (*Allocation personnalisée d'autonomie*), partially finances the use of formal care and at the same time implements measures to alleviate the burden of informal care for relatives. Evaluating such a policy requires to have an insight of the interactions existing between formal care and informal care.

This paper documents the effect of an increase in formal care use on informal care provided by relatives. An increase of formal care may lead to a decrease of informal care if both services are substitutes: the care provided by formal caregivers does not need to be provided by relatives. Conversely, both services could be complement: an increase in formal care would increase informal care through behavioral responses, if formal care intensity signals the importance of the disability for relatives for instance. Additional support from informal carers could also be needed with increasing formal care use, for instance to cope with administrative costs.

There is a prolific literature on the effect of informal care provision on formal care use and it typically shows that informal care and formal care are substitutes (see Bonsang (2009) for a review). The literature studying the impact of formal care use on informal care is more limited. Several studies have questioned the impact of public subsidies on both formal and informal care consumption (Christianson, 1988; Ettner, 1994; Pezzin et al., 1996; Stabile et al., 2006; Rapp et al., 2011; Fontaine, 2012; Arnault, 2015). They aimed

at forecasting the effect of public policies financing formal care on care arrangements. The causal impact of formal care on informal care has been little studied, mainly because of the difficulty to find an instrument for formal care. Carrino et al. (2018) use variations in individuals' eligibility status in Austria, Belgium, Germany and France to instrument formal care consumption (at the extensive and intensive margin) and analyze its effects on informal care.

Our paper contributes to this literature by analyzing the effect of formal care intensity on informal care. To the best of our knowledge, it is the first paper to concentrate on the effect of formal care intensity on informal care *among formal care users*. Studying the intensive margin of formal care is of interest in a context where long-term care policies are gaining importance. In 2016, a reform of the French long-term care policy, the so-called ASV law,¹ increased the generosity of subsidies on formal care for individuals already benefiting from the APA program. Evaluating its effects on informal care requires to have an insight on how increasing formal care use affects informal care.

We use the national and cross-sectional French survey CARE (*Capacités, aide et ressources des seniors*), collected in 2015, which is representative of the elderly population at the national level. From this survey, we extract a sample of formal care users. To ensure exogeneity of formal care use, we implement an original instrumental variable strategy that makes use of local variations existing in the prices of the home care sector. We obtain this information from the departmental *SolvAPA* survey. We estimate a two-part model, which highlights the effect of formal care on the extensive and intensive margin of informal care.

Our results show that an exogenous increase of formal care affects the extensive margin of informal care, with a limited magnitude of one percentage point. According to heterogeneity tests, this negative effect is mainly concentrated on caregiving for daily life activities, provided by women, and secondary caregivers (not spouse and children). The intensive margin of informal care is unaffected. Thus, an increase in formal care use as

¹*Loi relative à l'adaptation de la société au vieillissement* – Law for the adaptation of society to ageing.

the one planned by the 2016 APA reform can be expected to have a limited effect on the involvement of relatives in the provision of care, and concentrated on specific caregivers.

2 Conceptual framework

To analyze this effect, we use a theoretical framework classically considered in the literature and comprehensively described in Pezzin and Schone (1999). We present here a simplified version of the model. It formalizes the utility of the parent (indexed by p) and the child² (indexed by c) denoted $U_i, i \in \{c, p\}$. The child provides a quantity of informal care IC while the parent can also consume hours of formal care FC . Both contributes to produce the well-being of the parent W , and their effect is conditional on the disability level of the parent D . We assume a Cournot-Nash equilibrium where the child chooses unilaterally the informal care quantity, assuming as given the formal care volume; and the parent chooses unilaterally the formal care quantity, assuming as given the informal care volume.

The child is assumed to be altruistic as he/she takes into account the well-being of the parent. His/her utility is formalized as follows:

$$\begin{cases} \text{Max}_{X^c, IC, L} U^c(X^c, W(IC, FC; D), L) \\ \text{s/c } V^c + \omega T = X^c + \omega(L + IC) \end{cases}$$

With V^c the nonlabor income of the child, ω is his/her labor wage, T is the total time endowment, X^c is the consumption of private good and L is leisure.

The parent chooses X^p and FC to maximize his/her utility:

$$\begin{cases} \text{Max}_{X^p, FC} U^p(X^p, W(IC, FC; D)) \\ \text{s/c } V^p = X^p + p_{FC}FC \end{cases}$$

²Since we are not interested in the long term care arrangement within the family, we only consider the total volume of informal care, whatever if this help comes from one or several helpers. Thus, we summarize the total number of care received in the model as those from one child, whatever the real number of caregivers.

Where V^p is the parent nonlabor income and p_{FC} is the price of formal care.

The amount of informal care is chosen by the child while the quantity of formal care depends on the parent's decision. It gives the following reaction functions:³

$$IC^c = f^{IC}(V^c, \omega, FC(p_{FC}); D) \quad (1)$$

$$FC^p = f^{FC}(V^p, p_{FC}, IC; D) \quad (2)$$

This theoretical framework gives interesting results for our empirical strategy. Indeed, according to this model, the price of formal care has an impact on informal care only through the formal care function. The price of formal care is thus a potential candidate for instrumenting formal care use.

3 An instrumental variable for formal care use

We face the classical endogeneity issues that arise when studying simultaneously formal care and informal care. The first endogeneity threat is reverse causality: we could capture the effect of informal care on formal care use. The second is the omitted variable bias: unobserved determinants affecting both formal and informal care use could yield biased estimators.

To deal with these endogeneity issues, we implement an instrumental variable strategy. Local variations in home care supply provide an exogenous source of variations in the volume consumed. In particular, we may expect the consumption to be higher when available prices are lower, since elder's demand for formal care is sensitive to the price (Roquebert and Tenand, 2017). According to Equation 1, the price of formal care should affect informal care only through the effect on the quantity of formal care consumed. We use information on prices at the local level rather than individuals prices to guarantee that variations in this price are exogenous.⁴ We thus consider the departmental level,

³This function came from the first order condition of the utility function. See Appendix A for details and Pezzin and Schone (1999) for further details on the resolution of this maximization program.

⁴It is due to the atomicity condition, i.e the fact that one individual's consumption cannot influence

where the home care sector is managed in France (Hege et al., 2014).

Alternative instruments have been investigated, regarding the characteristics of local policies financing the demand or individual characteristics, but none has been assessed as relevant. Appendix B.1 gives more details.

We use as an instrument the lowest regulated price available in the department. In France, both regulated and non-regulated providers⁵ operate on the home care sector.⁶ We focus on regulated prices, for which data are available. Regulated providers are allowed to enter the market by departmental councils, they have to meet quality requirements and their prices are fixed by the departmental council.⁷ The departmental council fixes a price for each structure, which depends on the provision costs of the provider: it is supposedly set at the average hourly provision cost. But it also depends on administrative and political considerations of the departmental council (Gramain and Xing, 2012). For instance, the departmental council can modulate the importance of qualified caregivers in the workforce through the pricing process. The heterogeneity in regulated prices thus reflects the variations in provision costs as well as departmental variations in pricing practices.

To be valid, our instrument should not affect informal care except through formal care (exclusion restriction). This is what is predicted in the conceptual framework (Equation 1). Arnault (2015) underlines this assumption does not hold if informal care is affected by parent's private goods consumption (X^p), which also depend on the price of formal care through the parent's budget constraint. Moreover, in case of financial transfers from parents to children, the price of formal care could affect the amount of the transfers which then modify the non-labor incomes of children (V^c), coming into play in the informal care

the price established at an aggregate level.

⁵In the home care sector, two regulatory status are existing in 2015: structures can be *authorized* (regulated) or not. In 2016, a reform has required all structures to get regulated; we exploit, however, a national survey collected in 2015, and a departmental survey from 2015, when the distinction was still existing.

⁶Roquebert et al. (2018) provide a detailed presentation of the different types of providers operating on the home care sector in France.

⁷Conversely, non-regulated providers are free to enter the market and only have a constraint on the increase rate of their price.

decision. Strategic behaviors could also come into play: with a high price, children could increase *ex ante* their informal care provision to limit the parent’s consumption of formal care and save money for inheritance. We argue such a biased behaviour should be limited since the money engaged for formal care remains relatively low (compared, for instance, to the price of nursing homes) and since such a mechanism should only concern relatively-high income individuals.

Arnault (2015) relaxes the hypothesis that informal care depends on the price of formal care only through formal care volume. Thus, he estimates a reduced-form model estimating the cross-price elasticities of formal care and informal care.⁸

4 Data and method

4.1 Data

This paper takes advantage of two datasets: a national survey on the elderly population in France and a survey on departmental practices regarding long-term care. This last survey is used to obtain our instrumental variable.

The French survey *CARE* We use the French survey *CARE* (*Capacités, aide et ressources des seniors*), which focuses on the elderly population living in the community in France. This cross-sectional survey, collected in 2015, surveyed close to 11,000 individuals, and is representative of the population aged 60 or more at the national level. It gives exhaustive information on the limitations encountered by individuals and on the formal and informal care they receive. In particular, when the individual has been able to declare them, we observe the number of hours provided by professional caregivers and relatives.

A departmental survey Our instrument comes from the *SolvAPA* survey (DREES, 2015a). As part of the *CARE* survey, this departmental survey was implemented by the Ministry of Health in 2015 to document the practices of departmental councils regarding

⁸Comparison of results are presented in Section 6.

long-term care policies.⁹ This survey offers the opportunity to have information on the way departmental councils implement the APA program and how they regulate the home care sector. Using this survey, however, implies to focus on individuals living in a department that did answer to the survey: 85 over 96 metropolitan departments responded to the survey.

Sample selection Our sample of interest is made of individuals living in the community that declare they consume formal care. We more specifically focus on those who consume unskilled formal care, provided by professional housekeepers or non-medical caregivers.¹⁰ Focusing of formal care users induces a selection: compared to the whole population of elderly, formal care users are more frequently women, living alone and with a low-income (see Section 6 and Appendix C.3). Finally, our sample is restricted to individuals whose department has responded to the *SolvAPA* survey¹¹ and we exclude outliers, defined as the 1% extreme values regarding formal and informal care volumes.¹²

Outcome and interest variables Our variable of interest is the number of formal care hours received by individuals. Our outcome variable is the volume of informal care they receive. This variable takes into account the hours of informal caregivers declared by the individual.¹³ Formal care and informal care volumes are directly declared by the elderly for each caregiver, either at the daily, weekly or monthly level. Since the most frequent unit is the week, we convert daily and monthly volume in weekly hours and

⁹The questionnaire can be found here (in French): <http://www.data.drees.sante.gouv.fr/TableViewer/document.aspx?ReportId=344>.

¹⁰In CARE Survey, these professionals are referred to as “aide à domicile”, “auxiliaire de vie”, “garde à domicile”, “femme de ménage”, and “aide-ménagère”.

¹¹76 departments over the 82 respondents are represented in our sample of elderly. The characteristics of formal care users whose department has not responded to the *SolvAPA* survey (420 observations) are not significantly different compared to formal care users in general.

¹²It corresponds to more than 167 informal hours per week or more than 70 formal hours per week. Appendix C.2 presents alternative estimations modifying the definition of outliers.

¹³It means that some caregivers are not taken into account if the individual has not been able to declare the volume they provided. If an individual has not been able to give the volume of care of any of his/her caregivers, he/she is not regarded as informal care recipient. Appendix E.4 provides more details. It reproduces our main results with an alternative definition of informal care reception. Results are robust to this change.

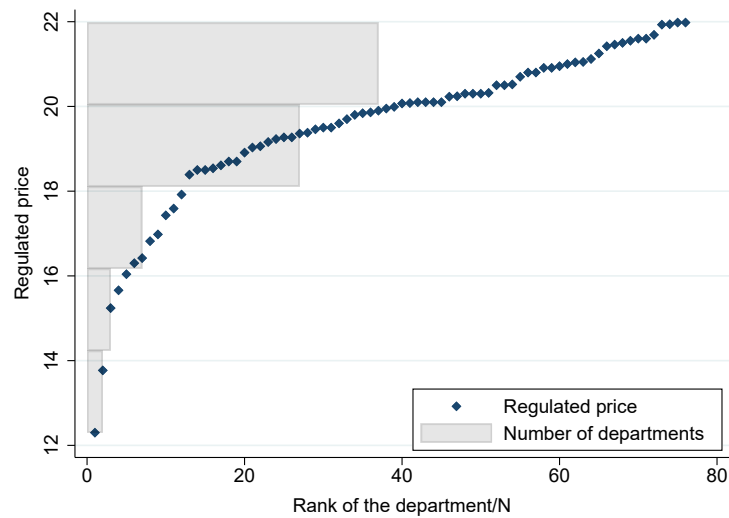
expressed, for each individual, the total number of informal or formal care received per week. Appendix C.1 presents the distribution of these variables. They are, in level, relatively skewed while the distributions of the log-variables are better shaped for the econometric model we use.

Descriptive statistics Table 1 presents summary statistics on the main variables used in the model for our estimation samples: formal care consumers (Column 1), and, among them, those who receive informal care (Column 2). The variables we use are the following: gender, age, living status (alone or not), number of children, education level (having the French *baccalauréat* or not), disability group, APA status, income level and tenant status (as a indicator of wealth). We additionally control for the fact that someone else has responded to the questions on the care received (proxy). The disability group corresponds to a synthetic indicator computed from activity limitations declared by individuals. It mimics the *AGGIR* scale, which is used in the APA program to assess the disability level of individuals. More details on the contents of each category are given in Appendix D. The typical individual of our baseline sample is a woman, living alone, having about two children and with a moderate disability level. Compared to this baseline sample, informal care users are older and have a higher number of children. They are more severely disabled, more frequently APA beneficiaries, and a proxy was more often in charge to answer the questionnaire. As a consequence, they consume significantly more formal care (in average, 6.48 hours by week in the baseline sample and 7.21 hours among the sub-sample of informal care consumers).

The instrument for formal care In the *SolvAPA* survey, departmental councils were asked to give information on prices fixed for regulated providers. We consider the lowest price available in the department, which shows the minimum price that has to be paid to get formal care from a regulated provider.¹⁴ In the 76 departments represented in our

¹⁴Individuals could potentially obtain lower prices if they are served by non-regulated providers - over-the-counter workers in particular. There is no data, however, on those prices. Moreover, for individuals benefiting from the APA program, departmental councils tend to favor regulated providers.

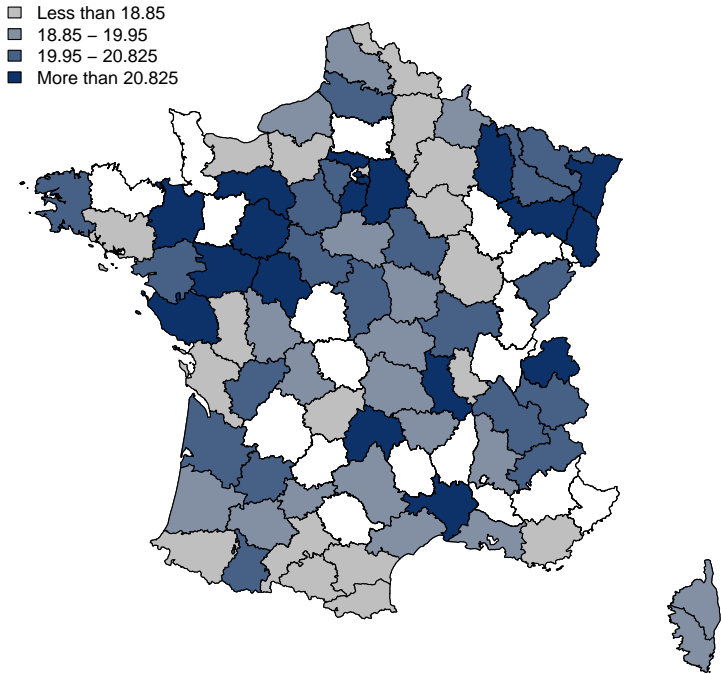
Figure 1: Distribution of the lowest regulated price of departments in our sample



Reading: Departments are ranked by importance of the regulated price. The department with the lowest price has a price close to 12 euros whereas the department with the highest price has a price close to 22 euros. 37 departments have a regulated price between 20 and 22 euros.
Source: SolvAPA survey, 2015.

sample, this price goes from €12.3 to €21.98, with an average share of €19.54 and a standard deviation of 1.88. Figure 1 illustrates the distribution of the lowest regulated price. Figure 2 maps the lowest regulated price in each department. To document the sources of variation of our instrument, we have tested if the level of this price is correlated with other departmental characteristics. We find that this price is not correlated with socio-economic characteristics of the population, nor with the characteristics of the elderly in the population or with the variables reflecting the orientation of departmental policies (Appendix B.2). We have conducted a test of spatial auto-correlation, to see whether the level of the lowest regulated price in one department is correlated to the level of this price in departments nearby (Appendix B.3). We find that there is no spatial auto-correlation between the value of the lowest regulated price and the value of this price in departments nearby. Overall, these tests support the exogenous dimension of our instrument.

Figure 2: Lowest regulated price in the French metropolitan departments



Notes: This map shows the regulated providers' price in each department. Departments in white are those which did not respond to the SolvAPA survey or have no regulated providers.
Source: SolvAPA survey, 2015.

Table 1: Descriptive statistics on the estimation sample

	Baseline sample	Informal care consumers	Difference between samples
Consumes informal care	56.57	100.00	-
Consumes formal care	100.00	100.00	-
Hours of formal care	6.48	7.21	***
Hours of informal care	13.35	23.60	***
Woman	77.68	78.30	n.s
Age	82.55	83.85	***
Living alone	71.03	70.69	n.s
Number of children	2.34	2.47	***
Education	13.37	10.75	***
APA beneficiary	44.26	48.53	***
Disability group:			***
1	2.45	3.60	
2	14.24	18.56	
3	13.71	17.36	
4	34.67	33.71	
5	14.46	12.48	
6	20.47	14.29	
Income:			***
< €10,000	25.38	24.97	
€10,000 - €15,000	27.87	30.91	
€15,000 - €20,000	22.05	21.70	
€20,000	24.70	22.43	
Tenant	28.81	28.57	n.s
Proxy	44.07	58.08	***
Observations	2,648	1,498	

Reading: In the baseline sample (consumers of formal care) 56.57% consume informal care. The average weekly hours of formal care consumed is 6.48 hours. In the sub-sample of informal care consumers, the average weekly hours of formal care consumed is 7.21 hours. The difference between the two samples is significant at the 1% level.

Notes: The test performed is a Student (resp. Pearson χ^2) test if the variable is binary or continuous (resp. categorical). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, n.s not significant.

Source: CARE survey (DREES, 2015b).

4.2 A two-part model for informal care use

Two-part model We aim at showing the causal impact of a variation of formal care intensity on informal care consumption - both at the intensive and extensive margin. Following [Bonsang \(2009\)](#) and [Carrino et al. \(2018\)](#), we use a two-part model (TPM) combined with an instrumental variable strategy ([Duan et al., 1983](#)).¹⁵

The first part of the model is a binary choice model (Probit model).¹⁶ With the instrumental variable (IV) strategy, this first part falls into two stages. The first stage corresponds to the variation of log-hour of formal care attributable to a variation in regulated price of the department (Equation 3) and the second stage of the first part of TPM is the variation in probability to report informal care attributable to the exogenous variation of log-hour of formal care (Equation 4).

$$\log(FC_i) = \pi_0 + T_{d(i)}\pi_1 + X_i\pi_2 + Y_{d(i)}\pi_3 + u_i \quad (3)$$

$$Pr(IC_i > 0 | X_i, Y_i, u_i) = \Phi(\widehat{\log(FC_i)}\alpha_1 + X_i\alpha_2 + Y_{d(i)}\alpha_3) \quad (4)$$

with $T_{d(i)}$, the lowest regulated price available in the department d of individual i ; X_i , controls for individuals characteristics; $Y_{d(i)}$, controls for departmental characteristics. Φ is the cumulative density function of the standard normal distribution.

The second part is a two-stage least square (2SLS) explaining the consumption level for consumers of informal care. Equation 5 (resp. 6) is the equivalent of Equation 3 (resp. 4) on the subsample of informal care consumers.

$$\log(FC_i) = \tau_0 + T_{d(i)}\tau_1 + X_i\tau_2 + Y_{d(i)}\tau_3 + v_i, \quad \forall i, IC_i > 0 \quad (5)$$

¹⁵See [Mihaylova et al. \(2011\)](#) for a recent review of econometric tools for healthcare resources and costs and long term care consumption studies; see [Leung and Yu \(1996\)](#) on the choice between sample selection model and two part model.

¹⁶We use the Stata command `ivprobit`.

$$\log(IC_i) = \beta_0 + \widehat{\log(FC_i)}\beta_1 + X_i\beta_2 + Y_{d(i)}\beta_3 + \epsilon_i, \quad \forall i, IC_i > 0 \quad (6)$$

Since our instrumental variable is varying at the departmental level, it is necessary to take into account potential correlations of disturbances among individuals living in the same department (Moulton, 1990). We thus estimate standard errors clustered at the departmental level.

Covariates Individual covariates include variables that are likely to correlate with informal care: gender, age, living status (alone or not), number of children, education level, disability group, APA status, proxy respondent, income level and tenant status. Regarding departmental variables, for the sake of precision, we only include relevant variables in departmental controls. We define relevant departmental variables as variables that influence our instrumental variable at the departmental level, or that contribute to explain formal or informal care consumption at the individual level. To select them, we first regress our instrument on a set of potentially relevant variables at the departmental level. These variables include demographic and socio-economic characteristics of the population at the departmental level. None of these variables are found to be correlated with our instrument (Appendix B.2). We then regress formal care volume and our outcome variables on the same set of departmental variables, while controlling for individual characteristics. We select those having a significant effect as departmental controls in our final regression. The final set of departmental controls included ($Y_{d(i)}$) are: the share of elderly population in the departmental population, the share of women among them, the poverty rate of the elderly population, the share of taxable household in the population and the political side of the departmental council.

5 Results

5.1 Main results

The results of our estimations are presented in Table 2. The two first Columns (“All”) correspond to the first part of our TPM, focusing on the decision to consume informal care: the first column is the first stage of our first part (Equation 3) while the second column corresponds to the second stage (Equation 4). Similarly, the two last Columns show the results of the second part of the model (first stage (Equation 5) and second stage (Equation 6)), centered on informal care consumers.

Instrumental validity To be used as an instrument, the regulated price has to be correlated with individual consumption (relevance condition). In our sample, a 1% increase of the regulated price leads to a significant average decrease by 0.579% of the formal care consumption, significant at the 1% level (Table 2, Column (1)). It is also the case when focusing on informal care consumers: a 1% increase of regulated price leads to an average decrease of formal care consumption by 0.604%, significant at the 1% level (Column (3)). In both cases, the F-test is low: our instrument should be regarded as relevant but weak.¹⁷ To cope with this issue, we have estimated in Appendix E.2 the confidence intervals using the conditional likelihood-ratio (CLR) statistic proposed by Moreira (2003). It is expected to be robust to the bias induced by weak instruments in small samples. Results show that the bias induced by our weak instrument is limited on the first part of our model, while it seems to be more important on the second part of our model. We thus need to be cautious when interpreting the results at the intensive margin of informal care.

¹⁷Note that the usual rule of thumb stating that there is a weak instrument issue when the F-test is lower than 10, coming from Staiger and Stock (1997), has been established for the case of IID errors and thus are not relevant in our estimation including clusters (Cameron and Miller, 2015). However, in the absence of alternative thresholds, we remain conservative and consider the weak instrument issue has to be dealt with.

Causal impact of formal care on informal care At the extensive margin, an exogenous increase of formal care consumption decreases the probability that individuals declare they consume informal care by 0.969 percentage point.¹⁸ (Table 2, Column (2)). This effect is significantly different from zero at the 1% level. At the intensive margin (Column (4)), an exogenous increase of formal care does not significantly affect the volume of informal care declared by individuals.

Size of the effect The effect found at the extensive margin is small: the increase by one of the log-hour is equivalent to the effect of multiplying formal care use by 2.718.¹⁹ For an average individual who consume 6.28 hours of formal care by week, it represents an increase by 10.79 hours of formal care.²⁰ This 10.79 hours increase leads to a decrease of the probability to consume informal care by 0.969 percentage point, i.e., a drop of the probability of having informal care from 56.5% to 55.6% for the average individual.

Underlying mechanisms The negative impact we find at the extensive margin could illustrate the eviction of informal care by formal care: when formal carers provide a high volume of care, relatives withdraw from the care provision. Since information on care is from a declarative survey, it could also be due to a declarative bias (“self-assessed” mechanism): the increase in formal care could decrease the propensity of our sample members to recognize informal care as such. Receiving visits from relatives would not be directly associated to the care provision since it is already provided by paid formal caregivers.

5.2 Extensions: alternative outcomes

The data we used contain rich information on caregivers and the type of care they provide: it makes it possible to explore the heterogeneous impact of formal care intensity

¹⁸By comparison, a naive analysis including directly formal care and informal care would predict a zero effect on the probability to consume informal care (see Appendix E.1). It means that the negative causal effect we observe with the IV strategy is cancelled out by a reverse causality or an omitted variable bias.

¹⁹ $\ln x_2 = \ln x_1 + 1 \Leftrightarrow \ln \frac{x_2}{x_1} = 1 \Leftrightarrow \frac{x_2}{x_1} = e^1 = 2.718 \Leftrightarrow x_2 = 2.718 \times x_1$

²⁰ $(2.718 \times 6.28) - 6.28$

Table 2: Main results: effect of an increase of formal care on informal care

	First part (All)		Second part (Informal care consumers)	
	(1) Regression $\ln(FC)$	(2) IV-Probit $Pr(IC > 0)$	(3) Regression $\ln(FC IC > 0)$	(4) IV-regression $\ln(IC IC > 0)$
Regulated price (log)	-0.579*** (0.209)		-0.604** (0.241)	
Formal care hours (log)		-0.969*** (0.304)		1.406 (1.028)
F-test	7.70	-	6.27	-
R ²	0.26	-	0.28	-
Individual controls	Yes		Yes	
Departmental controls	Yes		Yes	
Clusters	76		74	
N	2,648		1,498	

Reading: In the first stage of the first part (resp. second part), a 1% increase of the regulated price in the department leads to an average decrease of 0.579% (resp. 0.604%) of formal care hours weekly consumed. An exogenous increase of one log-hour of formal care decreases the probability to receive informal care by 0.969 percentage point. Among consumers of informal care, an increase of one log-hour of formal care non significantly decreases the volume of informal care (by 1.406 log-hours).

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses, clustered at the departmental level. Individuals and departmental characteristics are controlled for. The regulated price is the lowest regulated price available in the department. Models of Equations 3, 4, 5, 6.

Source: CARE survey (DREES, 2015b).

on informal care. We consider here the heterogeneity according to the characteristics of the care provided (care for daily life activities, moral support, material help) and the characteristics of the caregiver (relationship with the individual, gender). For these heterogeneity tests, we focus on the first part of the model. Intensive margin can not be studied for some variables (hours are not declared according each type of care) and for others, restrictions to consumers on the second part often threaten the validity of our first stage. We additionally explore, among the elderly that report receiving informal care, an alternative measure for informal care intensity by considering the number of caregivers reported by consumers.

Type of care There is evidence in the literature that the substitution between formal and informal care varies across the type of formal and informal care (Bonsang, 2009). When individuals declare caregivers in the CARE survey, they are invited to specify

for which type of care the caregiver operates: in our sample, among the elderly that report receiving informal care, 99.73% report receiving care for daily life activities, 54.81% for moral support and 8.80% for material support. Table 3 shows the impact of an exogenous increase in formal care on the probability to receive these three types of care. An exogenous increase in formal care significantly decreases the probability to receive informal care for daily life activities. It echoes our main result since mostly all informal care declared is associated with daily life activities. But this increase in formal care intensity leaves unaffected the probability to receive moral support or material help. Thus, the substitution of formal care for informal care is concentrated on the activities of daily living, which can be performed by both types of care providers, but not on the type of care which are specific to informal caregivers.

Relationship with the elderly The effect of a change in formal care intensity is potentially heterogeneous according to caregivers' characteristics, especially given their relationship with the elderly. In our sample, among those who report receiving informal care, 84.65% of elderly report receiving care from their partner or from a child (what we call primary caregivers)²¹ and 25.10% from neighbors, friends or broader-family members (secondary caregivers). Table 3 shows that an exogenous increase in formal care does not affect the probability to report receiving help from primary caregivers but it decreases the probability to report care from a secondary caregivers. It echoes previous findings that have shown that informal caregivers who withdraw in the presence of formal care are mainly friends or neighbors (Christianson, 1988).

Caregivers' gender We are also interested in the heterogeneity of formal care intensity according to the gender of caregivers. In our sample, 66.56% of elderly report receiving care from at least one women and 53.47% from at least one men. Table 3 shows that there is a significant decrease of the probability to report receiving care from women, but not from men. This result echoes the differentiation of tasks performed by men and women

²¹22.90% from spouse, 66.36% from children

(Billaud and Gramain, 2014), with women performing basic activities for domestic help and personal care and men being specialised in administrative or material help. Thus, the tasks performed by women would be substitutes to formal care activities more than those performed by men.²²

Table 3: Extensions: characteristics of care and caregivers

	Probability to receive informal care								
	Daily life activities	Moral support	Material help	Primary caregivers	Secondary caregivers	Partner	Children	Women	Men
Formal care hours (log)	-0.982*** (0.251)	-0.487 (0.601)	-0.117 (0.463)	-0.675 (0.567)	-0.832*** (0.290)	-0.997** (0.472)	-0.441 (0.597)	-0.818** (0.333)	-0.239 (0.670)
Observations	2,648	2,648	2,648	2,648	2,648	2,648	2,648	2,648	2,648

Reading: An increase of one log-hour of formal care decreases the probability to receive informal care for the daily life activities by 0.982 percentage point.

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses, clustered at the departmental level. Individuals and departmental characteristics are controlled for. Formal care hours are instrumented by the lowest regulated price available in the department. Estimation of IV-Probit models.

Source: survey *Capacités, aides et ressources des seniors* (DREES, 2015b).

Number of caregivers Our main results show an impact at the extensive margin of informal care but not at the intensive margin. We propose an alternative measure of informal care at the intensive margin by studying the number of caregivers (rather than the total hours of caregiving). In our sample, among those receiving informal care, the average number of caregivers is 1.77. 57% report only one caregiver, 24.37% report two caregivers; 17.75% three caregivers or more. Considering this outcome does not affect our conclusion at the intensive margin of informal care: an exogenous increase in formal care volume does not affect significantly the number of caregivers reported by elderly receiving informal care.²³

²²Given the frequency of care provided by men and women, the heterogeneous effect we observed cannot be attributed to a lower precision on care provided by men.

²³The coefficient estimated by our regression is 0.327 with a standard error of 0.720. More details results available upon request.

5.3 Extensions: results on subsamples

Heterogeneity by APA status Informal care reaction to formal care might depend on the disability level on the individual: we test here this hypothesis by estimating our model on the subsample of individuals who benefit from the APA program (Table 4).²⁴ The effect is similar to our baseline results: an exogenous increase of formal care decreases the probability to declare receiving care, while it does not affect informal care at the intensive margin.

Table 4: Effect of formal care volume on informal care use for APA beneficiaries

	First part (All)		Second part (Informal care consumers)	
	(1) Regression $\ln(FC)$	(2) IV-Probit $Pr(IC > 0)$	(3) Regression $\ln(FC IC > 0)$	(4) IV-regression $\ln(IC IC > 0)$
Regulated price (log)	-0.663*** (0.213)		-0.993*** (0.291)	
Formal care hours (log)		-1.064*** (0.228)		0.882 (0.642)
F-test	9.72		11.63	
R^2	0.135		0.171	
Clusters		75		72
N		1,172		727
Individual controls			Yes	
Departmental controls			Yes	

Reading: In the first stage of the first part (resp. second part), a 1% increase of the regulated price in the department leads to an average decrease of 0.663% (resp. 0.993%) of formal care hours weekly consumed. An exogenous increase of one log-hour of formal care consumed decreases the probability to receive informal care by 1.064 percentage point. Among consumers, an increase of one log-hour of formal care non significantly increases the volume of informal care (by 0.882 log-hours).

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses, clustered at the departmental level. Individuals and departmental characteristics are controlled for. The regulated price is the lowest regulated price available in the department. Models of Equations 3, 4, 5, 6.

Source: CARE survey (DREES, 2015b).

Table 5 shows the results on the subsample of elderly living alone. The first part shows that a 1-log-hour increase in formal care decreases the probability to consume informal care by 0.926 percentage points. It is similar to our baseline results, showing that the effect observed in the main results is not driven by those living alone. The second part

²⁴We also also focus on the subsample of individuals with a disability level between GIR 1 and 4. Since this sample is very close to the sample of APA beneficiaries, the results are similar.

cannot be interpreted since the first stage is not significant anymore. This change in the first stage could be explained by a lower price sensitivity on this subsample of elderly living alone and having informal care, potentially because of a higher disability level.

Table 5: Effect of formal care volume on informal care use for individuals living alone

	First part (All)		Second part (Informal care consumers)	
	(1) Regression $\ln(FC)$	(2) IV-Probit $Pr(IC > 0)$	(3) Regression $\ln(FC IC > 0)$	(4) IV-regression $\ln(IC IC > 0)$
Regulated price (log)	-0.558*** (0.206)		-0.321 (0.222)	
Formal care hours (log)		-0.926*** (0.312)		2.485 (2.813)
F-test	7.36	-	2.10	-
R^2	0.300	-	0.313	-
Individual controls		Yes		Yes
Departmental controls		Yes		Yes
Clusters		76		74
N		1,881		1,059

Reading: In the first stage of the first part (resp. second part), a 1% increase of the regulated price in the department leads to an average decrease of 0.558% (resp. 0.321%) of formal care hours weekly consumed among the elderly living alone. An increase of one log-hour of formal care consumed decreases the probability to receive informal care by 0.926 percentage point. Among informal care consumers, an exogenous increase of one log-hour of formal care non significantly decreases the volume of informal care consumed (by 2.485 log-hours).

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses, clustered at the departmental level. Individuals and departmental characteristics are controlled for. The regulated price is the lowest regulated price available in the department. Models of Equations 3, 4, 5, 6.

Source: survey *Capacités, aides et ressources des seniors* (DREES, 2015b).

6 Discussion

Selection of formal care users Our work is centered on formal care users only. This population, however, is selected compared to the whole population of elderly. In Appendix C.3, we estimate the individual and departmental determinants of consuming formal care. Results show, consistently with the literature, that the probability to consume formal care is higher for women, living-alone individuals, APA beneficiaries and low-income individuals. It is also increasing with age and the disability level, and is decreasing with the number of children. Our results are thus relevant for this sub-population

of elderly specifically. Further developments could address this selection issue.

Co-residence choice Increasing formal care use could have an impact on cohabitation probability. In our sample, the correlation between the lowest regulated price and the co-residence with children is close to zero (0.008). It shows that our instrument is little related to the probability to live with a child. We have tested if an increasing formal care use, instrumented by the lowest regulated price, affects the probability to live with a child. It shows no effect of formal care use on co-residence with children.²⁵

Relevance of the departmental level The relevance of our instrument relies on the hypothesis that the price set at departmental level has an impact on the use of formal care. As a placebo test, we have studied if the lowest price established at the regional level is correlated with formal care use (Appendix E.3). It shows that the lowest price in the region is not significantly associated with the volume of formal care consumed.

Quantified informal care The outcome variables we consider are the probability to declare receiving informal care and the volume of care received. In order to make the first and the second part of our model consistent, individuals who receives informal care are those who have been able to quantify the number of hours they receive. However, in our sample, 17% of individuals declare they receive informal care but have not been able to give the number of hours they receive. We have estimated the first part of our model, using as an outcome variable a dummy indicating if the individual receives some informal care, even if he/she has not been able to quantify it (Appendix E.4). It shows that our results are robust to this change of definition.

Comparison with previous results Our work follows [Christianson \(1988\)](#); [Ettner \(1994\)](#); [Pezzin et al. \(1996\)](#); [Rapp et al. \(2011\)](#); [Fontaine \(2012\)](#), which aimed at forecasting the effect of implementing public policies financing formal care on care arrangements.

²⁵Results are available upon request. The coefficient of the instrumented volume of formal care is 0.75, with a robust standard error of 0.48.

To do so, they have analyzed the effect of receiving or not public subsidies on formal care (binary treatment), on both the extensive and the intensive margin of informal care. They find a negative effect of receiving a public subsidy on informal care. We are going one step further by analyzing the effect of a change in the intensity of formal care on informal caregiving. Our work is thus closer to the studies of Carrino et al. (2018), Arnault and Goltz (2014) and Arnault (2015).²⁶ Using the SHARE data, Carrino et al. (2018) estimate the causal impact of formal care consumption on informal care. They find a positive effect of formal care volume on both the intensive and extensive margin of informal care. There are several important points that could explain these differences with our results. First, Carrino et al. (2018) are considering both consumers and non-consumers of formal care. Thus, they capture the effect of a change in the extensive and in the intensive margin of formal care. Moreover, they focus on a population with several European countries (while we are centered on France), in a earlier time period: our data are from 2015 while they use the SHARE waves from 2004 and 2006, which corresponds in France to the very beginning of the APA policy. Using the French survey *Handicap-Santé Ménages* (2008), Arnault and Goltz (2014) use out-of-pocket expenses for the formal care as an instrumental variable in a bivariate Tobit model. They show that an exogenous increase of formal care is associated with a decrease in informal care use. Though they are focused on a different population,²⁷ our results are consistent with this findings and show that such a decrease is concentrated at the extensive margin of informal care. Using the same data, Arnault (2015) relaxes the IV hypothesis and estimates a reduced-form model identifying the cross-price elasticity of formal care and informal care volumes. He finds that a higher price of formal care in the department²⁸ decreases the volume of formal care consumed but leaves the informal care volume unaffected. The differences of results focusing on different populations, with alternative measures of formal and informal care, shows the complexity of the relationship between both types of care. It calls for further

²⁶Chapter 4 of the thesis.

²⁷Arnault and Goltz (2014) focus on the elderly living alone with ADL and IADL limitations.

²⁸This variable corresponds to the price of the biggest provider in the department.

investigation of the existing heterogeneity among the elderly consuming long-term care.

7 Conclusion

This paper documents the causal impact of an exogenous variation in formal care on informal care use, both at the intensive and the extensive margin. This effect is estimated on formal care users only. To tackle endogeneity issues, we propose an original instrumental variable strategy taking advantage of local disparities in the price of regulated providers. Using a two part model, we show that increasing formal care leads to a significant but limited decrease of the probability to use informal care. Heterogeneity tests show that this negative effect is mainly concentrated on caregiving for daily life activities, provided by women, and secondary caregivers (not spouse and children). At the intensive margin of informal care, however, no significant effect is observed. Overall, an increase in formal care use as the one planned by the 2016 APA reform can be expected to have a limited effect on the involvement of relatives in the provision of care, concentrated on secondary caregivers and women.

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Online Appendix

A Details on the theoretical framework

The child is assumed to be altruistic as he/she takes into account the well-being of the parent. His/her utility is formalized as follows:

$$\begin{cases} \text{Max}_{X^c, IC, L} U^c \left(X^c, W(IC, FC; D), L \right) \\ \text{s/c } V^c + \omega T = X^c + \omega(L + IC) \end{cases} \quad (7)$$

With V^c the non-labor income of the child, ω is her labor wage, T is the total time endowment, X^c is the consumption of private good and L is leisure.

$$\text{Equation 7} \Rightarrow \text{Max}_{X^c, IC} U^c \left(X^c, W(IC, FC; D), L(IC, X^c, V^c) \right) \quad (8)$$

Considering a Cournot-Nash equilibrium, the child chooses the optimal level of informal care, taking as given the formal care level. Thus,

$$\text{Equation 8} \Rightarrow \text{Max}_{X^c, IC} U^c \left(X^c, W(IC, \bar{FC}; D), L(IC, X^c, V^c) \right) \quad (9)$$

The first order condition is:

$$\begin{cases} \frac{\partial U^c \left(X^c, W(IC, FC; D), L \right)}{\partial X^c} = 0 \\ \frac{\partial U^c \left(X^c, W(IC, FC; D), L \right)}{\partial IC} = 0 \end{cases} \quad (10)$$

The parent chooses X^p and FC to maximize his/her utility:

$$\begin{cases} \text{Max}_{X^p, FC} U^p \left(X^p, W(IC, FC; D) \right) \\ \text{s/c } V^p = X^p + p_{FC} FC \end{cases} \quad (11)$$

Where V^p is the parent nonlabor income and p_{FC} is the price of formal care.

$$\text{Equation 11} \Rightarrow \text{Max}_{X^p, FC} U^p \left(X^p(V^p, FC), W(IC, FC(V^p, X^p; D)) \right) \quad (12)$$

Considering a Cournot-Nash equilibrium, the parent choose the optimal level of formal

care, taking as given the informal care provision. Thus, the first order condition is:

$$\begin{cases} \frac{\partial U^p \left(X^p(V^p, FC), W(IC, FC(V^p, X^p; D)) \right)}{\partial X^p} = 0 \\ \frac{\partial U^p \left(X^p(V^p, FC), W(IC, FC(V^p, X^p; D)) \right)}{\partial FC} = 0 \end{cases} \quad (13)$$

First order conditions of child and parent maximisation program gives the following reaction functions:

$$IC^c = f^{IC}(V^c, \omega, FC(p_{FC}); D) \quad (14)$$

$$FC^p = f^{FC}(V^p, p_{FC}, IC; D) \quad (15)$$

B Details on the instrument

B.1 Finding an instrumental variable for formal care studies

Instrument variables for formal care are relatively scarce in the literature. Using the SHARE data in Austria, Belgium, Germany and France, [Carrino et al. \(2018\)](#) exploit the inter-regional variations in the eligibility rules for formal care subsidies. Such an instrument requires specific hypotheses on the sources inter-regional variations and can hardly be used when working at the national level. Using French data, [Barnay and Juin \(2016\)](#) use local variations in the eligibility practices of the APA policy to instrument formal care use. This variable, however, cannot be used as an instrument when studying the impact of formal care on informal care: it has been shown that departments often take into account informal care provided by relatives to decide on one individual’s eligibility ([Billaud et al., 2012](#)).²⁹ More generally, any variable that rests on departmental practices regarding the APA policy is likely to be directly related to informal care, not only through the effect on formal care consumption.

To find an instrument for formal care, we have investigated potential individual determinants explaining differences in volume consumed. Socio-demographic variables and health characteristics are not good candidates since they are directly affecting informal care. Proximity to the head office of a professional caregiver could be an exogenous reason explaining variations in formal care consumption. The service we consider is, however, specific: the provider covers a given geographical area, but the head office location gives little information on this area. It explains why we observe that there is no empirical correlation between the intensity of use and the proximity to a professional head office location.

We have also consider, on the supply side, the potential effect of the capacity of formal care providers. Individual consumption could theoretically be influenced by the capacity of formal care providers in the department. The higher the capacity of formal care providers, the more individuals are likely to be able to consume with no restriction on the supply side. There is here a technical issue: data on the home care sector present the number of providers available at the departmental level. This number, however, gives little information on the importance of the supply: one provider can serve a low or a high number of beneficiaries. There is no available data on the capacity of providers.

²⁹The APA policy is supposedly “care-blind”:the APA benefits should be independent of informal care received by the individuals. Field studies, however, have shown that it actually depends on departmental practices.

B.2 Explaining the variation in our instrument

In this section, we estimate the correlation between the lowest regulated price in the department and other departmental characteristics. It makes it possible to document the sources of variation of our instrument and additionally gives an insight of the relevant departmental controls for our main estimations. We have selected departmental variables related to general socio-economic characteristics of the population (share of elderly, interdecile ratio, share of taxable households), variables illustrating the characteristics of the elderly population in the department (share of women, share of living alone, share living in nursing home, poverty rate, among the elderly) and variables reflecting the orientation of social and general departmental policies (equipment rate in institutions, share of APA beneficiaries, political side of the departmental council).

Table B1 presents the estimation results. It shows that the level of the lowest regulated price in the department is not correlated with the socio-economic characteristics of the departmental population, nor with the characteristics of the elderly population or the variables related to the orientation of policies in the department. Overall, the departmental variables we consider explain less than 10% of the variation of the lowest regulated price in the department. We have alternatively tested a stepwise procedure to see if excluding some variables without a significant effect could help gaining precision on others. Results are stable. Local characteristics, thus, do little in explaining the variations of our instrument.

B.3 Spatial autocorrelation

To further document the sources of variation in our instrument, we have investigated the spatial autocorrelation in this variable using Moran's index (Moran, 1948). Moran's index I makes it possible to evaluate if departments that are close tend to have a similar level of regulated price, compared to others. It is computed as follows:

$$I = \frac{N}{S_0} \frac{\sum_i \sum_j w_{i,j} (y_i - \bar{y})(y_j - \bar{y})}{\sum_i (y_i - \bar{y})^2}$$

with N the total number of departments, y_i the lowest regulated price in department i ; \bar{y} the average price computed over all departments available, $S_0 = \sum_i \sum_j w_{i,j}$, $w_{i,j}$ is the spatial weight between department i and j .

In this feature, we use as a spatial weight the distance between the center of the department i and the others. It makes it possible to weight the importance of other departments according to their proximity to the department j . It also takes into account the department size.³⁰

³⁰An alternative measure would have take into account only the neighbouring departments of depart-

Table B1: Instrument variations are not correlated to departmental characteristics

	Lowest regulated price in the department
Share of 75+ in the population (2015)	2.148 (17.39)
Interdecile ratio (2014)	0.720 (0.928)
Share of taxable households (2014)	0.0371 (0.0818)
Share of women among 75+ (2015)	1.571 (32.49)
Share of 75+ living alone (2014)	-0.0806 (0.189)
Share of 75+ living in nursing home (2014)	0.299 (0.384)
Poverty rate 75+ (2014)	-0.0628 (0.187)
Equipment rate in institutions - medical beds (2014)	-0.00958 (0.0376)
Share of APA beneficiaries in the 60+ population (2005)	0.0668 (0.226)
Left-wing departmental council (2015)	-0.270 (0.570)
Constant	15.28 (17.70)
R^2	0.087

Reading: An increase by one percentage point of the share of 75+ in the department is associated with a non significant increase of the lowest regulated price in the department (by 2 percentage points).

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Linear regression model among the 76 departments respondent to the SolvAPA survey and having regulated providers.

Source: survey *SolvAPA* (DREES, 2015a).

The Moran's Index with this spatial weight is a measure of the auto-correlation between the distance between departments and the lowest regulated price of the departments. The value of the index is $I = -0.00699$, with a p-value equal to 0.365: it shows that there is no spatial correlation between the lowest regulated price in the department and the localisation of one department compared to another.

B.4 Exclusion of some departments with a low regulated price

We test the robustness of our results to the exclusion of a few departments having a regulated price especially low (Table B2) and thus being slightly atypical when looking at the distribution of departments (see Figure 1). In the first stages, F-tests are lower

ment i but such a measure is limited. For instance, it does not account for the similarities between non-neighbouring departments of the same region.

when excluding the first or the two first departments with the lowest price. Results on the second stage of the first part are consistent with our baseline results. On the second stage of the second part, the positive coefficient gains statistical significant at the 10% level. Overall, our results on the intensive margin of informal care are sensitive to the exclusion of departments and should then be interpreted cautiously.

Table B2: Sensitivity to the exclusion of department with low regulated price

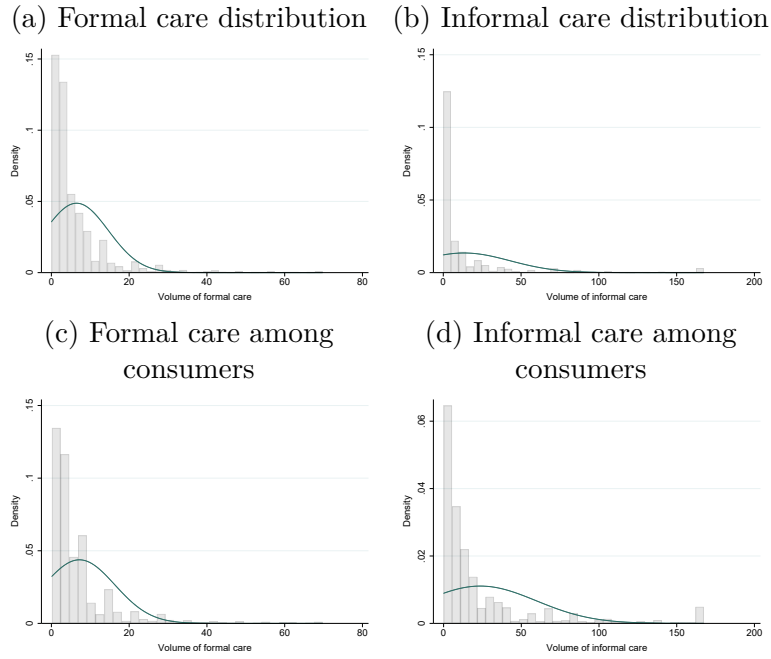
	First part (All)		Second part (Informal care consumers)	
	(1) Regression $\ln(FC)$	(2) IV-Probit $Pr(IC > 0)$	(3) Regression $\ln(FC IC > 0)$	(4) IV-regression $\ln(IC IC > 0)$
Exclusion of the department with the smallest price				
Regulated price (log)	-0.481** (0.211)		-0.481* (0.254)	
Log of total hours of formal care		-1.119*** (0.162)		2.493* (1.540)
F-test	5.19		3.59	
R^2	0.27		0.28	
Observations	2,636	2,636	1,489	1,489
Exclusion of the two departments with the smallest prices				
Regulated price (log)	-0.496** (0.240)		-0.542** (0.282)	
Log of total hours of formal care		-1.108*** (0.189)		2.832* (1.624)
F-test	4.28		3.69	
R^2	0.26		0.28	
Observations	2,619	2,619	1,481	1,481

Reading: A 1% increase of the regulated price in the department leads to an average decrease of 0.481% of formal care hours consumed (first stage). An exogenous increase of one log-hour of formal care consumed decreases the probability to receive informal care by 1.119 percentage point (second stage). Among informal care consumers, a 1% increase of the regulated price in the department leads to an average decrease of 0.481% of formal care hours consumed (first stage). Among consumers, an exogenous increase of one log-hour of formal care decreases the volume of informal care consumed to by 2.493 log-hours. The first part of the Table is with the exclusion of all individuals living in the department with the lowest regulated price, and the last part is excluding the two department with the lowest price.

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses, clustered at the departmental level. Individuals and departmental characteristics are controlled for. The regulated price is the lowest regulated price available in the department. Models of Equations 3, 4, 5, 6.

Source: survey *Capacités, aides et ressources des seniors* (DREES, 2015b).

Figure C1: Weekly volume of formal and informal care (in hours)



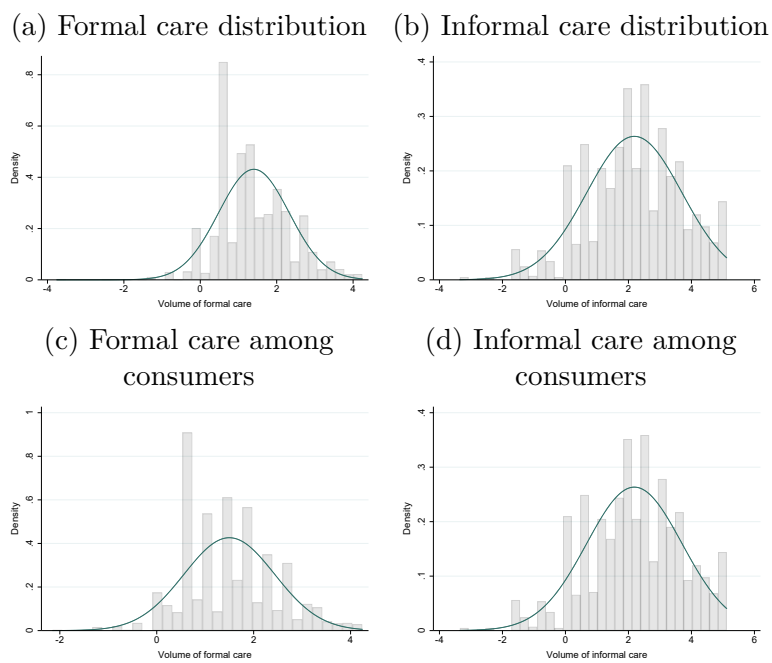
Notes: Distribution of the number of hour of care in our baseline sample and among the formal care consumers.
Source: survey *Capacités, aides et ressources des seniors* (DREES, 2015b).

C Details on the sample

C.1 Distribution of formal and informal care variables

Distributions of the number of hours of care in our main sample and in the sub-sample of informal care consumers (Figure C1) have a mass point in zero and a long right tail. Using a logarithm transformation (Figures C2) both for informal and formal care makes it possible to get closer to a normal distribution of our variables of interest.

Figure C2: Weekly volume of formal and informal care (in log- hours)



Notes: Distribution of the number of log-hour of care in our baseline sample and among the formal care consumers.

Source: survey *Capacités, aides et ressources des seniors* (DREES, 2015b).

C.2 Exclusion of extreme values in the sample

We have tested whether our results are sensitive to the exclusion of extreme values in the sample (Table C1). In our baseline results, the extreme values for formal care and informal care consumption (beyond the 99th percentile) are excluded from the sample.³¹ Without any exclusion, the coefficient of the second part of our model gains precision to reach the 10% significance level. If the exclusion of outliers is extended to the extreme 5% values of informal care or formal care,³² our baseline results are unchanged.

Table C1: Sensitivity tests on outliers exclusion

	First part (All)		Second part (Informal care consumers)	
	(1) Regression $\ln(FC)$	(2) IV-Probit $Pr(IC > 0)$	(3) Regression $\ln(FC IC > 0)$	(4) IV-regression $\ln(IC IC > 0)$
No exclusion				
Regulated price (log)	-0.585*** (0.213)		-0.638*** (0.229)	
Formal care hours (log)		-0.901*** (0.310)		1.637 (1.048)
F-test	7.52	-	7.77	-
R ²	0.26	-	0.27	-
N	2,689		1,529	
Exclusion of extreme 5% of formal consumers				
Regulated price (log)	-0.486*** (0.167)		-0.481*** (0.178)	
Formal care hours (log)		-1.133*** (0.290)		1.720 (1.244)
F-test	8.42	-	7.30	-
R ²	0.25	-	0.26	-
N	2,453		1,332	

Reading: Using our sample without exclusion of outliers on formal and informal care consumption, A 1% increase of the regulated price in the department leads to an average decrease of 0.585% of formal care hours weekly consumed (first stage). An exogenous increase of one log-hour of formal care consumed decreases the probability to receive informal care by 0.901 percentage point (second stage). Among informal care consumers, a 1% increase of the regulated price in the department leads to an average decrease of 0.638% of formal care hours weekly consumed (first stage). Among consumers, an exogenous increase of one log-hour of formal care decreases the volume of informal care consumed to by 1.637 log-hours but the effect is not significantly different from zero (second stage). The second part is with the exclusion of the 5% extreme distribution of formal and informal care.

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses, clustered at the departmental level. Individuals and departmental characteristics are controlled for. The regulated price is the lowest regulated price available in the department. Models of Equations 3, 4, 5, 6.

Source: survey *Capacités, aides et ressources des seniors* (DREES, 2015b).

³¹Corresponding to more than 167 informal hours per week or more than 70 formal hours per week.

³²Corresponding to more than 24 informal hours per week or more than 84 formal hours per week.

C.3 Determinants of formal care consumption

This work concentrate on elderly consuming formal care. Table C2 presents the determinants of formal care consumption, on all individuals surveyed in CARE (Column 1) and, among them, on individuals whose department has responded to the SolvAPA survey (Column 2). This last column makes it possible to include our instrument in the determinants. These estimations show that the probability to consume formal care is higher for women, living-alone individuals, APA beneficiaries and low-income individuals.³³ The probability to consume formal care is increasing with age and the disability level, and is decreasing with the number of children. Moreover, the lowest regulated price in the department is not correlated with formal care use at the extensive margin: there is no direct link between our instrument and the selection of formal care users.

³³This effect of income has already been observed on French data (Roquebert et al., 2018). It could reflect two mechanisms. First, richer individuals do not apply to the APA program financing home care since the expected value of the subsidy is lower for them (Arrighi et al., 2015). Second, even when controlling for the disability status, income could be associated to unobserved dimensions of health: then, low income would reflect higher needs for care.

Table C2: Explaining formal care use

	Consumes formal care	
	(1)	(2)
Woman	0.448*** (0.0410)	0.445*** (0.0446)
60 ≤ age < 75	-0.634*** (0.0404)	-0.626*** (0.0449)
<i>Ref: 75 ≤ age < 90</i>		
Age ≥ 90	0.159*** (0.0592)	0.144** (0.0632)
Lives alone	0.385*** (0.0398)	0.387*** (0.0432)
Disability group 1	-0.107 (0.176)	-0.135 (0.193)
Disability group 2	0.0217 (0.0850)	-0.0551 (0.0938)
<i>Ref: disability group 3</i>		
Disability group 4	-0.217*** (0.0801)	-0.265*** (0.0885)
Disability group 5	-0.521*** (0.0923)	-0.564*** (0.101)
Disability group 6	-1.188*** (0.0844)	-1.249*** (0.0925)
APA beneficiary	1.197*** (0.0793)	1.185*** (0.0855)
Has the <i>baccalauréat</i>	0.121*** (0.0417)	0.122*** (0.0447)
Number of children	-0.0241*** (0.00921)	-0.0229** (0.00995)
Income < €10,000	0.141*** (0.0511)	0.144*** (0.0538)
Income: €10,000 - €15,000	0.137*** (0.0480)	0.146*** (0.0524)
<i>Income: €15,000 - €20,000</i>		
Income > €20,000	0.0786 (0.0515)	0.0837 (0.0560)
Tenant	0.00649 (0.0343)	-0.0173 (0.0352)
Regulated price (log)		0.167 (0.287)
Observations	10,290	8,882

Reading: Ceteris paribus, a woman has a higher probability of receiving formal care; while being in low disability group decreases this probability.

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. Estimation of Probit models among (1) 10,920 individuals surveyed by the CARE survey ; (2) among them, 8,882 whose department has responded to the survey *SolvAPA*.

Source: survey *Capacités, aides et ressources des seniors* (DREES, 2015b).

D Details on the institutional context

Since 2002, disabled elderly have been entitled to benefit from a specific program: the personalized allowance for autonomy (*Allocation personnalisée d'autonomie*, APA). This program aims at financing formal care consumption for the disabled elderly. This is a central, national program, which is implemented at the local level by departmental councils.

To be eligible, an individual aged 60 or more has to apply to the program and to be assessed as disabled. She receives at home a visit from a medico-social team from the Departmental council in charge of establishing her disability level, using the French administrative scale AGGIR (*Grille autonomie, gérontologie, groupe iso ressource*). This scale aims at assigning individuals to one of the six disability levels of the scale, from GIR 1 (severely disabled) to GIR 6 (independent). Table D1 summarizes the classification and the disabilities associated to each group. All individuals in the same group are supposed to require the same amount of resources to cope with their activity limitations. Thus, each group is assumed to be homogeneous in long term care needs. Only individuals in GIR 1 to 4 are eligible to the APA.

When an individual is eligible, the team estimates the number of care hours she needs to perform the activities of daily living, referred to as a "care plan" (*plan d'aide*). The monetary equivalent of this care plan must not exceed a given GIR-specific ceiling established at the national level. The APA beneficiary is then free to consume the number of care hours she wants. For each hour under the care plan volume, the hourly price will be reduced by the APA subsidy, which is a decreasing function of income through a copayment rate.

The 2016 reform has extended the generosity of the program through two ways. First, it has modified the computation rule of the copayment rate. It now depends on the income and on the disability level, and, compared with the pre-reform scheme, it makes the policy more generous especially for low-income and/or severely-disabled individuals. Second, it has increased the level of the national GIR-specific ceiling established at the national level, such that care plan volumes in the post-reform scheme are likely to be higher.

Table D1: Definition of each disability level (AGGIR scale)

GIR 1	invalid individuals (bedridden persons) with important cognitive troubles, who need to be constantly taken care of
GIR 2	are invalid but have their cognitive functions less deteriorated than elderly in GIR 1, or are not invalid but have important cognitive troubles
GIR 3	individuals need every-day help for personal care but they do not have any important mental troubles
GIR 4	individuals who need some help, either for getting out of bed, or for meal preparation, dressing or undressing
GIR 5	individuals who punctually need help for activities of daily living, but not on a regular basis
GIR 6	no daily activity limitations

E Robustness checks

E.1 Reduced form and naive analysis

Table E1: Naive analysis

	First part (All) Probit $Pr(h_{IC,i} > 0)$	Second part (Informal care consumers) Regression $\ln(h_{IC,i} h_{IC,i} > 0)$
Formal care	-0.024 (0.0285)	-0.027 (0.03169)
R ²	0.12	0.35
N	2,648	1,498

Reading: An increase by one log-hour of formal care non significantly decreases the probability to consume informal care by 0.0024 percentage point. An increase by one percent of formal care decreases non significantly the level of informal care use by 0.027 percent among informal care consumers.

Notes: Standard errors in parentheses, clustered at the departmental level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The log-number of formal care hours is instrumented by the lowest regulated price in the department. Individual and departmental characteristics are controlled for. Column (1) is the Probit regression of formal care on informal care. Column (2) is the OLS regression of formal care on informal care among informal care users.

Source: survey *Capacités, aides et ressources des seniors* (DREES, 2015b).

Table E2: Reduced form

	First part (All) Probit $Pr(h_{IC,i} > 0)$	Second part (Informal care consumers) Regression $\ln(h_{IC,i} h_{IC,i} > 0)$
Regulated price (log)	0.861** (0.428)	-0.849* (0.466)
R ²	0.12	0.36
N	2,648	1,498

Reading: An increase by one of log-regulated price increases the probability to consume informal care by 0.861 percentage point, significant at the 5% level. An increase by one percent of the regulated price decreases the level of informal care use by 0.849 percent among informal care consumers, significant at the 10% level.

Notes: Standard errors in parentheses, clustered at the departmental level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The log-number of formal care hours is instrumented by the lowest regulated price in the department. Individual and departmental characteristics are controlled for. Column (1) is the Probit regression of regulated price on the probability to consume informal care. Column (2) is the OLS regression of the informal care hours on the log-regulated price among informal care users.

Source: survey *Capacités, aides et ressources des seniors* (DREES, 2015b).

E.2 Models for weak instruments

Our instrument, while being the most relevant we have been able to find, is correlated to the consumption of formal care users but not strongly enough to avoid the weak instrument issue. The first issue with a weak instrument is the precision: a weak correlation between the instrument and the independent variable of interest might substantially lower the precision of the estimations. The second issue lies in the bias that it might create with limited sample size. This is a major concern here given the relatively low number of observations in our sample. Our F-test is above the critical values defined by [Stock and Yogo \(2005\)](#) for 15% maximal IV size bias but is not able to reach the 10% level.³⁴

In this section, we provide tests and confidence intervals robust to weak instrument. Following the guidelines proposed by [Cameron and Trivedi \(2009\)](#), we use the confidence interval based on the conditional likelihood-ratio (CLR) statistic, proposed by [Moreira \(2003\)](#).³⁵

The intuition is the following. In the presence of a weak instrument, the normal approximation of the t-statistic used for the construction of the confidence interval poorly performs. [Moreira \(2003\)](#) proposes a procedure for testing the hypothesis $H_0 : \beta = \beta_0$ with weak instruments. This test is based on critical values that are functions of the data. A confidence region for the parameter robust to weak instruments can then be constructed by inverting the test ([Mikusheva, 2010](#)).

The robust confidence interval obtained is only comparable to a confidence interval with a classical IV-estimation: we thus first estimate a IV-regression for the first part (probability to consume informal care) and the second part of our two part model (volume of informal care for consumers). For these two parts, we additionally provide the confidence interval constructed with the CLR test. The comparison of IV-regression models and confidence intervals obtained with the CLR gives an insight of the importance of the bias due to the weakness of the instrument. These results, however, can not be directly compared to our baseline results, since clusters can not be included.

According to [Table E3](#), for the first part of our model, both the 2SLS estimation and the CLR confidence interval make it possible to conclude that an increase in formal care has a significant and negative effect on the probability to consume informal care. Results on the second part of the model are more ambiguous: while the confidence interval obtained with the 2SLS estimation includes zero, it is not the case for the CLR confidence interval. With the CLR approach, an increase in formal care use is found to have a significant and positive effect on informal care use at the intensive margin. Our interpretation

³⁴We use the thresholds provided in the Stata command *ivreg2*: 16.38 for a 10% maximal IV size, 8.96 for a 15% maximal IV size, 6.66 for a 20% maximal IV size and 5.53 for a 25% maximal IV size.

³⁵We use the stata command `CONDIVREG`.

of results at the intensive margin of informal care thus needs to be particularly cautious, since the bias induced by the weakness of our instrument seems to impact our baseline results.

Table E3: Confidence intervals robust to weak instruments

<i>Dependent variable</i>	All (1) <i>Pr(IC > 0)</i>	Informal care consumers (2) <i>ln(IC IC > 0)</i>
2SLS	[-0.972 ; -0.059]	[-0.249 ; 3.062]
CLR	[-1.435, -0.160]	[0.178 ; 7.576]
N	2,648	1,498

Reading: Estimations of IV two stage least squares model with standard confidence intervals (“2SLS”) or conditional confidence interval from conditional likelihood ratio (“CRL”).

Notes: Individual and departmental characteristics are controlled for.

Source: survey *Capacités, aides et ressources des seniors* (DREES, 2015b).

E.3 Placebo test using larger areas

The relevance of our instrument relies on the hypothesis that the price set at departmental level has an impact on the use of formal care. We consider the departmental level, where the APA program is implemented and the home care sector is regulated.

To test that the department is the relevant geographical/political level to consider, we have conducted a Placebo test where we consider the lowest regulated price of the region³⁶ rather than the department. Table E4 shows that there is no correlation between this regional price and the consumption of formal care.

Table E4: Impact of the lowest regional regulated price on formal care use

	All	Among consumers
<i>Dependent variable:</i>	<i>Formal care hours (log)</i>	
Regulated price (log)	-0.0106 (0.0093)	-0.00104 (0.014)
R^2	0.26	0.28
F-test	1.29	0.01
Individual controls	Yes	Yes
Departmental controls	Yes	Yes
Clusters	22	22
N	2,648	1,498

Reading: The lowest regulated price of the region does not significantly affect the probability to consume formal care. Among the formal care consumers, it does not significantly change the number of hour of consumption.

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses, clustered at the regional level. Individuals and departmental characteristics are controlled for. The regulated price is the lowest regulated price available in the region. Models of Equations 3, and 5.

Source: survey *Capacités, aides et ressources des seniors* (DREES, 2015b).

³⁶The 96 metropolitan French departments were grouped in 22 regions until 2018.

E.4 Dealing with missed caregivers

The variable we use is built on the individual’s declaration: someone who receive informal care has declared informal caregivers and have been able to quantify the volume of care they provide. Such a definition is restrictive: for some informal caregivers, the individual is not able to quantify the care they provide and thus are not taken into account. They could be called “missed caregivers”. Three quarters of individuals in our sample (73%) haven’t any missed caregivers.

The others are divided in two categories. 9% have both quantified and non-quantified informal caregivers: thus, they are identified as care recipient but the volume of informal care they receive is underestimated. 17.5% have exclusively missed caregivers and thus are not identified as receiving informal care while they have missed caregivers.

Table E5 presents the determinants of having at least one missed caregiver. Younger and living-alone individuals have a lower probability to be unable to quantify the volume provided by one caregiver. Surprisingly, the disability status has a non-linear effect: the most severely-disabled individuals (disability group 1/2) and those with a low disability level (disability groups 5/6) have a significantly lower probability to have at least one missed caregiver.

We consider an alternative definition of informal care reception: individuals receive informal care if they declared a caregiver – whatever the declaration on the volume. We estimate the first part of our two-part model with this alternative definition (Table E6). Results are consistent with our baseline results: increasing the formal care volume decreases the probability that individuals receive informal care, with a similar magnitude of the coefficient.

In Table E7, we estimate our results while excluding individuals who have at least one missed caregiver. It shows that our baseline results are robust to this exclusion. Note that the probability to have at least one missed caregiver is uncorrelated with the number of formal care hours consumed or with our instrument (estimation of a Probit model controlling for parents’s characteristics).

Table E5: Probability to have at least one missed caregiver

	Has at least one missed caregiver
Woman	0.00705 (0.0680)
$60 \leq \text{age} < 75$	-0.120 (0.0787)
<i>Ref: $75 \leq \text{age} < 90$</i>	ref.
Age ≥ 90	-0.0309 (0.0693)
Lives alone	-0.165** (0.0681)
Disability group 1	-0.433** (0.187)
Disability group 2	-0.187* (0.0978)
<i>Ref: disability group 3</i>	ref.
Disability group 4	-0.187** (0.0837)
Disability group 5	-0.287*** (0.102)
Disability group 6	-0.339*** (0.0973)
APA beneficiary	-0.0455 (0.0579)
Have the <i>baccalauréat</i>	-0.0256 (0.0858)
Number of children	0.0684*** (0.0152)
Income $< \text{€}10,000$	0.0804 (0.0809)
Income: $\text{€}10,000 - \text{€}15,000$	-0.00529 (0.0761)
<i>Income: $\text{€}15,000 - \text{€}20,000$</i>	ref.
Income $> \text{€}20,000$	-0.0601 (0.0827)
Tenant	-0.0688 (0.0615)
Have a proxy respondent	0.134** (0.0631)
Observations	2,648

Reading: The probability of having at least one missed caregiver is significantly lower for individuals living alone, with a very high or very low disability level.

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. Estimation of a Probit model.

Source: *Capacités, aides et ressources des seniors* (DREES, 2015b).

Table E6: Alternative definition of informal care use

Probability to receive some informal care	
Formal care hours (log)	-0.884*** (0.311)
<i>N</i>	2,648

Reading: An exogenous increase by 1% of formal care volume leads to a significant decrease of the probability to declare receiving informal care by 0.884 percentage point. In this model, those who declare receiving informal care but cannot quantify it are included.

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. Estimations of an IV Probit model where the log-number of formal care hours is instrumented by the lowest regulated price in the department. Individual and departmental characteristics are controlled for.

Source: survey *Capacités, aides et ressources des seniors* (DREES, 2015b).

Table E7: Results on the subsample excluding missed caregivers

	First part (All)		Second part (Informal care consumers)	
	(1) Regression $\ln(FC)$	(2) IV-Probit $Pr(IC > 0)$	(3) Regression $\ln(FC IC > 0)$	(4) IV-regression $\ln(IC IC > 0)$
Regulated price (log)	-0.679** (0.252)		-0.648** (0.267)	
Formal care hours (log)		-0.991*** (0.289)		1.117 (0.956)
F-test	7.25	-	5.88	-
R^2	0.28	-	0.29	-
Individual controls	Yes		Yes	
Departmental controls	Yes		Yes	
Clusters	75		74	
<i>N</i>	1,949		1,255	

Reading: In the first stage of the first part (resp. second part), a 1% increase of the regulated price in the department leads to an average decrease of 0.679% (resp. 0.648%) of formal care hours weekly consumed among the elderly living alone. An increase of one log-hour of formal care consumed decreases the probability to receive informal care by 0.901 percentage point. Among informal care consumers, an exogenous increase of one log-hour of formal care non significantly decreases the volume of informal care consumed (by 1.117 log-hours).

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses, clustered at the departmental level. Individuals and departmental characteristics are controlled for. The regulated price is the lowest regulated price available in the department.

Source: survey *Capacités, aides et ressources des seniors* (DREES, 2015b).