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Demand of long-term care and benefit eligibility across European countries

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Abstract

In this paper, we study how elderly individuals adjust their informal long-term care utilization to changes in the provision of formal care. Despite this is crucial to design effective policies of formal elderly care, empirical evidence is scant due to the lack of credible identification strategies to account for the endogeneity of formal care. We propose a novel instrument, an index that captures individuals' eligibility status for the long-term care programs implemented in the region of residence. Our estimates, which are robust to a number of different specifications, suggest that higher formal care provision would lead to an increase in informal care utilization as well. In the context of current theoretical economic model of care use, this result points to the existence of a substantial unmet demand of care among older people in Europe.

KEYWORDS

home care, instrumental variables, SHARE data, unmet demand

1 | INTRODUCTION

The demand of long-term care (LTC) by elderly Europeans is growing rapidly due to an unprecedented demographic transition fueled by declining mortality and fertility rates. The health economics literature recently started to focus on how the elderly population might adjust the amount of care provided informally by relatives and friends (informal care) as a response to changes in the amount of care provided by public institutions (formal care), as this information would be crucial to design effective care programmes and informal care supports and services. Should total demand for care be satisfied, an increase in formal assistance would reduce the burden of care on informal caregivers and the

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overall care utilization would remain almost constant. The rate at which formal and informal care are substituted depends on the rate of substitution between the two goods, that is, on individual preferences for each type of care. Vice versa, economic theory predicts that if the amount of care provided formally and informally does not satisfy the total demand by the vulnerable elderly, increasing subsidized provision may induce to increase informal care (Stabile, Laporte, & Coyte, 2006).

Formal and informal care utilization are likely to be simultaneously determined (Van Houtven & Norton, 2004). In addition, the formal care receipt may be correlated with unobserved health characteristics and preferences for care, which are likely to affect also the demand for informal care services (Bonsang, 2009; Carrieri, Di Novi, & Orso, 2017; Charles & Sevak, 2005). Thus, a source of exogenous variation of formal care utilization is needed to identify a causal effect on informal care. We exploit the between-country heterogeneity in the eligibility rules for publicly-provided domiciliary LTC and the within-country variation in health conditions to identify the effect of formal on informal care. The interaction between individual health conditions and country-specific legislation is the trigger for causal identification: The individual eligibility status varies both because of different health conditions across subjects and because of different assessments of the same health conditions across programmes. As a matter of fact, in the highly heterogeneous set of European LTC regulations, individuals with similar clinical profiles may be eligible under some programmes yet not under others. As an example, a Belgian–Walloon and a German citizen with three limitations in instrumental activities of daily living (iADLs) and two in activities of daily living (ADLs)—a common profile for the European elderly population—may be alternatively eligible in Belgium or in Germany only, depending on the specific combination of iADL and ADL lost.

Compared to previous research, our approach has two main advantages: First, we introduce a new legislation-based instrument, exogenous to individual decisions regarding informal care utilization. Second, our identification strategy does not rely on formal care price changes, allowing us to interpret results within the relevant theoretical literature.

We use comparative microdata from the Survey of Health, Ageing, and Retirement in Europe (SHARE) and construct a dichotomous individual variable identifying individuals who are eligible for public formal home care, based on LTC regulations implemented in their area of residence. We show that receiving formal home care positively and significantly affects informal home care provision from family and friends.

The paper is organized as follows. We first discuss the endogeneity issue and the identification strategy. We then present the SHARE dataset as well as our regulation-based instrument (Section 3). Section 4 describes the empirical specification, whereas results are presented in Section 5. Robustness checks are performed in Section 6, and Section 7 concludes.

2 | ENDOGENEITY OF FORMAL AND INFORMAL CARE

The Organisation for Economic Cooperation and Development (OECD) acknowledges that protecting the right to a life in dignity of frail older people is becoming a major policy challenge and defines LTC as a range of services required by persons who cannot cope with basic ADL due to a reduced degree of physical or cognitive capacity (OECD, & Commission, E, 2013). Such services are frequently provided in the form of medical services such as nursing care, prevention, rehabilitation, or palliative care services, as well as lower-level care related to domestic help or less demanding tasks. LTC can be provided at the recipient's own dwelling (home-based/domiciliary care) rather than in nursing homes or residential care facilities (residential/institutional care).

It is common to differentiate the LTC assistance between formal care, which includes care services provided within the context of formal regulations (paid out-of-pocket or through public reimbursement), and informal care, which, conversely, refers to the unpaid assistance provided by respondent's partners, children, relatives, and friends.

Most of the empirical work has focused on how a change in the informal care utilization can affect the probability and/or the intensity of receiving formal care, stemming from the family decision-making model developed by Van Houtven and Norton (2004). Typical findings are that informal and formal home care are substitutes (Bolin, Lindgren, & Lundborg, 2008; Van Houtven & Norton, 2004),[1] whereas a positive relation is found when restricting the analysis to skilled formal care or for recipients with high vulnerability levels (Balia & Brau, 2013; Bonsang, 2009).

The literature looking at the causal effect of a change in the availability of formal care on the demand of informal care is scant. Stabile et al. (2006) developed a choice model of household decision making with respect to caregiving provision and the utilization of subsidized and not subsidized home care services. Their model suggests that an increase

[1]Lo Sasso and Johnson (2002) find similar results for residential care.

in subsidized home care keeping input prices fixed (i.e., without changing market price for professional care, the unitary subsidy nor market wages) allows to substitute formal care paid out-of-pocket with the subsidized one, therefore reducing the average formal care price. More precisely, formal care can be bought from private providers (M2, at a price P), or from public sources (M1, at a unitary cost P − S, where S is subsidy). Publicly provided formal care is rationed: Each individual can consume up to a maximum amount m. The household maximizes utility under a budget constraint (labour earnings can be allocated between expenditures in formal care and other consumption goods) and a time allocation constraint (time is divided between leisure, work, and caregiving activities). Private and public formal care are assumed to be equally productive in care provision and normal inputs in the care receiver health production function. The model delivers clear empirical implications for policy changes affecting the quantity of publicly provided care m holding prices constant (i.e., holding P, S, and the market wage constant). If the household exhausts all the publicly provided care ($M1 = m$) and additionally buys private care ($M2 > 0$, $M = m + M2$), then increasing m will increase the household nonwage income (the fraction of subsidized formal care increases), leading to an increase of informal caregiving. If, conversely, the household consumes public care at its limit ($M1 = m$), but does not purchase private care ($M2 = 0$), increasing the generosity of the public home care programme will lead to a reduction of informal care provision. They validate the model on Canadian data and use three province-level variables (share of 65+ population, provincial spending on education, and province tax rate) as instruments for generosity of the public home care.

Doubts were raised by Golberstein, Grabowski, Langa, and Chernew (2009) on the validity of the proposed instruments. Balia and Brau (2013) develop a latent factor model and estimate it on SHARE data aiming at correcting the endogeneity bias without the need for an individual-level instrument, which they highlight as particularly difficult to be found. Finally, Pezzin, Kemper, and Reschovsky (1996) use data from the U.S. "Channelling" experiment and find that informal care provision is not reduced in the presence of public subsidy of formal care.

We follow a different approach, exploiting individual-specific information on eligibility status to local subsidized programmes of home-based care. A similar econometric strategy has been often proposed in the local average treatment effects literature (Kroll & Lampert, 2011), though only Kim and Lim (2015) implement it in the LTC framework, using data from South Korea. The authors use administrative individual information on eligibility and apply a regression discontinuity design: They find no evidence of a statistically significant impact of home care on child caregiving. In Europe, publicly provided LTC is either free of charge or subject to relatively low copayments. Therefore, in line with Stabile et al. (2006), we look at the effect of a variation in the total amount of publicly provided care holding prices constant.

Access to formal home care is largely not discretionary for older adults in Europe: Regulations of most public programmes define eligibility by comparing an applicant's "vulnerability profile" with some "requirements for objective vulnerability" (Brugiavini, Carrino, Orso, & Pasini, 2017). Objective vulnerability often consists in a nonlinear aggregation of information on functional (e.g., ADL and iADL tasks) and cognitive limitations, yet such algorithms are highly heterogeneous within and between countries, in terms of what outcomes are included in the vulnerability profile and of weights assigned to each outcome. As a consequence, the same clinical profile may result eligible for formal home care provision under one regulation yet not under others.

We construct an individual-specific dichotomous eligibility index, which identifies individuals fulfilling the minimum requirements of any LTC programme implemented in their region or country, and we use it as an instrument for the potentially endogenous regressor. This allows us to avoid the well-known weak-instrument issues of policy evaluations based on discrete policy variations affecting specific population subgroups (Bound, Jaeger, & Baker, 1995).

3 | DATA, DESCRIPTIVE EVIDENCE, AND SAMPLE SELECTION

We pool observations from the first two waves of SHARE, a multidisciplinary survey on European individuals aged 50-plus and their spouses, conducted in 2004 and 2006. SHARE contains detailed information about respondents' morbidity and disability status, based on self-reports of objective limitations and health conditions. Respondents are asked to report their dependency status in performing 14 ADLs[2] that conform to the ADL and iADL taxonomies by Katz, Downs, Cash, and Grotz (1970) and Lawton and Brody (1969), as well as in specific mobility limitations. All the aforementioned limitations are assessed on a dichotomous scale (present or not), but no intensity is measured.

[2]These are (a) dressing, (b) walking, (c) bathing, (d) eating, (e) getting in and out of bed, (f) using the toilet, (g) using a map to determine how to get around in a strange place, (h) preparing a hot meal, (i) shopping for groceries, (j) making telephone calls, (k) taking medicines and following medical prescriptions, (l) doing work around the house, (m) managing money, and (n) suffering from urinary incontinence.

TABLE 1 Descriptive statistics

	Whole sample	Austria	Germany	France	Belgium Flanders	Belgium Wallonia
Observations	7,781	1,075	2,178	2,048	1,673	807
Receiving formal personal/nursing care (%)	10.7	5.3	3.8	17.8	11.7	16.7
Receiving informal care from any provider (%)	19.9	22.1	22.6	16.4	18.8	21.3
Receiving informal care from children (%)	15.3	17.3	17.8	12.5	14.5	15.1
Annual hours formal personal/nursing home care	12.9	31	9.5	8.9	13.5	6.7
Annual hours informal care (any provider)	88	97	103	79	89	59
Annual hours informal care from children	67	80	87	57.2	60	39.8
Age	73.4	73.1	72.4	74.2	73.9	73.8
Aged 80+ (%)	18.5	17.3	14	22.2	19.5	20.8
Females (%)	54.7	59.4	50.6	57.5	53.4	54.9
Years of education	10.1	9.1	12.3	8.4	9.8	10.1
Number of children	2.4	2.3	2.3	2.5	2.6	2.58
At least 1 ADL lost (%)	18.8	16.8	15.7	20	18.9	27.3
At least 1 iADL lost (%)	22.2	23.1	17.8	24.5	20.6	30
At least 1 ADL & 1 iADL lost (%)	11.8	11.3	9.4	12.6	11.4	17.3
# mobility deficits (out of 10)	1.9	2	1.94	2	1.6	2.3
Orientation impaired (%)	1.3	0.8	1.4	1.7	1.1	1.4
EURO-D score	2.3	2	2	2.8	2.1	2.8

Note. Data from SHARE Waves 1 and 2 for Austria, Belgium, France, and Germany. Sample selection: individuals aged 65+, with children (no coresidence), not institutionalized. ADL = activities of daily living; iADL = instrumental activities of daily living.

Depression and loss of orientation are covered by two different sets of variables. First, the EURO-D index (Prince et al., 1999) is offered, whose values range from 0 to 12. We interpret a value of 4 (or higher) as being associated with a clinically significant level of depression (Colombo, Llena-Nozal, Mercier, & Tjadens, 2011). Second, four questions on mental orientation and coherence ask respondents to report the current date, month, year, and day of week; following Castro-Costa et al. (2007), we label as impaired (orientation impairment) those respondents who gave zero or one correct answers. This information allow us to build individual clinical profiles comparable with the LTC regulations of the selected countries (see Brugiavini et al., 2017).

As for LTC services, SHARE Waves 1 and 2 (unlike successive waves) detail the frequency of both formal and informal domiciliary care. Respondents are asked whether they made use of any formal personal care (publicly or privately provided), domestic help, or meals-on-wheels services in the last 12 months because of health problems and, if any, the average number of weeks (per year) and of hours (per week) of care received. We limit our analysis to average annual hours of personal and nursing care, the most demanding type of help that is commonly regulated by the public sector (domestic help may indeed include some tasks performed by private workers to seniors not in need-of-care). Meals-on-wheels are measured in weeks of service per year: Given the difficulties in aggregating it with the former type of care and its limited diffusion, we excluded it from the analysis.

With respect to informal care, recipients indicate whether the caregivers are their children, relatives, friends, or neighbours, the frequency (daily, weekly, monthly, or annual) and the average number of care hours received. We thus build a continuous variable for the average annual hours of informal care use.[3] Finally, we highlight that SHARE does not include quantitative information about the intrahousehold assistance (by, e.g., spouse and children).

We also exploit information on chronic conditions that the individual may suffer from, on labour market and economic status, on education (both the ISCED classification—see OECD, 1999—and the number of years of completed education), and on respondents' children.

Table 1 reports descriptive statistics of the baseline estimation sample selection.

We selected noninstitutionalized individuals aged 65 and older, having children, but not living with them, as in, for example, Balia and Brau (2013), Bonsang (2009), Kalwij, Pasini, and Wu (2014).[4]

[3]We follow Bolin et al. (2008) in the way we map SHARE questions about intensity of care into average annual hours.

[4]SHARE lacks information on any informal support provided by people living in the same household. Individuals without children can be expected to receive a large support from their spouse when they are vulnerable. Therefore, we exclude them from the sample as, for example, in papers by Bolin et al. (2008), Bonsang (2009) and Balia and Brau (2013).

TABLE 2 Summary of vulnerability outcomes included in assessment-of-need scales

ADL	Non-ADL
Bathing & hygiene ✓	Communication ✓
Dressing ✓	Shopping for groceries/medicines ✓
Using the toilet ✓	Cooking ✓
Transferring ✓	Housework ✓
Continence ✓	Doing laundry ✓
Feeding ✓	Moving outdoor ✓
Moving indoor ✓	Responsibility for own medications ✓
Hygiene for post-surgery conditions or advanced medications ✗	Behavioural/Cognitive impairment ✓
	Other mobility limitations ✓

Note. ✓ = information available in SHARE; ✗ = information missing from SHARE. The underlined tasks do not belong to the Katz's ADL scale but are treated as basic activities of daily livings in the LTC regulations that include them. The category "hygiene for post-surgery conditions or advanced medications" refers to patients with difficulties in performing advanced medications such as enemas or maintenance of tubes/bags resulting from surgical operations. Additional mobility limitations include, for example, crouching and walking down stairs. ADL = activities of daily living; LTC = long-term care.

We include observations from countries were LTC regulations are "carer-blind," and no role is played by other factors such as informal care availability, family environment, social network, or neighbourhood (Eleftheriades & Wittenberg, 2013): Austria, Belgium (divided into Flanders, Wallonia, and Brussels), Germany, and France.[5]

3.1 | The eligible population

Table 2 lists in detail the vulnerability dimensions that are taken into account in the assessment of need process to determine the eligibility status. We split these measures in two groups. The ADL group resembles the taxonomy introduced by Katz et al. (1970), whereas the non-ADL is a residual set that includes iADL and cognitive/behavioural limitations. Each LTC programme directly assesses a different subset of these outcomes and builds an "eligibility index" for each claimant, through different nonlinear and nonadditive algorithms.

SHARE respondents provide self-reported information about each of these health conditions; thus, a clinical profile $\pi_{i,\,r,\,c}$ can be built for a generic individual i living in country c and region r (the online Appendix details the correspondence between SHARE and the actual regulations). It is worth highlighting that the "eligibility" status does not necessarily identify those who are actually "treated" by public programmes; furthermore, SHARE lacks information on whether or not an individual made an application for LTC benefits. Finally, medical evaluators who take the decision on eligibility may deviate from the strict application of laws and guidelines. We assume those deviations are not systematic. This is an important assumption: The fact that evaluators may deviate systematically from the law had been documented in previous literature (Maestas, Mullen, & Strand, 2013). Still, we think that the specific dataset at hand makes this assumption credible in our context. We have individuals from different countries and, within countries, from different regions. LTC regulation, the way the evaluation committees are composed, and evaluation procedures vary across countries, if not even across regions. As we will explain in Section 4, all the proposed specifications include a full set of regional dummies to account for unobservable effects common to individuals from the same region, including systematic deviation of medical evaluators facing the region-specific LTC regulation. The remaining unobservable variation in the deviations from the strict application of diverse LTC legislations can be safely assumed to be idiosyncratic.

Table 3 reports descriptive statistics on care utilization by the eligible population, compared with a generic sample of individuals with some functional limitations, the whole sample, and the sample of noneligible elderly. The eligibility status identifies a subsample that is notably different from an arbitrary selection of "dependent" individuals, where the definition of dependency is fixed-for-all.

Formal care users are over 44% among eligible individuals, 24% among the functionally impaired and 10% in the whole sample. Moreover, the eligible population—very much unlike the other samples—exhibits similar incidences as well as closer levels of intensity of formal and informal care received. Finally, 7.7% of noneligible respondents report receiving formal care, with an average of three care hours per year (compared to 124 hr per year in the eligible sample). As discussed in Carrino and Orso (2015), there are at least two reasons, besides measurement error, for observing this pattern: First, formal care, as it is asked in SHARE, includes privately paid care not publicly provided. Second, the

[5]Monetary resources are sometimes taken into account to determine the amount of the benefits, but they do not have discriminatory power to define eligibility. Details are available in the online Appendix.

TABLE 3 Care utilization among subsamples

	Eligible	Individuals with 1+ ADL, 1+ iADL	Whole sample	Noneligible
Observations	640	2278	7,781	7,141
% individuals receiving:				
formal care (%)	44.3	24.1	10.7	7.7
informal care from any provider (%)	43.2	33.9	19.9	17.9
informal care from children (%)	37.1	27.9	15.3	13.4
Average annual hours of:				
formal care	124	41	13	3
informal care	409	205	88	60
informal care from children	329	161	68	44
formal care (among receivers)	313	201	140	46
informal care from any provider (among receivers)	945	603	442	334
informal care from children (among receivers)	897	584	444	333
Age	79.3	76.4	73.4	72.9
Number of ADL lost	2.7	1.2	0.4	0.15
Number of iADL lost	3.2	1.65	0.5	0.24
EURO-D score	4.4	3.56	2.3	2.1
Orientation impaired (%)	11.2	3.1	1.3	0.4

Note. Data from SHARE Waves 1 and 2 for Austria, Belgium, France, and Germany. Sample selection: individuals aged 65+, with children (up to 4; no coresidence), not institutionalized. *F* tests on interactions between regions and health controls in linear regression of the eligibility indicator on the full set of region-fixed effects, the health variables used to build the eligibility indicator and a full set of interactions. ADL = activities of daily living; iADL = instrumental activities of daily living.

eligibility index is based on main home care programmes regulated at national or regional level yet not also at municipal-level, because the exact municipality of residence is not available in SHARE due to non-disclosure policies.

4 | ECONOMETRIC SPECIFICATION

We investigate the effect of receiving formal home care on the utilization of informal care, both at the extensive margin (i.e., the probability of receiving informal care) and at the intensive margin (i.e., the amount of care received). Similarly to previous studies (Bolin et al., 2008; Bonsang, 2009; Duan, Manning, Morris, & Newhouse, 1983; Van Houtven & Norton, 2004), we adopt a two-part model (2PM) to model the demand for informal care: First, the individual decides whether to use informal care or not. Then conditional upon receiving informal care, the amount is determined. This model is appropriate for estimating actual outcomes, that is, fully observed variables. This is exactly our case: Zero values for informal home care indicate that no care was received, and we regard them as corner solutions because hours of care cannot be negative.

The first part of the 2PM is a probit for the probability of receiving informal care. We estimate the following regression:

$$I(TIHC_{i,r}) = \gamma_0 + \gamma_1' HS_{i,r} + \gamma_2' CV_{i,r} + \gamma_3 \log(FHC_{i,r}) + \gamma_4 R_{r,c} + \varepsilon_{i,r}, \quad (1)$$

where $I(TIHC_{i,\,r})$ is a dummy variable taking value 1 if the total amount of informal care received by individual i, from region r is greater than zero; the key regressor is log of hours of formal home care $\log(FHC_{i,\,r})$.[6] Other regressors include socio-demographic covariates, namely, years of education, residential area (big city, suburbs, and large/small town), region-specific household income, and wealth quintiles. Moreover, we control for the same health status variables ($HS_{i,\,r}$) that determine eligibility, that is, a binary variable for mobility limitations, the number of ADL and iADL losses, and an interaction term between mobility and ADL to capture the combined effect between having at least one mobility limitation and the number of ADL limitations. Furthermore, we include binary indicators for being disoriented in space and time and for being depressed (i.e., having a EURO-D score greater or equal than 4). Finally, we include regional

[6]In line with previous studies (e.g., Bonsang, 2009; Pezzin et al., 1996), a unit was added to the natural hours of formal care before the log transformation to avoid the problem of zero hours.

TABLE 4 Medical profiles evaluated under the eligibility rules of Belgium–Wallonia and Germany

	Profile A	Profile B	Profile C	Profile D
	Limited in 2 ADL, 3 iADL	Limited in 2 ADL, 3 iADL	Limited in 2 ADL, 3 iADL	Limited in 3 ADL, 3 iADL
Age	74	85	74	84
Limitations in ADL	Dressing	Dressing	Incontinence	Bathing
	Bathing	Transferring	Bathing	Eating
				Using the toilet
Limitations in iADL	Outdoor movement	Meal preparation	Outdoor movement	Shopping for groceries
	Using the telephone	Shopping for groceries	Shopping for groceries	Housework
	Managing money	Housework	Housework	Managing money
Cognitive limitations	Yes	No	No	No
Eligibility status	Eligible only in Belgium	Eligible only in Belgium	Eligible only in Germany	Eligible only in Germany

dummies R_r in order to control for unobserved confounding effects between local legislations and LTC eligibility rules.[7] In order to account for the simultaneity in the individual decision regarding formal and informal care use, $\log(FHC_{i,r})$ is instrumented with the eligibility status dummy described in Section 3.1; thus, Equation (1) is estimated by IV probit through the two-stage residual inclusion approach. In the first stage, an ordinary least squares (OLS) regression is performed with $\log(FHC_{i,r})$ as dependent variable and the full set of included exogenous variables, plus the eligibility index as regressors. We obtain the residuals from the first stage and include them as an additional regressor in the second stage probit alongside the original endogenous variable and the remaining controls (Deb, Norton, & Manning, 2017; Terza, Basu, & Rathouz, 2008). In order to control for correlation among unobservables for individuals living in the same regions, we cluster the standard error at the regional level. Given that the number of clusters is at most 36, we follow Kline and Santos (2012) and Cameron and Miller (2015) and obtain the standard errors with wild bootstrap.

The second part of the model is a linear regression run on the conditional sample of care receivers where the dependent variable is a logarithm of hours of informal care, with the same regressors as in (1):

$$\log(TIHC_{i,r}) = \gamma_0 + \gamma_1^{'} HS_{i,r} + \gamma_2^{'} CV_{i,r} + \gamma_3 \log(FHC_{i,r}) + \gamma_4 R_{r,c} + \varepsilon_{i,r}. \tag{2}$$

Again, $\log(FHC_{i,r})$ is instrumented with the eligibility status dummy; Equation (2) is estimated by two-stage least squares and standard errors are obtained with the appropriate wild bootstrap method (Cameron & Miller, 2015).

Consistency of our estimates hinges on two assumptions: the independence between the first and second stage, typical of a two-part model, and the validity of our instrument. As regards the former assumption, following Dow and Norton (2003) and Duan et al. (1983), the 2PM is often preferred to Tobit and Heckman selection models in the health economic literature because compared to a Tobit model, the 2PM does not impose any constraint on the coefficients, while not relying on any exclusion restriction or functional form, as in a Heckman model.

The eligibility index we construct is the result of a highly nonlinear function of individual health conditions and regional eligibility criteria. It is a valid instrument if it is informative and exogenous. Informativeness lies on the high heterogeneity in the algorithm and weights embedded in each programme's eligibility rules (Brugiavini et al., 2017). An illustration on why this is the case is provided in Table 4. Here, we show how the eligibility status of similar clinical profiles strongly differs depending on, for example, the regulations of Belgium–Wallonia and Germany. In Belgium–Wallonia, eligibility is granted through the National Institute for Sickness and Disability Insurance to individuals limited in washing and dressing or disoriented in time and space; a further care benefit (Assistance to Elderly People, APA) is granted to individuals scoring at least 7 points on a scale that evaluates some ADL, iADL, and cognitive limitations. In the German *Pflegeversicherung*, eligibility requires a minimum overall daily need of 90 min of help for ADL and iADL, with at least 45 min attributable to ADL, whereas cognitive limitations did not account in the evaluation until 2012. We selected profiles characterized by two/three limitations in ADL and iADL; we report their age and the presence of cognitive limitations. Profiles A and B are eligible under the Walloon regulations, the remaining ones under the German rules.

Indeed, being incontinent is explicitly accounted for in Germany but not in Wallonia (Profile C). Moreover, the Belgian's APA gives the same weight to ADL and iADL, whereas Germany assigns outcome-specific need-of-care allotments (with ADLs having higher weights) and requires that ADL difficulties account for minimum 45 min of care:

[7]Namely, we include regions at NUTS 1 level (Eurostat's Nomenclature of Units for Territorial Statistics).

This explains why Profiles A and B are not eligible in Germany. Conversely, bathing and eating have the highest weights in the German but not in the Belgian rules, hence the outcome of profile D.

The exogeneity of the instrument comes from its legislation-based nature: The way a legislation evaluates a specific combination of health outcomes should not directly affect the demand for informal care, if not through its effect on formal care use. However, the strength of such hypothesis could be weakened when the nature of the LTC programmes is mixed between in-kind and in-cash: The utilization of the latter is characterized by a higher degree of freedom and could, partially result in the compensation for informal caregivers. As a robustness check, we will re-estimate our model on a subset of countries and regions where we can use the sole eligibility for in-kind LTC as an instrument for care use.

Furthermore, although eligibility clearly affects the probability of receiving care, it is not simply a different proxy for formal care use, as the sample includes both eligible individuals not receiving any of it, and noneligible ones who do (Table 3).

Finally, in order to control for potential correlation in unobservables among individuals living in the same region, we cluster the standard error at the NUTS1 level. Given that the number of clusters is at most 36, we follow Cameron and Miller (2015) and obtain the *p* values through wild bootstrap methods (and the score bootstrap suggested by Kline and Santos (2012) for probit models).

5 | RESULTS

Table 5 reports the first-stage regression estimates at both the extensive and the intensive margin.

The first-stage outcome shows that the individual's eligibility status for public programmes of domiciliary assistance is a strong predictor for the log hours of received formal home care. The estimated coefficient for eligibility is positive, with a wild-bootstrapped Quasi-F statistics of 8.3, significant at the 1% level. It is useful to recall that the reported *F*-stat cannot be interpreted in the light of the weak instruments cut-offs proposed by Staiger and Stock (1997)—that is, checking whether the test statistic is greater or smaller than 10—as they were developed for the simpler case of IID errors (Cameron & Miller, 2015).

TABLE 5 First stages of the IV regression for the extensive and intensive margins

	Extensive margin Formal care utilization (annual log hours)		Intensive margin Formal care utilization (annual log hours)	
Dependent variable	**marg. eff.**	**S.E.**	**marg. eff.**	**S.E.**
Being eligible	0.499 ***	0.173	0.499	0.319
Age	0.013 ***	0.003	0.013 ***	0.005
Being retired	0.035	0.023	0.032	0.123
Female	0.039	0.037	0.006	0.111
Living with spouse	−0.095 **	0.036	−0.267 ***	0.073
Years of education	0.016	0.033	0.076	0.073
Euro-D	0.031	0.023	0.072	0.067
Low orientation-score	−0.414 *	0.177	−0.398	0.457
Any mobility deficit	0.008	0.026	−0.036	0.046
# ADL limitations	0.058	0.076	0.323 *	0.104
# iADL limitations	0.171 ***	0.040	0.188 **	0.066
Mobility*ADL	0.138	0.079	0.025	0.111
Living area (w.r.to rural)				
Big city	−0.048	0.058	−0.210	0.131
Suburbs big city	0.002	0.056	−0.074	0.117
Large town	−0.017	0.040	−0.043	0.108
Small town	−0.004	0.029	−0.018	0.076
Observations	7,781		1,556	

Note. Additional controls include dummies for regions, income, wealth, and wave effects. Formal home care corresponds to nursing care and personal care assistance at the patient's home. Sample selection: individuals aged 65+ from Waves 1 and 2 from SHARE, having children but not living with them. Standard errors are clustered at the regional level (37 clusters at the extensive margin, 36 at the intensive). *p* values are obtained using the wild cluster bootstrap method (Roodman (2017)), with 1,000 repetitions and imposing the null hypothesis as per Cameron and Miller (2015).

*p value $< .1$; **p value $< .05$; ***p value $< .01$.

TABLE 6 Two-part model for overall informal care from outside the household: intensive and extensive margin

	Any informal care received				Log hours of informal care, among receivers			
	Probit		IV probit		OLS		2SLS	
Dependent variable	**marg. eff.**	**S.E.**	**marg. eff.**	**S.E.**	**marg. eff.**	**S.E.**	**marg. eff.**	**S.E.**
Log-hours FHC	0.016 ***	0.004	0.118 **	0.056	0.058 *	0.025	0.676 **	0.240
Age	0.007 ***	0.001	0.005 ***	0.001	0.019 **	0.007	0.010	0.008
Being retired	0.010	0.013	0.006	0.015	−0.093	0.078	−0.128 *	0.078
Female	−0.001	0.010	−0.004	0.010	0.126	0.099	0.129	0.098
Living with spouse	−0.212 ***	0.014	−0.202 ***	0.018	0.009	0.130	0.176	0.143
Years of education	−0.009 ***	0.009	−0.010	0.008	−0.153 **	0.057	−0.198 ***	0.056
Euro-D	0.044 ***	0.010	0.040 ***	0.010	0.134 *	0.076	0.075	0.080
Low orientation-score	−0.053 *	0.032	−0.020	0.042	0.114	0.195	0.311	0.208
Any mobility deficit	0.074 ***	0.012	0.073 ***	0.013	0.130	0.070	0.149 *	0.072
# ADL limitations	0.044	0.019	0.035	0.022	0.057	0.185	−0.159	0.183
# iADL limitations	0.028 ***	0.005	0.006	0.012	0.259 ***	0.035	0.116 *	0.056
Mobility*ADL	−0.064 **	0.019	−0.082 ***	0.016	−0.038	0.187	−0.083	0.192
Living area (w.r.to rural)							−0.042	0.155
Big city	−0.003	0.021	0.002	0.020	−0.166	0.149	−0.124	0.107
Suburbs big city	0.011	0.019	0.011	0.018	−0.171	0.107	0.017	0.169
Large town	0.006	0.013	0.007	0.013	−0.005	0.166	−0.107	0.114
Small town	−0.004	0.011	−0.004	0.011	−0.114	0.114		
Observations	7774		7774		1556		1556	
F test excluded instrument	-		8.3***		-		2.5	
Test of exogeneity			3.25*				7.1**	

Note. Additional controls include dummies for regions, income, wealth, and wave effects. Formal home care corresponds to nursing care and personal care assistance at the patient's home. Informal home care from outside the household by children, relatives, friends and neighbours corresponds to unpaid help with personal care, practical household tasks, and paperwork. Sample selection: individuals aged 65+ from Waves 1 and 2 from SHARE, having children but not living with them. Standard errors are clustered at the regional level (37 clusters at the extensive margin, 36 at the intensive). *p* values are obtained using the wild cluster bootstrap method (Roodman (2017)), with 1,000 repetitions and imposing the null hypothesis as per Cameron and Miller (2015). None of the seven observations from French regions "Midi-Pyrénées" and "Corse" report use of informal care; therefore, they are dropped due to collinearity.

*p value $< .1$, **p value $< .05$, ***p value $< .01$.

Table 6 reports the marginal effects for the determinants of informal home care from children, relatives, friends, and neighbours at both margins.

The coefficient for formal care use in the instrumented model is positive and significant at the 5% level. The Wald test for exogeneity of formal care can be significantly rejected at the 10% level, indicating that the decisions on using formal and informal assistance are simultaneously determined. A 10% increase in the annual hours of personal/nursing care leads to a 1.19% increase in the probability of receiving informal assistance. Being 19.9% the average probability of receiving informal care, a yearly increase of formal assistance by 10% would increase the average likelihood of informal care use to 20.8% with respect to the unconditional mean.

Comparing the results with a noninstrumented model, the sign and significance of the coefficient of interest are not affected, whereas the point estimate of the IV probit is 10 times bigger than its noninstrumented counterpart due to the simultaneity bias.

The second part of the model—the intensive margin—is the equation for the yearly log hours of informal care received from any provider (conditional to receiving any) and is estimated both by 2SLS (with eligibility status as instrument) and by OLS (assuming exogeneity of formal care). The null hypothesis of exogeneity as per the modified Hausman test (Cameron & Miller, 2015) is rejected with a p value of 2.4 (F-stat = 7.1), thus indicating that decisions about hours of formal assistance (conditional on receiving) are endogenously determined with respect to informal care. The first-stage of the 2SLS reports an F-statistics of 2.5 for the excluded instrument, thus signaling that the combination of a reduced sample size and a large set of controls make the instrument become weak. In Section 6, we show results form a modified specification with a health index in place of the single health characteristics where the instrument does not appear to be weak. The 2SLS estimates for yearly log hours of formal home care in Table 6 confirm the lack of crowding out of informal care by the formal care: An increase of 1% in the intensity of formal care provision actually leads to an increase of 0.7% in the intensity of informal care, among those who receive it. Table 6 reports also the

TABLE 7 Subsample of in-kind programmes only, for France and Belgium–Wallonia

	Any informal care from children				Log hours of informal care, among receivers			
	Probit		IV probit		OLS		2SLS	
Dependent variable	marg. eff.	S.E.	marg. eff.	S.E.	marg. eff.	S.E.	marg. eff.	S.E.
Log hours FHC	0.006	0.005	0.153**	0.046	0.045	0.032	0.735	0.736
F test excluded instrument			3				0.7	
Test of exogeneity			6.13**				0.8	
Observations	2,848		2,848		508		508	

Note. Additional controls include socio-economic and health status, regions-, income-, wealth-, wave effects. Formal home care corresponds to nursing care and personal care assistance at the patient's home. Informal home care from outside the household by children, relatives, friends, and neighbours corresponds to unpaid help with personal care, practical household tasks, and paperwork. Sample selection: individuals aged 65+ from Waves 1 and 2 from SHARE, having children but not living with them. Standard errors are clustered at the regional level (eight clusters). *p* values are obtained using the wild cluster bootstrap method (Roodman (2017)), with 1,000 repetitions and imposing the null hypothesis as per Cameron and Miller (2015). None of the seven observations from French regions "Midi-Pyrénées" and "Corse" report use of informal care; therefore, they are dropped due to collinearity.

*p value < .1, **p value < .05, ***p value < .01.

noninstrumented estimates of the second part. As for the extensive margin, sign and significance are preserved, but OLS point estimate of the coefficient of interest is 10 times smaller than the 2SLS one.

According to Stabile et al.'s (2006) theoretical framework, a positive coefficient can be found between the use of formal (private + subsidized) and informal care only if the status quo scenario is characterized by the existence of an unmet demand for public LTC, satisfied resorting to the private market: Households exhaust all the available public formal care, they then determine the hours of informal care but must supplement informal and subsidized care with formal care bought on the market. Thus, in the words of the aforementioned authors, our results highlight that "the extension of public coverage may meet some previously unmet need, and thereby, increase overall utilization as these services complement existing care."

6 | ROBUSTNESS

Throughout the paper, we made the hypothesis that the eligibility for LTC benefits (in-kind or in-cash) would affect directly the take-up and conditional use of formal care services, and only indirectly informal care. It may be argued that cash benefits may be used to compensate informal caregivers directly. In the main specification, we did not restrict the analysis to in-kind LTC benefits in order to have a sufficiently large sample to allow for a rich set of covariates. We re-estimate our model on a narrower geographic selection where we could use the eligibility rules for in-kind LTC programmes as instruments, namely, France and Belgium–Wallonia[8] to show that results are not affected by the in-kind or in-cash nature of the public LTC benefits. Table 7 summarizes our results for the France + Wallonia sample, where only eligibility rules for in-kind LTC are used as instruments for formal care utilization.

At the extensive margin, our results are confirmed and exogeneity is rejected. At the intensive margin, results are not significant because we do not have enough observation to precisely estimate the baseline specification with its demanding set of controls. All in all, we feel confident to enlarge our eligibility rules to the full sample of available countries and LTC programmes in order to be able to estimate precisely our rich baseline model.

As recent literature mostly focused on informal care from children only, we run our model on a dependent variable that accounts for the sole assistance provided by respondent's children, grandchildren, and children-in-law living outside the household (Table 8).

At both intensive margins, unlike in our main specification, the exogeneity of formal care cannot be rejected, as found by recent analyses on SHARE with a similar sample selection (Bonsang, 2009). Moreover, although the marginal

[8]Indeed, the France LTC programmes are entirely in-kind in nature (Joël, Dufour-Kippelen, Duchêne, and Marmier (2010)). Within Belgium, where LTC is predominantly provided as a service in-kind (Willemé (2010)), the Belgian Wallonia is characterized by the national in-kind programme of home care provided by the National Institute for Health and Disability Insurance (INAMI-RIZIV), complemented by an allowance for assistance to elderly persons (APA), which is part of several allowances for the handicapped. We then use the Wallonia sample and compute the eligibility index based only on the rules that refer to the in-kind programme, namely, INAMI-RIZIV. We exclude the Flanders region were the LTC programmes are more cash oriented, as well as Germany and Austria, where LTC benefits are mixed in nature between in-cash and in-kind.

TABLE 8 Two-part model of informal home care provision from children only

	Any informal care from children				Annual log hours of informal home care received from children, among receivers			
	Probit		IV probit		OLS		2SLS	
Dependent variable	marg. coeff.	S.E.	marg. coeff.	S.E.	marg. coeff.	S.E.	marg. coeff.	S.E.
Log hours FHC	0.009 **	0.004	0.062	0.047	0.067 *	0.024	0.522 *	0.337
F test excluded instrument			8.3***				2.1	
Test of exogeneity			$\chi^2(1) = 1.05$				2.66	
Observations	7,776		7,776		1,184		1,184	
Adjusted R^2	0.219				0.274		0.072	

Note. Additional controls include socio-economic and health status, regions, income, wealth, and wave effects. Formal home care corresponds to nursing care and personal care assistance at the patient's home. Informal home care from children corresponds to unpaid help with personal care, practical household tasks, and paperwork. Sample selection: individuals aged 65+ from Waves 1 and 2 from SHARE, having children but not living with them. Standard errors are clustered at the regional level (37 clusters at the extensive margin, 36 at the intensive). *p* values are obtained using the wild or score cluster bootstrap method (Roodman (2017)), with 1,000 repetitions and imposing the null hypothesis as per Cameron and Miller (2015) and Kline and Santos (2012). None of the seven observations from French regions "Midi-Pyrénées" and "Corse" report use of informal care; therefore, they are dropped due to collinearity.

$^*p$ value $< .1$, $^{**}p$ value $< .05$, $^{***}p$ value $< .01$.

coefficients associated to formal assistance are positive and significant at both parts for the noninstrumented model, no or weaker statistical significance emerges when we account for endogeneity.

These results are in line with Kalwij et al. (2014): Informal caregivers are likely to be substitute among them, and the allocation of care needs to different providers is likely to be a two-step decision: Care receivers first determine jointly the total amount of formal and informal care they need to meet their demand for care, and then they allocate the informal care provision to the different potential providers.

Because SHARE lacks quantitative information on intrahousehold assistance, we perform two robustness analyses regarding spousal- and cohabiting children support. First, we restrict our sample to singles only in order to avoid potential underestimation of informal caregivers (Balia & Brau, 2013; Bolin et al., 2008). Although the significantly reduced sample size weakens our instrument, the main results remain substantially unchanged (Table 9).

Second, we allow for parent–children cohabitation by including all individuals having at least one child living outside the household and including a dummy for cohabitation as in Bonsang (2009). We confirm our main findings (Table 10) and detect endogeneity at both margins.

Finally, we implemented several specifications in which we varied the set of regressors. First, we estimate a set of models where controls are subsequently included (Table 11). Starting with formal care utilization (*fc*) as the sole independent variable, we add (a) regional dummies, (b) health variables, and (c) demographics. As Table 12 illustrates, the coefficient for formal care is always significantly different from zero at all margins, with the instrument being relevant in almost all

TABLE 9 Two-part model for the population of single only

	Any informal care from children, relatives, and friends				Annual log-hours of informal home care from children, relatives, and friends (among receivers)			
	Probit		IV probit		OLS		2SLS	
Dependent variable	marg. coeff.	S.E.	marg. coeff.	S.E.	marg. coeff.	S.E.	marg. coeff.	S.E.
Log-hours FHC	0.029 **	0.009	0.114	0.111	0.059 **	0.026	0.760 ***	0.216
Testing the null of formal care exogeneity			$\chi^2(1) = 0.36$				$F(1, 35) = 10.79$***	
First-stage weak-instrument test			$F(1, 35) = 3.26$				$F(1, 35) = 2.43$	
Observations	2,502		2,502		1,010		1,010	

Note. Standard errors are robust to heteroskedasticity and clustered at the individual level. Additional controls include socio-economic and health status, regions, income, wealth, and wave effects. Formal home care corresponds to nursing care and personal care assistance at the patient's home. Informal home care from outside the household by children, relatives, friends, and neighbours corresponds to unpaid help with personal care, practical household tasks, and paperwork. Sample selection: individuals aged 65+ from Waves 1 and 2 from SHARE, having children but not living with them. Standard errors are clustered at the regional level (37 clusters at the extensive margin, 36 at the intensive). *p* values are obtained using the wild or score cluster bootstrap method (STATA command boottest by Roodman (2017)), with 1,000 repetitions and imposing the null hypothesis as per Cameron and Miller (2015) and Kline and Santos (2012).

$^*p$ value $< .1$, $^{**}p$ value $< .05$, $^{***}p$ value $< .01$.

TABLE 10 Two-part model for the population aged 65+, including households with cohabiting children

	Any informal care from children, relatives, friends				Annual log hours of informal home care from children, relatives, friends (among receivers)			
	Probit		IV probit		OLS		2SLS	
Dependent variable	marg. coeff.	S.E.	marg. coeff.	S.E.	marg. coeff.	S.E.	marg. coeff.	S.E.
Log hours FHC	0.015 ***	0.004	0.15 **	0.065	0.068 **	0.025	0.644 **	0.274
Testing the null of formal care exogeneity			$\chi^2(1) = 4.5$*				$F(1, 35) = 4.55$*	
First-stage weak-instrument test			$F(1, 36) = 6$***				$F(1, 35) = 2.23$	
Observations	8,258		8,258		1,672		1,672	

Note. Standard errors are robust to heteroskedasticity and clustered at the individual level. Additional controls include socio-economic and health status, regions, income, wealth, and wave effects. Formal home care corresponds to nursing- and personal-care assistance at the patient's home. Informal home care from outside the household by children, relatives, friends and neighbours corresponds to unpaid help with personal care, practical household tasks and paperwork. Sample selection: individuals aged 65+ from waves 1&2 from SHARE, having children. At least one child lives outside the household. Standard errors are clustered at the regional level (37 clusters at the extensive margin, 36 at the intensive). P-values obtained using the wild or score cluster bootstrap method (Roodman (2017)), with 1000 repetitions and imposing the null hypothesis as per Cameron and Miller (2015) and Kline and Santos (2012). None of the seven observations from French regions "Midi-Pyrénées" and "Corse" report use of informal care; therefore, they are dropped due to collinearity.

*p value < .1, **p value < .05, ***p value < .01.

TABLE 11 Alternative sets of explanatory variables

Dependent variable	Extensive margin (IV probit) Informal care utilization (dummy)			Intensive margin (2SLS) Informal care utilization (log-hours)		
Specification	Marginal coeff. *fc*	Instrument strength	Exogeneity test (Wald)	Marginal coeff. *fc*	Instrument strength	Exogeneity test Wu Hausman
fc only	0.130***	61.88	33.68*****	0.638***	$F = 33.80$***	125.45***
fc + region	0.132***	31.91***	52.82***	0.657***	$F = 27.55$***	105.32***
fc + region + health	0.131**	9.53***	3.68*	0.657**	$F = 2.80$	6.50***
Full model: *fc* + region + health + demographics	0.119**	8.3**	3.25*	0.705*	$F = 2.50$	7.1
Number of obs.	7,774			1,556		

*p value < .1, **p value < .05, ***p value < .01.

TABLE 12 Alternative health measures

	Marginal coefficients for yearly log-hours of formal home care							
Dep. variable: informal care utilization	Probit coeff	IV probit coeff	*F* test weak instr.	Exogeneity test $\chi^2(1)$	OLS coeff	2SLS coeff	*F* test weak instr.	Exogeneity test $F(1, 1468)$
With disability index	0.01***	0.03**	52.1***	12.7***	0.13***	0.55***	22***	54***
All health dummies	0.01**	0.16	2.6*	2.18*	0.046*	1.1**	0.65	5.7**

Note. Additional controls include socio-economic and health status, regions, income, wealth, and wave effects. Formal home care corresponds to nursing care and personal care assistance at the patient's home. Informal home care from outside the household by children, relatives, friends, and neighbours corresponds to unpaid help with personal care, practical household tasks, and paperwork. Sample selection: individuals aged 65+ from Waves 1 and 2 from SHARE, having children but not living with them. Standard errors are clustered at the regional level (37 clusters at the extensive margin, 36 at the intensive). p values are obtained using the wild or score cluster bootstrap method (Roodman (2017)), with 1,000 repetitions and imposing the null hypothesis as per Cameron and Miller (2015) and Kline and Santos (2012).

*p value < .1, **p value < .05, ***p value < .01.

specifications. Exogeneity is always rejected at both extensive and intensive margins, with the only exception of the full model at the intensive margin.

Second, because specific functional or cognitive limitations may have different effects on individuals' health and are weighted differently in some LTC regulations, we tested our results under different strategies of accounting for health outcomes in the model (Table 12).

We, first, followed Bonsang (2009) and summarized the entire set of health variables with an individual disability index. This index is constructed on the basis of a categorical variable from the SHARE questionnaire that asks to which extent, if any, the respondent is limited in his daily activities because of health-related problem. After estimating an ordered probit model with the limitation question as dependent variable and out main set of health variables as explanatory variables, we compute the latent index and define it as the disability level of the respondent. Under this more parsimonious specification, findings are fully confirmed, and instrument diagnostics are improved.

Moreover, when including a dummy for each ADL/iADL limitation, results are confirmed even though the sample size is too small to obtain precise estimates due to the larger set of parameters.

7 | CONCLUSIONS

This paper investigates the effect of a change in the amount of formal home care services on the demand for informal care by children, relatives, friends and neighbours. We use data from SHARE Waves 1 and 2 for Austria, Belgium, France, and Germany. We focus on home-based services; as in Europe, they are now prioritized by policymakers with respect to residential/institutional care. This causal relationship has been less studied than the opposite one due to the difficulty of addressing the potential endogeneity of formal care. We propose a novel instrumental variable that exploits self-reported health profiles and regional differences in LTC legislation. We therefore instrument the formal care utilization (nursing/personal assistance, public, and/or private) with the eligibility for public home care programmes. Hence, we are actually looking at the change in the formal care use that can be attributed to changes in subsidized care. Adopting a two-part model for informal care utilization, we show that an increase in formal care use has a positive and significant effect on the informal care provided by family and friends. The magnitude of such an effect is economically relevant: A 1% increase of formal assistance would increase the probability of informal care use by 2.1% and by 0.7% the number of hours of informal care, conditional on receiving informal care.

According to the theoretical framework by Stabile et al. (2006), this result directly points to the existence of an unmet residual demand for LTC services, as a result of an insufficient supply of public assistance. This is an important result for policymakers because it clarifies the nature of the issues at stake regarding LTC. The evidence is that throughout Europe, frail elderly already receive less care than what they would desire. This implies that public, private, and informal care providers are not substitutes: Policies targeted to incentivize informal care as well as the development of an LTC insurance market to pay for LTC private service providers will not necessarily reduce the pressure on public finances.

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