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Reaching the consumer: importance of travel costs in home care provision*

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Abstract

Providing care at home generates specific constraints, particularly the travel of caregivers to the consumers' place. This paper analyzes the empirical significance of travel costs in the context of home care provision in France, expliciting the sources of their variation and their effect on the organization of providers. It makes use of original data obtained from a large home care provider. Travel time and distance generated by caregiver rounds are computed from geographical information in the data, to retrieve the travel costs borne by the provider. They are found to be higher in rural municipalities and to decrease with the size of urban units. This is due higher travel distances but also to the characteristics of the demand living there. Indeed, severely disabled individuals are over-represented in these areas and their fragmented consumption generates higher travel costs. In this context, the unique price charged to all consumers entails a redistribution towards rural areas and disabled individuals. The travel costs are found to have a limited effect on the duration of interventions.

JEL Classification: I11, I18, J14, R32

Keywords: disabled elderly, home care services, travel costs.

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1 Introduction

Disabled and older individuals living in the community are often provided with basic domestic help, such as meal preparation, assistance with personal hygiene or house chores. Long-term care policies encourage the use of professional services: in France, the APA policy partially finances the professional support for the activities of daily living for the disabled elderly. While the scheme is opened to individuals living in the community and those in institutions, 60% of the beneficiaries were community-dwellers in 2018.[1]

Providing care at home implies a specific constraint: the provider bears the costs generated by the travels of caregivers to the consumers' place. This feature of the provision influences the costs and the organization of home care providers. It might be unequally constraining for providers, depending on the spatial distribution of their consumers. It is expected to depend on the size of the area served, its geographical characteristics and the density of consumers. Several public or research reports have underlined existing differences for consumers, according to where they live, in the number and the type of providers available for care provision and in the price individuals pay for professional home care (Aube-Martin et al., 2010; Blondel et al., 2013; Garabige et al., 2015; Branchu et al., 2015).

This work aims at documenting the importance and the source of variations of travel costs for home care providers. It additionnally questions their effect on home care provision and the implications of pricing schemes. Are travel costs negligible? How do they vary? How do they influence the organization of the home care provision? The issue of travel costs has been widely addressed in the logistic literature: many works aims at optimizing caregiver rounds in order to reduce costs. In economics, travel costs are often considered from the consumer point of view, in transport economics (Button, 1993). In health economics, travel costs are often studied when looking at the distance necessary to reach health services (Lucas-Gabrielli et al., 2016; Chevillard et al., 2018). The economic questions raised by the provision of a service at home are rather close to those of the distri-

[1] Source: DREES (2016).

bution networks (water, gas or electricity). In both cases, providers serve different points in space; it raises efficiency issues, regarding the optimal size of the network, and equity issues, with respect to the optimal pricing in particular (Fleurbaey and Trannoy, 1998; Crampes and Laffont, 2014). In the provision of services, however, demand points are not only connected once, but repeatedly, and serving one consumer excludes the others. It is also the case for postal services, whose cost function has received specific attention in the literature (Cazals et al., 2004b,a). The provision of care is additionally relatively constrained by the demand regarding the day and hours of intervention, while rounds are not similar from one day to the other. This paper brings new evidence on the specificity of travel cost in the context of home care provision.

I use original data obtained from a large home care provider serving thousands of consumers spread over a French department. Using geographical tools, rounds of caregivers are reconstituted and travel costs are computed. They are found to be higher in rural municipalities and decreasing with the size of urban units. This is due to geographical constraints, especially higher travel distances, in these areas. It also comes from the characteristics of the demand living there. Indeed, severly disabled individuals are over-represented in rural municipalities and small urban units. Their consumption is fragmented (short and repeated interventions), and they receive care from highly qualified caregivers whose wage rate is higher. Overall, serving severely disabled individuals generates higher travel costs. I finally test if travel costs affect the duration of interventions and find limited evidence of such an effect.

The existence and the variations of travel costs have direct implications for public policies. With a unique price being charged to the consumers of a given service, they organize a redistribution from the consumers who are the less costly to serve to the others. Given our results, the unique price charged to all consumers entails a redistribution towards rural areas and disabled individuals.

2 Context

2.1 Existing evidence on travel costs

The issue of travel costs has been widely addressed in the logistic literature. Many studies use logistic tools to optimize the scheduling and routing of home care nurses in order to reduce costs (see for instance, Begur et al. (1997); Bertels and Fahle (2006); Eveborn et al. (2006); Bachouch et al. (2009)). In economics, spatial constraints of home care providers are sometimes alluded to[2] but, to the best of my knowledge, there are few works directly dealing with the travel costs of providers serving consumers at home. Hege and Cassou (Cassou, 2017; Hege, 2018)[3] have provided a theoretical model analyzing the effects of travel costs on the geographic coverage of firms, in a context of a mixed market with asymmetric universal service obligations. They find that the coverage by the unconstrained firm will be excessive, since its expected surplus from serving an area is often larger than the associate gain in welfare.

Empirically, travel costs seem to represent a non-negligible provision constraint for professional care providers. The various components of production costs are described in qualitative studies, either in academic works (Gramain and Xing, 2012) or in public reports. By order of importance, provision costs can be decomposed as follows (Roquebert and Tenand, 2017): workforce costs (80% of total charges); operating costs (10-15% of total charges); transportation costs (5-10% of total charges). There is, though, no national, comprehensive benchmark study on the costs of home care services. Public reports regularly deplore the lack of information on costs as a major shortcoming preventing from understanding the functioning of the sector (Vanlerenberghe and Watrin, 2014; Poletti, 2012). Chevreul (2009) finds that travel costs represent about 21% of total costs in a

[2]"Constraints in this market tend to be associated with rural residence, since it is more difficult for a home care agency to serve patients who are located in remote places" (Ettner, 1994); "The difficulty in accessing isolated areas in mountainous districts, for example, may imply higher costs of production and higher prices of regulated formal care providers." (Arnault, 2015) "Provider costs may differ due to differences in travel costs to reach clients (e.g, higher travel costs in rural areas where clients may be more disperse)" (Mosca et al., 2010).

[3]See Cassou (2017) for the English version and Hege (2018) for the French version.

sample of 36 nursing providers serving consumers at home. In a case study led by Aube-Martin et al. (2010), the unproductive hours spent travelling represent 5% of the paid work time.

Travel costs are found to vary with the characteristics of the served areas. In Aube-Martin et al. (2010), the compensation of employees for travel costs represents 5% of total costs for providers serving rural areas, while it falls to 1% for providers focusing on urban areas. Such a relationship, however, is not systematically observed. Serving urban areas can be associated with costly traffic jam or parking impediments, as is reported by the interviews led by Ramos-Gorand (2015).

Travel costs could then lower the incentives for home care providers to serve consumers in costly areas. According to Branchu et al. (2015) and Blondel et al. (2013), consumers living in costly areas have a reduced choice of providers, and some have even no provider serving their municipality. Roquebert and Tenand (2017) observe, in a French department, that 35% of the APA beneficiaries have only one provider operating in their municipality. These municipalities mostly correspond to small and rural areas.

Travel costs have been found to entail higher prices, either directly or through a pricing process. At this point, it is important to stress the importance of the regulation of the sector. In France, most home care providers serving the disabled elderly are regulated by local authorities, the departmental councils (Hege et al., 2014). For each regulated provider, the departmental council fixes the price charged by the provider to its consumers, on the basis of average provision cost (Gramain and Xing, 2012). With such a rule for the pricing process, a higher hourly provision costs (due, for instance, to higher travel costs) should result in a higher price. Garabige et al. (2015) find that providers serving costly areas have higher prices because of a higher hourly costs. Roquebert and Tenand (2017) find that providers serving more municipalities, including the remote ones, have a higher price. Consequently, individuals living in remote municipalities have little choice regarding their provider, and they face a higher price on average. Despite this higher price, providers serving costly areas face more difficulties to balance their budget than

other providers (Branchu et al., 2015).

To sum up, there is empirical evidence that travel costs are a substantial dimension of the care provision, and that it affects the area of intervention of services and their price. This paper aims at measuring the travel costs and highlighting their sources of variations. It builds on a micro-economic approach which precisely reconstitutes caregiver rounds thanks to the rich and original data obtained from a large home care provider.

2.2 Composition of travel costs

Travel costs are borne by the provider when caregivers move from one intervention's location to another. One travel is costly for two reasons. First, the time spent travelling is paid to the caregiver, corresponding to what will be called the *transportation wage*. In most cases, it does not correspond to the time elapsed between two successive interventions of one caregiver in the same day, called the inter-vacation time. Indeed, the inter-vacation period comprises both travel time and waiting time. According to French collective agreements, travel time is part of the effective work and has to be paid as such. Waiting time, however, is not systematically regarded as effective work. It depends on the agreements regulating the provider, on the duration of the break and possibly on the specific rule of the provider.[4]

The second component of travel costs is the *compensation cost*: this is the money paid to the employee to cover, partly at least, the travelling expenses (car gaz, for instance). It should depend on the distance driven by the employee and her means of transport. Collective agreements propose a simplied formula to compensate the caregivers for their distance, in which the compensation costs is a linear function[5] of the distance driven.[6]

A third component could be added to costs generated by travels, namely the foregone revenue. Indeed, travel time corresponds to time that could have generated profit by

[4]See Appendix 8.1 for more details on French collective agreements.

[5]This rule might not fit the real fees paid by the caregiver. It is relevant when caregivers use a car and there is no congestion. But with public transport or congested areas, the compensation costs might differ from the effective travelling expenses of employees.

[6]The minimum compensation per kilometer is of €0.20 in for-profit enterprises and €0.35 in non-profit structures.

treating another patient. In this work, however, I am focusing on the monetary costs paid out-of-pocket by the provider; thus, I won't take this foregone earnings into account.

3 Data

3.1 General presentation

I collected data from a home care provider serving a whole French department.[7] It counts more than 10,000 consumers spread all over the department. The provider is a non-profit organization, regulated[8] and priced by the departmental council. I have three databases, presenting information on interventions, consumers and employees. Data are cross-sectional, collected for the month of October 2015.

Our key database presents the recording of the remote management system (data on interventions). For the 88,910 interventions provided during the month of October are observed the starting and ending hours, an identification number for the employee providing home care and an identification number for the consumer receiving care. With these data, caregiver rounds can be reconstructed. Data additionnaly give the characteristics of the care that has been provided for each intervention (body care, housekeeping, shopping, meals). One intervention can be spent providing several types of care.

This database can be supplemented with information on consumers and employees, from the billing and pay files. There is substantial heterogeneity in the consumers served by the provider. Half of the consumers served during the month are APA beneficiaries, whose consumption is partially publicly financed. Others are not benefiting from any subsidy and are consuming comfort services that are privately funded.

The pay file provides the wage rate of the employee, her qualification category,[9] her

[7] For confidentiality matters, the provider will remain anonymous.

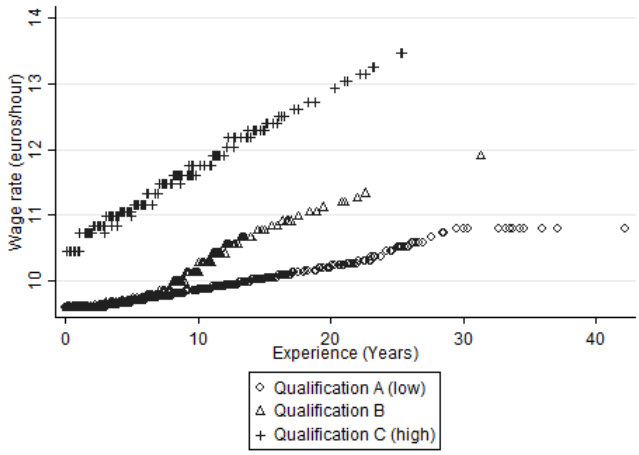
[8] The regulated status applies to the structure employing the caregivers, not the caregivers themselves.

[9] In the French system, the qualification of caregivers is described with three categories. Caregivers belonging to the A-category are the low-skilled one (no specific diploma). The B-category refers to the middle-skilled caregivers (*BAP, BEP, CAP*) and the C-category to the high-skilled caregivers (*CAFAD, DEAVS, BEP mention Aide à domicile, TISF*).

experience and her location. It also shows the number of kilometers compensated for during the month. By construction, following the requirements on the collective agreements in the home care sector, the hourly wage rate directly depends on qualification and experience, as illustrated in Figure 1. Caregivers are paid according to the time they work, regardless of the type of care they provided, the type of consumers they serve or the area they go to.

The three databases are matched on the basis of consumers and employees identification numbers.[10]

Figure 1: Hourly wage depending on years of experience and qualification



SAMPLE: 1,209 caregivers working during the week of observation.
SOURCE: data from one home care provider.
NOTES: Category A is the lowest level of qualification; category B is the intermediate level; category C is the highest level of qualification.

3.2 Descriptive statistics on travels

Travel time and distance are the key elements when investigating travel costs. Both are not directly observed in the data, which only shows the inter-vacation period and the total number of kilometers that is compensated for in the whole month. The information provided on the consumers' place[11] makes it possible to reconstruct the distance, by the

[10] See Appendix 8.2 for details on the cleaning and the matching of databases.

[11] 428 consumers (5% of consumers for the week of observation) receives intervention but are not in the consumer file. According to the provider, they are under the billing process. For them, geographical

roads, from one location to the other and the associated travel time (in normal traffic conditions).[12]

Table 1 presents the distribution these variables for one day. As the rounds are organized on a weekly basis,[13] these statistics are provided over one week. For instance, the first column presents the mean of the daily values over the week. I select the second week of October 2015, which is completely observed and not affected by holidays. On average, a caregiver spends a little more than 5 hours and a half in intervention during a day (or 70% of a daily full-time). 0.33 hour (20 minutes) over the inter-vacation time, which is on average of 2 hours and 12 minutes, is devoted to traveling. On average, the travel time represents 5% of the daily working time of caregivers (including both travel and interventions), with a maximum at 30%. There is a considerable variability in kilometers driven across caregivers, with a daily average of 12.9 kilometers, a standard deviation almost as large and a maximum of more than 80.5 kilometers for one day. A caregiver drives 2.2 kilometers per intervention hour, still with substantial variations. This short description of variables relative to the travels of caregivers shows the importance of caregiver travels as a provision constraint for the provider.

4 Methods

4.1 A micro-economic approach of travel costs

My approach builds on the micro-costing methodology (Guerre et al., 2018). The cost components are observed at a very detailed level. It makes it possible to identify resource inputs necessary to reach each consumer and their monetary equivalent can be computed.

information is missing and I am not able to reconstruct the time or the distance. 3 other individuals have inadequate geographical information (located outside of the department). In these cases, the distance and travel time from the preceding intervention or to the next were set to zero. The statistics provided are slightly underestimating actual distance and travel time.

[12] I use the Stata command `georoute`, which makes it possible to compute travel distance and time between two points using the geographical information in the data, namely the latitude and longitude of consumers (Weber and Péclat, 2017).

[13] See Appendix 8.3 for more details.

Table 1: Distribution of travel variables for one day

	Mean	Standard deviation	Median	Min	Max
Intervention hours [A]	5.59	1.64	5.63	1.38	12.08
Intervacation hours [B]	2.24	0.64	2.25	1.03	4.93
Travel hours [C]	0.33	0.25	0.28	0.00	1.84
Kilometers driven [D]	12.89	12.21	9.14	0.00	80.49
C over (A+C)	0.05	0.03	0.05	0.00	0.29
D over A	2.24	2.00	1.75	0.00	17.20

SAMPLE: 1,209 caregivers working during the week of observation.
SOURCE: data from one home care provider.

Micro-costing is relevant when it comes to compare costs across consumers and providers. It is generally used to reconstruct costs in order to explain their variations across sub-groups of consumers or providers. It considers overall costs tied to the care provision, comprising both fixed costs and variable costs.

I only focus on travel costs. Fixed costs are negligible in the home care provision and they are not varying within one provider. Variable costs comprise intervention costs and travel costs. Intervention costs mechanically correspond to the time spent in intervention, monetary valuated by the wage rate of caregivers. Contrary to the health care sector, there is no technological or drug-related costs in the care provision. Thus, costs related to interventions could be appropriately studied by showing the link between the characteristics of consumers, the volume consumed and the characteristics of the caregivers, which is rather straightforward. This will be partly done in this study but the main focus lies in the more ambiguous variations of travel costs according to consumer characteristics.

The micro-costing approach used is "top-down" (computing an average cost per patient or intervention) rather than "bottom-up" (individually evaluating the costs generated by each consumer). This is tied to the object of study. I am interested in the travel costs generated by the rounds of caregivers. It is methodologically hard to attribute to *each* consumer a given share of the costs generated by the travels necessary to reach her home and then to go to the next consumer. I will thus consider the daily round each consumer is part of, and compute a mean cost per intervention over the round.

4.2 Framework

Denote k a professional caregiver employed by the provider. I_k is the set of interventions of caregiver k for a given day. $j^k_{i,i'}$ is the journey through which the professional caregiver k goes from intervention i's location to intervention i''s location. $J(I_k)$ is the set of journeys needed to provide all interventions in I_k.

The transportation wage for the journey $j^k_{i,i'}$ can be written:

$$w(j^k_{i,i'}) = t^*_{i,i'}.w^0_k \tag{1}$$

Where $t^*_{i,i'}$ is the travel time to go from i to i' and w^0_k is the hourly wage of the caregiver k in travel.[14] The form of Equation (1) implies that the travel time between two interventions does not depend on the caregiver k while the wage rate does.

The compensation costs for the journey $j^k_{i,i'}$, corresponding to the money paid to the employee to cover, partly at least, the travelling expenses (car gaz, for instance), are written:

$$c(j^k_{i,i'}) = d_{i,i'}.r \tag{2}$$

Where $d_{i,i'}$ is the distance between i and i', and r is the fixed compensation rate per distance unit. The form of Equation (2), consistently with collective agreements, implies that compensation costs are linearly increasing with distance.

Travel costs for $j^k_{i,i'}$ are expressed as the sum of the compensation costs and the transportation wage:

$$C(j^k_{i,i'}) = c(j^k_{i,i'}) + w(j^k_{i,i'}) \tag{3}$$

$$= d_{i,i'}.r + t^*_{i,i'}.w^0_k \tag{4}$$

For each duos of interventions $\{i, i'\}$, I can thus compute the travel costs between the

[14] I could have differentiated between the effective travel time needed to go from i to i', $t^*_{i,i'}$, and the time paid by the provider to the caregiver for this journey, $t_{i,i'}$, as these two values do not necessarily equal. I also could have defined w^1_k the wage in intervention and let the possibility that $w^1_k \neq w^0_k$. But I stick for the moment to a simple framework.

first and the second intervention. In order to compare costs across caregiver rounds, the travel costs created by a round can be compared either to the total number of intervention provided during this round, or to the total number of hours provided. The first estimate is the "unitary" travel cost while the second is the "hourly travel costs".

The unitary travel costs for a caregiver k denoted u_k, is:

$$u_k = \frac{\sum_{i,i' \in J(I_k)} C(j^k_{i,i'})}{N_{I_k}} = \frac{\sum_{i,i' \in J(I_k)} d_{i,i'}.r + t^*_{i,i'}.w^0_k}{N_{I_k}} \tag{5}$$

Where N_{I_k} is the number of interventions provided by caregiver k during the day (I_k).

The hourly travel costs for a caregiver k denoted h_k, is:

$$h_k = \frac{\sum_{i,i' \in J(I_k)} C(J^k_{i,i'})}{\sum_{i \in I_k} h_i} = \frac{\sum_{i,i' \in J(I_k)} d_{i,i'}.r + t^*_{i,i'}.w^0_k}{\sum_{i \in I_k} h_i} \tag{6}$$

Where h_i is the duration of intervention i.

The hourly wage rate w^0_k is directly observed in the data and $d_{i,i'}$ and $t^*_{i,i'}$ are reconstructed. The compensation rate r used is the minimum rate of €0.35 per kilometer that is set by the collective agreement for non-profit home care providers.[15]

The distance and time driven from the caregiver home to the first location (and the return from her last intervention to her home) are not taken into account. According to the labour law, employees are not paid or compensated for these trips.[16] Consequently, isolated interventions, defined as the single intervention of the day for the caregiver, do not generate travel costs. These interventions, though, are quite rare (2.5% of interventions in the week of observation). When she serves several interventions during the day, the caregiver is not supposed to choose the order in which she sees consumers, as it is determined by the provider with the consumer. She is not able to serve the consumers closest to her home at the beginning and at the end, so as to externalize travel costs to

[15] This choice is made to grant the anonimity of the provider. This rate is lower than the rate actually used by the provider I study. Then, for a given distance, the cost computation would provided a lower bound for the travel cost borne by the provider I study.

[16] They can be compensated for kilometers if the distance is really high. I do not take this case into account.

the provider.

4.3 Econometric analysis of rounds

I am interested in the effect of travel costs on the organization of the home care provision. As the provider I study is a regulated (and non-profit) organization, it is supposedly accepting to serve any consumer asking for its services, wherever she lives. With our data, we cannot test this hypothesis as we only observe the effective consumers of the provider. Empirically, consumers are highly dispersed on the departmental territory, suggesting there is no *ex-ante* selection by the provider.

Travel costs could influence other dimensions of the organization of rounds. While the provider is not allowed to select consumers, it could adapt the caregiver's rounds to lower its costs and influence, at least marginally, the duration of visits. I study econometrically study this link, while controlling for consumer and caregiver characteristics. If the provider is able to manipulate the duration of interventions, it could try to increase the duration of interventions for costly to serve consumers, in order to diminish the number of interventions served during the week. Conversely, the provider might face an important demand and choose to limit the duration of interventions when travel time is important in order to be able to serve an important number of consumers in the area during the day.

I use the unitary travel cost, resting on the number of consumers served during the day, rather than the hourly travel costs, which takes into account the duration of intervention in its construction. The estimated model is the following:

$$log(y_i) = \beta_0 + \beta_1 X_{c(i)} + \beta_2 X_{k(i)} + \beta_3 X_i + \beta_4 log(u_k + 1) + \epsilon_i \tag{7}$$

Where y_i is the duration of intervention i provided to consumer $c(i)$ by caregiver $k(i)$ on the day of observation. $X_{c(i)}$ is a set of characteristics for the consumer receiving the intervention i (APA status, APA disability group, APA participation rate, consumption on Sunday), $X_{k(i)}$ controls for caregiver's characteristics (qualification, experience, con-

tractual working time) and X_i corresponds to the characteristics of the intervention (tasks performed, day of intervention). $log(u_k + 1)$ is the logarithm of the unitary cost for the round of caregiver k during that day where one is added to deal with zero values. ϵ_i is the error term. As our variable of interest, u_k, is at the level of one day for one caregiver, standard errors are clustered at the caregiver level, assuming there might be a correlation of disturbances in the measurement of intervention lenght at the caregiver level.

5 Results

5.1 Travel costs

Table 2 presents the travel costs generated by a daily round and the associated unitary and hourly travel costs, computed with the formula given in Equations (4), (5) and (6). During the week of observation, a caregiver round generates on average a daily cost of approximately €8, with a large dispersion. Comparing this cost to the number of interventions provided during the round, we get the unitary travel cost which is, on average, of about €2.07 per intervention, with a minimum of zero and a maximum of €6.7. As interventions are, on average, longer than one hour, the average hourly travel cost falls to €1.4. We compare it to the price range provided by Hege et al. (2014) for one hour of care: in 2012, the provider prices of the largest home care providers declared by departmental councils were between €17.1 and €23.[17] The price charged by our provider belongs to this range. Then, the hourly travel costs represent between 6% and 8% of the provider price.[18] The maximum value of the hourly travel cost is much higher than the maximum unitary travel cost (€10.6 versus €6.7), revealing rounds with important travel time and distance to provide relatively short interventions.

[17] In departments fixing one price per provider (46/67). See Hege et al. (2014) for more details.

[18] I do not compare the unitary cost to the provider price, as it is less meaningful. Indeed, serving one hour of care generates a revenue equal to the hourly price, while it is not necessary the case when serving one consumer.

Table 2: Travel costs over daily rounds

	Mean	Standard deviation	Median	Min	Max
Cost of one daily round	7.95	6.83	6.14	0.00	47.40
Travel cost per intervention	2.07	1.40	1.83	0.00	6.72
Travel cost per hour of intervention	1.39	1.10	1.16	0.00	10.62

SAMPLE: 1,209 caregivers working during the week of observation.
SOURCE: data from one home care provider.

5.2 Determinants of travel costs

5.2.1 Spatial distribution of consumers

Travel costs are expected to depend on the spatial distribution of consumers. Several public reports have underlined that serving rural areas is more costly than serving urban areas because of travel costs. This section evaluates how this assessment holds in this case study.

To characterize the place where consumers live, I use the "urban unit" (*unité urbaine*).[19] It is defined by the French National Institute of Statistics and Economic Studies(INSEE) as: "a municipality or a group of municipalities which includes a continuously built up zone (no cut of more than 200 meters between two constructions) and at least 2,000 inhabitants."[20] This definition rests mostly on morphological conditions (neighbouring municipalities) and size. The INSEE classification isolates municipalities that are outside an urban unit (rural municipalities) and the others that are differentiated according to their size: less than 10,000 inhabitants (that we will call small urban unit), between 10,000 and 50,000 inhabitants (intermediate urban unit), 50,000 to 1,000,000 (upper-intermediate urban unit) and between 1,000,000 and 2,000,000 (large urban unit). 26.5% of consumers served by the provider live in a rural municipality (Table 3). More than one third of consumers live in a urban unit with more than 1,000,000 inhabitants. 21% live in small urban units (with less than 10,000 inhabitants) and the last 15% live

[19] See Appendix 8.4 for the discussion of the observation unit.
[20] Reference: https://www.insee.fr/en/metadonnees/definition/c1501

in intermediate urban units. For the provider, the heterogeneity of areas to serve is thus remarkably high.

I compute travel distance, time and costs at the urban unit level. For each journey I observe, I attribute the travel distance, time and costs to the urban unit where consumers both live. When the journey connects two consumers who do not live in the same urban unit (40% of travels), I attribute half of the distance, time and costs to each area. The travel distance, time and costs per intervention served are the highest in rural municipalities and they decreases with the size of urban units (Table 4). One intervention is associated to 5.36 kilometers on average in rural municipalities, while it falls to 2.60 in large urban units. The difference in unitary times is smaller, though significant. One intervention is associated to 0.12 hours of travel (7 minutes) in rural areas while it is 0.08 in large urban units. Even though the difference is significant, its magnitude is much lower than the difference in the distance. It probably reflects differences in travel speed in the different areas. Hourly variables, when travel distance, time and costs are compared to the number of hours provided, reveals the same trend. Yet, the difference is not significant for the travel time, meaning that the difference in the unitary travel time are compensated by difference in the duration of interventions. The difference in travel costs is close to be significant (p-value at 0.13).

Overall, the travel costs are varying according to the area served, especially because of longer distances to drive in rural areas. There is, however, another potential source of variation. Consumers living in each area do not have the same characteristics, as shown in Table 4. APA beneficiaries are over-represented in rural municipalities. Among them, severly disabled individuals are also over-represented in rural municipalities and small urban units. Low-income APA beneficiaries are also to be found in rural municipalities, as shown by the increase in the average copayment rate, which is a linear increasing function of income (from 16% in rural municipalities to 23% in the large urban units). Regarding consumption profiles (Table 3), the main differences are observed for large urban units, where the average duration of interventions is higher and the number of interventions

provided during the week is lower. There is no significant difference between the average volume received by consumers according to the area of residence. One could have expected important gaps in the consumption given the significant differences in the disability status. The next section focuses more specifically on the link between the disability level and the consumption profile.

Table 3: APA status, consumption profile and area of residence of consumers

	Rural municipalities	Small UU	Intermediate UU	Large UU	Total	Difference (p-value)
Consumers	26.5%	21.2	14.8%	37.5%		
Characteristics						
APA beneficiaries	57.48%	51.81%	51.81%	48.51%	51.51%	0.00
Among APA beneficiaries:						
Co-payment rate	0.16	0.20	0.23	0.23	0.20	0.00
Disability group 1-2 (most severe)	22%	21%	16%	18%	20%	0.02
Disability group 3	24%	23%	26%	27%	25%	
Disability group 4 (moderate)	53%	56%	57%	55%	55%	
Consumption						
Weekly volume (hours)	3.61	3.63	3.62	3.57	3.60	0.91
Length of interventions (hours)	1.79	1.80	1.74	1.87	1.81	0.00
Number of interventions	2.45	2.44	2.54	2.29	2.40	0.04

SAMPLE: 8,078 consumers served during the week of observation.
SOURCE: data from one home care provider.
NOTES: 428 consumers served during this week but with missing geographic information were excluded from the sample. "UU" stands for urban unit. P-values from Anova (resp. Pearson χ^2) test for continuous (resp. categorical) variables.

5.2.2 Disability levels of consumers

This section underlines another determinant of travel costs: the organization of rounds depends on the characteristics of the demand and it impacts on travel costs. Indeed, the more severely disabled individuals are, the higher the travel costs of the associated rounds. The consumption of highly disabled individuals is indeed more fragmented than the consumption of others. The volume they consume is higher (Figure 2) and they receive interventions more frequently: over the week of observations, GIR 1-2 individuals

Table 4: Travel costs and area of residence of consumers

	Rural municipalities	Small UU	Intermediate UU	Large UU	Total	Difference (p-value)
Unitary						
Distance (km)	5.36	4.94	3.84	2.60	4.72	0.01
Time (hours)	0.12	0.12	0.10	0.08	0.11	0.05
Cost	3.09	2.92	2.38	1.75	2.82	0.02
Hourly						
Distance (km)	3.66	3.27	2.74	1.69	3.16	0.07
Time (hours)	0.08	0.08	0.07	0.05	0.07	0.24
Cost	2.11	1.94	1.69	1.14	1.88	0.11

SAMPLE: 65 areas with consumers served during the week of observation.
SOURCE: data from one home care provider.
NOTES: "UU" stands for urban unit. P-values from Anova tests. "unit" variables correspond to the variables (distance, time and cost) divided by the number of interventions provided in the urban unit; "hourly" correspond to the variables (distance, time and cost) divided by the number of hours of intervention provided during the day.
READING: in rural municipalities, the average distance driven per intervention is 5.36 kilometers. The average travel time per intervention is 0.12 hours (7 minutes). The travel cost is at €3.09 per intervention.

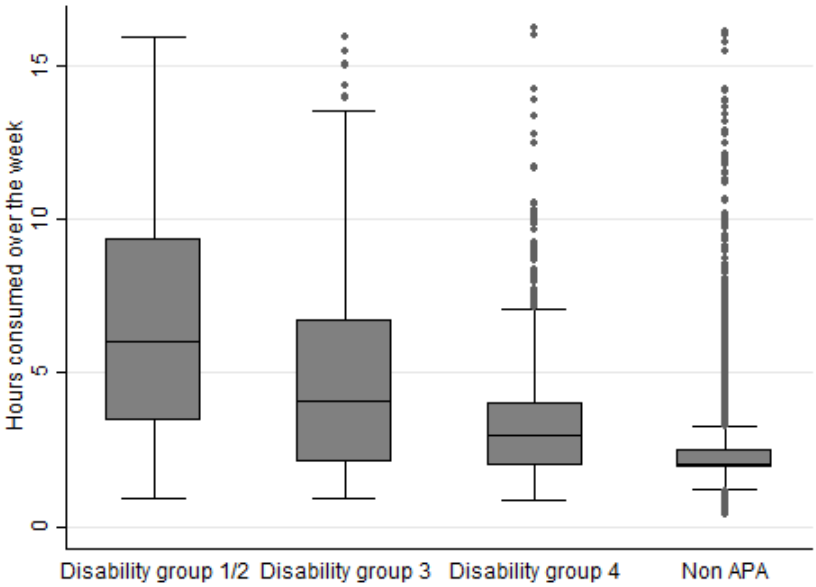
receive on average 6 interventions, while it falls to 3.6 for GIR 3 individuals, 2 for GIR 4 individuals and less than 1.5 on average for non-APA beneficiaries. The interventions for highly disabled individuals are also shorter than individuals with a lower disability level (Figure 3). This is tied to the type of care being provided: interventions including personal care are shorter than the others, like house chores. They are more frequently provided to disabled individuals: 51% of interventions provided to GIR 1-2 individuals include personal care, while this percentage is of 37% and 20% for GIR 3 and GIR 4 individuals, and it falls to 20% for non-APA individuals. These differences in the structure of the consumption according to the disability level has also been observed in the study of nursing providers serving consumers at home (Chevreul, 2009). It could be reinforced by the prescription of the socio-medical team in the APA program: in some departments, the care plan volume is set up such that the provider has to give frequent and repeated interventions (Ministère des affaires sociales et la santé, 2016).

A specific matching between the consumer characteristics and the caregiver qualification is additionnally observed. When consumers are severely disabled, they are more

frequently provided care by a qualified caregiver. 40% of interventions provided to GIR 1 and 2 are served by caregivers with high qualification level (C category), while it is 30% for disability group 3 and 25% for disability group 4 and non-APA consumers. This distribution echoes the specialization according to qualification: when a caregiver is highly qualified, 48% of her interventions on average include personal care whereas this percentage falls to 37% and 14% for middle- and low-qualified caregivers respectively. Conversely, interventions for household chores are more systematically provided by low- and middle-qualified caregivers: when the caregiver belongs to the A or B category, 84% and 67% of interventions include household chores, while it falls to 61.5% when the caregiver is C. Consequently, the more skilled the caregivers, the shorter their interventions (Figure 4). It thus increases the time spent travelling, which is also paid at a higher wage rate.

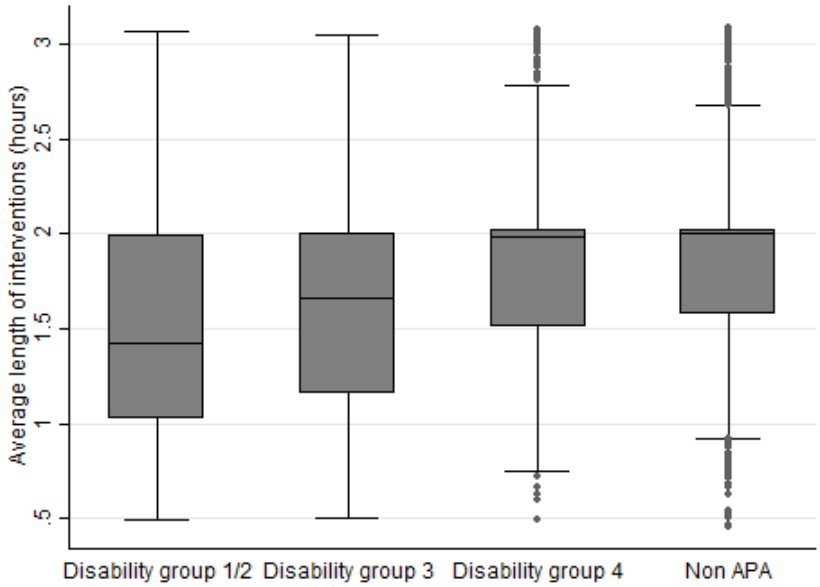
Overall, rounds including severely disabled individuals tend to be more fragmented than the others. Thus, they generate high travel time and distance. As the caregivers serving disabled individuals are more qualified, this travel time is mechanically paid at a higher wage rate. Rounds serving highly disabled individuals are expected to be more costly for the provider.

Figure 2: Weekly volume consumed, by disability group



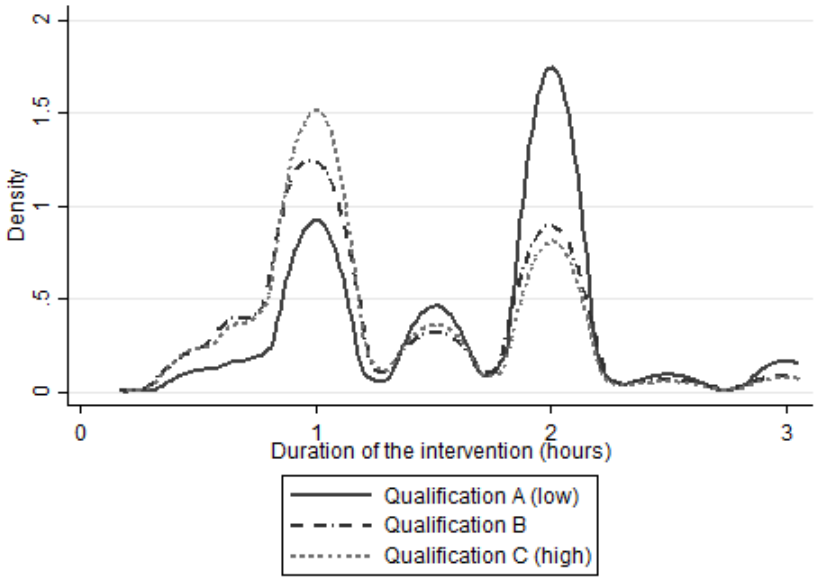
Sample: 8,506 consumers served during the week of observation, among which 85 consumers having the 1% highest volumes have been excluded to ease the reading of the graph.
Source: data from one home care provider.
Notes: disability group 1-2 corresponds to the more severe disability group in the APA program, while disability group 4 corresponds to a moderate disability level.

Figure 3: Average duration of interventions, by disability group



Sample: 8,506 consumers served during the week of observation, among which 76 consumers having the 1% highest duration have been excluded to ease the reading of the graph.
Source: data from one home care provider.
Notes: disability group 1-2 corresponds to the more severe disability group in the APA program, while disability group 4 corresponds to a moderate disability level.

Figure 4: Duration of interventions depending on qualification



Sample: 20,061 interventions provided during the week of observation, among which 195 interventions having the 1% highest duration have been excluded to ease the reading of the graph.
Source: data from one home care provider.

5.3 Travel costs and duration of interventions

Table 5 presents the estimation of Equation 7, with the duration of intervention and the unitary travel cost with a logarithm transformation. Other things being equal, an increase in the unitary travel cost significantly shortens the intervention. The effect, though, has a very limited magnitude: when the travel cost of the round is increasing by 1% by per intervention served during the day, the duration decreases by 0.06%, on average. For the average intervention during 90 minutes, it represents a decrease of about 5 minutes. This decrease is potentially driven by marginal adjustments of caregivers: caregivers may leave consumers more rapidly, or arrive a bit latter, when the relative travel distance and time are important in the day compared to the number of consumers served.

Turning to consumer characteristics, the duration of interventions decreases with the disability level: non-APA beneficiaries have longer interventions than APA beneficiaries and in within this group, moderately disabled individuals have longer interventions (GIR-4) than the others. There is no effect of the copayment rate. Individuals having interventions recorded on Sunday have much shorter interventions, suggesting that they need shorter but potentially more frequent interventions. At the caregiver level, a low qualification entails slightly longer interventions, potentially reflecting that productivity correlates with qualification.

Compared to interventions devoted to personal care, interventions for housekeeping or activities like gardening, manual work and shopping are much longer, while there is no difference compared to interventions related to meals (preparation or administration). When several types of tasks are performed, the intervention is also longer. Finally, interventions are shorter during the week-end than during the week. It potentially reveals that interventions are shorter during days when informal care or visits from relatives are more likely.

Other indicators reflecting the organization of rounds would deserve attention, in particular, the number of visits received each week or the total volume consumed. The methodological issue would then be to impute to each consumer a given travel costs. It

has not been adressed yet in this work and could be a future developement.

Table 5: Travel costs and duration of interventions

	Log-duration of the intervention
Travel cost per intervention (log)	-0.064***
	(0.010)
Consumer characteristics	
Not APA beneficiary	0.053***
	(0.012)
APA disability level 1-2 (severe)	-0.004
	(0.012)
Ref: APA disability level 3	
APA disability level 4 (moderate)	0.037***
	(0.010)
APA copayment = 0%	-0.017
	(0.014)
Ref: 0 < APA copayment < 90%	
APA copayment ≥ 90%	0.052
	(0.033)
Consumes on Sunday	-0.252***
	(0.013)
Not in the billing file	0.059**
	(0.024)
Caregiver characteristics	
Qualification A (low)	0.053***
	(0.013)
Ref: Qualification B	
Qualification C (high)	0.009
	(0.015)
Experience (years)	0.001
	(0.001)
Intervention characteristics	
Only housekeeping	0.528***

Continued on next page

Table 5 - *Continued from previous page*

	Log-duration of the intervention (minutes)
	(0.017)
Ref: Only personal care	
Only meals	0.021
	(0.019)
Only gardening, manual work, shopping	0.342***
	(0.044)
Several tasks performed	0.264***
	(0.015)
Ref: Monday, Tuesday, Thursday, Friday	
Wednesday	-0.006
	(0.006)
Week-end	-0.106***
	(0.015)
Constant	4.147***
	(0.023)
Observations	20,061
Number of clusters	1,233
R–squared	0.437

SAMPLE: 20,061 interventions provided during the week of observation.

SOURCE: remote management system recordings and pay file of a French home care provider.

NOTES: Standard errors in parentheses, clustered at the provider level; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Estimation of a linear model.

6 Discussion

The precise information obtained on the rounds is at the price of limited external validity. The results obtained on the travel costs, their sources of variation and their effect on

the home care provision are obtained for a given provider, observed during a given week. Nonetheless, the structure of the consumption (with more fragmented for severe disability levels) should not be specific to the provider. Indeed, this organization tends to be structural to the demand of severly disabled individuals, who need short and frequent interventions (Chevreul, 2009). The spatial distribution of the consumers, with APA beneficiaries — and especially those severely disabled — living in rural municipalities or in small urban units, is similar to the general trend observed in France, with the elderly representing a higher share of the population in rural areas (Albertini, 2018). Overall, the evidence of a distorsion of travel costs induced by the service of highly disabled individuals could be regarded as a contribution going beyond the case study.

We have limited information on the consumers' sociodemographic characteristics, as well as on the other professional providers serving the department. It is problematic since informal care and potential consumption from other professional providers are likely to be unequally distributed according to the area of residence. Important travel costs for informal caregivers are associated with higher costs for informal care and a higher willingness to pay for formal care (Fevang et al., 2008; Davin et al., 2015). Thus, differences in the consumption profil according to the area of residence are potentially reflecting differences in informal care provision and availability of other professional services.

The travel costs computed are additionnaly widely depending on the methodological choice made in study, especially regarding the computation of the travel time and the monetary valuation of the distance. In general, providers do not observe the exact travel time spent between two interventions and they compute the travel cost rather using flat period of time for each travel. Further developments could compare the travel costs computed with the reconstituted time and the travel costs effectively borne by the provider.

Given our results, the pricing process of providers and its implication for consumers deserves attention. Imposing a uniform price to all the consumers of one provider, as is done in the home care sector, organizes a transfer from less costly to serve to more

costly to serve providers. In general, it is economically inefficient as it is similar to a targeted subsidy. This cost balancing, though, has spatial equity purposes (Fleurbaey and Trannoy, 1998). In our case, we are considering a service that is provided both to a fragile population, whose consumption is partially publicly financed (APA beneficiaries), and to "classical" consumers, who receive privately funded comfort services. Thus, the relevance of the cost balancing organized by the uniform pricing should be assessed with an insight on which group belong the costly to serve consumers. In this case study, the APA beneficiaries are found to be over-represented in costly to serve areas, because of geographical constraints as well as because the characteristics of their demand. Hence, on average, severly disabled individuals — and especially those living in rural areas or small urban units — benefits from the redistribution organized by the uniform price.

7 Conclusion

This paper studies the importance of travel costs borne by a professional home care provider due to the travels of caregivers, and their effect of the organization of the care provision. Travel costs are higher in rural municipalities and small urban units. This is due to geographical constraints, but also to the characteristics of the demand in these areas. Indeed, severely disabled individuals are over-represented in these areas and they generate more costly rounds, due to fragmentation of the interventions they receive and the higher wage rate of caregivers they receive care from. Finally, limited effect of travel costs on duration of intervention is found.

These results are descriptive and they are obtained on a given home care provider, with its specific organization and a given week of observation. They can hardly be extended beyond this case study but they give an insight of the importance of travel costs and their consequences for consumers. More work is needed on this topic, regarding the modeling of travel costs in the care provision function and their effect on both the organization of providers and the delivery of care to consumers.

References

Albertini, J.-B. (2018): "Le vieillissement de la population et ses enjeux," Fiche d'analyse de l'observatoire des territoires, Observatoire des Territoires.

Arnault, L. (2015): "La prise en charge des personnes âgées dépendantes : analyse microéconométrique de l'aide familiale," Thèse pour le Doctorat ès Sciences Economiques, Université Paris Dauphine, Paris.

Aube-Martin, P., A. Bruant-Bisson, and J.-B. De Reboul (2010): "Mission relative aux questions de tarification et de solvabilisation des services d'aide à domicile en direction des publics fragiles," Rapport RM2010-138P/ IGF 2010-M052-02, Inspection générale des affaires sociales, Inspection générale des finances.

Bachouch, R. B., M. Fakhfakh, A. Guinet, and S. Hajri-Gabouj (2009): "Planification des tournées des infirmiers dans une structure de soins à domicile," .

Begur, S. V., D. M. Miller, and J. R. Weaver (1997): "An integrated spatial DSS for scheduling and routing home-health-care nurses," *Interfaces*, 27, 35–48.

Bertels, S. and T. Fahle (2006): "A hybrid setup for a hybrid scenario: combining heuristics for the home health care problem," *Computers & Operations Research*, 33, 2866–2890.

Blondel, F., S. Delzescaux, and B. Fermon (2013): "Mesure de la qualité et qualité de la mesure de l'aide au domicile Construction des points de vue sur la qualité de l'aide à domicile," Rapport, LEDa Legos ; Laboratoire de changement social.

Branchu, C., V. Jaouen, and P. Naves (2015): "Evaluation des expérimentations relatives à la tarification des services d'aide et d'accompagnement à domicile (SAAD)," Tech. Rep. 2014-130R, Inspection générale des affaires sociales.

Button, K. J. (1993): *Transport economics*, Aldershot, England: Edward Elgar Publishing, 2^{nd} ed.

Cassou, M. (2017): "About the optimality of competition among health-care providers," Ph.D. thesis, Paris 1 Panthéon Sorbonne.

Cazals, C., M. de Rycke, J.-P. Florens, and S. Rouzaud (2004a): "Monopole naturel et économies d'échelle dans la distribution postale," in *Economie postale. Les fondements.*, Economica.

Cazals, C., P. Duchemin, J.-P. Florens, B. Roy, and O. Vialaneix (2004b): "Une étude économétrique des élasticités du coût de production des guichets postaux," in *Economie postale. Les fondements.*, Economica.

Chevillard, G., V. Lucas-Gabrielli, and J. Mousques (2018): "« Déserts médicaux » en France : état des lieux et perspectives de recherches," *LEspace geographique*, Tome 47, 362–380, publisher: Belin.

Chevillard, G., J. Mousques, V. Lucas-Gabrielli, Y. Bourgueil, S. Rican, and G. Salem (2015): "Mesure de l'impact d'une politique publique visant à favoriser l'installation et le maintien de médecins généralistes : l'exemple du soutien au développement des maisons et pôles de santé en France," *Revue d'économie Régionale & Urbaine*, 4, 657–694.

Chevreul, K. (2009): "Les patients en service de soins infirmiers à domicile (SSIAD). Le coût de leur prise en charge et ses déterminants," Etude réalisée par l'URC Eco IdF, Direction générale de l'action sociale.

Crampes, C. and M. Laffont (2014): "Connection Pricing and Universal Service Obligations in Distribution Networks," *Competition and Regulation in Network Industries*, 15, 32–58.

Davin, B., A. Paraponaris, and C. Protière (2015): "Pas de prix mais un coût ? évaluation contingente de l'aide informelle apportée aux personnes âgées en perte d'autonomie," *Economie et statistique*, 475, 51–69.

DREES (2016): *Enquête annuelle Aide sociale auprès des conseils départementaux.*

Ettner, S. L. (1994): "The effect of the Medicaid home care benefit on long-term care choices of the elderly," *Economic Inquiry*, 32, 103–127.

Eveborn, P., P. Flisberg, and M. Rönnqvist (2006): "Laps Care: an operational system for staff planning of home care," *European Journal of Operational Research*, 171, 962–976.

Fevang, E., S. Kverndokk, and K. Roed (2008): "A Model for Supply of Informal Care to Elderly Parents," Working Paper 12.

Fleurbaey, M. and A. Trannoy (1998): "La péréquation territoriale en question," *Flux*, 14, 91–98.

Garabige, A., B. Gomel, and L. Trabut (2015): "Dynamiques de transformation des modèles économiques des structures de l'économie sociale et solidaire dans les services à domicile. Analyse de cas," Rapport 90, Centre d'Etude de l'Emploi.

Gramain, A. and J. Xing (2012): "Tarification publique et normalisation des processus de production dans le secteur de l'aide à domicile pour les personnes âgées," *Revue française des affaires sociales*, 218–243.

Guerre, P., N. Hayes, and A.-C. Bertaux (2018): "Estimation du coût hospitalier : approches par "micro-costing" et "gross-costing"," *Revue d'épidémiologie et de Santé Publique*, 66, S65–S72.

Hege, R. (2018): "La régulation du marché de l'aide à domicile," Ph.D. thesis, Paris 1 Panthéon Sorbonne.

Hege, R., Q. Roquebert, M. Tenand, and A. Gramain (2014): "La tarification des services d'aide à domicile : un outil au service des politiques départementales ?" Notes MODAPA 2.

Lucas-Gabrielli, V., A. Pierre, L. Com-Ruelle, and M. Coldefy (2016): "Pratiques spatiales d'accès aux soins," Les rapports de l'IRDES 564, IRDES.

Ministère des affaires sociales et la santé (2016): "Aide à domicile aux personnes âgées : le guide des bonnes pratiques," Tech. rep.

Mosca, I., M. Pomp, and V. Shestalova (2010): "Market Share and Price in Dutch Home Care: Market Power or Quality?" *De Economist*, 158, 61–79.

Poletti, B. (2012): "Mission relative aux difficultés financières de l'aide à domicile et aux modalités de tarification et d'allocation de ressources des services d'aide à domicile pour publics fragiles," Mission confiée par Madame Roselyne Bachelot-Narquin, Ministre des Solidarités et de la Cohésion Sociale.

Ramos-Gorand, M. (2015): "Accompagnement professionnel de la dépendance des personnes âgées: enjeux territoriaux en France métropolitaine," Ph.D. thesis, Université Paris Est Créteil.

Roquebert, Q. and M. Tenand (2017): "Pay less, consume more? The price elasticity of home care for the disabled elderly in France," *Health Economics*, 26, 1162–1174.

Vanlerenberghe, J.-M. and D. Watrin (2014): "Rapport d'information fait au nom de la Commission des affaires sociales sur l'aide à domicile," Rapport d'information 575, Sénat.

Weber, S. and M. Péclat (2017): "A simple command to calculate travel distance and travel time," *Stata Journal*, 17, 962–971.

8 Appendices

8.1 Travel and waiting times in collective agreements

In for-profit enterprises, waiting time is paid up to 15 minutes. When the waiting time is higher than 15 minutes, the employee is regarded as free to go on with her own activities. In non-profit providers, the collective agreement does not give a common direction for all providers: it only states that any work break with the employee remaining at the disposal of the employer is regarded as effective paid work.

This section presents extracts from the collective agreements dealing with waiting and travel time, both for the employees of for-profit home care providers (*"Convention collective nationale des entreprises de services à la personne du 20 septembre 2012"*) and for the employees of non-profit home care providers (*"Convention collective nationale de la branche de l'aide, de l'accompagnement, des soins et des services à domicile du 21 mai 2010"*).

Extracts from the collective agreement for for-profit home care enterprises, *"Convention collective nationale des entreprises de services à la personne du 20 septembre 2012"* :

"Le temps de déplacement professionnel pour se rendre d'un lieu d'intervention à un autre lieu d'intervention constitue du temps de travail effectif lorsque le salarié ne peut retrouver son autonomie." (Section 2, chapitre I)

"Les temps entre deux interventions sont pris en compte comme suit :
- en cas d'interruption d'une durée inférieure à 15 minutes, le temps d'attente est payé comme du temps de travail effectif ;
- en cas d'interruption d'une durée supérieure à 15 minutes (hors trajet séparant deux lieux d'interventions), le salarié reprend sa liberté pouvant ainsi vaquer librement à des occupations personnelles sans consignes particulières de son employeur n'étant plus à sa disposition, le temps entre deux interventions n'est alors ni décompté comme du temps de travail effectif, ni rémunéré." (Section 2, chapitre I)

Extracts from the collective agreement of non-profit home care providers, *"Convention collective nationale de la branche de l'aide, de l'accompagnement, des soins et des services à domicile du 21 mai 2010"* :

"Le temps de travail effectif est le temps pendant lequel le salarié est à la disposition de l'employeur et doit se conformer à ses directives sans pouvoir vaquer librement à des occupations personnelles. Sont donc notamment des temps de travail effectif : [...]
– les temps de déplacement entre deux séquences consécutives de travail effectif ;" (Titre V, chapitre I, A, Article 1er)

"Sont comptabilisés comme du temps de travail effectif les temps de pause pendant lesquels les salariés restent en permanence à la disposition de l'employeur." (Titre V, chapitre I, A, Article 14)

"Les temps de déplacement entre deux séquences consécutives de travail effectif sont considérés comme du temps de travail effectif et rémunérés comme tel." (Titre V, chapitre I, A, Article 14)

Table 6 summarizes the wage for travel time and waiting time according to the status of the home care provider.

Table 6: Travel and waiting time in French collective agreements

	For-profit providers	Non-profit providers
Travel time	Paid as working time	Paid as working time
Waiting time	Paid as working time if inferior to 15 minutes	Paid as working time if the employee remains at the disposal of her employer

SOURCES: collective agreement enforced in for-profit home care enterprises (2012) and collective agreement in non-profit home care providers (2010).

To allow comparisons, I detail how travel time is taken into account in the home care sector in the United-States and in the United-Kingdom.

In the United-States, regulation is closed to what is proposed in France for non-profit providers. According to the Department of labor, travel time from job site to job site must be paid whatever its duration. Travel from worker's home to work are not paid.[21]

"A worker who travels from home to work and returns to his or her home at the end of the workday is engaged in ordinary home-to-work travel which is a normal incident of employment. Normal travel from home to work and return at the end of the workday is not work time. This is true whether the employee works at a fixed location or at a different location each day. [...]

Travel that is all in a day's work, however, is considered hours worked and must be paid.

Example: Barbara is a personal care aide providing assistance to Mr. Jones. Barbara drives him to the Post Office and grocery store during the workday. Barbara is working and the travel time must be paid.

Travel away from the home is clearly work time when it cuts across the employee's workday. The employee is merely substituting travel for other duties. Thus, if an employee hired to provide home care services to an individual (consumer) accompanies that

[21]Source: https://www.dol.gov/whd/homecare/travel_time.htm

consumer on travel away from home, the employee must be paid for all time spent traveling during the employee's regular working hours. [...] However, periods where the employee is completely relieved from duty, which are long enough to enable him or her to use the time effectively for his or her own purposes, are not hours worked and need not be compensated."

In the United-Kingdom, a range of types of working time is provided, including time spent "at work and required to be working, or on standby near the workplace" and "travelling in connection with work, including travelling from one work assignment to another". It excludes explicitly "travelling between home and work", "away from work on rest breaks".[22]

The following examples, based on the home care sector, are provided:

"Example 1

A care worker has 2 appointments in the morning and doesn't take any breaks. The worker must be paid at least the minimum wage for the time hespends at the appointments, plus the travel time between appointments.

Example 2

A care worker has 2 appointments, one in the morning and one in the afternoon. After the first appointment he goes home to have a break before he goes to his afternoon appointment. The time spent travelling from the first appointment to his home and from his home to the second appointment doesn't count towards the minimum wage. If the care worker didn't go home but took a break on the way to his next appointment, he would be paid for any travel time but not for the break."

[22]Source: https://www.gov.uk/minimum-wage-different-types-work/overview

8.2 Data cleaning and matching

The initial billing file counts 18,105 lines, corresponding to 10,234 consumers. The monthly consumption of one consumer was associated with several billing lines when it corresponded to several administrative operations. Administrative lines can be due to cancellations or adjustments (i.e. previous excess payment); other administrative lines are due to a shared financing: when the financing of an intervention is shared between the consumer and an external subsidizing institution (the departmental council for instance), two lines are observed, one for each source of funding. Several lines for the same consumer can also be due to the consumption of different types of hours: the billing file differentiates between week hours, week-end hours or delayed hours.

I reshaped the data to get one line per consumer. I dropped the administrative lines when they were not associated with a consumption line in the month of observation (i.e. adjustment of anterior consumption). Doing so, I loose 7 consumers. I also dropped 9 consumers presenting strong inconsistencies in their consumption. I suppressed consumers when they do not have any consumption billed for the month of observation (18 consumers). I end up with a database of 10,200 lines corresponding to 10,200 individuals.

The pay file initially counted 1,522 lines, corresponding to 1,517 employees. 5 employees have 10 lines, because their work contract changed during the period. I sum the hours they provided and the wage they get in the two lines. I retain the latest value of contractual work hours and the higher level of qualification and years of experience. For one employee, the second line of observation is inconsistent and I drop the line without changing the other line. I end up with a database of 1,517 employees.

The database on interventions (remote management system recordings) initially counted 134,112 interventions, corresponding to 88,929 interventions provided by 1,332 employees to 10,310 consumers.[23] One intervention is associated with several lines when several tasks are done during this intervention (body care, housekeeping, shopping, meals). I simply reshaped the database to get one line per intervention, with several variables indicating the type of tasks that have been performed during the intervention. The main cleaning I had to do is related to the starting and ending hours registered in the data: I observe some juxtaposition of interventions the same day for the same caregiver. Some juxtapositions are due to duplication (same hours, same employee, same consumer for the two interventions). I drop one line over the two (19 lines are dropped). The other case is when the starting hour of an intervention is anterior to the end hour of the previous (283 interventions). I assume that the employee forgot to signal the end of the first intervention and I set the end hour of the first intervention at the starting hour of the second one

[23] The numbers of employees and consumers do not exactly correspond to the billing and pay databases. See below the paragraph on the matching.

(no inter-vacation periods will be observed between these interventions). I end up with a database of 88,910 interventions.

In the database on interventions, I observe the identifying number of the employee and the consumer. I am thus able to matching it with the pay database and the billing database. The matching, however, is not perfect. I detail here the (partial) correspondence between the three database. In the database on interventions, 1,332 employees are providing care. Compared to the pay database, 185 employees are missing. 158 have no working hours registered in the pay database, meaning they are in vacation or previous employees not yet erased from the file. The other 27 employees have working hours registered. It should correspond to the employees providing care to consumers without the remote management system recordings. In the database on interventions, 10,310 consumers are provided care. Compared to the billing database, some consumers are missing: 461 consumers are in the billing database without being in the intervention database. It probably corresponds to the consumers that do not use the remote management system recordings. Other consumers are observed in the intervention database whereas they are not in the billing database: it is the case for 2,933 interventions, corresponding to 570 consumers. According to the provider, there are consumers who were not charged for care yet. Overall, 9,740 consumers are found both the remote management system recordings and in the billing file.

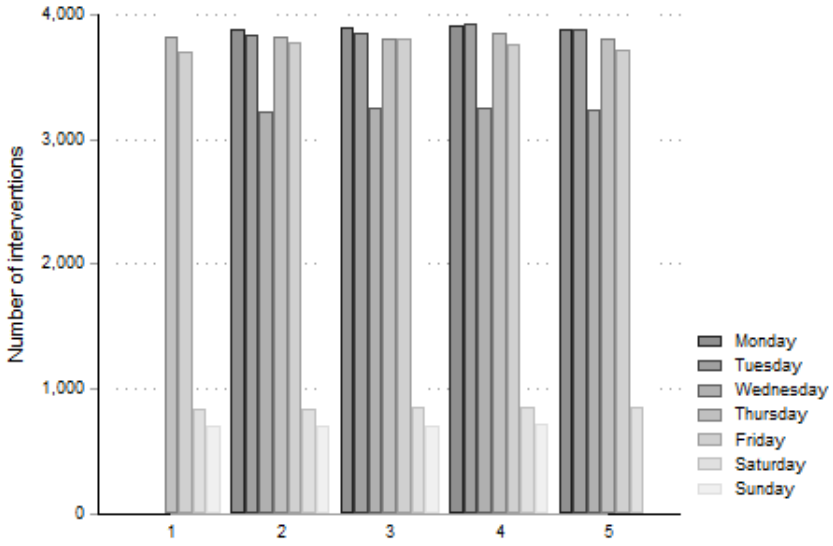
8.3 A weekly schedule

Our data show strong regularities in home care consumption for individuals from one week to another: I observe that individuals most often receive care the same day(s) each week and they consume the same volume of care, at the same hour.

I first describe the distribution of interventions over days in the week, during the month (Figure 5). A week correspond to the days between Monday and Sunday. The first and the last weeks are then truncated: the first starts at Thursday and the last ends at Saturday. The number of interventions for each day of the week is stable, with a slightly lower number of interventions during Wednesday and a consequential drop in the number of interventions provided during the week-end. The Figure shows that the daily number of interventions is relatively stable from one week to another. At the individual level, I define individuals as "regular" if they have the same day(s) of consumption each week. For instance, Mister B. will consume every Monday and Wednesday, but will never consume on Tuesday, on Thursday or during the week-end. It is the case for 62% of the 10,310 consumers over the month of October 2015. Overall, the probability of consuming one given day of the week is of 85% when an individual has consumed that day the preceding week, while it falls to 6% when she did not consumed that day the preceding week.

If I add a condition on the beginning hours of the interventions, I see that 81% of interventions occurring during the second week have at least one "twin" intervention, that is to say one intervention occurring the same day of the week, at the same time window (same beginning and ending hours, plus or minus one hour). The volume consumed one given day of the week is also very similar from one week to another. The correlation coefficient between the volume consumed a given day in different weeks is at minimum of 0.74 (week 2 to week 5) and at maximum of 0.82 (week 2 to week 4).[24]

Figure 5: Distribution of interventions over days of the weeks during the month



SAMPLE: 88,910 interventions recorded in the remote management system during October 2015.
NOTES: the first and the last week are truncated: the first starts at Thursday 1^{st} and the last ends at Saturday 31^{st}.

Another empirical evidence regarding the weekly organization of formal comes from the HSM survey. Individuals who declare they consume formal care are invited to declare the number of hours they receive, either by day, by week or by month. 60% of individuals aged 60 and more have given the weekly volume, whereas it was 33% by day and 7% by month.

The organization of home care provision on a weekly basis deserves emphasis, as the APA program is organized on a monthly basis in France. The maximum number of hours that can be subsided is set at the monthly level. If consumption depends on the day of the week, individuals could consume more than what they are entitled to during some months because of the size of the month (28 days versus 31) or because of the distribution of days in the month.

[24] I exclude here the first week which started on Tuesday.

8.4 Observation unit at the geographical level

I observe costs at level of the "urban unit" as it is defined by the INSEE. The most common units of observation used for the geographical analysis are employment areas (*bassins d'emploi*), urban area (*aires urbaines*), urban unit (*unités urbaines*) and living zone (*bassins de vie*). Here are the definitions proposed by the INSEE.

An employment area is "a geographical area within which most of the labour force lives and works, and in which establishments can find the main part of the labour force necessary to occupy the offered jobs." This unit is particularly relevant for studies on employment.

An urban area is "a group of touching municipalities, without pockets of clear land, encompassing an urban centre (urban unit) providing at least 10,000 jobs, and by rural districts or an urban units (urban periphery) among which at least 40% of employed resident population works in the centre or in the municipalities attracted by this centre."

A urban unit is "a municipality or a group of municipalities which includes a continuously built up zone (no cut of more than 200 meters between two constructions) and at least 2,000 inhabitants."

The living zone is "the smallest territory on which residents have access to facilities and the everyday services. The everyday services and facilities used to define these living zones include six categories : personal services; commerce; education; health ; sports, recreation and culture; transport."

The urban unit has the advantage to be directly characterized by the INSEE according to the size of the area (*Tranches d'unité urbaine*). Thus, it avoids making strong assumptions on the characterization of the different territories. Using employment zones or living zones would have make necessary to select the relevant information to characterize the area. Moreover, urban unit is more precise level than the employment areas or urban areas, while remaining relevant for the different existing types of areas in the department; living zones, conversely, are not optimal to analyze dense urban spaces, as they frequently overlap in these spaces (Chevillard et al., 2015). Overall, the choice of the unit of analysis was pragmatic but it could be interesting to reproduce the analysis using other geographical levels of analysis.