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The Policy Implications of the Cost Structure of Home Health Agencies

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Purpose: To examine the cost structure of home health agencies by estimating an empirical cost function for those that are Medicare-certified, ten years following the implementation of prospective payment.

Design and Methods: 2010 national Medicare cost report data for certified home health agencies were merged with case-mix information from the Outcome and Assessment Information Set (OASIS). We estimated a fully interacted (by tax status) hybrid cost function for 7,064 agencies and calculated marginal costs as percent of total costs for all variables.

Results: The home health industry is dominated by for-profit agencies, which tend to be newer than the non-profit agencies and to have higher average costs per patient but lower costs per visit. For-profit agencies tend to have smaller scale operations and different cost structures, and are less likely to be affiliated with chains. Our estimates suggest diseconomies of scale, zero marginal cost for contracting with therapy workers, and a positive marginal cost for contracting with nurses, when controlling for quality.

Implications: Our findings suggest that efficiencies may be achieved by promoting non-profit, smaller agencies, with fewer contract nursing staff. This conclusion should be tested further in future studies that address some of the limitations of our study.

Keywords: home care, cost functions, economies of scale, marginal costs, case-mix

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Introduction

Home health care plays an increasingly important role in the spectrum of long-term care services that the elderly and those with chronic disease rely on. The trend emphasizes home and community based services over institutionalization, spurred by the Olmstead decision handed down by the Supreme Court in 1999 (Olmstead, 1999) and the more recent "Money Follows the Person Rebalancing Demonstration Grant," (Medicaid.gov, 2013a, 2013b) which feature home care as a core component. More recently, hospitals have increased referrals to home health care at discharge to prevent rehospitalization. Yet, an examination of the history of the home care industry in recent decades suggests that the availability of services, as measured by number of agencies and expenditures, is driven to a large extent by the financial environment the industry is facing (Murkofsky & Alston, 2009). Home health agencies seem to enter and exit the market as the financial attractiveness of the business changes.

The Interim Payment System (IPS), implemented by the Centers for Medicare & Medicaid Services (CMS) in 1997, cut Medicare payments to home health agencies. This led to a dramatic reversal in the previous increasing trend in both number of agencies and expenditures (Davitt & Choi, 2008; Choi & Davitt, 2009). Between 1997 and 1998, the first year of the IPS, about 20% of Medicare certified home health agencies closed their doors, and expenditures decreased by roughly 60% (Murkofsky & Alston, 2009). This decline continued, albeit at a more moderate rate, until 2000, when Medicare again changed its payment, implementing the Prospective Payment System (PPS; CMS, 2010). Because PPS was much more generous, financially, than the IPS, the

declining trend in the number of home health agencies was reversed (Kulesher & Wilder, 2006). Medicare certified home health agencies and total expenditures began steadily climbing as Medicare PPS returned the industry to a stable and favorable financial environment. The number of Medicare certified agencies has increased from 7,061 in 2001 (MedPAC, 2010) to 11,815 by 2010 (MedPAC, 2012). Medicare home health expenditures more than doubled between 2001 and 2009, increasing from $8.0 to $18.3 billion (MedPAC, 2012). By 2010, total home health care expenditures, for all payers, amounted to more than $70 billion (CMS, 2012a).

The role of home health care is expected to continue to expand in the coming years as the population ages, the prevalence of chronic conditions increases, and the emphasis on community based placement and support services continues. By 2021, total expenditures on home health are expected to more than double, increasing to $156 billion (CMS, 2012b). Given these trends, the sensitivity of the industry to the financial incentives it faces as its history demonstrates, and the potential impact on service availability and possibly quality, understanding the cost structure of home care agencies can offer important insights and guidance to policy makers.

Despite the growing importance of home health care, studies of the cost structure of the home care industry to-date are all from periods prior to 2000 (Dudzinski, Erekson, & Ziegert, 1998; Gonzales, 1997; Hay & Mandes, 1984; Kass, 1987; Nyman & Dowd, 1991; Nyman & Svetlik, 1989). These studies reflect practices from an era prior to the implementation of home care PPS and the introduction of the federal quality report card published by CMS—Home Health Compare (HHC). Since then, the market environment and the financial incentives facing home health agencies have changed. These changes have likely influenced the operation of the industry and its cost structure. In this paper we estimate a cost function for home care agencies based on 2010 national cost data to provide an updated view of the industry's cost structure as it operates in the current market and payment environment and discuss the policy implications.

Methods

Data and Sample

The initial sample included all 9,660 Medicare certified home health agencies with Medicare cost reports in 2010. These cost reports are annual financial reports that each certified, free-standing, home health agency is required to file with CMS. The reports include information about annual revenues, expenditures, patients, and volume of services provided. These reports have been used in previous studies of home health agencies' costs (Gonzales, 1997; Huckfeldt, Sood, Escarce, Grabowski, & Newhouse, 2011; Kass, 1987).

The number of agencies included in our study, 9,660, is lower than the 11,000 plus reported by MedPAC (MedPAC, 2012), because the Medicare cost reports do not include hospital-based agencies.

Of the 9,660 agencies, 461 had no Medicare utilization and 1,171 were defined by their fiscal intermediary as a low Medicare utilization agency. These agencies submit only an abbreviated cost report and, therefore, could not be included in the study, decreasing the sample to 8,028 agencies. We also excluded agencies that were not operational for the full year and government owned agencies, because their cost structure was very different. Furthermore, the number of government agencies with complete data, including quality measures, was too small, at 144, to allow a separate analysis. We further excluded agencies outside the contiguous U.S. Thus, our initial sample included 7,325 agencies, or 91.2% of those with full cost reports.

These data were merged with case-mix data for Medicare patients calculated from the Outcome and Assessment Information Set (OASIS) for 2010 obtained from CMS. OASIS is a patient level dataset that includes information about patients' health and mental status at admission to and discharge from the agency, as well as specific treatments received. These data are used by CMS to calculate the Home Health Resource Group's (HHRGs) case-mix index, which in turn is used in the home health PPS. These data are also used in calculating the quality measures reported in HHC. The HHRGs are used to classify patients according to the severity of their health conditions at admission to home health in three domains: clinical, functional, and rehabilitation therapy. Weights are assigned to patients based on their level of severity in these domains. Individual patients' HHRG weights are aggregated to yield an agency-level case-mix index. Agencies with a higher case-mix index have, on average, sicker or more disabled patients than agencies with a lower case-mix index. The OASIS dataset has been reported to have high inter-rater reliability for clinical and functional characteristics of Medicare home health patients (Madigan & Fortinsky, 2004). Functional disability and cognitive status OASIS items were found to have acceptable validity when compared with well-established measures of these constructs (Tullai-McGuinness, Madigan, & Fortinsky, 2009).

OASIS and cost report data were merged using the agency's Medicare provider number. A total of 261 (3.6%) agencies that had missing OASIS case-mix indices or other covariates were excluded from the analysis. The final sample included 7,064 agencies.

The cost report data were also merged with the December 2010 HHC data in order to obtain quality measures (QMs). The HHC data include 21 QMs for home health agencies (13 process measures and 8 outcome measures). March and June 2010 HHC data were also available. However, these data included only process QMs, and since those were very highly correlated with the QMs in the December 2010 data, we used the December data. Because HHC requires that an agency have at least 20 eligible patients in order to have a QM reported (Medicare.gov, 2013), the smaller agencies did not have a large number of the QMs reported. Only 20% of agencies had all QMs reported. Therefore, we split the sample into two. Agencies that had at least 16 QMs reported accounted for 55% of agencies. For this sample, we estimated models with QMs. Agencies with few or no QMs accounted for 45% of the sample. For this sample we estimated cost functions without QMs.

Variables

The dependent variable was defined as total agency reimbursable costs and included direct patient care costs, administration, and capital costs. Independent variables included measures of outputs, a wage index, and agency characteristics. The wage index we used is the Home Health Wage Index used by CMS in the Home Health PPS (Department of Health and Human Services, 2009). It captures cross sectional variation in labor wages. Output variables included the unduplicated number of patients served during the year, the HHRG case-mix index based on Medicare patients served, Medicare patients served as percent of all patients, the number of Low Utilization Adjustment Payment (LUPA) episodes, the number of Partial Episode Payment (PEP) episodes, and the QMs. LUPA and PEP episodes refer to lower numbers of visits than typically encountered and, therefore, affect costs, but neither is reflected in the case-mix index. We created 4 composite QMs from the 16 QMs reported in HHC using factor analysis: improvement, treatment, assessment, and hospitalization. See Exhibit 1 for which individual QMs fall into which composite QM and their loading factors.

Agency characteristics included five dichotomous variables indicating if any of the staff—skilled

Exhibit 1. Factor Analysis of Home Care Quality Measures

Quality Measures	Description	Loading Factors			
		Improvement	Assessment	Treatment	Hospitalization
Process Measures:					
Timely initiation of care	How often the home health team began their patients' care in a timely manner.	—	0.7	—	—
Drug education on all medications provided to patient/caregiver during short-term episodes	How often the home health team taught patients (or their family caregivers) about their drugs.	—	—	0.8	—
Multifactor fall risk assessment conducted for all patients who can ambulate	How often the home health team checked patients' risk of falling.	—	0.6	—	—
Depression assessment conducted	How often the home health team checked patients for depression.	—	1.0	—	—
Influenza immunization received for current flu season	How often the home health team determined whether patients received a flu shot for the current flu season.	—	—	—	—
Pneumococcal polysaccharide vaccine ever received	How often the home health team determined whether their patients received a pneumococcal vaccine (pneumonia shot).	—	0.7	—	—
Diabetic foot care and patient education implemented during short-term episodes of care	For patients with diabetes, how often the home health team got doctor's orders, gave foot care, and taught patients about foot care.	—	—	—	—
Pain assessment conducted	How often the home health team checked patients for pain.	—	0.9	—	—
Pain interventions implemented during short-term episodes	How often the home health team treated their patients' pain.	—	—	1.0	—

(Continued)

Exhibit 1 Continued. Factor Analysis of Home Care Quality Measures

Quality Measures	Description	Loading Factors			
		Improvement	Assessment	Treatment	Hospitalization
Heart failure symptoms during short-term episodes	How often the home health team treated heart failure (weakening of the heart) patients' symptoms.	—	—	—	—
Pressure ulcer prevention included in the plan of care	How often the home health team included treatments to prevent pressure sores (bed sores) in the plan of care.	—	—	0.9	—
Pressure ulcer risk conducted	How often the home health team checked patients for the risk of developing pressure sores (bed sores).	—	1.0	—	—
Outcome Measures:					
Improvement in ambulation	How often patients got better at walking or moving around.	1.0	—	—	—
Improvement in bed transfer	How often patients got better at getting in and out of bed.	1.0	—	—	—
Improvement in bathing	How often patients got better at bathing.	1.0	—	—	—
Improvement in pain interfering with activity	How often patients had less pain when moving around.	1.0	—	—	—
Improvement in dyspnea	How often patients' breathing improved.	1.0	—	—	—
Improvement in status of surgical wounds	How often patients' wounds improved or healed after an operation.	—	—	—	—
Improvement in management of oral medications	How often patients got better at taking their drugs correctly by mouth.	1.0	—	—	—
Acute care hospitalizations	How often home health patients had to be admitted to the hospital.	—	—	—	1.0

NOTES: 1) Only loading Factors greater than 0.2 are shown. 2) All QMs shaded grey were excluded from the factor analysis because a large number of HHAs had missing values for these QMs. 3) There were two additional QMs in the HHC data that have missing values for all agencies - 'How often patients had more pressure sores (bed sores) when home health care ended' and 'Emergency department use without hospitalization.'
SOURCE: Authors' calculations.

nurses, home aides, occupational therapists, physical therapists, and speech therapists—were employed on contract instead of or in addition to salaried employees. We included dichotomous variables indicating if the agency was designated by CMS as a "small agency" (i.e., (a) less than $35,000 in Medicare payments for the year and (b) if Medicare payment is less than 50% of the agency's total receipts), if it was part of a chain, and if it was a non-profit or for-profit organization. The number of years the agency had Medicare certification was also included.

Analyses

Average costs

We calculated the average costs per unduplicated patient, average costs per visit, as well as these costs divided by the agency average HHRG to account for differences in case-mix. These were calculated separately for the for-profit and non-profit agencies. We used *t* tests to determine the significance of the difference in average costs between the for-profit and non-profit agencies.

Cost model specification and estimation

A cost function analysis typically models costs as a function of wages and outputs. It often also includes agency characteristics that may shift the cost function, such as tax status and environmental factors (e.g., regulations). It does not include levels of inputs, such as nursing FTEs, because those are likely to be endogenous with costs. We estimated a hybrid cost function following Grannemann, Brown, and Pauly (1986) and Nyman (1988), of the following general form:

$$\log C = \theta X + \alpha \, \mathrm{f}\,(0) + \beta \log W + \gamma QM + \delta S + u \quad (1)$$

where C is total annual costs, X is a vector of agency characteristics described above in the variables section, O is a vector of outputs, W is the wage index, QM is a vector of the four composite quality measures, S is a vector of state fixed effects, and u is the error term. O includes both the number of unduplicated patients served by the agency and variables measuring case-mix. The dependent variable was logged because the cost data were skewed with a heavy right tail. Because two of the case-mix variables (LUPAs and PEPs, defined above) could obtain the value zero, f(O) was specified as a hybrid and includes both logged and linear variables. State fixed effects were included because states have different economic and regulatory environments that are likely to affect the performance of home health agencies.

Because initial analyses indicated significant differences between for-profit and non-profit agencies' cost structures, the model we present is a fully interacted model in which all variables are interacted with the variable indicating tax status. Inference is based on robust standard errors with clustering by state to account for heteroscedasticity.

Because the cost function is not linear and because some of the variables are logged and some are not, it is difficult to compare their impact on cost based on the estimated coefficients of the cost function. Therefore, we calculated the marginal cost of each factor as a proportion of total costs: For linear factors, such as outputs, O, the marginal cost as a proportion of total costs is given by $\frac{\partial c / \partial o}{c} = \alpha$ and for logged variables, such as wages, W, the marginal cost as a proportion of total costs is given by $\frac{\partial c / \partial w}{c} = \frac{\beta}{w}$. Because the proportion of the logged variables depends on the level of the variable, we present data also at the quartiles and the median of the distributions.

Predicted costs were calculated based on each agency's actual values for all variables and then transformed back from the log of costs. To avoid bias due to the transformation, we applied the Baser correction (Baser, 2007), which accounts for the heteroscedasticity.

Data management was performed in SAS 9.2 and analyses were performed in STATA 13.0.

Results

Exhibit 2 presents descriptive statistics for the full study sample split into for-profit and non-profit agencies as well as the 9% of agencies that were excluded from the analysis. Examination of Exhibit 2 shows that the excluded agencies were quite different from the 91% of agencies included

Exhibit 2. Descriptive Statistics Comparing the Study Sample to Agencies Excluded From the Study

	Agencies excluded from the study			Agencies included in the study	
	Government	For-Profit	Non-Profit	For-Profit	Non-Profit
Number of agencies	284	527	87	6,364	700
Total annual expenditures (in millions of $)	2.801	0.894	2.248	2.192	5.177
Standard Deviation	(17.667)	(1.347)	(3.158)	(4.354)	(7.266)
Median	[0.861]	[0.533]	[1.413]	[1.247]	[2.688]
Unduplicated patients	626	238	1,987	549	2,008
Standard Deviation	(1,413)	(381)	(9,674)	(926)	(3,196)
Median	[283]	[95]	[595.5]	[261]	[902]
Wage index (range 0.69-1.67)	0.89	0.97	0.79	0.97	0.99
Standard Deviation	(0.12)	(0.15)	(0.29)	(0.13)	(0.16)
HHRG case-mix index (range 0.58-3.49)	1.173	1.310	1.282	1.337	1.244
Standard Deviation	(0.227)	(0.321)	(0.241)	(0.274)	(0.189)
Proportion Medicare patients (range 0-1)	0.516	0.770	0.460	0.799	0.572
Standard Deviation	(0.223)	(0.272)	(0.247)	(0.241)	(0.205)
Proportion LUPA episodes (range 0-1)	0.127	0.061	0.142	0.062	0.126
Standard Deviation	(0.077)	(0.059)	(0.090)	(0.050)	(0.066)
Proportion PEP episodes (range 0-1)	0.029	0.044	0.042	0.037	0.036
Standard Deviation	(0.039)	(0.049)	(0.049)	(0.037)	(0.044)
Skilled nursing contract (yes = 1)	0.261	0.433	0.529	0.434	0.449
Home aide contract (yes = 1)	0.257	0.247	0.276	0.255	0.284
Occupational therapy contract (yes = 1)	0.820	0.622	0.322	0.758	0.610
Physical therapy contract (yes = 1)	0.894	0.736	0.425	0.865	0.743
Speech therapy contract (yes = 1)	0.757	0.529	0.264	0.653	0.611
Years with Medicare certification	33.49	5.92	23.66	8.53	24.13
Standard Deviation	(11.27)	(7.58)	(14.09)	(7.77)	(14.15)
Agency is chain affiliated (yes = 1)	0.025	0.186	0.483	0.214	0.403
Agency is small agency (yes = 1)	0.042	0.049	0.000	0.025	0.017

NOTE: We report means with standard deviations in parenthesis. For variables with a highly skewed distribution, we report the median in square brackets. Standard deviations are not shown for dichotomous variables.

SOURCE: Authors' calculations.

in the analysis, and generally smaller. Ninety percent of the over 7,000 Medicare certified, free-standing agencies nationally were for-profit. There were substantial differences between the for-profits and the non-profits in terms of patients served and the operational characteristics. The non-profits tended to be much larger, both in terms of number of patients served (medians of 902 versus 261) and annual expenditures (medians of $2.7 million versus $1.2 million). Both categories were, however, quite heterogeneous with large standard deviations and a distribution that was heavily skewed to the right. The for-profits tended to admit more Medicare patients (80% versus 57%) and their Medicare patients tended to have a higher case-mix (HHRG of 1.34 compared with 1.24). They also tended to have fewer low utilization episodes (LUPAs) at 6% compared with 13% for the non-profits. Patterns of contracting with skilled nurses and home health aides were similar for both types of agencies, but the for-profits were somewhat more likely to contract out for services of therapists. More striking is the fact that twice as many non-profits were affiliated with a chain (40% versus 21%), and in particular have been operating as Medicare certified home health agencies for an average of 24 years compared with a much shorter time than the for-profits, which averaged 8.5 years.

Exhibit 3 presents a comparison of the 3,913 agencies that had QMs reported and the 3,151 agencies that did not. The agencies without QMs were much smaller, serving (at the median) fewer

Exhibit 3. Descriptive Statistics Comparing Agencies With and Without QMs

	Analysis Sample			
	Agencies with QMs		Agencies without QMs	
	For-Profit	Non-Profit	For-Profit	Non-Profit
Number of agencies	3,349	564	3,015	136
Total annual expenditures (in millions of $)	3.401	6.230	0.850	0.811
Standard Deviation	(5.701)	(7.718)	(0.716)	(1.051)
Median	[2.170]	[3.739]	[0.672]	[0.539]
Unduplicated patients	890	2,434	169	241
Standard Deviation	(1,160)	(3,424)	(202)	(315)
Median	[550]	[1,260]	[118]	[145]
Wage index (range 0.69–1.67)	0.97	1.00	0.98	0.95
Standard Deviation	(0.14)	(0.16)	(0.11)	(0.13)
HHRG case-mix index (range 0.58–3.49)	1.372	1.255	1.298	1.200
Standard Deviation	(0.234)	(0.168)	(0.308)	(0.257)
Proportion Medicare patients (range 0–1)	0.760	0.564	0.843	0.603
Standard Deviation	(0.228)	(0.184)	(0.246)	(0.273)
Proportion LUPA episodes (range 0–1)	0.077	0.130	0.045	0.113
Standard Deviation	(0.045)	(0.048)	(0.049)	(0.112)
Proportion PEP episodes (range 0–1)	0.034	0.035	0.039	0.041
Standard Deviation	(0.023)	(0.019)	(0.047)	(0.091)
Skilled nursing contract (yes = 1)	0.395	0.472	0.478	0.353
Home aide contract (yes = 1)	0.214	0.298	0.301	0.228

(Continued)

Exhibit 3 Continued. Descriptive Statistics Comparing Agencies With and Without QMs

	Analysis Sample			
	Agencies with QMs		Agencies without QMs	
	For-Profit	Non-Profit	For-Profit	Non-Profit
Occupational therapy contract (yes = 1)	0.755	0.598	0.762	0.662
Physical therapy contract (yes = 1)	0.852	0.725	0.879	0.816
Speech therapy contract (yes = 1)	0.721	0.606	0.577	0.632
Years with Medicare certification	11.19	25.87	5.58	16.90
Standard Deviation	(8.45)	(13.89)	(5.62)	(12.91)
Agency is chain affiliated (yes = 1)	0.348	0.424	0.066	0.316
Agency is small agency (yes = 1)	0.006	0.011	0.046	0.044
Proportion of patients with improvement in health status (range 0–1)	0.533	0.544	—	—
Standard Deviation	(0.103)	(0.07)		
Proportion of patients who received treatment (range 0–1)	0.801	0.797	—	—
Standard Deviation	(0.08)	(0.089)		
Proportion of patients who were assessed (range 0–1)	0.72	0.726	—	—
Standard Deviation	(0.062)	(0.061)		
Proportion of patients who were hospitalized (range 0–1)	0.306	0.265	—	—
Standard Deviation	(0.084)	(0.066)		

NOTE: We report means with standard deviations in parenthesis. We report medians in square brackets for variables that have a highly skewed distribution. Standard deviations are not shown for dichotomous variables.

SOURCE: Authors' calculations.

than 200 clients, compared with over 500 for the median for-profit and over 1,200 for the median non-profit agencies that had QMs. This difference is not coincidental, because QMs are not calculated and reported by CMS if the denominator is less than 20 eligible patients (Medicare.gov, 2013).

Exhibit 4 presents average and median costs per patient and per visit by tax status. Median costs per patient were higher among the for-profit agencies by $1,848. This differential declined by almost 40% to $1,180 after adjustment for case-mix. On the other hand, the median costs per visit were higher among the non-profit, with the differential increasing by more than 100%, from $7 to $15 after adjusting for case-mix.

Exhibit 5 presents four estimated cost functions (not showing the fixed state effects). The first model was estimated on the full sample of 7,064 agencies. The second model was estimated on the 3,151 small agencies that did not have QMs reported. The next two models were estimated on the same sample of 3,913 agencies that had QMs. For these agencies we present a cost function that does not include the QMs (model 3) and a cost function that does (model 4).

Models 3 and 4 are quite similar and both are different from model 2. This leads us to conclude that: 1) despite the potential for endogeneity between quality and costs, the inclusion of the QMs in the cost function does not bias the estimates of other covariates in the model; and 2) the cost functions for

Exhibit 4. Average Costs[1] By Tax Status (Full Sample: 700 Non-Profit and 6,364 For-Profit Agencies)

	Costs per unduplicated patient		Costs per visit		Costs per unduplicated patient adjusted for case-mix[2]		Costs per visit adjusted for case-mix[2]	
	Non-profit	For-profit	Non-profit	For-profit	Non-profit	For-profit	Non-profit	For-profit
Mean	3,320	5,905	142	136	2,702	4,697	116	106
Difference (non-profit minus for-profit)	–2,585*		6		–1,995*		10*	
Median	2,826	4,674	135	128	2,325	3,505	111	96
Difference (non-profit minus for-profit)	–1,848		7		–1,180		15	

NOTES: [1]Costs in dollars.

[2]Case-mix adjustment was performed by dividing by the HHRG case-mix index for each agency.

* This difference was significant at the 0.05 level.

SOURCE: Authors' calculations.

Exhibit 5. Estimated Home Health Agency Cost Functions: Dependent Variable—Log (Total Annual Cost)

Model:	1	2	3	4
Independent Variables	All Agencies N = 7,064	Agencies without QMs N = 3,151	Agencies with QMs; Model without QMs N = 3,913	Agencies with QMs; Model with QMs N = 3,913
Constant	9.552***	9.692***	9.774***	9.709***
Log (# of unduplicated patients)	0.807***	0.761***	0.788***	0.794***
Log (wage index)	0.655***	0.429**	0.792**	0.733**
Log (HHRG case-mix index)	0.167	0.161	0.192*	0.310***
Log (Proportion Medicare)	0.205***	0.210***	0.162*	0.188**
Log (HHRG) x Log (Proportion Medicare)	0.288***	0.257***	0.358	0.319
Proportion LUPA episodes	–2.197***	–1.998***	–2.458***	–2.313***
Proportion PEP episodes	–0.955***	–0.804**	–1.085	–0.670
Skilled nursing contract (yes = 1)	0.035	0.044	0.047**	0.046**
Home aide contract (yes = 1)	0.050*	0.034	0.064**	0.058**
Occupational therapy contract (yes = 1)	0.020	0.009	0.037	0.030
Physical therapy contract (yes = 1)	–0.029	–0.027	–0.027	–0.012
Speech therapy contract (yes = 1)	0.048***	0.030	0.042*	0.024
Years with Medicare certification	0.032***	0.051***	0.017**	0.016**
Years with Medicare certification squared	–0.001***	–0.002***	0.000*	0.000*

(Continued)

Exhibit 5 Continued. Estimated Home Health Agency Cost Functions: Dependent Variable—Log (Total Annual Cost)

Model:	1	2	3	4
Independent Variables	**All Agencies N = 7,064**	**Agencies without QMs N = 3,151**	**Agencies with QMs; Model without QMs N = 3,913**	**Agencies with QMs; Model with QMs N = 3,913**
Agency is chain affiliated (yes = 1)	–0.070***	–0.032	–0.078***	–0.070***
Agency is a small agency (yes = 1)	–0.045	–0.032	0.042	0.023
Agency is non-profit	–0.445	0.098	–0.707*	–0.900**
Quality Measures:				
Proportion patients with improvement in health status	—	—	—	–0.160
Proportion patients who received treatment	—	—	—	0.152
Proportion patients who were assessed	—	—	—	–0.541**
Proportion patients who were hospitalized	—	—	—	1.086***
Interactions with "Agency is non-profit:"				
Log (# of unduplicated patients served)	0.052	–0.19	0.073	0.076
Log (wage index)	0.039	0.256	–0.073	–0.039
Log (HHRG case-mix index)	0.511	0.796	0.207	0.128
Log (Proportion Medicare)	–0.134	–0.300***	0.029	0.025
Log (HHRG) x Log (Proportion Medicare)	0.414	0.697	–0.087	–0.066
Proportion LUPA episodes	1.278**	0.979	1.918**	1.746**
Proportion PEP episodes	–0.968**	–1.468**	–0.579	–0.430
Skilled nursing contract (yes = 1)	0.043	0.012	0.027	0.028
Home aide contract (yes = 1)	–0.002	0.091	–0.017	–0.021
Occupational therapy contract (yes = 1)	–0.038	0.037	–0.088	–0.092*
Physical therapy contract (yes = 1)	–0.062	–0.178	–0.022	–0.038
Speech therapy contract (yes = 1)	–0.038	–0.132	–0.009	–0.002
Years with Medicare certification	–0.028***	–0.049**	–0.011	–0.009
Years with Medicare certification squared	0.001***	0.001**	0.000	0.000
Agency is chain affiliated (yes = 1)	0.123**	–0.089	0.162***	0.172***
Agency is a small agency (yes = 1)	0.135	–0.014	–0.043	–0.048
Quality Measures:				
Proportion patients with improvement in health status	—	—	—	0.050
Proportion patients who received treatment	—	—	—	0.204
Proportion patients who were assessed	—	—	—	0.039
Proportion patients who were hospitalized	—	—	—	0.062
R^2—within states	0.81	0.64	0.78	0.79
R^2—between states	0.89	0.72	0.80	0.84
R^2—overall	0.82	0.64	0.76	0.79

NOTE: *** $p < 0.001$; ** $0.001 \leq p < 0.01$; * $0.01 \leq p < 0.05$.Fixed state effects not shown.

SOURCE: Authors' calculations.

small and large agencies are substantially different, suggesting that they operate differently.

The models interact for-profit status with all other covariates. Thus, the estimates for the for-profit agencies are given by the main effect coefficients. The non-profit estimates are given by the sum of the main effects and the corresponding interaction terms. Due to the interactions, many of the variables tend to be highly collinear and, therefore, insignificant.

We tested the hypothesis that all the non-significant interaction terms are jointly equal to zero and rejected it with a $p<0.001$, concluding that they belong in the model. The models for the full sample and the larger agencies have high overall R^2 around 0.8, indicating that the included variables are explaining a large percent of the variation in costs. Model 2, for the smaller agencies, has a somewhat lower, albeit still high, R^2 of 0.64.

Because the interpretation of the coefficients in these models is not immediate, we converted them to marginal costs and present them in Exhibits 6 and 7 as percent of the total median costs. The marginal costs are the incremental costs associated with one additional unit for each variable. For example, the marginal costs of an unduplicated patient are the additional costs associated with the home care services provided to one additional patient. The marginal costs of a percent of Medicare are the incremental costs of increasing the percent of Medicare by 1 percent. We discuss them below.

Unduplicated patients: The marginal cost for an additional patient ranged from $2,500 to $4,500. As percent of total median costs it ranged from 0.1% to 0.65%. Marginal costs were higher among the for-profit agencies, both in dollars and as percent of total costs.

Wage index: The marginal cost for the wage index ranged from about $10,000 to $25,000 except for the small agencies, accounting for about 0.7% to 0.8% of total marginal costs.

Case-mix variables: Two of the case-mix variables, the HHRGs and the percent of Medicare patients, had positive marginal costs. Percent of Medicare had a higher share of marginal costs compared with HHRGs for both for-profit and non-profit agencies, but both the dollar amounts and the percent of total costs were higher for the non-profit agencies. The marginal costs of the HHRGs implied that an increase of 0.01 units would increase costs by $600 to $3,500 for the median for-profit agency and $1,500 to $8,400 for the median non-profit agency. The proportion of LUPA and PEP episodes on the other hand had negative marginal costs and a much larger effect at 1%–2%. The effect, however, differed by tax status. Among the for-profits, the LUPA episodes had a larger and more significant impact on costs, while among the non-profits it was primarily the PEP episodes that impacted costs.

Contract labor: The marginal cost for contract labor measures the incremental costs associated with engaging a particular type of employee through a contract rather than by hiring them as a salaried employee. The marginal cost for contracting skilled nursing and home health aides was positive at around 5% for the large for-profit agencies. Among the non-profits, the marginal cost for skilled nursing was higher at over 7%, but was not significantly different from zero for home health aides. Marginal costs for contracting with therapists were for the most part not significantly different from zero, especially once quality was included in the model.

Longevity in Medicare: The marginal costs associated with the length of Medicare certification were positive, except for the small non-profit agencies. This was one area in which the marginal costs of the for-profits substantially exceeded those of the non-profits, both in absolute value—about $20,000 versus less than $10,000—and as a percent of total costs. For-profit marginal costs ranged between 1% to 4% of total costs and among non-profits the range is -0.1% to 0.3%.

Exhibit 6. Marginal Costs—For-Profit Agencies—All Models

Model:	1		2		3		4	
	All Agencies (n=6,364)		Agencies without QMs (n=3,015)		Agencies with QMs (n=3,349)			
	(Predicted Median Cost=$1,259,273)		(Predicted Median Cost=$664,728)		Cost function without QMs (Predicted Median Cost=$2,282,052)		Cost function with QMs (Predicted Median Cost=$2,269,167)	
Independent Variables	Median Marginal Costs	As % of Total Costs	Median Marginal Costs	As % of Total Costs	Median Marginal Costs	As % of Total Costs	Median Marginal Costs	As % of Total Costs
Unduplicated patients	3,975	0.31	4,521	0.64	3,361	0.14	3,341	0.14
Wage index*	8,457	0.67	2,905	0.44	18,866	0.82	17,462	0.76
HHRG case-mix index*	876	0.09	599	0.11	1,565	0.09	3,452	0.17
Proportion Medicare patients*	4,520	0.34	2,060	0.31	8,332	0.35	8,794	0.37
Proportion LUPA episodes*	–27,665	–2.20	–13,283	–2.00	–56,087	–2.46	–52,490	–2.31
Proportion PEP episodes*	–12,024	–0.95	–5,341	–0.80	—	—	—	—
Skilled nursing contract (yes = 1)	—	—	—	—	107,411	4.71	105,471	4.65
Home aide contract (yes = 1)	62,373	4.95	—	—	146,553	6.42	131,484	5.79
Occupational therapy contract (yes = 1)	—	—	—	—	83,403	3.65	—	—
Physical therapy contract (yes = 1)	—	—	—	—	—	—	—	—
Speech therapy contract (yes = 1)	60,492	4.80	—	—	94,927	4.16	—	—
Years with Medicare certification	20,582	2.26	21,993	3.84	19,494	1.11	18,075	1.04
Agency is chain affiliated (yes = 1)	–87,763	–6.97	—	—	–179,054	–7.85	–159,031	–7.01
Agency is small agency (yes = 1)	—	—	—	—	—	—	—	—
Proportion Improvement Quality Measure*	—	—	—	—	—	—	—	—
Proportion Treatment Quality Measure*	—	—	—	—	—	—	—	—
Proportion Assessment Quality Measure*	—	—	—	—	—	—	–12,278	–0.54
Proportion Utilization Quality Measure*	—	—	—	—	—	—	24,635	1.09

NOTE: * Calculated for a 0.01 rather than a 1 unit change.

'-' indicates that the variable was not significant in the model.

SOURCE: Authors' calculations.

Exhibit 7. Marginal Costs—Non-Profit Agencies—All Models

Model:	1		2		3		4	
	All Agencies (n = 700)		Agencies without QMs (n = 136)		Agencies with QMs (n = 564)			
	(Predicted Median Cost = $2,740,261)		(Predicted Median Cost = $579,092)		Cost function without QMs (Predicted Median Cost = $3,615,040)		Cost function with QMs (Predicted Median Cost = $3,636,858)	
Independent Variables	Median Marginal Costs	As % of Total Costs	Median Marginal Costs	As % of Total Costs	Median Marginal Costs	As % of Total Costs	Median Marginal Costs	As % of Total Costs
Unduplicated patients	2,569	0.10	2,587	0.51	2,510	0.07	2,518	0.07
Wage index*	19,366	0.72	—	—	26,313	0.74	25,433	0.71
HHRG case-mix index*	4,520	0.22	1,438	0.36	6,945	0.20	8,408	0.23
Proportion Medicare patients*	11,233	0.38	249	0.07	16,767	0.44	17,900	0.47
Proportion LUPA episodes*	–25,174	–0.92	–5,900	–1.02	—	—	—	—
Proportion PEP episodes*	–52,703	–1.92	–13,154	–2.27	–60,158	–1.66	–40,010	–1.10
Skilled nursing contract (yes = 1)	214,122	7.81	—	—	266,486	7.37	272,594	7.50
Home aide contract (yes = 1)	—	—	—	—	—	—	—	—
Occupational therapy contract (yes = 1)	—	—	—	—	—	—	—	—
Physical therapy contract (yes = 1)	–196,448	–7.17	–118,448	–20.45	—	—	—	—
Speech therapy contract (yes = 1)	—	—	—	—	—	—	—	—
Years with Medicare certification	4,028	0.20	–427.98	–0.09	7,902	0.29	8,989	0.33
Agency is chain affiliated (yes = 1)	—	—	—	—	300,534	8.31	370,315	10.18
Agency is small agency (yes = 1)	-	-	-	-	—	—	—	—
Proportion Improvement Quality Measure*	—	—	—	—	—	—	—	—
Proportion Treatment Quality Measure*	—	—	—	—	—	—	12,921	0.36
Proportion Assessment Quality Measure*	—	—	—	—	—	—	–18,247	–0.50
Proportion Utilization Quality Measure*	—	—	—	—	—	—	41,735	1.15

NOTE: * Calculated for a 0.01 rather than a 1 unit change.

SOURCE: Authors' calculations.

'-' indicates that the variable was not significant in the model.

Chain Affiliation: Belonging to a chain was associated with negative marginal costs for the for-profits at about –7% and a positive marginal cost ranging from 8% to 10% for the non-profit agencies.

Small agency designation: These were not significant for either tax type.

Quality measures: The assessment related QM had a negative marginal cost of similar magnitude—about 0.5%—for both tax type agencies. The treatment QM had a positive marginal cost of 0.36%, but only among non-profits. Hospitalizations had a positive marginal cost of about 1% for both tax types. The costs associated with improvement QMs were not statistically significant.

Another important result, shown in Exhibit 8, is diseconomies of scale with marginal costs increasing as total costs increase. (Exhibit 8 shows results only for model 4. Similar results were obtained for the other models.) It is particularly apparent for unduplicated patients, for whom the marginal costs increased the most as the total number of patients increased. For unduplicated patients, the difference in marginal costs between the 75th and the 50th percentile was twice as much as it was between the 50th and the 25th percentiles for all models and all samples. Wages, case-mix, and percent of Medicare also exhibited marginal costs that increase with scale, but the increases were not as large. This finding holds for both the for-profit and non-profit agencies.

Discussion

We present in this paper descriptive statistics and cost function estimates for non-profit and for-profit Medicare certified home health agencies in 2010. These data show that the industry was dominated by for-profit agencies. In our sample, for-profit agencies account for close to 90% of all agencies. However, because the non-profits tend to be larger than the for-profit agencies, the latter served only 71.3% of all patients (not only Medicare) in 2010. Most of these agencies were relatively new, with a median "age" as a Medicare certified agency of only 6 years, suggesting that the majority, mostly for-profit agencies, entered the market after 2000, possibly in response to the introduction of PPS. This is in sharp contrast to the non-profit agencies whose median "age" in Medicare was 25 years, indicating that these organizations have been serving patients for decades, including the 1990s, which were more financially turbulent times for the industry.

The for-profit and non-profit agencies differed in many important ways. The scale of operation of the median non-profit was more than three times that of the median for-profit agency in terms of the number of patients served and more than twice in terms of costs. As a result, the average costs per unduplicated patient of the non-profits, at $2,826, were 40% lower than the $4,674 corresponding figure for the for-profits. Their operating characteristics were very different as well. The for-profits served a higher proportion of Medicare patients and had a higher case-mix index. As a result, the costs per case-mix adjusted visit were actually lower among the for-profit agencies by about 15%.

The marginal costs as a percent of total costs (shown in Exhibits 6 and 7 for the median agency) also differed substantially, although there is no clear pattern. While the non-profits had a lower percent of marginal costs for unduplicated patients, they had a higher percent of marginal costs for contracting with nurses and similar marginal costs for the QMs.

Of particular note is the higher marginal costs that the non-profits have for case-mix, which may explain why their average case-mix index is lower than that of the for-profit agencies. However, this finding may also reflect a limitation of our data, because our data included case-mix information only for the Medicare patients. We have controlled

Exhibit 8. Distribution of Marginal Costs as % of Total Costs – Sample with QMs – Model Including QMs (Model 4)

	For-Profit Agencies			Non-Profit Agencies		
	Distribution of % of total costs			Distribution of % of total costs		
Independent Variables	25th percentile	50th percentile	75th percentile	25th percentile	50th percentile	75th percentile
Unduplicated patients	0.08	0.14	0.26	0.03	0.07	0.15
Wage index*	0.70	0.76	0.85	0.64	0.71	0.78
HHRG case-mix*	0.11	0.17	0.22	0.19	0.23	0.27
Proportion Medicare patients*	0.29	0.37	0.48	0.40	0.47	0.60
Proportion LUPA*	–2.31	–2.31	–2.31		Not Significant	
Proportion PEP*		Not Significant		–1.10	–1.10	–1.10
Skilled nursing contract (yes = 1)	4.65	4.65	4.65	7.50	7.50	7.50
Home aide contract (yes = 1)	5.79	5.79	5.79		Not Significant	
Occupational therapy contract (yes = 1)		Not Significant			Not Significant	
Physical therapy contract (yes = 1)		Not Significant			Not Significant	
Speech therapy contract (yes = 1)		Not Significant			Not Significant	
Years with Medicare certification	0.44	1.04	1.24	0.13	0.33	0.47
Agency is chain affiliated (yes = 1)	–7.01	–7.01	–7.01	10.18	10.18	10.18
Agency is small agency (yes = 1)		Not Significant			Not Significant	
Proportion Improvement Quality Measure*		Not Significant			Not Significant	
Proportion Treatment Quality Measure*		Not Significant		0.36	0.36	0.36
Proportion Assessment Quality Measure*	–0.54	–0.54	–0.54	–0.50	–0.50	–0.50
Proportion Utilization Quality Measure*	1.09	1.09	1.09	1.15	1.15	1.15

NOTE: * Calculated for a 0.01 rather than a 1 unit change.
'Not Significant' signifies a p-value > 0.05.
SOURCE: Authors' calculations.

for this by weighting the HHRG variable by the percent of Medicare patients in the agency, but this may not have sufficed, particularly if the case-mix of other patients, Medicaid and private pay, is not highly correlated with that of Medicare patients. We would expect the bias introduced by this limitation of the data to affect the estimates for the non-profit agencies more than the estimates for the for-profits, because only 57% of their patients are on Medicare, while 80% of the for-profit patients are on Medicare.

All of these suggest that the for-profit and the non-profit agencies may be operating quite differently, serving different types of patients, and possibly operating on different cost curves, using different processes to combine inputs into the final output, namely a home care episode. In the language of economists, they may be using different production functions.

We find that the marginal costs with respect to quality are in the expected direction. Agencies

that provide more assessment services experience lower costs at the margin. This may reflect the ability to prevent poor health outcomes, thus, avoiding the need to treat them and the associated costs. On the other hand, agencies that provide more treatments or whose patients are hospitalized more incur higher costs at the margin, as both treatment and hospitalizations increase costs. The impact of quality on costs, in terms of the percent of their marginal costs out of total costs, is of the same order of magnitude as most other factors in the cost function. Interestingly though, the marginal costs of the improvement QMs were not significantly different from zero, perhaps because these measures were newly introduced in 2010 and agencies had not yet had an opportunity to adjust to them. The marginal cost for the treatment QM was significant only for the non-profits.

The effect on costs of contracting out labor rather than hiring salaried staff cannot be predicted a priori. Economic theory suggests that agencies will engage contract labor in lieu of salaried workers if the incremental costs of contract labor is equal to or less than salaried workers. This would lead us to expect negative or zero marginal costs associated with contracting. However, in periods of labor shortages, agencies may have no choice, but to hire contract labor, even if it is a more costly alternative, which may lead to positive and high marginal costs for contracting. Our findings are mixed. In all but two models, speech therapy for the for-profits in the full sample and speech and occupational therapy for the model without the QMs, we indeed find that the marginal costs associated with contracting for therapists are either negative or zero (i.e., not significantly different from zero). However, we are finding positive and non-negligible marginal costs for contracting with skilled nursing and home aides (for the for-profits). While a nursing shortage has been a long standing phenomenon (Institute of Medicine, 2008) and may explain this finding vis. a vis. skilled nursing, it is more difficult to understand the positive marginal cost for contracting with home aides among the for-profit agencies. These are not skilled workers, salaries are often at the minimum wage level, and the labor pool for these individuals is not specific to health care. Perhaps the explanation lies in the fact that some states require more hours of training for home health aides than other states and hence the training costs increase the marginal costs, while at the same time the high turnover that typically plagues this type of position forces agencies to contract for aides despite the positive marginal cost (Institute of Medicine, 2008). We should also note that our variable for contract labor was limited, capturing only whether or not the agency engaged in any contracting and not the level of contracting. Further research may shed more light on this issue.

An important question to address is whether there are economies of scale in the home health industry. As the descriptive statistics show, the industry is highly heterogeneous with respect to scale. Furthermore, the non-profit agencies have a substantially lower cost per patient, even after adjustment for case-mix. This may suggest, at least at first glance, that there are efficiencies to be gained by encouraging all agencies to increase in size and mimic the practice style of the non-profits. Our analysis indicates, however, that this may not be the case, and that size alone does not drive the lower costs per patient among the non-profits. We find that the industry actually exhibits diseconomies of scale, with marginal costs increasing as scale increases. And this finding is true for both the for-profits and the non-profits. This finding suggests that economies can be achieved for both agency types if they operate at smaller sizes. This finding echoes findings of earlier studies. Kass (1987), using 1982 data, concluded that economies of scale are not substantial, while Nyman and Dowd (1991), studying Wisconsin agencies in

1987–1988, and Dudzinski et al. (1998), studying a 1989 national sample, found similar diseconomies of scale; i.e., marginal costs increasing as the scale of the operation of the agency increases. Our findings, with 2010 national data for over 7,000 agencies, confirm this result for current data. The explanation for this phenomenon might reflect the geographic dependency of services, which are provided at patients' homes. A large scale implies an agency that covers a larger geographic territory, which perhaps may contribute to both functional and managerial inefficiencies.

To summarize, our findings suggest that efficiencies in home care services could be promoted by encouraging more small scale agencies and by encouraging contract therapy labor and salaried nursing labor. Efficiencies may possibly also be achieved by encouraging more non-profit agencies or more adoption of a "non-profit like" practice style. However, a better understanding of the differences in practices between the non-profits and the for-profits is required before we can deduce that expansion of the non-profits to other segments of the patient population will lead to cost savings rather than resulting in different cost structures, more similar to those of the for-profits.

We should also note that this is the first study to examine the cost structure of this industry in over a decade and it has several important limitations that should be addressed in follow up studies, before these conclusions are translated into policy. In particular, case-mix should be measured more accurately, to include both Medicare and Medicaid patients and, if possible, private pay patients as well. Current CMS regulations do not require OASIS data collection that would allow HHRG assignment for non-Medicare patients. CMS may wish to reconsider this policy. Furthermore, had we had patient level HHRG data, rather than agency-level case-mix indices, we would also have been able to estimate actual coefficients for each HHRG and identify their marginal costs. Finally, the heterogeneity of the for-profit agencies should be explored further to better understand both the impact of scale economies and the differences between different agency types, be it ownership (i.e., chain affiliation and profit status), age, or size.

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