Alternative Work Arrangement and Performance: Evidence from Nurses in Home Health Care

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1 Introduction

An increasing number of firms in the US hire workers in alternative work arrangements, defined as temporary help agency, on-call, contract company, and independently contracted or freelancing workers (Katz and Krueger, 2016). Between 2005 and 2015, the percentage of workers in those arrangements rose from 10.7 percent to 15.8 percent, and 94 percent of the net employment growth in the US economy during this period is estimated to have occurred in alternative work arrangements (Katz and Krueger, 2016). Health care, in particular, is one of the fastest growing industry groups with a 53-percent growth in the percentage of health care professionals in alternative work arrangements between 2005 and 2015 and a 74-percent growth between 1995 and 2015 (Katz and Krueger, 2016).[1] This trend of an increasing use of workers in alternative arrangements in health care naturally raises the question of whether using more of these workers has any impact on patient health outcomes, a central measure of performance in health care.

Key problems in estimating the impact of using alternative work arrangements on health outcomes are attribution and selective assignment. A multitude of other organizational factors, such as facility resources or technology tools, simultaneously influence the patient experience and health outcomes. Provider organizations with more resources may adopt staffing practices—such as hiring more professionals in permanent work arrangements or providing better work environments—that achieve favorable health outcomes (Aiken et al., 2007). Moreover, providers may selectively assign patients to professionals in different work arrangements: for example, relatively healthier patients are matched with professionals in alternative work arrangements.

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[1] The percentage of health care professionals in alternative work arrangements was 5.3 percent, 6 percent, and 9.2 percent in 1995, 2005, and 2015, respectively. *Health care professionals* refers to workers in the *Healthcare Practitioners and Technical Occupations* and *Healthcare Support Occupations* groups, as defined by the Bureau of Labor Services. The former group includes physicians and nurses while the latter includes physician aides and nurse aides.

In this paper, I use a novel and rich dataset on home health and develop an empirical framework that allows me to overcome these inference challenges. First, I use novel proprietary data on home health care utilization in which patients are isolated in their homes and thus their health outcomes are unlikely to be confounded by other facility resources. Second, I use a plausibly exogenous variation in patient assignment to different types of nurses using permanent nurses' activeness in the patient's area.

There are different work arrangements used for both permanent and temporary workforces, respectively, in home health. Thus, to investigate whether permanent and temporary nurses yield a systematically different patient outcome, I estimate whether receiving more care from full-time nurses leads to a different likelihood of hospital readmission.

My identification strategy is to exploit the variation in full-time nurses' activeness across ZIP codes and care timings. When a patient happened to live in a ZIP code or start home health care at a time that her firm used more full-time nurses, she would receive more full-time nurse visits. The patient's location and timing of care are potentially exogenous with respect to the patient's likelihood of readmission.

For this analysis, I use proprietary home health data and construct patient-episode level data for a set of elderly patients who had a hospitalization prior to home health care during the years 2012–2015. I use a two-stage least squares (2SLS) estimation using the instrumental variable discussed above. My findings are twofold. First, patients who lived in ZIP codes where full-time nurses were more active at the start of care indeed had a higher proportion of full-time nurse visits. Second, patients who received a higher proportion of full-time nurse visits were less likely to be readmitted to a hospital. One-standard-deviation increase in the proportion of full-time nurse visits (0.41)—equivalent to about two more full-time nurse visits out of 6 in total—was associated with a 7-percent decrease in the likelihood of readmission compared to the mean. This effect holds after controlling for patients' underlying health characteristics, office-level demand and labor supply characteristics, patients' ZIP code fixed effects, firm fixed effects, month fixed effects, and fixed effects related to the timings of the start and end of care. Moreover, this estimated effect is conservative since when full-time nurses were active, firms tended to have sicker patients by several severity measures.

Previous literature has examined the effect of workers in alternative work arrangements on performance but there is a lack of consensus (Bae et al., 2010; Xue et al., 2012; Lotti and Viviano, 2012; Aiken et al., 2013; Figlio et al., 2015; Lasater et al., 2015; Hockenberry and Becker, 2016; Lu and Lu, 2016). On the one hand, Figlio et al. (2015) find in the university setting that students learned relatively more from contingent faculty in the first-term courses after controlling for student fixed effects and next-class-taken fixed effects, compared to tenure-track or tenured professors. In the hospital setting, Xue et al. (2012) and Aiken et al. (2013) find no statistically significant difference in mortality in hospital units run by a higher share of supplemental registered nurses (RNs). Aiken et al. (2007) similarly find that supplemental nurses were not associated with poor patient outcomes after controlling for the quality of work environments. Lasater et al. (2015) find a greater use of supplemental RNs to have no statistically significant association with patient satisfactions measured by whether patients would recommend their hospital. On the other hand, Hockenberry and Becker (2016) find that 10 dimensions of patient satisfaction scores were lower in hospitals with a higher proportion of contract nurse hours, even for patient satisfaction data coming from the same source as Lasater et al. (2015). Bae et al. (2010) find the positive association

between the level of external temporary RN hours and several poor patient safety outcomes, such as patient back injuries and falls, in hospitals. Pham et al. (2011) find that temporary staff, including physicians and nurses, was associated with more harmful medication errors in emergency departments. Lu and Lu (2016) also find greater service quality deficiency citations in nursing homes employing greater RN contract hours as a proportion of total resident days. Lotti and Viviano (2012) find that reforms incentivizing the use of permanent labor were associated with higher total factor productivity in Italian manufacturing firms.

The principal contribution of this paper is to overcome weaknesses in the prior literature by accounting for the non-random matching of providers in different work arrangements with patients. I demonstrate that accounting for this endogeneity is important as the OLS effects of the proportion of full-time nurse visits are not statistically significant whereas the 2SLS effects are statistically significant and greater in magnitude. To the best of my knowledge, this paper is the first to use an econometric method to overcome the inference problem. Broadly, the paper is related to the literature on the relationship between staffing and quality (Needleman et al., 2011; Tong, 2011; Cook et al., 2012; Mark et al., 2013; Lin, 2014; Matsudaira, 2014).

The remainder of this paper is organized as follows. In Section 2, I provide brief background on home health care to provide necessary institutional details to understand my empirical strategy. In Section 3, I describe the data and sample restriction rules. In Section 4, I describe the key inference problems in estimating the effect of the proportion of full-time nurse visits on patient readmission. In Section 5, I discuss the empirical strategy. In Section 6, I present the estimation results. In Section 7, I conclude the paper.

2 Background

2.1 Home Health Industry and Nursing Workforce

Home health care, which is provided to homebound patients who need skilled nursing or therapy services, is an important and rapidly growing segment of the post-acute care delivery system. Home health care is composed of largely six service disciplines in which home health firms demand labor: skilled nursing, home health or personal care aid, physical therapy, speech-language pathology, occupational therapy, and medical social services.[2]

In this paper, I focus on the skilled nursing workforce—the combination of registered nurses (RNs) and licensed practice nurses (LPNs)—since nurses provide the medical service most relevant to potentially determining hospital readmissions and since their visits account for the majority of overall home health visits. Thus, among the six service disciplines, home health firms' demand for skilled nurses is the highest and they maintain the largest capacity of them each week.

Nurses are hired under largely two compensation schemes: salary with guaranteed work and expected number of visits for each week and piece-rate pays with no guaranteed work and visit-based hiring. Thus, one can think of salaried nurses as "permanent" and piece-rate paid as "temporary" workers in this paper. Under salary, nurses can be hired either on a full-time, part-time with benefits, or part-time without benefits basis, or for managerial or

[2]Medicare covers only these six discipilnes.

administrative positions. Full-time nurses are the primary salaried work arrangement, comprising 40 percent of a firm's workforce every week on average. Under piece-rate pay, nurses can be hired either on an on-call basis directly by the firms or hired as contractors through temporary help agencies. On-call nurses are the primary piece-rate paid work arrangement, comprising more than 30 percent of a firm's workforce every week on average.

2.2 Differences between Traditional and Alternative Work Arrangements: Descriptive Statistics

A lack of consensus in the previous literature on the effect of alternative work arrangements on quality and performance may reflect the fact that the effect plausibly varies across settings. However, theoretically there are opposing directions through which workers in alternative work arrangements can affect performance. On the one hand, lower-quality workers may be more likely to sort into alternative work arrangements if firms have lower standards of hiring for those arrangements. Once employed by a firm, workers hired in alternative work arrangements may also have shorter engagement with the firm and lack opportunities to develop firm-specific skills (Broschak and Davis-Blake, 2006; Cuyper et al., 2008) or receive support from colleagues (Witte and Nswall, 2003). Negative worker outcomes for workers in alternative work arrangements, such as lower wages or lower benefits, could reduce their morale and productivity (Harley, 1994; Hockenberry and Becker, 2016).

On the other hand, using workers in alternative work arrangements could have a positive effect on performance if they provide supplementary labor to address a shortage or high workload of regular workers. Flexible staffing strategies could offset the negative effects of low staffing or high workload per worker which have been consistently noted by previous literature (Aiken et al., 2010; Kuntz et al., 2014; Berry Jaeker and Tucker, 2016). Moreover, to the extent that alternative work arrangements are used as a screening device or stepping stones for more permanent positions, the former do not necessarily attract less competent nurses (Booth et al., 2002). However, this case is unlikely in in my data since it is rare for permanent nurses to be hired first in temporary work arrangements and for temporary nurses to change into permanent positions.

Before examining the effect of the proportion of full-time nurse visits on patient readmission, I explore whether full-time nurses are different from nurses hired in other work arrangements. If there is no meaningful difference, there is no reason for firms to differentially treat them and expect any difference in the quality of care. In Table 1, I report mean values of key labor supply and pay characteristics of nurses in each work arrangement. I focus on the comparison of full-time and on-call nurses, who represent the majority of salaried and piece-rate paid workforce.

Full-time nurses had substantially higher workloads, as measured in terms of number of visits. Panel A shows that conditional on providing at least one visit, full-time nurses provided 22 visits per week on average compared to on-call nurses who provided 9 visits per week. However, the average length of visits provided by full-time nurses was at 46 minutes shorter by 4 minutes than that of on-call nurses. Reflecting the difference in workloads, full-time nurses were paid slightly less than 3 times the total weekly pay of on-call nurses, as shown in Panel B. However, on the per-visit rate, full-time nurses get paid less than on-call

nurses by $12 on average, which may be a compensating differential for benefits. Moreover, full-time nurses' average length of employment of 21 months was 5 months longer than that of on-call nurses.[3]

Another qualitative difference between salaried and piece-rate paid nurses lies in the amount of training and attendance of case review conferences. Data on these aspects are unavailable. However, according to interviews with administrators in the company which provided me with the data, salaried nurses must receive training at the start of employment and get additional training regularly. They also spend more time in the firm offices and attend conferences with other care team members to review patient cases. On the other hand, piece-rate paid nurses are not obliged to receive training at the start of employment and do not typically receive additional training afterwards. They also do not usually attend conferences for case reviews.

Table 1 alone cannot entirely explain why a higher proportion of full-time nurse visits would improve patient outcome (i.e. reduce hospital readmission). However, data suggest that full-time nurses accumulate much more experience by providing more visits as well as staying employed for longer. To the extent that the experience has a positive correlation with performance—whether it is due to the vintage effect or selection (Murnane and Phillips, 1981) or learning by doing (David and Brachet, 2009)—full-time nurses may provide higher quality of care.[4] The same effect is predicted to the extent that full-time nurses develop greater expertise and superior knowledge of firms' culture and standards by spending more time at firms' offices and with colleagues. These forces, however, might be counterbalanced with factors such as shorter visit lengths or higher workloads (Brachet et al., 2012), which could produce a positive effect of proportion of full-time nurse visits on hospital readmission.

2.3 Firms' Assignment of Temporary and Permanent Nurses to Patients

Why do some patients receive more full-time nurse visits than others? Before investigating the impact of receiving more full-time nurse visits on readmission, I describe firms' practice of assigning nurses to patients, which drives the variation in the proportion of full-time nurse visits across patients. Home health firms' assignment of nurses to patients is based largely on matching by distance as it involves mobile workforces.[5] Since many nurses commute from home directly to patients' homes, firms try to assign to a patient the nurses who live close by to her in order to minimize nurses' travel time and costs. Travel time has the potential to affect not only directly firms' mileage payment to nurses but also indirectly employee

[3]To obtain these statistics, I restricted to nurses who terminated their employment, where the termination was defined as either permanently exiting the workforce or providing no visits for more than 90 consecutive days.

[4]Medoff and Abraham (1980) find no correlation between experience and relative rated performance though they find a strong correlation between experience and relative earnings among managerial and professional employees within the same grade level.

[5]The geography-based assignment of service providers to patients has been well noted in the home health care settings as well as in other mobile workforce settings, such as police. The operations management literature has long addressed this "districting" problem of how to partition a firm's service market region into a contiguous set of districts and assign workers to each district to minimize each worker's travel distances and equalize the workload across workers (Tavares-Pereira et al., 2007).

retention (Chapple, 2001) and labor supply (Gutiérrez-i Puigarnau and van Ommeren, 2010; Gimenez-Nadal et al., 2011). This is despite the possibility that a nurse may incur one-time costs of traveling to and from a remote area at the beginning and end of the day and mostly travel short distances between different patients' homes located near each other during the day.

In my data, for a given patient, nurses who actually visited the patient lived closer to her than other nurses who were active but did not visit her. Nurses who actually visited the patient lived 11 miles away whereas those who did not visit her lived 14 miles away.[6] The mean difference of 3 miles within the patient is not only economically significant but also statistically significant at the one percent level according to the paired t-test.

While matching of nurses with patients is largely based on distance, a majority of patient's care is provided by full-time nurses. On average, a patient receives 6 nurse visits in total. Approximately 60 percent of them are provided by full-time nurses; 8 percent by part-time with benefits nurses; 6 percent by part-time with benefits nurses; 17 percent by on-call nurses; 0.3 percent by contractor nurses; and 8 percent by office or other nurses. Figure **??** shows the variation in the proportion of full-time nurse visits across patient episodes. A large number of patients receive either zero or only full-time nurse visits. 24 percent of the patients receive zero full-time nurse visits, and 36 percent of patients receive only full-time nurse visits. The remaining 40 percent receive a mix of full-time nurse and other nurse visits, with the median proportion of full-time nurse visits being 0.75.

3 Data

I use rich and novel data from a large US for-profit freestanding home health provider firm operating 106 autonomous offices in 18 states during January 2012 through August 2015.[7][8] These data provide information for each patient including underlying risk factors and outcomes at an unusual level of detail since the Center for Medicare and Medicaid Services (CMS) requires each office to collect extensive demographic and health risks data using the CMS's Outcome and Assessment Information Set (OASIS) surveys.[9] The patient data contain a rich set of underlying health risks assessed at the beginning of each home

[6] To analyze this, for each patient, I divide nurses who were active during months of the patient's care into two groups by whether they actually visited her. Within the patient, I compute the mean distance to the nurses in each group at the 5-digit ZIP-code level, the finest level of geography I can obtain for the patients' and nurses' home addresses.

[7] These 18 states are Arizona, Colorado, Connecticut, Delaware, Florida, Hawaii, Massachusetts, Maryland, North Carolina, New Jersey, New Mexico, Ohio, Oklahoma, Pennsylvania, Rhode Island, Texas, Virgina, and Vermont.

[8] This large set of independently run offices alleviates some concern about the generalizability of our results to other HHAs even if they all belong to one company. During 2013, compared to a national sample of freestanding agencies, home health offices in our sample tend to be larger, have a lower share of visits provided for skilled nursing and instead have a higher share of visits provided for therapy, and have a lower share of episodes provided to dual-eligible Medicare or Medicaid beneficiaries, which seem to be more common characteristics of proprietary agencies (Cabin et al., 2014; MedPAC, 2016).

[9] These patients include all the patients enrolled in both public and private versions of Medicare, Medicaid and a small fraction of private insured patients for which their plans required the collection of OASIS data.

health admission and hospital readmission outcomes.[10] I focus on hospital readmissions as a key measure of quality of care since both hospitals and freestanding HHAs view it as a key competitive differentiator among HHAs under the Hospital Readmissions Reduction Program (HRRP) established by the Affordable Care Act (ACA) (Worth, 2014).

These data contain the entire home health visit records in each office showing all the interactions between a patient and individual providers who served her. I match these visit-level data with the human resources data containing the history of employment arrangements for each provider to measure the proportion of visits provided by nurses in each work arrangement during each patient's care. Using these visit-level data, I can also construct the firm-day level data showing office's demand and labor supply conditions. I use this dataset to construct the mean level of ongoing home health care episodes and active nurses, and the mean proportion of nurses in each work arrangement during each patient's care.

Finally, my data provide 5-digit ZIP code level home addresses for both patients and nurses. It is rare to have home addresses for nurses in health care data, which offers a unique opportunity to construct an instrument based on the distance between patient and nurse's homes as described in Section **??**.

I construct the sample at the patient episode level, where an episode is defined as a 60-day period of receiving home health services.[11] Each patient episode is handled by a single office. Since each office autonomously decides scheduling and staffing and is run as a profit center, I regard each office as a separate "firm" in my empirical analysis. In my sample, I exclude firms that are senior living offices whose primary clientele is residents of senior living facilities since these firms pursue a different workforce configuration strategy than firms that focus on home health care. I also exclude firms serving fewer than 50 episodes in a ZIP code for stable estimation. Furthermore, I restrict to the set of patients who received a single episode of home health care since patients receiving multiple episodes likely face a different distribution of labor mix. I also exclude patients who received only one nurse visit since they cannot experience a mix of nurses in different work arrangements. I exclude outlier patients who received greater than 99th percentile (18) of the number of nurse visits during care. Thus, my final sample used for the analysis contains 21,200 patient episodes that live in 203 ZIP codes and are served by 39 firms operating in 10 states.

4 Inference Problem

Estimating the effect of the proportion of full-time nurse visits on patient readmission is challenging for several reasons. The first and central problem is that firms' assignment of full-time nurses to patients may depend on patients' severity. Sicker patients are more likely to be assigned full-time nurses because those nurses can provide more continuous care or have more experience due to longer tenure. Section 2.2 shows that full-time nurses work

[10] The OASIS data actually contain two variables which I use to identify whether a patient had a hospital readmission: whether patients had a hospitalization prior to home health care and hospitalization dates during home health care.

[11] This definition of a 60-day home health episode is based on the fact that the Center for Medicare and Medicaid Services (CMS) pays a prospective payment rate for each episode to home health agencies for "traditional Medicare" (Part A) enrollees, not privately insured Medicare enrollees. A patient can have multiple episodes during a home health care admission.

more per week and work longer. To the extent that patients who are sicker in unobserved dimensions have a higher proportion of full-time nurse visits, estimating an OLS effect of such a proportion on the patient readmission would result in an upward bias and work against finding a negative effect.

Indeed patients who received a higher proportion of full-time nurse visits appear to be sicker according to many observed characteristics. Table 2 shows the mean values for several patient characteristics for four different groups of patients based on the proportion of full-time nurse visits: 1) zero; 2) greater than zero and less than median (0.75); 3) equal to or greater than median and less than one; and 4) one. Overall, Group 1 patients who received zero full-time nurse visits were most saliently healthier than Groups 2–4 of patients who had at least one full-time nurse visit during care. Panel B shows that Group 1 had a low risk for hospitalization: these patients had few past hospitalizations, did not show mental decline, and took few medications. In Panel C, Group 1 was older but more likely to be white and enrolled in Medicare Advantage, both of which have been shown to be associated with better health (Kawachi et al., 2005; Brown et al., 2014). In Panel D, Group 1 had a lower Charlson comorbidity index and was less likely to report severe overall status and have severe pre-home health care conditions.

One can observe a similar gradient of severity across Groups 2–4. Groups 3–4 patients who had at least 75 percent of full-time nurse visits appeared similar, and Group 3 was even sicker than Group 4 on some measures. However, both of these groups tended to be sicker than Group 2 in many characteristics. In our estimation framework, we control for all of these observed patient severity characteristics. However, to the extent that these observed characteristics are correlated with unobserved characteristics, such as dynamic progression of severity during patient's care, the effect of full-time nurse visits on patient readmission cannot be identified. To address this problem, I use an instrument variables approach, which I describe in detail in Section 5. This approach relies on activeness of full-time nurses in the patient's local area and the number of nearest full-time nurses who did not visit the patient as an exogenous source of variation.

5 Empirical Strategy

To address the inference problem described in Section 4, I use an instrumental variables method to estimate the labor mix on hospital readmission.[12] I use the activeness of full-time nurses in the patient's ZIP code at the start of care, which yields a plausibly exogenous variation in the labor mix. I describe this instrument in detail below.

5.1 Activeness of Full-Time Nurses

A single firm typically serves multiple ZIP codes, and naturally, there is a variation in the activeness of full-time nurses across ZIP codes. If a new patient needing home health care happens to live in a ZIP code where full-time nurses are originally active, then she would receive a higher fraction of full-time nurse visits. Therefore, the activeness of full-time nurses

[12]The description of my empirical analysis using the 2SLS estimation follows that done by Doyle Jr et al. (2015).

in the patient's ZIP code must have a strong positive correlation with her fraction of full-time nurse visits.

To construct the instrument variable measuring the activeness of full-time nurses for each patient episode i, I use the share of total nurse visits in i's ZIP code that are provided by full-time nurses hired by i's firm at i's start of care. For each i, let $f(i)$, $z(i)$, and $m(i)$ denote the firm that serves her, the ZIP code she lives in, and the month of her start of home health care, respectively. Define $P_{\hat{i}}$ as the set of patients other than patient i who have the vector of these three characteristics $(f(i),\ z(i),\ m(i))$, where the hat denotes omission. That is:

$$P_{\hat{i}} := \{j | j \neq i,\ (f(j),\ z(j),\ m(j)) = (f(i),\ z(i),\ m(i))\}.$$

Finally let $v_{j,w}$ be the number of nurse visits provided to each patient $j \in P_{\hat{i}}$ by nurses in work arrangement w. w can be one of the six arrangements: 1) full-time, 2) part-time with benefits, 3) part-time without benefits, 4) on-call, 5) contractor, and 6) office/other. For each i, the activeness of full-time nurses is then defined as

$$Active_i = \frac{\sum_{j \in P_{\hat{i}}} v_{j,full-time}}{\sum_w \sum_{j \in P_{\hat{i}}} v_{j,w}}. \tag{1}$$

I exclude the given patient episode i from this measure to avoid predicting the patient's fraction of full-time nurse visits using her own full-time nurses' visits. This leave-out method has been used in previous literature (Angrist Joshua and Pischke, 2009; Doyle Jr et al., 2015).

The quasi-experimental set up here is comparing two patients served by the same firm in two different ways. The first comparison is cross-sectional—comparing two patients who started home health care at the same month but lived in different ZIP codes. Here one patient may have happened to live in a ZIP code area where full-time nurses were more active than other nurses. The second comparison is cross-time—comparing two patients who lived in the same ZIP code but started in different months. Here one patient may have happened to start care when full-time nurses were more active.

I illustrate how these two variations in the activeness instrument explain the proportion of full-time nurse visits in Table **??**. Panel A shows that in ZIP codes where full-time nurses were more active (i.e. above or equal to median), patients had 16 percentage points higher proportion of full-time nurse visits even within the same firm-month pairs. The median values are created for each firm-month pair using the patient's start-of-care month. The difference is statistically significant at the one percent level by the t-test of the equality of the means. Panel B shows that when patients happened to start care in months during which full-time nurses were more active, they received 20 percentage points higher proportion of full-time nurse visits within the same firm-ZIP code pairs. This difference is also statistically significant at the one percent level.

5.2 Empirical Specifications

First, I model the first-stage relationships between the patient i's proportion of full-time nurse visits FTV_i and the instrument variable Z_i, $Active_i$, at the patient episode level. For each patient episode i who is served by firm $f(i)$, lives in ZIP code $z(i)$, and has her home

health care start in month $m(i)$ and end in time period $t(i)$, her proportion of full-time nurse visits FTV_i is a function of the form:

$$FTV_i = \alpha_0 + \alpha_1 Z_i + \gamma X_i + \delta_{f(i)} + \zeta_{z(i)} + \eta_{m(i)} + \theta_{t(i)} + \nu_{i,f(i),z(i),m(i),t(i)}. \quad (2)$$

The vector X_i includes observed patient characteristics including the number of nurse handoffs, total number of nurse visits, mean interval of nurse visits (i.e. mean number of days between two consecutive nurse visits), a set of firm level service demand and labor demand characteristics, a set of hospitalization risk controls, a set of demographic controls, and a set of comorbidity controls. The set of firm level service demand and labor demand controls includes mean of firm-day level variables capturing the caseload and labor supply conditions in each firm across the patient's home health days. The firm-day level variables include the number of ongoing episodes, the number of active nurses, and the fraction of active piece-rate nurses working in an firm-day cell. The set of hospitalization risk controls represents a set of indicator variables associated with high risk of hospitalization, and includes history of 2 or more falls in the past 12 months, 2 or more hospitalizations in the past 6 months, a decline in mental, emotional, or behavioral status in the past 3 months, currently taking 5 or more medications, and others. The set of demographic controls includes six 5-year age group dummies for ages ranging from 65-94 (age 95 or higher is an omitted group), gender, race, insurance type, an indicator for having no informal care assistance available, and an indicator for living alone.[13] The set of comorbidity controls includes a Charlson comorbidity index, indicators for overall health status, indicators for high-risk factors including alcohol dependency, drug dependency, smoking, obesity, and indicators for conditions prior to hospital stay within past 14 days including disruptive or socially inappropriate behavior, impaired decision making, indwelling or suprapublic catheter, intractable pain, serious memory loss and/or urinary incontinence.[14] $\nu_{i,f(i),z(i),m(i),t(i)}$ is an idiosyncratic error.

Controlling for the number of handoffs and total number of nurse visits in the regression equation is important. Experiencing a mix of permanent and temporary labor during patient care inevitably involves switching of providers or "handoffs," which may independently affect the patient outcome. Fewer handoffs mechanically lead to either one or zero proportion of full-time nurse visits: this is illustrated in Table 2 with much smaller ratio of handoffs to nurse visits for Groups 1 and 4, who received zero and 100 percent of full-time nurse visits, respectively. (**?**) find nurse handoffs—defined as being visited by a different nurse than the last one—to substantially increase the probability of readmission.[15] In addition, sicker patients may receive more nurse visits, which affects the proportion of full-time nurse visits and the likelihood of readmission.

[13] Insurance types include Medicare Advantage (MA) plans with a visit-based reimbursement, MA plans with an episode-based reimbursement, and dual eligible with Medicaid enrollment (reference group is Medicare FFS).

[14] Indicators for overall health status include indicators for very bad (patient has serious progressive conditions that could lead to death within a year), bad (patient is likely to remain in fragile health) and temporarily bad (temporary facing high health risks).

[15] Although handoffs are found to be an important determinant of readmission in (**?**), I do not treat it as an endogenous variable to be instrumented for in this specification. The reason is that my instrument for the proportion of full-time nurses poorly capture the variation of handoffs. Since the causal effect of handoffs is not of main interest in this paper, I just control for it as an explanatory variable.

I also include a set of fixed effects for firm, patient ZIP code, start-of-care month, and end-of-care time period, where the time period refers to the day of week (6 dummies), week of year (52 dummies), and year (4 dummies). Therefore, this estimation compares patients in two ways, as explained above. First, it compares patients who were served by the same firm, started care in the same month and ended home health care at the same time but lived in different ZIP codes having a different level of activeness or preoccupied nearest full-time nurses. Second, the regression compares patients who were served by the same firm, lived in the same ZIP code, and ended home health care at the same time but had a different level of activeness or preoccupied nearest full-time nurses at the start of care.

The main estimating model for the second-stage relationship between the proportion of full-time nurse visits and patient readmission takes the form

$$Readmit_i = \beta_0 + \beta_1 FTV_i + \gamma X_i + \delta_{f(i)} + \zeta_{z(i)} + \eta_{m(i)} + \theta_{t(i)} + \epsilon_{i,f(i),z(i),m(i),t(i)}. \quad (3)$$

where $Readmit_i$ is an indicator variable for hospital readmission of a patient episode i. I compare the OLS estimation of equation 3 with its 2SLS estimation using the instruments explained above. This comparison will show the importance of taking into account the non-random assignment of full-time nurse visits in identifying the effect of labor mix on patient readmission. I estimate a linear probability model.

5.3 Potential Limitations

There are potential concerns about the instruments. First, there could be unobserved ZIP code-month level shocks that are correlated with the full-time nurses' activeness and the patient readmission. For example, do demographic changes such as a surge in the elderly population in a given ZIP code-month pair affect both full-time nurses' activeness and patient readmission? A lack of availability of such high-frequency ZIP code level information makes it hard to directly control for these relevant ZIP code-month level controls. However, for example, if an elderly population grows in a ZIP code in a given month, the omitted variable bias is expected to work against finding a negative effect of full-time nurse visits on readmission. The reason is that full-time nurses would become more active due to increased home health care demand while the readmission would be more likely among the elderly.

Second, firms may selectively admit patients into home health care based on the full-time nurses' activeness. To the extent that firms admit healthier patients into home health care when full-time nurses were more active, I will likely overstate the negative effect of full-time nurse visits on patient readmission. To allay this concern, I investigate the balancing of observed characteristics by whether the patient had high or low activeness of full-time nurses. High values are marked by whether the activeness is above or equal to median. Table 4 reports the mean values of regression controls for the two groups of patients. The first row in Panel A shows that when full-time nurses are more active, patients' proportion of full-time nurse visits is higher, as expected. When patients had high activeness of full-time nurses, they had nearly double the proportion of full-time nurse visits in column (2) by 40 percentage points, compared to patients who had low activeness in column (1). The hospital readmission rate is also greater for patients with high activeness of full-time nurses. Simultaneously, the hospitalization risk factors in Panel C and comorbidity characteristics

in Panel E show that patients with high activeness of full-time nurses were indeed sicker. On average, these patients had higher Charlson comorbidity index and higher likelihood of having their overall status to remain in fragile health. Thus, I can refute the concern that firms may selective admit healthier patients when full-time nurses are more active. It was rather the opposite: firms tended to admit sicker patients when full-time nurses were more active, which works against finding a negative effect of full-time nurse visits on readmission.

6 Results

6.1 First-Stage Results on the Proportion of Full-Time Nurse Visits

Table 5 shows the first-stage results on the relationship between the proportion of full-time nurse visits and my instrument—full nurses' activeness in the patient's ZIP code—in equation (2). Standard errors in these models are clustered at both the firm and patient ZIP code levels.

In column (1), I begin by estimating the equation with fixed effects for each firm and ZIP code, respectively, and end-of-care time fixed effects for the week of year, year, and day of week. I also control for the number of nurse handoffs, total number of nurse visits, mean interval of nurse visits and office-week level overall demand and labor supply characteristics. I incrementally control for more patient characteristics in columns (2)–(4).

There is a strong correlation between the patient's proportion of full-time nurse visits and my instrument, as shown by the statistically significant correlations at the one percent level and large F-statistic values of around 300. In column (4) for the richest specification, when full-time nurses were more active in the patient's ZIP code during the start-of-care month by one standard deviation (0.26), she received 16 percentage points or 26 percent higher proportion of full-time nurse visits given the mean of 0.6.[16] This would translate to nearly one more full-time nurse visit during her care which involved six total nurse visits on average.

6.2 Second-Stage Results on Patient Readmission

I begin with the OLS estimation of the effect of the proportion of full-time nurse visits on patient readmission in equation (3). Panel A shows that the proportion of full-time nurse visits is negatively correlated with an indicator for hospital readmission: patients receiving a one-standard-deviation higher proportion of full-time nurse visits (0.41) were 0.4 percentage points or 2 percent less likely to be readmitted given the mean readmission rate of 0.2. However, this effect is not statistically significant even at the 10 percent level in all columns. This result reflects the upward bias I described in Section 4, which likely occurs since sicker patients tended to have a higher proportion of full-time nurse visits. Indeed, the coefficient decreases twofold from column (1) to (2), and threefold from column (1) to (4). This pattern

[16] A 26-percent increase is obtained by multiplying the one standard deviation, 0.26, by the coefficient estimate 0.608 and dividing by the mean proportion of full-time nurse visits 0.6 (with the final number multipled by 100 for the percentage).

corroborates that sicker patients in terms of hospitalization risk controls, demographic controls and comorbidity controls were systematically assigned a higher proportion of full-time nurse visits while those patients were independently more likely to be readmitted.

Panel B shows the 2SLS estimates using the first-stage results from Table 5. There is a stronger negative correlation between the proportion of full-time nurse visits and hospital readmission by almost four times. The effects are statistically significant at the ten percent level once hospitalization risk, demographic, and comorbidity controls are included in columns (2)–(4). The rise of statistical significance reflects, shown in Section 5.3, that sicker patients were more likely to be admitted when full-time nurses were active—which works against estimating a negative effect of full-time nurse visits on readmission. This pattern also contributes to reducing the precision of the estimates. On the other hand, the estimated effects of full-time nurse visits on readmission can be viewed as conservative. From the richest specification in column (4), I find that patients having a one-standard-deviation (0.41) higher proportion of full-time nurse visits or about 2 more full-time nurse visits were 1.4 percentage points or 7 percent less likely to be readmitted.

7 Conclusion

Alternative work arrangements are becoming increasingly popular modes of labor contracts in many industries due to the appeal of the flexibility and potential labor cost reductions. Health care, a labor-intensive service industry facing demand uncertainty, particularly has experienced one of the largest increases in the use of alternative work arrangements over the past two decades. These arrangements might be particularly necessary for supplementing labor supply in the presence of state regulations of the minimum nurse staffing levels and staffing shortages (Tong, 2011; Cook et al., 2012; Mark et al., 2013; Lin, 2014; Matsudaira, 2014). Therefore, it is crucial to understand whether providers hired in traditional and alternative work arrangements lead to any difference in the quality of care and performance.

However, estimating this hypothesis is challenging due to confounding factors and non-random matching of patients and providers in particular work arrangements, as described above. Home health care and the dataset I use provide an ideal opportunity to overcome these challenges and investigate the effect of full-time nurse visits on patient readmission. Home health is also an important market to study as it is one of the fastest growing sectors of health care, and is a sector in which a large proportion of the workforce is hired in alternative work arrangements.

I find that patients receiving a higher proportion of full-time nurse visits were less likely to be readmitted. This finding is obtained by exploiting an exogenous variation across ZIP codes and care timings in the proportion of full-time nurse visits from full-time nurses' activeness. Moreover, this effect holds after controlling for patients' underlying health characteristics, office-level demand and labor supply characteristics, patients' ZIP code fixed effects, firm fixed effects, month fixed effects and fixed effects related to the timings of the start and end of care.

My findings suggest that increasing the use of full-time nurses can improve the quality of care. It will be a fruitful target for policymakers and providers to focus on understanding the determinants of and reducing the gap in quality provided by nurses in different work

arrangements. Consequently, future work on the specific mechanisms underlying my finding is critical. If experience were an important determinant of quality difference between full-time nurses and others, it is crucial to investigate nurses' learning curve, which also has broader implication on the choice of work arrangements and the value of retention. Furthermore, future work on the variation in the gap in quality of care among nurses in different work arrangements across different firms is crucial. Organizational learning by doing on the management and configuration of alternative work arrangements will provide valuable insights.

References

Aiken, Linda H, Jingjing Shang, Ying Xue, and Douglas M Sloane (2013), "Hospital use of agency-employed supplemental nurses and patient mortality and failure to rescue." *Health Services Research*, 48, 931–948.

Aiken, Linda H., Douglas M. Sloane, Jeannie P. Cimiotti, Sean P. Clarke, Linda Flynn, Jean Ann Seago, Joanne Spetz, and Herbert L. Smith (2010), "Implications of the california nurse staffing mandate for other states." *Health Services Research*, 45, 904–921, URL http://dx.doi.org/10.1111/j.1475-6773.2010.01114.x.

Aiken, Linda H, Ying Xue, Sean P Clarke, and Douglas M Sloane (2007), "Supplemental nurse staffing in hospitals and quality of care." *The Journal of Nursing Administration*, 37, 335.

Angrist Joshua, D and Jörn-Steffen Pischke (2009), *Mostly Harmless Econometrics: An Empiricists Companion.* Princeton University.

Bae, Sung-Heui, Barbara Mark, and Bruce Fried (2010), "Use of temporary nurses and nurse and patient safety outcomes in acute care hospital units." *Health Care Management Review*, 35, 333–344.

Berry Jaeker, Jillian A. and Anita L. Tucker (2016), "Past the point of speeding up: The negative effects of workload saturation on efficiency and patient severity." *Management Science*, 1–21.

Booth, Alison L, Marco Francesconi, and Jeff Frank (2002), "Temporary jobs: stepping stones or dead ends?" *The Economic Journal*, 112, F189–F213.

Brachet, Tanguy, Guy David, and Andrea M Drechsler (2012), "The effect of shift structure on performance." *American Economic Journal: Applied Economics*, 219–246.

Broschak, Joseph P. and Alison Davis-Blake (2006), "Mixing standard work and nonstandard deals: The consequences of heterogeneity in employment arrangements." *The Academy of Management Journal*, 49, 371–393, URL http://www.jstor.org/stable/20159769.

Brown, Jason, Mark Duggan, Ilyana Kuziemko, and William Woolston (2014), "How does risk selection respond to risk adjustment? new evidence from the medicare advantage program." *The American Economic Review*, 104, 3335–3364.

Cabin, William, David U Himmelstein, Michael L Siman, and Steffie Woolhandler (2014), "For-profit medicare home health agencies' costs appear higher and quality appears lower compared to nonprofit agencies." *Health Affairs*, 33, 1460–1465.

Chapple, Karen (2001), "Time to work: Job search strategies and commute time for women on welfare in san francisco." *Journal of Urban Affairs*, 23, 155–173.

Cook, Andrew, Martin Gaynor, Melvin Stephens Jr, and Lowell Taylor (2012), "The effect of a hospital nurse staffing mandate on patient health outcomes: Evidence from california's minimum staffing regulation." *Journal of Health Economics*, 31, 340–348.

Cuyper, Nele De, Jeroen de Jong, Hans De Witte, Kerstin Isaksson, Thomas Rigotti, and René Schalk (2008), "Literature review of theory and research on the psychological impact of temporary employment: Towards a conceptual model." *International Journal of Management Reviews*, 10, 25–51, URL http://dx.doi.org/10.1111/j.1468-2370.2007.00221.x.

David, Guy and Tanguy Brachet (2009), "Retention, learning by doing, and performance in emergency medical services." *Health Services Research*, 44, 902–925.

Doyle Jr, Joseph J, John A Graves, Jonathan Gruber, and Samuel A Kleiner (2015), "Measuring returns to hospital care: Evidence from ambulance referral patterns." *Journal of Political Economy*, 123, 170–214.

Figlio, David N., Morton O. Schapiro, and Kevin B. Soter (2015), "Are tenure track professors better teachers?" *Review of Economics and Statistics*, 97, 715–724, URL http://dx.doi.org/10.1162/REST_a_00529.

Gimenez-Nadal, J Ignacio, José Alberto Molina, et al. (2011), "Commuting time and labour supply: A causal effect?" *IZA Discussion Paper*.

Gutiérrez-i Puigarnau, Eva and Jos N van Ommeren (2010), "Labour supply and commuting." *Journal of Urban Economics*, 68, 82–89.

Harley, Bill (1994), "The conditions associated with peripheral employment in Australia." *Employee Relations*, 16, 19–31, URL http://dx.doi.org/10.1108/01425459410073924.

Hockenberry, Jason M and Edmund R Becker (2016), "How do hospital nurse staffing strategies affect patient satisfaction?" *ILR Review*, 890–910.

Katz, Lawrence F. and Alan B. Krueger (2016), "The rise and nature of alternative work arrangements in the united states, 1995-2015." *National Bureau of Economic Research*, Working Paper.

Kawachi, Ichiro, Norman Daniels, and Dean E Robinson (2005), "Health disparities by race and class: why both matter." *Health Affairs*, 24, 343–352.

Kuntz, Ludwig, Roman Mennicken, and Stefan Scholtes (2014), "Stress on the ward: Evidence of safety tipping points in hospitals." *Management Science*, 61, 754–771.

Lasater, Karen B., Douglas M. Sloane, and Linda H. Aiken (2015), "Hospital employment of supplemental registered nurses and patients' satisfaction with care." *The Journal of Nursing Administration*, 45, 145–151, URL http://dx.doi.org/10.1097/NNA.0000000000000174.

Lin, Haizhen (2014), "Revisiting the relationship between nurse staffing and quality of care in nursing homes: An instrumental variables approach." *Journal of Health Economics*, 37, 13–24.

Lotti, Francesca and Eliana Viviano (2012), "Temporary workers, uncertainty and productivity." *The Society of Labor Economists, mimeo*.

Lu, Susan Feng and Lauren Xiaoyuan Lu (2016), "Do mandatory overtime laws improve quality? staffing decisions and operational flexibility of nursing homes." *Management Science*.

Mark, Barbara A., David W. Harless, Joanne Spetz, Kristin L. Reiter, and George H. Pink (2013), "California's minimum nurse staffing legislation: Results from a natural experiment." *Health Services Research*, 48, 435–454, URL http://dx.doi.org/10.1111/j.1475-6773.2012.01465.x.

Matsudaira, Jordan D (2014), "Government regulation and the quality of healthcare evidence from minimum staffing legislation for nursing homes." *Journal of Human resources*, 49, 32–72.

Medoff, James L and Katharine G Abraham (1980), "Experience, performance, and earnings." *The Quarterly Journal of Economics*, 95, 703–736.

MedPAC (2016), *Report to the Congress: Medicare Payment Policy*, chapter Home Health Care Services, 209–234. URL http://www.medpac.gov/documents/reports/chapter-9-home-health-care-servichttp://www.medpac.gov/documents/reports/chapter-8-home-health-care-services-(march-2016-report).pdf?sfvrsn=0.

Murnane, Richard J and Barbara R Phillips (1981), "Learning by doing, vintage, and selection: Three pieces of the puzzle relating teaching experience and teaching performance." *Economics of Education Review*, 1, 453–465.

Needleman, Jack, Peter Buerhaus, V Shane Pankratz, Cynthia L Leibson, Susanna R Stevens, and Marcelline Harris (2011), "Nurse staffing and inpatient hospital mortality." *New England Journal of Medicine*, 364, 1037–1045.

Pham, Julius Cuong, Mary Andrawis, Andrew D Shore, Maureen Fahey, Laura Morlock, and Peter J Pronovost (2011), "Are temporary staff associated with more severe emergency department medication errors?" *Journal for Healthcare Quality*, 33, 9–18.

Tavares-Pereira, Fernando, José Rui Figueira, Vincent Mousseau, and Bernard Roy (2007), "Multiple criteria districting problems." *Annals of Operations Research*, 154, 69–92, URL http://dx.doi.org/10.1007/s10479-007-0181-5.

Tong, Patricia K. (2011), "The effects of california minimum nurse staffing laws on nurse labor and patient mortality in skilled nursing facilities." *Health Economics*, 20, 802–816, URL http://dx.doi.org/10.1002/hec.1638.

Witte, Hans De and Katharina Nswall (2003), "'objective' vs 'subjective' job insecurity: Consequences of temporary work for job satisfaction and organizational commitment in four european countries." *Economic and Industrial Democracy*, 24, 149–188, URL http://dx.doi.org/10.1177/0143831X03024002002.

Worth, Tammy (2014), "Home health on road to reducing readmits." *Healthcare Finance*, URL http://www.healthcarefinancenews.com/news/home-health-road-reducing-readmits. April 7, 2014 (Accessed on July 8, 2016).

Xue, Ying, Linda H Aiken, Deborah A Freund, and Katia Noyes (2012), "Quality outcomes of hospital supplemental nurse staffing." *Journal of Nursing Administration*, 42, 580–585.

Table 1: Labor Supply and Pay Characteristics of Nurses by Work Arrangements

	(1) Full-time	(2) Part-time with benefits	(3) Part-time without benefits	(4) On-call	(5) Contractor	(6) Office/ Other
A. Labor supply characteristics per week						
Number of visits	21.84	15.93	14.53	8.93	6.46	10.76
Number of days worked	4.95	4.51	4.35	3.45	2.27	3.40
Total time spent on visits (hours)	16.16	12.15	11.49	6.94	5.57	8.24
Mean visit length (hours)	0.77	0.79	0.80	0.84	0.87	0.85
Length of employment (months)	21.18	24.41	28.29	16.29	5.18	8.33
B. Pay characteristics						
Pay scheme	Salary	Salary	Salary	Piece rate	Piece rate	Salary
Total weekly pay ($)	1,239.27	819.25	711.91	445.06		
Per visit rate ($)	43.77	42.30	42.70	55.80		

Notes. The first four variables in Panel A are obtained using weeks during which the nurses provided at least one visit. The length of employment in Panel A is measured for nurses who terminated their employment, where the termination is defined as either permanently exiting the workforce or providing no visits for more than 90 consecutive days. For the pay scheme in Panel B, salary is defined as a fixed amount of pay for the specific expected number of visits per week, and piece rate as a fixed rate per visit. Salaried nurses are eligible for benefits, except part-time nurses without benefits in column (3); piece-rate paid ones are ineligible.

Table 2: Patient Severity and the Proportion of Full-Time Nurse Visits

Proportion of full-time nurse visits	(1) 0	(2) Greater than 0 and less than median	(3) At least median and less than 1	(4) 1
A. Key endogenous determinants of the patient readmission				
Proportion of full-time nurse visits	0.00	0.43	0.82	1.00
Ratio of handoffs to nurse visits	0.11	0.43	0.33	0.15
Number of nurse visits	5.61	5.92	7.20	5.42
Mean number of days between two consecutive visits	4.86	4.78	4.88	5.32
B. Hospitalization risk factors				
Risk for hospitalization: History of 2+ falls	0.26	0.25	0.26	0.26
Risk for hospitalization: 2+ hospitalizations	0.35	0.40	0.43	0.40
Risk for hospitalization: Recent mental decline	0.06	0.07	0.07	0.08
Risk for hospitalization: Take 5+ medications	0.87	0.88	0.88	0.89
Risk for hospitalization: Other	0.07	0.11	0.08	0.10
C. Demographic characteristics				
Age	79.24	78.39	78.82	78.92
Female	0.58	0.59	0.61	0.62
White	0.83	0.80	0.79	0.77
Enrolled in per-visit paying Medicare Advantage	0.22	0.17	0.16	0.17
Enrolled in per-episode paying Medicare Advantage	0.08	0.04	0.04	0.04
Dual eligible	0.00	0.01	0.01	0.01
No assistance available	0.02	0.02	0.02	0.02
Living alone	0.23	0.23	0.26	0.25
D. Comorbidity characteristics				
Overall status having serious progressive conditions (Very bad)	0.02	0.03	0.04	0.04
Overall status likely to remain in fragile health (Bad)	0.27	0.29	0.30	0.32
Overall status temporarily facing high health risks (Less bad)	0.63	0.59	0.60	0.58
High risk factor: Alcohol dependency	0.03	0.02	0.02	0.03
High risk factor: Drug dependency	0.01	0.01	0.01	0.01
High risk factor: Heavy smoking	0.13	0.13	0.13	0.14
High risk factor: Obesity	0.17	0.19	0.18	0.16
Pre-home health condition: Disruptive behavior	0.01	0.01	0.01	0.01
Pre-home health condition: Impaired decision-making	0.12	0.15	0.14	0.17
Pre-home health condition: Indwelling/Suprapublic catheter	0.02	0.02	0.02	0.01
Pre-home health condition: Intractable pain	0.12	0.12	0.09	0.11
Pre-home health condition: Memory loss	0.10	0.10	0.10	0.12
Pre-home health condition: Urinary incontinence	0.27	0.29	0.30	0.31
E. Other characteristics				
Length of care (in days)	24.42	25.14	31.05	25.36
Total number of unique nurses seen	1.46	2.82	2.65	1.58
Number of physical therapy visits	4.26	4.14	4.66	4.36
Number of occupational therapy visits	1.22	1.35	1.59	1.46
Number of speech therapy visits	0.22	0.27	0.32	0.30
Number of home health aide visits	0.60	0.66	0.83	0.59
Number of observations	4,975	4,927	3,672	7,626

Notes. The median proportion of full-time nurse visits is 0.75.

Table 4: Balance of Covariates in the Patient Sample

Full-time nurses' activeness	(1) Low	(2) High
A. Key variables of interest		
Proportion of full-time nurse visits	0.42	0.78
Indicator for hospital readmission	0.19	0.21
B. Care characteristics		
Number of nurse handoffs	1.26	1.53
Number of nurse visits	5.96	5.82
Mean number of days between two consecutive visits	4.85	5.18
C. Hospitalization risk factors		
Risk for hospitalization: History of 2+ falls	0.26	0.26
Risk for hospitalization: 2+ hospitalizations	0.37	0.41
Risk for hospitalization: Recent mental decline	0.07	0.07
Risk for hospitalization: Take 5+ medications	0.87	0.89
Risk for hospitalization: Other	0.09	0.10
D. Demographic characteristics		
Age	79.14	78.58
Female	0.60	0.61
White	0.83	0.76
Enrolled in per-visit paying Medicare Advantage	0.20	0.16
Enrolled in per-episode paying Medicare Advantage	0.06	0.04
Dual eligible	0.00	0.01
No assistance available	0.02	0.02
Living alone	0.24	0.24
E. Comorbidity characteristics		
Charlson Comorbidity Index	0.63	0.70
Overall status having serious progressive conditions (Very bad)	0.03	0.04
Overall status likely to remain in fragile health (Bad)	0.28	0.31
Overall status temporarily facing high health risks (Less bad)	0.61	0.58
High risk factor: Alcohol dependency	0.03	0.02
High risk factor: Drug dependency	0.01	0.01
High risk factor: Heavy smoking	0.13	0.14
High risk factor: Obesity	0.17	0.18
Pre-home health condition: Disruptive behavior	0.01	0.01
Pre-home health condition: Impaired decision-making	0.14	0.16
Pre-home health condition: Indwelling/Suprapublic catheter	0.02	0.02
Pre-home health condition: Intractable pain	0.11	0.12
Pre-home health condition: Memory loss	0.11	0.10
Pre-home health condition: Urinary incontinence	0.29	0.30
F. Firm characteristics		
Mean daily number of episodes in the office	170.54	192.59
Mean daily number of active nurses in the office	21.60	22.00
Mean daily proportion of full-time nurses in the office	0.41	0.54
Number of observations	10,600	10,600

Notes. Mean values are reported. The "High" group of patients is defined as those whose full-time nurses' activeness is above or equal to median. The median thresholds used for grouping patients is 0.66 for the full-time nurses' activeness.

Table 5: IV First-Stage Results: Effect of Full-time Nurses' Activeness on the Proportion of Full-Time Nurse Visits

	Dep. var.: Proportion of full-time nurse visits			
	(1)	(2)	(3)	(4)
Full-time nurses' activity share	0.602***	0.602***	0.602***	0.600***
	(0.034)	(0.035)	(0.035)	(0.035)
R-squared	0.32	0.32	0.33	0.33
F-statistic	307.20	301.83	299.66	301.47
Hospitalization risk controls	.	Yes	Yes	Yes
Demographic controls	.	.	Yes	Yes
Comorbidity controls	.	.	.	Yes
Observations	21,200	21,200	21,200	21,200

Source. Authors' proprietary data. *Notes.* The unit of observation is a patient episode. In all columns, I control for the number of nurse handoffs, total number of nurse visits, mean interval of nurse visits, mean of firm-day level demand and labor supply characteristics during the patient's episode; and firm fixed effects, patient's ZIP code fixed effects, fixed effects for day of week, week of year, and year of the last day of care, respectively. Firm-ZIP code level clustered standard errors in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 6: Main Results: Effect of Proportion of Full-Time Nurse Visits on Patient Readmission

	Dep var: Indicator for hospital readmission			
	(1)	(2)	(3)	(4)
	A. OLS			
Proportion of full-time nurse visits	-0.003	-0.007	-0.007	-0.009
	(0.013)	(0.010)	(0.010)	(0.009)
R-squared	0.13	0.15	0.15	0.18
	B. 2SLS			
Proportion of full-time nurse visits	-0.032	-0.036*	-0.035*	-0.035*
	(0.021)	(0.020)	(0.020)	(0.020)
R-squared	0.02	0.02	0.02	0.02
Hospitalization risk controls	.	Yes	Yes	Yes
Demographic controls	.	.	Yes	Yes
Comorbidity controls	.	.	.	Yes
Observations	21,200	21,200	21,200	21,200

Source. Authors' proprietary data. *Notes.* The unit of observation is a patient episode. I use a a two-step efficient generalized method of moments (GMM) estimator. In all columns, I control for the number of nurse handoffs, total number of nurse visits, mean interval of nurse visits, mean of firm-day level demand and labor supply characteristics during the patient's episode; and firm fixed effects, patient's ZIP code fixed effects, fixed effects for day of week, week of year, and year of the last day of care, respectively. Firm-ZIP code level clustered standard errors in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.