Online Appendix for

Staffing Subsidies and the Quality of Care in Nursing Homes

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This appendix presents the underlying model used in the theoretical discussion of our paper “Staffing Subsidies and the Quality of Care in Nursing Homes”

A Model of Nursing Home Behaviour

Pass-through can affect quality of care through (1) increases in staffing or (2) changes in worker effort\(^1\). Staffing can change because the price of labor nursing homes face decreases with a wage pass-through. Worker effort can change because one’s effort depends on the wage one receives from the nursing home as well as one’s opportunity wage, as typically stipulated in an efficiency wage model. The overall impact of the policy depends on how nursing homes respond not only to the change in market wage but also to the changes in nurse effort resulting from the change in market wage. In order to understand both the direct and indirect effects of wage pass-through on quality and to model the effect of wages on worker productivity we embed an efficiency wage model with staffing constraints into the nursing home model generally used in the literature (Gertler 1989, 1992, Norton 2000).

We assume that nursing homes accept both private-pay and Medicaid patients, provide the same quality of care to both patient types, and do not discriminate admission by patient type.\(^2\) The long-term care (LTC) market today is increasingly competitive, with more and more non-nursing home LTC providers, such as assisted living and other community-based services, competing with traditional nursing homes. The national average nursing home occupancy rate has fallen below 85% in recent years.\(^3\) This allows us to consider a nursing home’s Medicaid patient load as exogenously determined by the local market condition. Nursing home markets are local, with counties being a reasonable approximation, given patterns of funding and resident origin (Foster and Rahman 2011; Grabowski 2008). Nursing homes can charge different prices to private pay patients depending on the quality of care each facility provides. Finally, nursing homes face staffing constraints as mandated by federal and state law. Staffing standards vary widely across states with certain states setting statutes in terms of the nurse to patient ratio and

\(^1\) As Weiss (1990) points out quality of workers can improve because of the change in distribution of workers hired (adverse selection) or changes in individual effort (incentive effect or moral hazard). The model in this section is tailored to the incentive effects model because it concisely explains the heterogeneous effects without having to go through a more complicated job search model of turnover.

\(^2\) Grabowski, Gruber and Angelelli (2008) empirically show that quality is the same for both patient types.

\(^3\) The national nursing home occupancy rate in 2001 was 85.9% and has been falling steadily to 84.8% by 2007 (Harrington et al., 2008). Gertler’s (1989, 1992) studies are based on New York’s nursing home market in the early 1980s when occupancies were well over 95%.
others in nurse hours per patient day. Also, statutes in some states concern direct-care staff in general without specifically restricting CNA staffing hours. In our optimization problem, we generalize the staffing mandate as an inequality constraint on staffing.

An important element of our research is the distinction between hiring greater staffing and raising the quality of output per worker. It is unclear, for example, that an increase in staffing will improve patient well-being if the effect of this increase in staffing, given other conditions in the market, ends up reducing worker effort. To capture this idea we incorporate an efficiency wage model. In particular, the quality of care is produced in terms of efficiency labor units, i.e., \( q = e(w_1, w_2)l \), where \( q \) is quality, \( e \) is efficiency per worker, and \( l \) is staffing hour per patient. Efficiency is determined by the wage received from the nursing home, \( w_1 \), and the market wage, \( w_2 \). Efficiency increases as nurses earn higher wages \( (e_{w1} > 0) \) but decreases as the market wage increases holding own wage constant \( (e_{w2} < 0) \). A nursing home providing care of quality \( q \) and charging \( v \) per private-pay patient attains \( F(v, q) \) number of private pay patients where we assume \( F_q > 0 \) and \( F_v < 0 \). For Medicaid patients, nursing homes earn the Medicaid reimbursement rate \( s \), which is determined by the state, and the number of patients \( G_0 \) which we take as exogenously determined by the structure of the local market. Nursing homes receive the additional wage pass-through amount of \( pw_1 \) where \( p \) is the subsidy rate on the nurse wage \( w_1 \). Nursing homes choose the private pay patient price \( v \) and the number of staff \( l \) and their wage \( w_1 \) to maximize profit

\[
\Pi = vF(v, q; \delta) + sG_0 + pw_1lG_0 - w_1l(F(v, q; \delta) + G_0)
\]

subject to \( l \geq l_{\text{min}} \) where \( l_{\text{min}} \) is the mandated minimum staffing per patient. \( \delta \) is a type (or technology) parameter where higher \( \delta \) enables nursing homes to attract more private pay patients \( (F_\delta > 0) \), resulting in a lower share of Medicaid patients. The type parameter can also be thought of as reputational capital that captures the facility and management quality of each nursing home. We are primarily interested in the effects of introducing wage pass-through \( p \) on labor demand \( l \) and quality of care \( q \).

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\(^5\) The number of Medicaid patients is, of course, potentially endogenous with respect to nursing home quality, but less so, we believe because of the nature of Medicaid financing. E.g., those with Medicaid funding have overall fewer options for care than private pay patients.

\(^6\) Most nursing homes are for-profit. Moreover, for our purposes, and given a reasonable set of objectives for non-profit nursing homes the key behaviors of interest do not vary by for profit status.
We first heuristically discuss the impact of a wage pass-through introduction and then illustrate using a parametric example. For unconstrained nursing homes, that is, nursing homes of high reputation that optimally choose labor above \( l_{\text{min}} \), the first order conditions \( \Pi_v = 0, \Pi_l = 0 \) and \( \Pi_w = 0 \) determine optimal private pay price, staffing, and wage. However, low reputation nursing homes that would optimally choose staffing below \( l_{\text{min}} \) are mandated to choose \( l_{\text{min}} \) and determine a wage accordingly. Depending on whether a nursing home is constrained by the staffing mandate, the introduction of a wage pass-through will have different implications. The first order effect of a wage pass-through is to lower the price of labor for nursing homes resulting in an increase in demand for labor, and if nursing home labor is inelastically supplied to the relevant market, an increase in the market wage \( w_2 \). Nursing homes that are not constrained by the staffing mandate will increase staffing and adjust their own wages based on their first order conditions. However, nursing homes that were constrained will still choose \( l_{\text{min}} \), unless the subsidy was large enough to move them above \( l_{\text{min}} \), and thus utilize the full pass-through amount to increase wages for the staff. The increase in own wages would be large for these constrained nursing homes, resulting in increased worker efficiency, and ultimately, quality of care. Though staffing increases in high reputation nursing homes, worker efficiency may drop because the own wages may not rise as much as the market wage rises, resulting in a possible decrease in worker effort.

To graphically illustrate these twofold effects more clearly we consider the following parametric example. In particular, we assume

\[
F(v, q) = \frac{\delta q}{v^{\alpha+1}} \tag{2}
\]

\[
e(w_1, w_2) = \left( \frac{w_1 - \eta_1}{w_2 - \eta_2} \right)^\nu \tag{3}
\]

\[
w_2 = 4l \tag{4}
\]

and for parameter values we choose \( \eta_1 = 1, \eta_2 = 1, \alpha = 0.9 \) and \( \nu = 0.9 \). We solve the model by allowing \( \delta \) to vary and fixing \( l_{\text{min}} \) at 1. This exercise illustrates how the various nursing homes of different reputation levels across markets respond to wage pass-through. Figures 1A and 1B present nursing home staffing and wage decisions by the type parameter. As discussed before, staffing hours increase at high \( \delta \) but remain unchanged at low \( \delta \). On the contrary, wages increase.

\[\text{Equation (4) is a simple way to characterize the market wage that captures aggregate demand effects.}\]
at low $\delta$ but remain unchanged at high $\delta$. As a result, quality in low $\delta$ nursing homes improves with pass-through but quality slightly decreases in high $\delta$ nursing homes as illustrated in Figure 1C. The quality improvement is more pronounced in low $\delta$ nursing homes because it sees a considerable increase in staff efficiency due to the rise in own wages relative to that of the market. Quality change in high $\delta$ nursing homes is minimal because the increase in staffing is offset by the drop in staff efficiency. Staff efficiency may drop because, given the separability, own wages are fixed and market wages rise. Lastly, Figure 1D shows how the share of Medicaid patient decreases as the type parameter $\delta$ increases. The Medicaid share is higher with wage pass-through in place but as higher $\delta$ nursing homes are able to capture more private pay patients, the Medicaid share in those nursing homes steadily declines with $\delta$.

The parametric model illustrates how the impact of wage pass-through on the staffing level and quality of care differs depending on the type parameter. In other words, if there are two local patient markets, one characterized by high and the other by low end nursing homes, the low end market will increase wages without hiring additional nursing staff but the high end market will hire more nurses without increasing individual wages. In the empirical analysis that follows, we examine the average effect of wage pass-through on staffing and quality but also proxy nursing home type with the share of Medicaid patients to examine heterogeneous policy effects.
Figure 1. Impact of Pass-through by the Nursing Home Types

A. Staffing Level  
B. Wage

C. Quality of Care  
D. Share of Medicaid Patients

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No Pass-through  —  Pass-through