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Temporal Specificity and Task Alignment: Evidence from Patient Care

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tasks downstream to lower cost delivery systems by discharging patients earlier and in poorer health; and integration leads to greater post-hospitalization service intensity. While integration facilitates a shift in the allocation of tasks, health outcomes are no worse when patients receive
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1. Introduction

This paper examines how integration solves temporal specificity problems that arise from the misalignment of tasks between organizations. Temporal specificity refers to the value lost when an open market transaction is not performed in a timely manner, compared to the value of the same transaction when performed within an integrated firm (Masten, Meehan and Snyder 1991). Prior research on temporal specificity focused on the potential for counterparty opportunism to create disruptions in the supply chain by shifting the timing of exchange away from the technologically optimal point. For example, Nickerson and Silverman (2003) demonstrate how the disruption of closely coordinated breakbulk operations in the less-than-truckload (LTL) segment of the trucking industry can lead to costly ripple effects throughout the LTL network. As a result, in the presence of temporal specificity, firms are more likely to vertically integrate to internalize the externality associated with the timing of exchange. We build on the temporal specificity literature by examining how the timing of exchange influences transaction costs, and extend the literature by highlighting how task alignment, as opposed to *ex post* opportunism, influences firm boundaries.

We formalize the intuition behind the idea that task misalignment can be a determinant of temporal specificity, and test the predictions of the model in the context of the patient care continuum, where patients transition from acute care facilities (hospitals) into post-acute care (nursing homes and home health). The empirical application demonstrates the role of task alignment in transactions and firm boundary decisions. Taking the sequence of clinical interventions (or tasks) along the care continuum as fixed—patients need a well defined set of clinical interventions to address their health care needs—exchange is characterized solely by the timing of the transition across settings. Systematic variation in cost structures between hospitals and post-acute care providers and contractual incompleteness in their exchange relationships ensures that tasks will not be efficiently assigned unless the hospital and downstream providers are vertically integrated.[1] However, integration costs are non-trivial such that there is substantial heterogeneity in governance regimes: about half of all hospitals are vertically integrated into post-acute care.

One major advantage of our empirical design is that we can track patients across organizations, which allows us to pinpoint how integration influences tasks on both sides of the exchange relationship. The ability to observe the clinical procedures patients receive in post-acute care at a high-level of detail is particularly important to our empirical assessment of patient health at the time of discharge. The evidence shows that, on average, vertical integration leads to shorter hospital stays for one out of every two patients who are discharged to a skilled nursing facility or home health agency. We also find that patients received higher intensity of care from vertically integrated home health providers. The results support the central thesis of the paper: integration solves task misalignment problems. Notably, while we find striking differences in the organization of services across sites, vertical integration does not lead to a decline in patient health outcomes, suggesting that different allocations of tasks across assets (or sites) produces similar (or higher) levels of care quality.[2]

The contributions of this research are twofold. First, we develop a tractable model that extends the conceptual basis for temporal specificity to include the role of task alignment. Second, we demonstrate empirically how vertical integration changes the alignment of tasks to assets and, thereby, solves temporal specificity problems that arise in market exchange.

2. Theory and related literature

In this section, we describe and then formalize the intuition for task misalignment as a basis for temporal specificity, showing that when contracts are incomplete (for any reason), and counterparties' profit functions are heterogeneous with respect to a focal task, market exchange will fail to generate the optimal allocation of tasks.

[1] We focus on Medicare transitions where parties cannot influence the price of exchange and side payments are illegal.
[2] We use the terms assets and sites interchangeably throughout this paper. In health care, as in most service industries, tasks may be performed in multiple physical settings. These settings can be thought of as assets, as traditionally defined in the literature. However, it is perhaps more natural to refer to the location of service provision as a "site."

Therefore, even when hierarchical governance creates incentive and bureaucratic costs, task misalignment can lead to temporal specificity.

The prior literature on temporal specificity locates the source of contracting problems in the timely production or delivery of goods or services, an argument that rests on the idea that production takes a sequential form in which a sequence of tasks leads to production of an output. For example, Pirrong (1993) finds evidence that inefficiencies associated with haggling over quasi-rents that arise due to time-sensitive matching of shipments to carriers leads to long-term contracting and vertical integration in the bulk shipping market. In the bulk shipping context, shipping must follow production and precede sales in a pre-determined sequence, and contracting over the timing of shipments can lead to inefficiencies because capacity "spoils" if it is not filled when a ship leaves the harbor. Given a technologically determined sequence of production, and the risks of opportunistic interruptions or delays amidst the sequence of tasks, the extant literature analyzes how the timing of exchange can be affected by *ex post* maladaptation.

In this paper, we acknowledge the fundamental insight that temporal considerations influence the efficiency of exchange in a way that creates asset specificity, but shift the problem back before the emergence of *ex post* maladaptation in exchange by studying temporal specificity in terms of task misalignment. Instead of considering the timing of exchange as the choice variable, or threat point, of interest in a given transaction, we endogenize the timing of exchange by analyzing how the partitioning of the sequence of tasks across organizations (or sites or assets) influences production efficiencies. Thus, we propose that temporal specificity need not always arise from opportunistic behavior, but can also be due to production inefficiencies in market-based task alignment.

In transaction cost economics (TCE) and the property rights theory (PRT) of the firm, firms solve inefficiencies in market exchange arising from incomplete contracts and asset specificity by replacing market exchange with hierarchical governance (Williamson 1985, Grossman and Hart 1986, Hart and Moore 1990). Though task alignment, where tasks are defined as production activities (Jacobides and Winter 2005), is rarely explicitly discussed in TCE and PRT, the logic behind these theories would seem to imply that if market exchange led to task misalignment, firms could solve the externality by suppressing market mechanisms through integration.

Building on the idea that task misalignment could influence transaction costs and the timing of transactions, we analyze the allocation of tasks to assets in the case of a two-way vertical exchange relationship, using a framework where contracts are inherently incomplete. As is standard in the literature, we define integration as the joining of assets under unified management (Klein, Crawford and Alchian 1978; Williamson 2010). Transactions are characterized by exchanges between assets (or sites), and tasks are production activities used in conjunction with assets to produce outputs for exchange, where, for tractability, the sequence of tasks needed to achieve an outcome is technologically pre-determined. Further, we assume that integration results in increased bureaucratic costs, arising from the management of different lines of business, as is common in the theory of the firm literature. We do not, however, impose exogenous costs of market exchange. Instead, by distinguishing between two types of tasks—general and site-dedicated tasks—we express the cost of market exchange through the misalignment of tasks to sites. The introduction of two types of distinct tasks is crucial because if all tasks are site-dedicated—if all tasks are performed in conjunction with a particular site—tasks and assets are redundant constructs and task misalignment has no substantive meaning beyond the standard TCE/PRT models. In our framework, however, when some tasks are general, that is, when they are not site-specific, then task misalignment can be the basis for temporal specificity and integration will influence the efficiency of the allocation of tasks across sites.

From these foundations, we propose a model where the allocation of tasks to sites shapes firm boundaries by influencing production costs. To develop this result, we divide tasks into two groups: tasks dedicated to a particular site and tasks that can be performed at multiple sites. The first class of tasks—site-dedicated tasks—represent the focal source of hierarchical governance costs, as the management of heterogeneous site-task pairs within a single firm requires costly managerial oversight (Penrose 1959, Schoar 2002). In our model, site-dedicated tasks are efficiently aligned, as these tasks never cross the boundaries of their corresponding sites. Our second class of tasks, general tasks, are of particular interest, as they may span sites—that is, in an exchange relationship between two sites, both sites are technologically capable of performing the general tasks—and, therefore, may be allocated to sites differently under integration versus market exchange. Thus, in the presence of incomplete contracts, vertical integration represents a tradeoff between incurring administrative inefficiencies from governing additional heterogeneous site-specific tasks against the production benefits of aligning general tasks optimally to sites.

General tasks are the key driver of temporal specificity problems in our model, as non-cooperative equilibria may distort the allocation of these tasks to sites under market exchange. Ultimately, we show how the misallocation of general tasks across sites under market exchange creates temporal specificity that can be solved through integration. We begin with the simpler benchmark case where all tasks are site-dedicated and, hence, assets fully partition the task space. For simplicity, we normalize transaction costs from other potential sources to be zero. Under this assumption, when all tasks are site-dedicated, market-based exchange is always superior to vertical integration; however, once general tasks are introduced, this result may reverse.

The tension between the bureaucratic costs of integration and the cost of production inefficiencies associated with market exchange leads to two alternative second best solutions to the problem of exchange. When contracts are incomplete and tasks cannot be assigned to maximize total surplus, market exchange can distort the efficient allocation of general tasks because firms will choose how to allocate general tasks to their own sites without internalizing the externality imposed on their exchange partners. By contrast, integration allows the firm to correct production inefficiencies associated with market exchange by shifting general tasks either downstream or upstream. On the other hand, integration dampens incentives and creates bureaucracy costs that are avoided under market exchange. Thus, while our theory is consistent with transaction cost economics models, which highlight the tension between transaction costs and hierarchical governance costs (Williamson 1985), we explicitly model transaction costs in terms of production inefficiencies associated with task misalignment.

In the simplest case, there are two assets (or sites): A_i and A_j. These assets correspond to two tasks: *i* and *j*, such that, task *i* is dedicated to the asset A_i, whereas task *j* is dedicated to the asset A_j. *i* and *j* are a mapping from the importance of the task to the value of their corresponding assets, A_i and A_j. The "size" of tasks is fixed technologically; therefore, in this case, the value of the two assets is fixed and trivially dependent on matching the specialized assets to their corresponding tasks, with $A_i > 0$ and $A_j > 0$. Note that *i* and *j* do not cross the boundaries of their corresponding assets (sites), and under no integration, do not cross the boundaries of their corresponding firms. Assets can contribute differently to production and therefore can generate different payoffs to the firm that owns them. Each asset, A, generates a payoff $\pi(A)$, which is increasing in the value of the asset, while the marginal payoff is decreasing in the value of the asset, i.e. $\frac{\partial \pi(A)}{\partial A} > 0, \frac{\partial^2 \pi(A)}{\partial A^2} < 0.$

The payoffs to vertical integration are characterized by: $\pi(A_i) + \pi(A_j) - p_{ij}$, where p_{ij} is a fixed penalty that depends on characteristics of the two tasks i and j. When integrating i and j is costless (i.e. $p_{ij} = 0$), both transactions across firms and transaction within firms produce the first best efficient solution.

As discussed above, when there are no transaction costs, all tasks are site-dedicated, and $p_{ij} > 0$, vertical integration will not take place in equilibrium. On the other hand, in the presence of general tasks, task misalignment creates temporal specificities, and as a result vertical integration may constitute a superior way to organize transactions. To see this, we introduce a third task, k, which is a general one (i.e. can be performed by either A_i or A_j). We further assume that a certain predetermined level of k is needed for technological reasons and can be split across the two assets, A_i and A_j, such that: $k = k_i + k_j$.[3]

Market exchange is characterized by the following sum of payoffs to firms: $\pi(A_i) + \pi(A_j)$. However, the efficient allocation of general tasks across sites may be distorted when counterparties' profit functions are heterogeneous with respect to the focal general task. The importance of the general task, k, and its allocation across sites, k_i, endogenously determines the timing of exchange and the larger k the greater the cost of misallocating it across sites. Contractual incompleteness, which we impose exogenously, impairs arrangements (e.g. side payments) that would otherwise lead to an assignment of k that maximizes total surplus. For example, in our empirical application, regulation explicitly rules out the sharing of surplus across firms and leads firms to make decisions that may impose an externality on their exchange partner (Robinson 1996). The task mis-

[3] For simplicity we treat the level of k as fixed and discuss inefficiencies that arise from its misallocation across assets. In a less parsimonious model, the level of k could vary as well, such that market exchange leads to under-performance or over-performance of k. This would create an additional source of inefficiency, arising from market exchange.

alignment externality and, therefore, the temporal specificity associated with market-based exchange increases with the importance of the general task, *k*, and is only internalized through vertical integration.

Since firms on both sides of the exchange cannot share the benefits from maximizing total surplus, yet together they must perform a certain predetermined level of *k* in order to produce output, the choice of k_i and k_j is modeled as the result of a bargaining process. Following the static axiomatic theory of bargaining, we assume that the market allocation of *k* results in a Pareto optimal symmetric Nash bargaining solution (Nash 1953; Binmore, Rubinstein and Wolinsky 1986). Interestingly, since *k* is fixed (i.e. there is a fixed level of *k* that must be carried out for the payoff to be positive), the bargaining process involves two unique elements: first, the firms' threat points equal zero and second, bargaining exists even if the sum of both firms' proposals is less than *k* (i.e. firms bargain over *k* even if *k* is undesirable). Assume firm *i* owns asset A_i and firm *j* owns asset A_j. Denote the firms' proposed level of *k* as $(\bar{k}_i, \bar{k}_j)$ and the Nash bargaining solution as $(\tilde{k}_i, \tilde{k}_j)$. In the simplest case, firms are symmetric and, therefore, desire the same level of *k*. In one extreme, *k* is equally undesirable (i.e. $(\bar{k}_i, \bar{k}_j) = (0,0)$), while in the other, *k* is equally desired by both firms (i.e. $(\bar{k}_i, \bar{k}_j) = (k,k)$). The Nash bargaining solution, in both these cases, is $(\tilde{k}_i, \tilde{k}_j) = (\frac{k}{2}, \frac{k}{2})$. More generally, the solution to the Nash bargaining problem corresponds to $\tilde{k}_i$ that maximizes the Nash product $\left|\tilde{k}_i - \bar{k}_i\right| \cdot \left|(k - \tilde{k}_i) - \bar{k}_j\right|$, in this case, a product of utilities described as the distance between the Nash bargaining solution and the desired amounts of *k*. The general solution is given by: $\tilde{k}_i = \bar{k}_i - \frac{(\bar{k}_i + \bar{k}_j) - k}{2}$ and $\tilde{k}_j = \bar{k}_j - \frac{(\bar{k}_i + \bar{k}_j) - k}{2}$.

It is easy to see that when $\bar{k}_i = \bar{k}_j$, the symmetric Nash bargaining solution $(\tilde{k}_i, \tilde{k}_j) = (\frac{k}{2}, \frac{k}{2})$ is achieved. Under the model assumptions, there is a single efficient combination (exchange point) that maximizes the joint profits across firms, such that $\pi(A_i(k_i^*)) + \pi(A_j(k_j^*)) > \pi(A_i(k_i)) + \pi(A_j(k_j))$ for all $(k_i, k_j) \in k$, and, in particular when $(k_i, k_j) = (\tilde{k}_i, \tilde{k}_j)$, such that: $\pi(A_i(k_i^*)) + \pi(A_j(k_j^*)) > \pi(A_i(\tilde{k}_i)) + \pi(A_j(\tilde{k}_j))$. (See Figure 1 for a graphical illustration). The pair (k_i^*, k_j^*), chosen by the integrated firm, is not the result of market exchange.

Firms, in our model, will decide to vertically integrate when:

$$(1) \qquad \pi_{VI} = \pi(A_i(k_i^*)) + \pi(A_j(k_j^*)) - p_{ij} > \pi(A_i(k_i)) + \pi(A_j(k_j)) = \pi_{ME}.$$

This decision depends on the composition of *i*, *j*, and *k*. In particular, the greater *k* is and the smaller p_{ij} is, the more likely it is that the firms would vertically integrate (see Figure 2). Note, that since both market exchange and vertical integration involve cost, the first best payoff $\pi(A_i(k_i^*)) + \pi(A_j(k_j^*))$ is not attainable.

The interaction between site-dedicated and general tasks is crucial for the allocation of general tasks across sites. When site-dedicated and general tasks are complements (an increase in one task raises the marginal value of the other task), firms would benefit from concentrating general tasks in sites to maximize payoff. Alternatively, there can be diseconomies of scope in tasks. In the case of economies of scope (or task complementarily) $\frac{\partial A_i(k_i)}{\partial k_i} > 0, \frac{\partial A_j(k_j)}{\partial k_j} > 0$ the allocation of the general task to a single site will raise the marginal value of the site-dedicated tasks performed using that site. In this case, the integrated firm would maximize total surplus by performing the entire general task at the site that provides it with the greatest return. On the other hand, when firms make decisions in isolation and are precluded from sharing any surplus from cooperation, bargaining over *k* will lead both firms to inefficiently perform non-zero amounts of *k*. If tasks are technologically determined to be performed sequentially, this inefficiency is properly defined as a temporal specificity problem since the misallocation of tasks leads to a timing problem in exchange. Task alignment influences the cost of market exchange, in our model, by creating production inefficiencies that are due to temporal specificity, a problem that exists when there are economies of scope as well as diseconomies of scope (appendix omitted).

Given contractual incompleteness and divergent preferences over the allocation of general tasks to sites, task misalignment will lead to temporal specificity and integration will sometimes be superior to market exchange even in the presence of positive bureaucratic costs of joint ownership, p_{ij}. Thus, our simple model advances the idea that vertical integration and the allocation of (general) tasks to sites is jointly determined, which has a number of testable implications. In particular, when contracts are incomplete and performing a general task is costly to both exchange partners, as in our empirical application, vertical integration will lead to a shift in the allocation of general tasks, such that the low-cost site performs the bulk (or all) of the undesirable general task.

We believe our model is the first to explicitly consider the role of task alignment and temporal specificity, but, of course, the model is not completely novel. Indeed, our approach follows in the spirit of Grossman and Hart (1986) and Hart and Moore (1990) in that the owners of the upstream and the downstream assets/sites have the residual rights to control all aspects of production, in particular, the timing of exchange, which cannot be explicitly given away by contract. While their work focuses on vertical integration as a solution to *ex ante* noncontractible investments, which are *ex post* contractible, we focus on task misalignment problems that occur even when the state of the world is realized and there is no *ex post* opportunism. In our model, exogenous factors (e.g., regulatory restrictions) preclude efficient rent sharing *ex post*, which means efficient outcomes can only be achieved through integration. Corts's (2006) formal analysis of the allocation of tasks to assets in a stylized model of the tracking industry is also similar to ours in some important respects. In Corts's (2006) model a single asset (a truck) and a potentially delegable task (maintenance) are allocated between a principal (a firm) and an agent (a driver). When the principal delegates the maintenance task downstream, efficiency dictates asset ownership by the agent, which in turn results in greater effort in performing the delegated task. As in our model, Corts links task allocation and asset ownership, but in his model principal asset ownership hinders the delegation of tasks to the agent. In contrast, our analysis relies on the notion that asset (or site) ownership facilitates task delegation to achieve an efficient allocation of tasks.

3. Empirical context: From hospitals to post-acute-care settings

In order to focus our predictions, we map the theoretical constructs developed in section 2 (above) to our empirical setting. Broadly speaking, we test the predictions of the model by comparing practice patterns between vertically integrated (i.e., hospitals with home health agencies and hospitals with skilled nursing facilities) and non-integrated providers along the continuum of care from acute to post-acute care settings. The empirical context is appealing for at least four major of reasons. First, contracts are inherently incomplete between hospitals and post-acute care providers because they are subject to fixed prices set by Medicare with strict prohibitions on side payments between hospitals and post-acute providers. Fixed price exchanges are particularly likely to give rise to incomplete contracting because the counterparties cannot use price to adjust for supply and demand imbalances in bilateral exchange. Limitations on side payments make it difficult for relational contracts to remedy the rigidities of fixed price exchange.

Second, there are clear cut site-dedicated and general tasks in this setting, and the timing of exchange influences the efficiency of care in a direct and important way. Hospitals perform specialized hospital-dedicated acute care tasks, such as surgery, but once patients are stabilized, post-operative care rapidly becomes a task that need not necessarily be bundled with the physical infrastructure of a hospital (i.e. post-operative care becomes a general task once the patient is stabilized). Home health agencies and skilled nursing facilities also deliver site-dedicated and general tasks, providing care services that are only performed in patients' homes[4] or in the skilled nursing facility,[5] and assisting patients with recuperating in a manner that is customized to the living environment, but also offering a range of services that could be provided in a hospital setting, particularly monitoring, therapy, and recovery services. These general tasks are produced at much higher cost in a hospital setting compared with a post-acute setting, which, when coupled with incomplete contracts, creates temporal specificity and the impetus for vertical integration. On the other hand, hospital integration with skilled nursing facilities and/or home health providers creates bureaucratic oversight costs for the integrated entity.

Third, the health services industry is a collection of hundreds of distinct local markets that produce roughly homogenous outputs. We exploit the variation in local market conditions in our empirical design to overcome the effect of selection on unobservables to identify the impact of vertical integration on health outcomes; yet, the homogenous nature of outputs across markets facilitates an accurate comparison of the effects of vertical

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[4] Home health care is skilled health care services provided in the home, for a limited duration; most often by registered nurses, rehabilitative therapists, social workers, or home health aides. An episode of home health care is a set of visits over a limited number of weeks in which each visit lasts approximately 1-2 hours.

[5] Skilled nursing facilities (also called long-term care facilities or nursing homes) are establishments that house chronically ill, often elderly patients, and provide post-acute and long-term nursing care. Importantly, for the purposes of this study, skilled nursing facility services are offered by free-standing and hospital-based facilities.

integration on hospitals across markets. Finally, we have access to a large and novel dataset on hundreds of thousands of patients' medical history records that tracks their care across facilities, allowing us to measure the impact of vertical integration on the allocation of tasks to sites at an unusual level of detail.

Medicare reimburses care delivered by home health agencies and skilled nursing facilities through a Prospective Payment System (PPS). Under PPS for home care, a fixed reimbursement is given for a 60-day episode independent of the number of visits during the episode. Reimbursement is fixed and prospective as the amount is set at admission, according to the observable severity of the patient's condition, and is not altered based on the intensity of care delivered. In the case of skilled nursing facilities, reimbursement is given for each day of stay (up to 100 days) independent of the intensity of care while at the facility. Each episode payment is adjusted for differences in labor costs across geographic areas. Within this reimbursement strategy, skilled nursing facilities and home health agencies are free to provide the intensity of care that they deem appropriate for their patient. In general, the amount of service provided does not change the amount of reimbursement, which strengthens the foundation for our assumption that contracts are incomplete in our empirical context.

Given that the key assumptions of the model are met in the exchange relationships between hospitals and post-acute care providers—contracts are incomplete and general tasks can be performed at either hospital or post-acute care sites—the predictions of the model apply to the empirical context. In particular, we examine whether hospitals that are vertically integrated discharge their patients to skilled nursing facilities and home health agencies sooner and when the patients are in poorer health compared to non-integrated hospitals. The two predictions arise directly from the idea that vertical integration allows hospitals to allocate general tasks (i.e., recovery tasks) to their own skilled nursing facility and home health agency in a manner that is more efficient than under market exchange, subject to a bureaucratic cost penalty for integrating acute and post-acute organizations. Taking the integration penalty to be positive, but of a magnitude that varies by upstream firm-downstream firm pair based on exogenous factors, we can infer the nature of the benefits of vertical integration by studying the behavior of efficiency maximizing hospitals. The model predicts that vertically integrated firms will solve the temporal specificity problem by shifting the general task to the low-cost provider sooner, here the skilled nursing facility or home health agency. Thus, it follows that vertically integrated hospitals, while maintaining the same overall quality of care, will allocate recovery tasks to the downstream firm by shifting patients to it sooner in the recovery process and when the patient requires more extensive monitoring (i.e., when they are in worse health). Therefore, the three predictions of the model that we test in our context are:

Hypothesis 1: Vertically integrated hospitals will transition patients to skilled nursing facilities and home health agencies faster than non-integrated hospitals.

Hypothesis 2: Vertically integrated hospitals will transition patients to their own home health agencies when the patients are in need of more intensive monitoring and recovery services.[6]

Hypothesis 3: Overall quality of care need not be lower for patients transitioning faster and in worse health within vertically integrated hospitals compared to market-based transitions.

While our key predictions are formally derived from a general model of task alignment, they are consistent with an informal health economics literature on vertical integration in hospitals, which notes that patients can be expected to be discharged to post-acute care in poorer health and faster when transitioning to post-acute care within an integrated hospital system since integration eliminates opportunism (Robinson 1996, Lehrman and Shore 1998). Yet, opportunism is unlikely to drive temporal specificity problems in the context of patient care since hospitals tend to have market power versus post-acute care providers and are not tied to bilateral exchange relationships with any particular post-acute care provider. If a post-acute care provider tried to hold-up the hospital, the hospital could discharge patients to another provider, especially if the problem were systematic. The reality of the situation is that hospitals cannot discharge patients at the optimal time because care providers will not accept patients on whom they will lose money. Therefore, in the patient care setting, inefficiencies are more

[6] Ideally, we would test all three hypotheses developed for patients that transition to either skilled nursing facilities (SNF) or home health agencies. Unfortunately, there is no observable measure of care intensity (to the econometrician) in SNFs, so we confine our analyses in the SNF setting to tests of Hypotheses 1 and 3.

likely to be due to non-cooperative equilibria that stem from restrictions on rent sharing. Thus, the temporal specificity problem is not due to hold-up, but rather to contractual incompleteness and task misalignment.

4. Data and samples

Having shown how our model of temporal specificity and task alignment applies, in the context of patient care, we now turn to the empirical analysis. Our core data come from the Medicare Provider and Analysis Review (MEDPAR) Files for 2005. The MEDPAR is a research file compiled by the Center for Medicare and Medicaid Services, based on the billing claims of facility stays for fee-for-service Medicare beneficiaries. Each MEDPAR record represents a facility stay including acute-care-hospital stays and skilled nursing facility stays. It summarizes services provided to a beneficiary from time of admission to a facility through discharge. Each record includes: date of admission and discharge; codes for up to 5 procedures and 10 diagnoses (DRG); socioeconomic information; and a unique identification number that is specific to a beneficiary and the hospital. This is a near-complete record of health care facility encounters for Americans over 65.

To identify and characterize post-acute care home health care episodes that follow hospitalizations, we link the MEDPAR file acute-care-hospital stays to the Medicare claims for skilled nursing facilities and home health services by the scrambled identifier of the Medicare beneficiary. Home health services are recorded on the Medicare Home Health Agency Standard Analytical Files. We identify admissions to skilled nursing facilities and home health care agencies as those occurring within 3 days of the hospital discharge. Because all qualifying skilled nursing facility and home health care episodes of Medicare beneficiaries are paid by Medicare, these claims files are a complete record of home health use for the beneficiaries with MEDPAR hospitalizations. We also capture data on home health care services provided, including number of home health visits, the dates and types of visits as well as unique home health agency identifiers.

We augment the claims data with survey data on hospital organization from the American Hospital Association (2005) and with data from regulatory reports: for hospitals from the 2005 Hospital Cost Reports and for skilled nursing facilities and home health agencies from the 2005 Provider of Service Files. We use these three sources of data to determine whether hospitals are vertically integrated into skilled nursing facilities and into home health. We conservatively code hospitals as being vertically integrated when all three sources agree, though our results are robust to other criteria.

Our analysis focuses on MEDPAR hospitalizations for new health events that resulted in post-acute care admissions either directly into skilled nursing facilities or into home health, leaving us with 399,368 discharges to home health and 460,597 discharges to skilled nursing facilities from 2,571 hospitals. See Tables I-A and I-B for summary statistics for patients, hospitals and markets (counties) for discharges to home health and skilled nursing facilities, respectively. Our main explanatory variable is whether a hospital is vertically integrated into home health or skilled nursing (VI_HOSP), a binary variable that is equal to unity if a hospital owns at least one home health agency and zero otherwise.

Our dependent variables index the predictions of our hypotheses: discharges will be faster in vertically integrated hospitals (H1); patients from integrated hospitals will require more intensive monitoring and recovery tasks upon admission to home health (H2); and health outcomes need not be negatively affected by integration (H3). To measure how quickly a hospital discharges their patients, we use a measure of length of stay in the hospital (LOS) that is computed relative to the average length of stay of similar patients in other hospitals by de-meaning from the national average length of stay within each Diagnosis Related Group. The second dependent variable captures the impact of integration on the (downstream) intensity of home health care provision. The intensity of home health care is measured as the number of visits to a patient's home divided by the number of days the patient remains in the care of a home health agency, where visits are weighted by the average wages by occupation of the home health provider as determined from the 2004 Current Population Survey. Our third dependent variable is one of the crucial observable measures of the quality of care patients' receive along the care continuum and the center of policy debates: patient rehospitalization rate.

5. Empirical design

We test the predictions of the model by focusing on how length of stay, home health intensity, and rehospitalization rates (within 60 days of a discharge) vary between patients from non-integrated and hospitals that are vertically integrated into home health care and skilled nursing facilities. Since general tasks—monitoring and recovery activities—are costly to perform in our empirical setting, the model predicts that vertically integrated hospitals will use fiat to force its downstream facilities to accept patients (i) faster and (ii) in poorer health compared to in an arm's length exchange, but that vertically integrated hospitals will manage the cost savings opportunities such that (iii) rehospitalization rates are no greater than in non-integrated settings.

While we are concerned with the endogeneity of vertical integration,[7] we first test these predictions using the simple OLS model (2):

$$(2) \qquad Y_l = a + \beta_1 VI_h + \boldsymbol{X_c \beta_c} + e_i,$$

where l indexes patients, h indexes hospitals, and Y measures three outcomes: length of stay in the hospital *(LOS)*, intensity of care in home health, and rehospitalization rates. VI is an indicator variable that is equal to unity when the hospital is vertically integrated into home health and zero otherwise, $\boldsymbol{X}$ is a vector of patient, hospital, home health agency and market controls that might plausibly shift hospital practice patterns. Patient level controls include variables that capture the health of the patient at admission, measured by 28 comorbidities as well as patients' demographic characteristics, such as age, gender and race. Hospital controls include a set of dummies for ownership (for-profit, not-for-profit, and government), teaching status, and the number of licensed beds. Market controls include demographic variables such as the average years of schooling of the local population, median income, the percentage of the population over age 65, the percentage of the population of childbearing age (females aged 15-44), population density, and a categorical variable for metropolitan areas; supply shifters including the total number of hospital beds, skilled nursing facility beds, and the number of long-term care beds in the market; and the strength of insurance companies, measured by HMO enrollment rate.

[7] Although we include a large number of detailed controls, the cross-sectional nature of the analysis precludes us from making strong causal inferences from the OLS results, particularly in tests of the first hypothesis that vertical integration leads to shorter length of stay. Since both vertical integration and length of stay are choice variable for hospitals, our results are vulnerable to selection biases that lead to heterogeneous treatment effects and omitted variable bias. While it is possible that our OLS estimates could be biased downward due to selection into vertical integration based on (high) quality, it seems more plausible that the OLS estimates of vertical integration on length of stay will be biased toward zero as vertically integrated hospitals tend to be institutions with care management philosophies that emphasize more extensive care delivery over management of financial objectives. For example, non-profit hospitals are sometimes thought to "over deliver" services, at least compared to a for-profit benchmark. While profit status is observable, the hospital's care management philosophy is not, and we must therefore be concerned that our OLS estimates will confound the causal effect of vertical integration with selection effects.

We deal with the endogeneity of vertical integration using two approaches. First, we adjust for selection on observable differences between patient populations, by matching post-acute care patients from integrated hospitals to patients from non- integrated hospitals, based on all observable characteristics of patients, hospitals and markets. To do so, we use the Coarsened Exact Matching (CEM) procedure described by Iacus, King and Porro (2009), which facilitates multi-dimensional exact matching. CEM is similar to standard two-stage matching teccniques in that it controls for selection bias by eliminating non-analogous observations in the treatment (i.e. integrated) and control (i.e., non- integrated) populations, but has some technical advantages over standard matching approaches. However, no matching method can control for sources of heterogeneity that arise from unobservable characteristics of hospitals.

To adjust for selection on unobservables, we exploit variation in local market conditions in the health services industry, using the rate of vertical integration into home health or skilled nursing facilities by other hospitals in the same market (weighted by patient volume) as an instrument for the focal hospital's decision to vertically integrate into home health (VI_HOSP_{-h}). Other hospitals' integration decisions should not have any direct effect on a focal hospital's practice patterns, particularly given the extensive patient, hospital and market controls in specification (1); yet, interviews with industry leaders and experts suggest that hospital integration decisions are often determined by idiosyncratic local market conditions. Thus, our instrument satisfies the exclusion restriction and has the potential to be a powerful explanatory variable in the first stage of a two-stage procedure that adjusts for selection on unobservables.[8]

Because our main concern is with the endogeneity of hospital decisions, our key tests of Hypotheses 1 and 3 apply the instrument VI_HOSP_{-h} to correct for selection on unobservables at the hospital-level. Specifically, we use the two-stage residual inclusion (2SRI) method first proposed by Hausman (1978) and more recently by Terza, Basu and Rathouz (2008). The first stage of our 2SRI procedure is a logit model predicting hospital vertical integration into home health or skilled nursing facilities *(VI_HOSP),*including all of the controls in (1)

[8] A practical drawback of our instrumental variable is that it only generates market-level variation; we could not identify any hospital-level shifters of the costs or benefits of diversification that would satisfy the exclusion restriction. However, we find that our instrument generates substantial between-hospital variation in practice, since the 2,571 hospitals in our sample operate in hundreds of different local markets.

aggregated to the hospital level, where the integration rate of other hospitals in the same market is the source of exogenous variation in each hospital's vertical integration decision. The second stage of the 2SRI procedure includes the residual from the first stage, which by definition is uncorrelated with the covariates in $\boldsymbol{X}$ in (1), and controls for selection into vertical integration based on unobservables. 2SRI estimators have econometric properties that are similar to other two-stage estimators, like two-stage least squares (2SLS), but are particularly well suited for our application; importantly, they are consistent when endogenous regressors are non-linear and have correct asymptotic standard errors in the first stage, which facilitates a two-stage instrumental variables approach at two different levels of analysis (i.e., hospital and patient) without manually adjusting the standard errors. As a robustness check, we perform a similar analysis, using the more familiar 2SLS estimator, which predicts vertical integration with a first stage linear probability model, replacing the explanatory variable *(VI_HOSP)* in the second stage with the predicted probability of vertical integration into home health. We also verify that our results are robust to matching using CEM prior to 2SRI estimation.

Tests of our second hypothesis—that vertically integrated hospitals will discharge patients to their own (vertically integrated) home health agencies when the patients require more intensive care—compare the outcome resulting from the choice of home health intensity by vertically integrated hospitals with the outcome from market exchanges between non-integrated hospitals and home health agencies, using OLS on the full and matched samples.

6. Results

Table II Panel A shows the relationship between hospitals vertically integrated into home health and average length of stay at the patient-level. Column 1 reports a -0.12 raw correlation between vertically integration and length of stay. Including the full set of patient, hospital and market controls reduces the point estimate to -0.06, and the coefficient estimate becomes indistinguishable from zero (column 2). However, the results in Column 3 demonstrate that patient-level selection effects bias the OLS results toward zero as the coefficient estimate on *VI_HOSP* in the matched sample increases to -0.08. Columns 4-I and 4-II reveal the strength of our instrument and the influence of omitted variable bias on the OLS estimates. Column 4-I is the first stage instrumental variables regression predicting vertical integration at the hospital level. The instrument VI_HOSP_{-h}—other hospitals' rate of vertical integration in the same market (weighted by patient volume)—is very strong: the F-statistic on VI_HOSP_{-h} in the first stage is 63, and a 1% increase in the market vertical integration rate leads to a 0.31% increase in a focal hospital's propensity to vertically integrate. The second stage of our instrumental variables approach includes the residual from the first stage to adjust for the effects of unobservable hospital-specific factors that might influence vertical integration decisions. The, result is a point estimate on the coefficient on vertical integration of -0.19—approximately a one day reduction in length of stay for every five patients discharged—but continues to be only on the margin of statistical significance.[9] The interpretation of Table II Panel A is that hospital vertical integration allows hospitals to discharge patients to home health sooner relative to non-integrated hospitals, but the effect is small—representing savings of only about 3% of bed-days—and imprecisely estimated.

Table II Panel B shows that the results on length of stay effects for hospital vertically integrated into skilled nursing facilities are larger and more precise compared to vertical integration into home health. Without controls, the correlation between vertical integration and length of stay is -0.20, (column 1), and is precisely estimated. The full set of patient, hospital and market controls soak up more variation in the data, but have only a small impact on the coefficient on vertical integration (column 2). Column 3 shows the matched sample estimate. Matching exactly based on all observable characteristics of patients, hospitals, and markets yields a precisely estimated point estimate of -0.18. Finally, columns 4-I and 4-II show the two stages of our instrumental variables analysis. Column 4-I shows that increasing the extent of vertical integration in a local market by 1% increases the probability that a focal hospital will be vertically integrated by 0.32%. The interpretation of the point estimate of -0.73 on vertical integration is: hospitals that are vertically integrated into skilled nursing facilities are able to reduce patient length of stay in the hospital by one day for three out of every four patients who eventually receive post-acute care at a skilled nursing facility, a reduction in total bed-days of about 11%.

Table III summarizes the tests of the relationship between integration and the intensity of home health care provided to patients who are admitted to home health. Discharges from vertically integrated hospitals to their own home health agencies ("within firm transition") receive an additional 0.008 visits/day, relative to the baseline

[9] We obtained qualitatively similar results, using 2SLS with first stages at the patient and hospital level.

rate for patients discharged from non-integrated hospitals, while patients discharged from integrated hospitals to external non-affiliated home health agencies had 0.002 fewer visits per day compared to the baseline (column 1). The F-test on the difference between within firm transitions and external transitions from vertically integrated hospitals is significant at the 1% level, which suggests that within firm transitions are more demanding on the downstream organization relative to market transitions. Controlling for whether external discharges go to other integrated agencies or to non-integrated agencies and for discharges from non-integrated hospitals to vertically integrated agencies with a more refined set of interactions has little effect on the main result. After matching and including the full set of interactions, the point estimate on within firm transitions is 0.01 or one additional home health visit per 100 day episode.[10] With an average length of a home health episode around 33 days, this suggests that one of every three patients experiencing a within firm transition gets an extra home health visit. Increasing one home health visit for one of every 3 of the 400,000 home health admissions per year that come directly from hospitals would have increased total costs by about $13 million, assuming the average home health visit costs approximately $100. Under prospective payment, these costs are borne by the agencies rather than by Medicare.

The higher speed with which integrated hospitals discharge patients and the relatively greater severity of patients' health at admission to their home health agency raises an important public policy question. Are vertically integrated hospitals delivering lower quality care by discharging their patients sicker and quicker? Or do hospitals use integration to increase their efficiency while holding quality of care constant as we predict in our third hypothesis? To answer this question, we test in Table IV whether health outcomes differ between integrated and non-integrated hospitals for patients discharged to post-acute care by regressing integration on incidence of rehospitalization. We find that in home health the correlation between integration and rehospitalization is indistinguishable from zero in full-sample OLS regressions (column 1), as well as in matched sample (not shown) and 2SRI tests (column 2), suggesting that under integration into home health, patient recovery tasks are shifted downstream without meaningfully affecting quality of care.

Column (3) shows that rehospitalization rates for patients discharged to skilled nursing facilities within a vertically integrated system are 0.6% lower compared to patients discharged to skilled nursing facilities from non-

[10] We obtained similar results using propensity score matching.

integrated hospitals. While the coefficient is precisely estimated, the effect is small economically compared to a baseline rehospitalizaiton rate of approximately 20%. However, after adjusting for the endogeneity of vertical integration using 2SRI the point estimate on vertical integration increases to -2.1%. The interpretation is that integration actually leads to improved health outcomes. The results suggest that while integration enables quicker and sicker discharges, the savings obtained are not the result of lowering the quality of care received by patients. Hence, the costs of vertical integration are (presumably) borne administratively.

We close our empirical analysis with two caveats. Our empirical approach relies on interpreting the revealed preferences of hospitals, based on the assumption that hospital organizational decisions are made with efficiency criteria in mind. Though our reveled preference approach is standard in the empirical literature on vertical integration (Joskow 1985, Hortaçsu and Syverson 2007), we caution that we cannot estimate the costs and benefits of vertical integration directly in our analysis. Second, while the unique features of the health services industry make it a particularly appealing context for testing our theory of task alignment and temporal specificity, it is reasonable to question the external validity of our findings. We believe that the allocation of tasks to assets is a fundamental determinant of temporal specificity whenever the timing of exchange is important, but leave the issue open as an opportunity for future research.

These caveats aside, the results suggest that vertical integration creates economically meaningful opportunities for hospitals to discharge patients earlier and in worse health to home health agencies following hospitalization. We interpret the results as evidence that integration allows firms to solve temporal specificity problems by aligning tasks with assets more efficiently. Our findings do not dispute the idea that vertical integration increases administrative costs, such that, it may be superior to market exchange only for some hospitals (i.e., the ones that choose to become integrated). Nevertheless, the results point to one of the heretofore underappreciated advantages of vertical integration—control over the allocation of tasks to sites or assets.

7. Conclusion

This paper proposes and tests a simple theory where integration addresses temporal specificity problems by solving task misalignment problems. In our framework, we demonstrate how the allocation of general tasks to assets (or sites) influences the efficiency of an economic system by determining the timing of exchange. The model offers a step toward integrating the powerful idea that tradeoffs between discrete structural alternatives define the boundary of the firm in equilibrium, as in transaction cost economics (Williamson 1985), with the intuitively appealing idea that firms are defined by tasks or routines, which shape firm boundaries by influencing the efficiency of production (Nelson and Winter 1985).

We test the predictions of the model in the context of patient care along the care continuum, from hospitalization to home health agencies and skilled nursing facilities and find a strong relationship between vertical integration and practice patterns. Controlling for the endogeneity of vertical integration, patient characteristics, as well as a host of hospital and market factors, we find hospitals that are vertically integrated tend to discharge patients to their own home health agencies and skilled nursing facilities sooner and in poorer health compared with non-integrated hospitals; yet, health outcomes are actually better for patients who transition to hospitals' own skilled nursing facilities and no worse for patients who transition to hospital's own home health agencies. The variation in practice patterns and health outcomes reflects the integrated entity's ability to use fiat to shift patients in need of recovery and monitoring services (general tasks) from the hospital setting to post-acute care settings. Thus, the evidence suggests that vertical integration reduces temporal specificity problems that arise due to the misalignment of tasks under market exchange.

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Figure 1
General tasks and efficient exchange

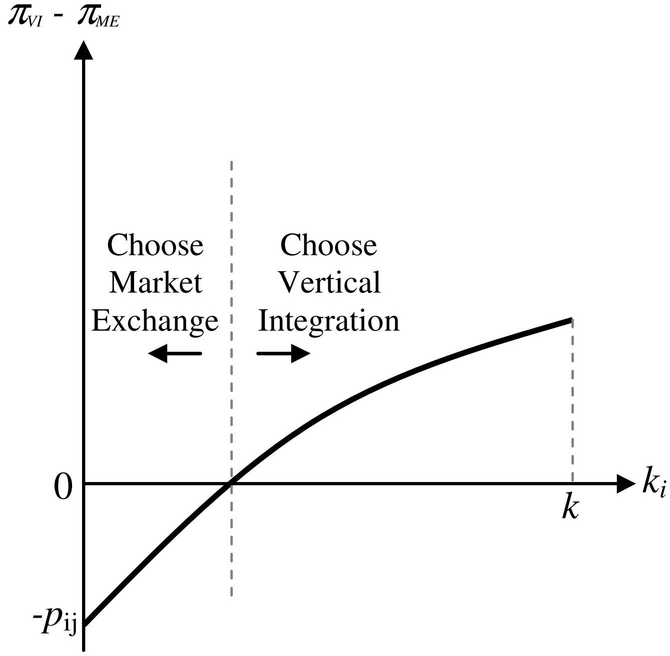

Figure 1 shows the relationship between the size or importance of the general task k_i and the efficiency of exchange (π) under vertical integration (VI) and market exchange (ME), where the cost of performing task k_i and task k_j in the same firm is p_{ij}.

Table I-A Descriptive statistics for key variables: home health

	Full sample n=399,368		non-VI hosp. n=269,917	VI hosp. N=129,451
	(1)	(2)	(3)	(4)
Patient characteristics	Mean	Stdv	Mean	Mean
Length of stay (days)	5.86	4.96	5.89	5.86
Age (years)	78.1	7.56	78.1	78.2
Male	0.38	0.49	0.38	0.38
White	0.88	0.32	0.87	0.91
Black	0.08	0.27	0.09	0.07
Number of comorbities	1.45	1.18	1.44	1.46
Chronic lung disease	0.20	0.40	0.20	0.21
Diabetes	0.19	0.39	0.19	0.19
Cong. heart failure	0.10	0.30	0.10	0.11
Hospital characteristics				
Vertically integrated into HH (VI_HOSP)	0.32	0.47	0.00	1.00
Rehospitalization rate	0.17	0.37	0.17	0.17
For-profit	0.14	0.35	0.19	0.03
Government	0.11	0.31	0.09	0.14
Teaching hospital	0.22	0.42	0.23	0.21
Total beds	382	266	382	379
Home health agency characteristics[*]				
Home health intensity (visits/day)	0.38	0.21	0.38	0.38
Vertically integrated (VI_HHA)	0.31	0.46	0.11	0.72
Within firm transfer (VI_HOSP_TX)	0.21	0.41	0.00	0.65
VI_HOSP to other HHA (VI_HOSP_EXT)	0.11	0.32	0.00	0.35
VI_HOSP to non-VI_HHA (VI_EXT_NON)	0.09	0.29	0.00	0.28
VI_HOSP to other VI_HHA (VI_EXT_VI)	0.02	0.15	0.00	0.08
Non-VI_HOSP to VI_HHA (VI_HHA_IN)	0.08	0.26	0.11	0.00
Market characteristics (counties)				
Others vert. int. into HH (VI_HOSP_{-h})	0.29	0.23	0.25	0.36
% population <9 yr school	7.26	4.41	7.22	7.36
% population college graduates	23.62	9.47	24.43	21.93
Median HH income ($K)	47.25	12.44	48.04	45.62
% population aged 65+	13.52	4.01	13.34	13.89
Metropolitan area dummy	0.80	0.40	0.84	0.72
Population density (pop./square miles)	2,018	6,764	2,407	1,209
Hospital beds	2,589	4,472	2,920	1,898
Long term care hosp. beds	182	406	207	131
Skilled nursing facility beds	3,896	6,566	4,291	3,071
% 15-44 female pop.	20.91	2.24	21.00	20.72
HMO enrollment rate	0.62	0.25	0.65	0.56

[*]VI_HOSP = VI_HOSP_TX + VI_HOSP_EXT. VI_HOSP_EXT = VI_EXT_NON + VI_EXT_VI. VI_HHA = VI_HHA_OWN + VI_HHA_IN + VI_HHA_TX.

Table I-B Descriptive statistics for key variables: skilled nursing facility

	Full sample		Non VI hosp.	VI hospitals
	n=460,597		n=293,895	n=166,702
	(1)	(2)	(3)	(4)
	Mean	Stdv	Mean	Mean
Patient characteristics				
Length of stay (days)	6.92	6.15	7.02	6.76
Age (years)	81.47	7.60	81.67	81.14
Male	0.28	0.45	0.28	0.29
White	0.90	0.30	0.90	0.90
Black	0.07	0.26	0.07	0.07
Number of comorbities	1.71	1.21	1.71	1.69
Chronic lung disease	0.19	0.40	0.19	0.20
Diabetes	0.17	0.38	0.17	0.18
Cong. heart failure	0.14	0.35	0.14	0.15
Hypertension	0.14	0.34	0.14	0.14
Hospital characteristics				
Vertically integrated into SNF (VI_HOSP)	0.36	0.48	0.00	1.00
Rehospitalization rate	0.20	0.40	0.20	0.19
For-profit	0.12	0.32	0.13	0.08
Government	0.10	0.30	0.10	0.10
Teaching hospital	0.20	0.40	0.21	0.17
Total beds	356	247	355	358
Market characteristics (counties)				
Others vertically integrated (VI_HOSP_{-h})	0.30	0.23	0.28	0.32
% population <9 yr school	6.89	3.88	6.72	7.18
% population college graduates	24.15	9.42	24.93	22.77
Median HH income ($K)	48.20	12.34	49.29	46.28
% population aged 65+	13.40	3.79	13.27	13.64
Metropolitan area dummy	0.81	0.39	0.83	0.76
Population density (pop./square miles)	1,644	5,006	1,862	1,260
Hospital beds	2,539	4,497	2,496	2,615
Long term care hosp. beds	181	382	172	195
Skilled nursing facility beds	3,991	6,748	3,944	4,072
% 15-44 female pop.	20.99	2.12	20.99	20.99
HMO enrollment rate	0.63	0.25	0.65	0.59

Table II Vertical integration and length of stay

	(1) OLS	(2) OLS	(3) Matched (CEM)	(4-I) 1st stage IV (logit)	(4-II) 2nd stage 2SRI (OLS)
Dependent variable:	*ΔLOS*	*ΔLOS*	*ΔLOS*	*VI_HOSP*	*ΔLOS*
Panel A: home health					
Hosp. vertically int. HH (VI_HOSP)	***-0.12*** **	***-0.06***	***-0.08*** *		***-0.19*** *
	(0.05)	***(0.04)***	***(0.05)***		***(0.11)***
Oth. hosp. vert. int. HH (VI_HOSP$_{-h}$)				0.31 ***	
				(0.04)	
Residual from 1st stage					0.06
					(0.05)
Patient controls	N	Y	Y	Y	Y
Hospital controls	N	Y	Y	Y	Y
Market controls	N	Y	Y	Y	Y
Constant	Y	Y	Y	Y	Y
R^2/Adj.-R^2/Pseudo-R^2	0.00	0.04	0.04	0.17	0.04
F-test on IV				63	
N	399,368	399,368	344,381	2,571	399,368
Panel B: skilled nursing facility					
Hosp. vertically int. SNF (VI_HOSP)	***-0.20*** ***	***-0.23*** ***	***-0.18*** ***		***-0.73*** ***
	(0.06)	***(0.06)***	***(0.07)***		***(0.20)***
Oth. hosp. vert. int. SNF (VI_HOSP$_{-h}$)				0.32 ***	
				(0.04)	
Residual from 1st stage					0.24 **
					(0.09)
Patient controls	N	Y	Y	Y	Y
Hospital controls	N	Y	Y	Y	Y
Market controls	N	Y	Y	Y	Y
Constant	N	Y	Y	Y	Y
R^2/Adj.-R^2/Pseudo-R^2	0.00	0.06	0.05	0.09	0.06
F-test on IV				71	
N	460,597	460,597	413,610	2,571	460,597

Standard errors are robust and clustered at the hospital level.*** Significant at 1%, ** Significant at 5%, * Significant at 10%
Regression (4-I) displays marginal effects at the means of all variables.

Patient controls include: age, gender, race, 28 controls for patient health characteristics upon admission to the hospital (Elixhauser comorbidities). Hospital controls include: ownership form dummies {for-profit, government, not-for-profit}, number of beds, and a dummy for teaching hospital. Market controls include: average educational attainment, median household income, percentage of the population over 65 year old, a dummy for metropolitan area, population density, number of hospital beds, number of long-term care hospital beds, number of skilled nursing facilities beds, the percentage of women of child bearing age (% of population that is female aged 15-44), and the HMO enrollment rate.

Table III Vertical integration and intensity of home health care

Dependent variable: home health intensity (visits/day)

	Full sample				Matched sample			
	(1)		(2)		(3)		(4)	
Within firm transfer	***0.008***	**	***0.009***	**	***0.009***	**	***0.010***	**
(VI_HOSP_TX)	***(0.004)***		***(0.004)***		***(0.004)***		***(0.004)***	
VI_HOSP to other HHA	-0.003				-0.001			
(VI_HOSP_EXT)	(0.004)				(0.004)			
VI_HOSP to other VI HHA			-0.001				-0.0002	
(VI_EXT_VI)			(0.005)				(0.004)	
VI_HOSP to non-VI_HHA			-0.002				-0.001	
(VI_EXT_NON)			(0.004)				(0.004)	
Non-VI_HOSP to VI_HHA			0.006				0.005	
(VI_HHA_IN)			(0.004)				(0.004)	
Patient controls	Y		Y		Y		Y	
Hospital controls	Y		Y		Y		Y	
Market controls	Y		Y		Y		Y	
Constant	Y		Y		Y		Y	
R^2	0.04		0.04		0.04		0.04	
N	399,244		399,244		344,373		344,373	

Standard errors are robust and clustered at the hospital level.*** Significant at 1%, ** Significant at 5%, * Significant at 10%
HHA stands for Home Health Agency. Controls are as above (see Table II).

Table IV Vertical integration and rehospitalization

Dependent variable: rehospitalization rate within 60 days of discharge

	Home health				Skilled nursing facility			
	(1)		(2)		(3)		(4)	
	OLS		2SRI		OLS		2SRI	
Hosp. vertically	***-0.001***		***-0.001***		***-0.006***	***	***-0.021***	***
integrated	***(0.002)***		***(0.005)***		***(0.002)***		***(0.007)***	
Residual from			0.001				0.007	**
1st stage			(0.002)				(0.003)	
Patient controls	Y		Y		Y		Y	
Hospital controls	Y		Y		Y		Y	
Market controls	Y		Y		Y		Y	
Constant	Y		Y		Y		Y	
R^2	0.02		0.02		0.02		0.02	
N	399,368		399,368		460,597		460,597	

Standard errors are robust and clustered at the hospital level.*** Significant at 1%, ** Significant at 5%, * Significant at 10%
Controls are as above (see Table II).