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COORDINATION, SWITCHING COSTS AND THE DIVISION OF LABOR IN GENERAL MEDICINE: AN ECONOMIC EXPLANATION FOR THE EMERGENCE OF HOSPITALISTS IN THE UNITED STATES

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Coordination, Switching Costs and the Division of Labor in General Medicine: An Economic Explanation for the Emergence of Hospitalists in the United States
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ABSTRACT

General medical care in the United States has historically been provided by physicians who care for their patients in both ambulatory and hospital settings. Care is now increasingly divided between physicians specializing in hospital care (hospitalists) and ambulatory-based care primary care physicians. We develop and find strong empirical support for a theoretical model of the division of labor in general medicine that views the use of hospitalists as balancing the costs of coordinating care across physicians in the hospitalist model against physicians' costs switching between ambulatory and hospital settings in the traditional model. Our findings suggest opportunities to improve care.

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I. Introduction

The division of labor is a necessary consequence of the accumulation of human capital in societies and has fundamental consequences for the organization of markets and organizations, and for overall productivity. Accordingly, the optimal division of labor has been the subject of close examination. With roots that go back at least to Adam Smith's *Wealth of Nations* (1776[1965]), the optimal division of labor can be understood as reflecting a balance between advantages of specialization that come from increasing returns to specialized human capital and the costs of specialization that arise from the need for coordination across persons with specialized human capital (Becker and Murphy 1992). This line of argument suggests that when returns to specialized human capital are lower and when coordination costs are greater, the optimal degree of specialization should be lower.

An important point made by Becker and Murphy (1992) is that coordination costs can be generated by a variety of mechanisms. For example, coordination costs may result from either agency problems or communication costs that increase as the number of parties involved in a production process increases. Less appreciated, perhaps, is the variety of mechanisms that may generate increasing returns to human capital. For example, Becker and Murphy emphasize the greater fixed time costs of acquiring multiple types of human capital. Another source of increasing returns to specialized human capital is switching costs. For example, in Smith's pin factory, a pin maker with expertise in both cutting wire and sharpening pins has to spend time switching between tools to do each, and so might naturally gravitate towards working in only one of the two roles. Switching costs can also arise in the use of human capital because of the need to shift one's "mental set". (Jerslid, 1927). Although switching costs may sometimes be small (e.g. the pin maker can easily pick/put down the hand tools used for sharpening and cutting), this may not always be the case. For example, when different tasks need to be executed in physically separate locations, switching costs may be concretely reflected in large transport costs. Even when switching costs are large, a worker with ability and motivation to perform both roles can often minimize switching costs by restructuring their work (e.g., the pin maker may cut many pieces of wire at a time and then sharpen the resulting pieces into pins en masse). However, sometimes such reorganization of work is not possible, for example when a task must be completed in specified time period to be of value. In these settings, switching costs may be an important cause of increasing returns to specialized human capital because the different tasks can be more easily performed in the required locations by discrete individuals with the needed specialized human capital.

The division of labor is an active and important subject of debate within medicine, and one in which these concepts of the determinants of the optimal division of labor may be particularly salient. The field of general internal medicine in the United States is an excellent example of this. Up until about the mid 1990s, the established model of general internal medicine in the U.S. involved a single physician providing general medical care in both clinics and in the hospital. This traditional model placed major emphasis on the value of coordinated care across settings that was afforded by having a single physician care for the patient in both settings (Peabody 1927, Meltzer 2001). In 1996, this model was challenged with the publication of an article in the New England Journal of Medicine describing the advent of a new type of physicians, "hospitalists", that focuses on the care of hospitalized patients, returning the care of those patients to ambulatory physicians after the hospitalization (Wachter and Goldman 1996). Since that time, hospitalists have become the fastest growing medical specialty in the United States, providing more than one third of all general medical care in the United States (Wachter and Goldman 2002).

The effects of hospitalists on the cost, quality, and outcomes of care remain areas of active study (Wachter and Goldman 2002). However, it is clear that the field has grown to the point where it is unlikely to go away, and its rapid growth raises questions about why it has grown so quickly, under what conditions continued growth would be desirable, and what the best direction would be for such growth. Critical to these discussions is an understanding of the forces that have caused the growth of the hospitalist movement.

A number of theories have been put forward to explain the development and growing use of hospitalists. The most prominent include: 1) the growth of managed care and hospital prospective payment, intensifying the incentives for hospitals to have physicians focused on the care of hospitalized patients, 2) the increasing organization of physicians into groups, facilitating the division of labor between inpatient and outpatient settings, 3) the increasing severity of illness of hospitalized patients, making it more important that the physician responsible for a patient's care be able to be physically present for a larger part of the day.

In this paper, we do not dispute the potential importance of these factors but instead develop a theory of the division of labor in general medical care that argues that efficiency of the hospitalist model compared to the traditional model is determined, at least in part, by the advantages of specialized human capital due to reduced switching costs between ambulatory and hospital settings relative to the costs of coordinating physicians across these settings. As perhaps might be expected, our theoretical model predicts that hospitalists are more advantageous as switching costs rise and coordination costs fall. There are also some less obvious predictions, such at that hospitalists become more advantageous as total physician work hours decline and as the time required for hospital care and ambulatory visits increase. The advantages of hospitalists are also found to depend on the rate of clinic visits compared to the rate of hospitalization, with hospitalists tending to be less advantageous when the rate of hospitalization is low compared to the rate of clinic visits. We test and find evidence for all these theoretical predictions using data from the Community Tracking Study, a longitudinal panel study of households, physicians, and employers in 60 communities that are nationally representative of health system change in the U.S. Our results provide evidence in support of all of our theoretical predictions. These findings, in turn, suggest that a number of previously unappreciated forces, such as the increasing role of female physicians within general internal medicine, the desire for physicians for controllable lifestyles, and the growing rate of ambulatory relative to hospital care, have likely contributed to the increased use of hospitalists in the United States. The findings also suggest the potential for new models of care that can optimize the use of the hospitalist model and traditional models that combine ambulatory and hospital care under the direction of a single physician. More generally, our results provide support for the value of theoretical constructs emphasizing the importance of coordination and switching costs in understanding the division of labor.

In developing our model and in our empirical work, we emphasize transportation costs between the clinic and hospital as the key element of switching costs in this context. However, switching costs may also include costs of adjusting to work in different settings with concomitant differences in standard operating procedures, such as different computer systems, medical records formats, and clinical protocols. Switching costs can also arise from changing sets of production teammates and colleagues, especially in a complex process such as hospital care that requires services from nurses and other staff. All these forms of switching costs may be salient in the decision of a general internist to work in both ambulatory and hospital settings or to focus on just one of the two. Nevertheless, we note that most of these switching costs have a large fixed component once a physician has decided to maintain any practice in both hospital and ambulatory settings, while transport costs are especially important when a physician decides to provide care for a specific set of patients in both ambulatory and hospital settings because the physician cannot typically schedule when those hospitalizations will be needed and so must travel to the hospital whenever the patients happens to need their care. Therefore, the model we develop is focused on the decision of physicians whether to provide care for a specified set of patients in both the inpatient and outpatient settings as an example of an instance in which switching costs may be an important cause of increasing returns to specialization. This is contrast to the situation – common (though decreasingly so) in many academic medical centers and rare elsewhere – in which physicians spend blocks of time caring for different sets of patients in both settings, which we see as motivated by the desire of physicians to retain expertise in a diverse set of clinical environments and to take advantage of revenue opportunities from relatively higher inpatient than outpatient fees as opposed to being motivated by fundamental economic efficiencies or by benefits to patients.

II. The Model

We analyze the conditions under which a system planner chooses to organize the delivery of general medicine services according to a hospitalist model with physicians specialized in either inpatient care or ambulatory care as opposed to a traditional internist model in which physicians care for their patients in both settings. A system-level perspective can reflect the decision of a firm such as a health maintenance organization, or it can reflect the decision of a generalist physician in solo practice deciding whether to organize his/her practice as a traditional internist practice, or as a hospitalist practice

In the context of our model, a “traditional internist” practice involves a generalist physician who provides both inpatient and outpatient care for his/her patients. Because internists alternate between outpatient and inpatient settings, they face switching costs, most notably the daily costs of traveling between their clinic location and the hospital wards. The alternative to care by a traditional internist is care by separate doctors providing hospital care ("hospitalists") and ambulatory care ("ambulists"). Neither hospitalists nor ambulists face switching costs, but instead face coordination costs. These coordination costs reflect the effort required by hospitalists and ambulists to communicate and acquire information needed to coordinate care of patients who transition between inpatient and outpatient settings.

In developing our model, we assume that a system-level decision-maker chooses a mode of organizing the delivery of services to minimize aggregate (total) physician time costs in caring for some defined patient population. It is not a difficult extension to argue that increasing the efficiency with which care can provided could translate into higher quality but we do not develop that idea in either our theoretical analysis or empirical analysis.

B. Traditional Internist Model

In a traditional internist practice, internists allocate their total professional time (T_I) between providing ambulatory care (t_A), providing hospital care (t_H), and transportation between the ambulatory and inpatient setting (t_T). An internist's professional time budget constraint is:

$T_I = n_{IA}t_A + n_{IH}t_H + t_T$ [Eq. 1], where

n_{IA} is the number of ambulatory visits seen by an internist during some period

n_{IH} is the number of hospital visits made by an internist during some period

To assess the total time needed to care for patients with N ambulatory visits in the internist model, one must first determine the number of ambulatory visits and associated inpatient activity that a single internist can provide and then calculate the number of internists needed to provide those ambulatory visits. Assume the probability a patient seen in the ambulatory setting will require hospitalization is π. For simplicity, further assume that all patients are admitted to the hospital from the outpatient setting. This implies that the total number of inpatients seen by an internist during a given period is $n_{IH} = \pi n_{IA}$. Substituting this expression into Equation 1, the number of ambulatory encounters that can be seen by an internist in a given period is:

$$n_{IA} = \frac{(T_I - t_T)}{t_A + \pi t_H} \text{ [Eq. 3]}$$

In this equation, the numerator reflects the effective time for direct patient care available for the internist once transport costs are accounted for, while the denominator is the total time costs of direct patient care linked to an ambulatory encounter, including also the expected time in hospital care. Since n_{IA} is the number of ambulatory visits per internist, providing N ambulatory visits will require N / n_{IA} internists at the system level, so that the total time required at the system level by all these internists would be $T_I N / n_{IA}$ hours. Aggregating up to the system level, total internist time costs are:

$$T^{Total}_{Internist\ Model} = \frac{T_I N}{n_{IA}} = N \frac{T_I}{(T_I - t_T)} \left(t_A + \pi t_H\right) \quad \text{[Eq. 4]}$$

Note that in Equation 4, as the total amount of professional time per internist increases, total system-level costs in the internist model approach the cost of direct care – i.e., as $T_I \rightarrow \infty$ approaches infinity, $\frac{T_I}{(T_I - t_T)} \rightarrow 1$ and total system-level costs in the internist model approach the cost of direct care.

B. Hospitalist Model

In the hospitalist model, hospitalists allocate total professional time (T_H) between providing direct patient care to hospitalized patients (t_H) and communicating with patients' outpatient physicians (t_C). Similarly, ambulists allocate their professional time (T_A) between providing direct patient care to ambulatory patients (t_A) and communicating with hospitalists about hospitalized patients. For simplicity, we assume that the time spent communicating per hospitalization is the same for ambulists and hospitalists, although it is a simple extension to allow these times to different between these two types of physicians. At the system level, total system-level time physician time costs of for providing N ambulatory encounters per year are:

$$T_{Hospitalist\ Model}^{Total} = N(t_A + \pi t_C) + N\pi(t_H + t_C) = N(t_A + \pi(t_H + 2t_C)) \quad \text{[Eq. 5]}$$

Comparative Statics

To compare the difference in costs of the hospitalist and internist models, it is useful to convert both to a per visit basis by dividing time costs by the number of visits needed (N) and to examine the difference, Δ, between them. Thus, the time costs of the hospitalist model relative to the internal medicine model are:

$$\Delta = \frac{T_{Hospitalist\ Model}^{Total}}{N} - \frac{T_{Internist\ Model}^{Total}}{N} \qquad \text{[Eq. 6a]}$$

Δ is the relative cost of hospitalist vs. internist care per hour of direct patient care. Substituting Equations 1 and 4 into the numerator of Equation 6a,

$$\Delta = \frac{N((t_A + \pi(t_H + 2t_C))}{N} - \frac{N\dfrac{T_I}{(T_I - t_T)}(t_A + \pi t_H)}{N} \qquad \text{[Eq. 6b]}$$

which can be simplified to be represented by any of the following three equations:

$$\Delta = 2\pi t_C - t_T \frac{(t_A + \pi t_H)}{(T_I - t_T)} \qquad \text{[Eq. 7a]}$$

$$\Delta = 2\pi t_C - \frac{t_T}{n_{IA}} \qquad \text{[Eq. 7b]}$$

$$\Delta = 2\pi t_C - \frac{t_T}{n_{IH}/\pi} = \pi\left(2t_C - \frac{t_T}{n_{IH}}\right) \qquad \text{[Eq. 7c]}$$

Equations 7a-c all highlight the costs of the hospitalist model relative to the traditional internist model as shaped by the costs of communication (first terms in 7a-c) relative to the costs of transport required to switch between the inpatient and outpatient settings (second terms a-c). Equation 7a shows the difference in time costs per visit in our model in terms of its underlying parameters, and is used for the comparative statistics exercise below. However, Equations 7b and 7c provide useful intuition into the results: Equation 7b reveals scale effects in our model: as the panel size (n_{IA}) of an internist increases, travel costs fall. The first term inside the brackets in Eq. 7c, captures the communication costs *per hospital visit* incurred in a hospitalist model, and the second term captures the *average* travel costs *per hospital visit* of internists. Hospitalists are more costly relative to internists when average bilateral communication costs per hospital visit are greater than average travel costs per hospital visit. The presence of π outside the bracket implies that, in the case that communication costs per hospital visits are greater than travel costs, the system cost per ambulatory visit also increases with the rate of hospitalization.

Comparative statics analysis of Equation 7a produces several key results:

RESULT 1 – Increasing communication costs increase the cost of the hospitalist model relative to the traditional internist model.

$$\frac{d\Delta}{dt_C} = 2\pi > 0 \quad \text{[Eq. 8]}$$

Because traditional internists deliver both ambulatory and hospital care, they do not face the coordination costs inherent in hospitalist models of care. Therefore, increasing communication costs unambiguously increases the costs of hospitalists compared to internists.

RESULT 2 – Increasing travel costs decreases the cost of the hospitalist model relative to the traditional internist model.

$$\frac{d\Delta}{dt_T} = -\frac{T_I\left(t_A + \pi t_H\right)}{\left(T_I - t_T\right)^2}, \qquad \frac{d\Delta}{dt_T} < 0 \quad \text{[Eq. 9]}$$

RESULT 3 – Increasing total professional time available to physician increases cost of the hospitalist model relative to the internist model:

$$\frac{d\Delta}{dT_I} = \frac{(t_A + \pi t_H)t_T}{(T_I - t_T)^2} > 0 \qquad \text{[Eq. 12]}$$

As the amount of internist professional time rises, the relative cost of hospitalists also rises. This is because the internist model benefits from distributing the fixed costs of switching over a greater number of remaining hours for direct patient care. This suggests that, if there is a greater preference for limited work hours among physicians, either for example because of a greater desire for limited hours overall or because of the large influx of women into general internal medicine and their tendency to work fewer hours than males physicians, then the desire for shorter hours may have contributed to the growth of hospitalists in the U.S.

RESULT 4 – Increasing ambulatory care time and increasing hospital care time increase the cost of the hospitalist model relative to the traditional internist model.

If the average amount of time required per ambulatory visit increases, total time requirements for direct patient care for each patient rises so that the number of patients a given internist can care for decreases and travel costs per patient become more important relative to total professional time available. Consequently, the costs of the internist model rise relative to those of the hospitalist model, with the difference between the hospitalist model and internist model falling by the ratio of travel time to patient care time:

$$\frac{d\Delta}{dt_A} = -\frac{t_T}{(T_I - t_T)}, \qquad \frac{d\Delta}{dt_A} < 0 \quad \text{[Eq. 10]}$$

Effect of changing hospital care time. Similarly, increasing the average amount of time required per hospital visit increases costs of the internist model and reduces the difference in costs between the hospitalist and internist models.

$$\frac{d\Delta}{dt_H} = -\frac{\pi t_T}{(T_I - t_T)} < 0 \qquad \text{[Eq. 11]}$$

RESULT 5 – The effect of changing probability of admission depends on the relative magnitude of communication costs and travel costs. To determine how changes in the probability of hospital admission affect the relative cost of hospitalists compared to traditional internists, we differentiate with respect to the probability of admission (π):

$$\frac{d\Delta}{d\pi} = 2t_C - \frac{t_H t_T}{(T_I - t_T)} \quad \text{[Eq. 13]}$$

$$\frac{d\Delta}{d\pi} > 0 \text{ if } 2t_C > \frac{t_H t_T}{(T_I - t_T)} \text{ but } \frac{d\Delta}{d\pi} < 0 \text{ if } 2t_C < \frac{t_H t_T}{(T_I - t_T)}$$

Equation 13 shows that the sign of the effect of changes in the probability of hospital admission on Δ is ambiguous, and depends on whether communication costs exceed travel costs. This makes predictions about the direction of this effect an empirical matter. However, if transit costs consume a small fraction of the time of internists so $\frac{t_T}{(T_I - t_T)}$ is generally small (e.g. 30 minutes / 9 hour work day $\cong 0.06$)) then $2t_C > \frac{t_H t_T}{(T_I - t_T)}$ should hold if communication costs relative to hospital care costs are more than 0.06. This seems likely in general but is particularly likely if one includes in communication costs time required by a hospitalist unfamiliar with a patient to learn their case when the patient is hospitalized, which would require not only time communicating with the patient's ambulatory care doctor, but also extra time communicating with the patient themselves and reviewing their records, which would be much reduced for a traditional internist already familiar with their case. This could also be modeled formally by defining separate communication costs for the hospitalist and the ambulatory care physician, but would complicate our notation somewhat without providing any major theoretical additional insights.

III. Empirical Tests

Data

We used data from the Restricted Use 2004-2005 Community Tracking Study Physician Survey (CTS PS) to test the empirical predictions of our model. Conducted by the Center for

Studying Health System Change (CSHSC), the CTS is a longitudinal panel study of households, physicians, and employers in 60 communities that are nationally representative of health system change in the U.S. The 60 sites correspond roughly to metropolitan statistical areas, and include large MSAs (48 sites), small MSAs (3 sites), and non-MSAs (9 sites). 48 sites are large MSAs (population > 200,000). The CTS PS survey covers several content areas, including: physician sociodemographic and professional background characteristics; practice characteristics; time use; computer use and care management; attitudes about care provision, and compensation and revenue. We used the 2004-2005 CTS PS because it is the only survey in the series that includes data on the number of hospital visits physicians made as well as the percent of a physicians patients who were cared for by hospitalists. As we discuss in detail below, both of these variables were critical for identification in our models.

The sample for the first CTS PS (1996-1997), was drawn using a complex stratified random sampling method of physicians in the American Medical Association (AMA) Masterfile and American Osteopathic Association (AOA) membership file who practiced at least 20 hours a week providing direct patient care. Within each site, physicians were stratified by primary care specialty (general internal medicine, general practice, family practice and general pediatrics) as well as expected survey response variables. A proportion of the physicians in the 2004-2005 sample were randomly drawn from the original 1996-1997 sample (approximately 70%) with the remaining randomly drawn from the sampling frame using the original sampling method.

In order to properly account for the complex survey sampling design in our estimation methods, we applied for, and obtained through a Data Use Agreement, the 2004-2005 CTS-PS Restricted Use Data from the CSHSC through the Interuniversity Consortium for Political and Social Research (ICPSR). The Restricted Use File contains survey design variables that are not available in the Public Use File, and which are necessary for estimating variance and standard errors. The Restricted Use File also contains geographic identifiers.

We restricted our analyses to generalist physicians in the CTS PS, which were defined as physicians reporting general internal medicine, family practice, or general practice as their primary specialty. All analyses were weighted to produce national-level estimates.

Empirical Strategy

Our theoretical model is framed from the perspective of a central planner choosing between alternative modes of organizing the delivery of healthcare services. However, the model can also apply at the physician level to explain the extent to which a generalist physician's practice departs from the traditional model in which s/he provides both inpatient and outpatient care for all his/her patients, and does not rely at all on hospitalists. We adopted a physician-level approach in the empirical analyses that follow.

The dependent variable in our analyses was the percent of a physician's patients who were hospitalized in the previous year who had a hospitalist involved their care (HSPLST). Greater use of hospitalists reflects greater departure away from the traditional model of organizing generalist care.

Hypothesis 1 – Communication (Coordination) Costs. RESULT 1 of our model predicts that as communication costs increase, the relative cost of the hospitalist model (Δ) increases, *ceteris paribus*. Therefore, physicians with greater expected communication costs are expected to rely less on hospitalists, and are predicted by our model to maintain greater levels of activity in the hospital setting.

We measured communication costs 4 ways using questions from the CTS PS that reflect varying dimensions of communication costs. First, the CTS PS asked physicians whether the lack of qualified specialists affects their ability to provide high quality care. Perceived lack of qualified specialists may imply greater expected communication costs (with less-qualified specialists, perhaps due to lack of trust). We created a dichotomous variable, SPECPROB, indicating whether a physician reported a lack of qualified specialists, which we hypothesize might require that physicians devote more time to communicating with specialists in order to reduce the risk of bad outcomes.[1] Second, physicians were asked in the survey whether failure to receive reports from other physicians and facilities affected their ability to provide high quality care, which we regard as a communication cost. REPPROB is a dichotomous variable indicating whether a physician reported problems obtaining timely reports. Third, physicians were asked whether medical errors in hospitals affected their ability to provide high quality of care. We regard medical errors as indicative of fundamental communication problems in the hospital that

[1] The original survey item response scale included three categories: "not a problem," "minor problem," and "major problem."

may result in expectations of interaction difficulties and lack of trust between the inpatient and outpatient setting. We created a dichotomous variable, ERRPROB, indicating whether a physician reported problems in providing quality care due to medical errors in hospitals. Finally, we summed across these four indicators to create an index of communication costs, and then created a dichotomous variable COMCOST indicating whether a physician reported 2 or more types of coordination costs.

Because our dependent variable was the fraction (percent) of a physician's hospitalized patients who were cared for by a physician in the last year, its range of values was bounded by (and included) 0 and 1. An estimation method such as ordinary least squares regression that does not account for this fact may yield predicted values that are out of range. Since our measure included both 0 and 1, we followed Papke and Wooldridge (1996) and estimated a generalized linear regression model with a binomial distribution and a logit link function.[2] We estimated separate fractional logit models for each measure of communication cost, with controls for physician age, physician gender, practice type, and a set of site fixed effects. Practice type included the following categories: Solo/2-Physician practice (omitted category); Group Practice; HMO; Medical School; Hospital Based; and Other. In each of these models, all communication cost variables were expected to have a negative sign: greater communication costs reduce use of hospitalists.

Hypothesis 2 – Switching (Travel) Costs. RESULT 2 of our model predicts that as travel costs increase, Δ narrows as total costs of the traditional internist model increases, *ceteris paribus.* Physicians facing greater expected travel costs are predicted to consolidate their practice within the outpatient or hospital setting. Physicians who maintain a presence in both settings are predicted to reduce activity in the hospital setting under higher travel costs.

The 2004-2005 data provide no information on the amount of time physicians would require to commute from their clinic location to where their patients would be hospitalized. In addition, even if such data were available, it would likely be endogenous to the decision about whether to practice in both settings. However, the Restricted Use File includes site identifiers, which correspond to MSAs, and identifiers for the county in which a physician's practice is

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[2] All models were estimated using the survey estimation (svy) commands in Stata 10.0, which take into account the complex survey design in estimating variance and standard errors.

located. To create a rough measure of travel costs, we used information from a 2009 article in *Forbes* that ranked 100 U.S. MSAs according to traffic congestion. We created a dichotomous variable, CONGEST25, indicating whether a physician's practice site was listed among the top 25 most congested MSAs.[3] Although the *Forbes* data are not perfectly congruent with our study period, rankings among the top 25 cities were relatively stable between 2007 and 2008 (reported in the article). Our measure captures the notion that physicians in the top 25 most congested cities face greater travel costs than physicians in less congested cities.

We estimated the effects of CONGEST25 on the percent of a physician's patients cared for by hospitalists using the fractional logit model described previously. We predicted that greater travel costs should increase the use of hospitalists, and decrease the extent to which primary care physicians make in-person hospital visits, *ceteris paribus.*

Hypothesis 3 – Total Professional Work Time Available. RESULT 3 of our model predicts that as the amount of professional time available to a physician increases, the cost of the hospitalist model compared to the traditional model (Δ) will increase so that physicians will rely less on hospitalists and maintain higher levels of inpatient activity.

As a measure of total professional work time available, we created a dichotomous variable indicating whether a physician worked 60 or more hours in medically-related work during the last full week of work (HRSMED60). Based on the hypothesis that women may have less total professional time available, we also examined the effect of gender (FEMALE) on use of hospitalists and own inpatient activity using the two models described in previous sections.

We do not have a direct test of RESULT 4 of our model because we cannot identify a variable that we think is a convincing marker of the time required for an individual ambulatory or hospital visit.[4]

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[3] The CTS-PS MSAs that ranked among the top 25 most congested cities were: Los Angeles, New York City, Chicago, Washington, D.C., Houston, San Francisco, Boston, Seattle, Minneapolis, Philadelphia, Atlanta, Phoenix, Miami, Denver, Baltimore, Detroit, Riverside (CA), Bridgeport (CT), Portland, and San Antonio.

[4] We considered the idea that older patients might be more complex and therefore require more time for care, but were not convinced that this was empirically true since clinic visits are generally of a fixed duration. In addition, younger patients may come for clinic visits less frequently but with a larger list of issues to address in any visit. Similarly, conditional on hospitalization, it is not clear whether younger patients require more or less time than older ones, as younger patients with relatively minor health problems tend not to be hospitalized even when they would

Hypothesis 4 – Probability of Admission. RESULT 5 of our model suggests that the theoretical effect of the probability of admission is ambiguous, and depends on whether communication costs exceed travel costs. However, as noted above, we have reason to believe that communication costs will often exceed travel costs so we expect that the costs of the hospitalist model, and consequently extent generalist inpatient activity, will rise as the probability of admission rises.

Assuming that older patients are also at greater risk of hospitalization, we constructed a variable, MCPROB, indicating whether 33% or more of a physician's total payments came from Medicare.[5] We regressed the percent of a physician's patients that were cared for by hospitalists on MCPROB.

Results

Descriptive Statistics. Frequencies and descriptive statistics for the variables in our analyses are presented in Table 1. Our weighted sample size was 112,946 generalist physicians, of which 41% were general internists, and 59% were family or general practitioners. Coordination costs were common in this sample: more than 50% reported that lack of qualified specialists reduced their ability to provide quality care; over three-quarters of the sample (76%) reported lack of timely reports, and nearly 60% reported that hospital errors reduced their ability to provide quality care. Sixty-five percent of the physicians in this sample reported problems with 2 or more of the dimensions of communication cost we measured. Roughly a third of the physicians in our sample practiced in one of the top 25 most congested MSAs in the U.S. Half of the physicians reported that 33% or more of their total payments came from Medicare, which suggests an older patient population that may be more likely to require hospitalization at any given time, other things being equal.

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have been had they been older, so that hospitalized younger patients may be more complex than might be expected otherwise.

[5] Constructing a variable based on the fraction of a physician's patient panel that are Medicare patients would have been preferable because a few high-cost services may result in a large share of revenue from Medicare. However, such data were not available in the CTS-PS.

Tests of Hypotheses. Table 2 summarizes the fractional logit estimates of the effects of communication costs, switching costs, work time, and hospital admission probability from the 8 models. For ease of interpretation, we also present the sample average marginal effect of each variable, which represents the change in the fraction of patients seen by a hospitalists resulting from a move from 0 to 1 for each variable (all dichotomous), *ceteris paribus.*

In our tests of the association of measures of communication costs with the use of hospitalists, we found that reporting a perceived lack of qualified specialists was associated with a 6 percentage point decline in the fraction of a physician's patients that were cared for by hospitalists in the previous year. Similarly, reporting a lack of timely reports and hospital errors resulted in 7 and 9 percentage point declines in the percent of patients cared for by hospitalists, respectively. Reporting two or more of these communication costs was associated with an 11 percentage point decline in the use of hospitalists, compared to those who reported one or none.

As predicted, our measure of travel costs – practicing in one of the top 25 most congested MSA in the U.S. – was associated with increased the use of hospitalists, with physicians in the top 25 most congested areas having an 11 percentage point higher rate of using hospitalists.

Findings relating to our measures of work time were also consistent with our hypothesis; greater work time available reduced use of hospitalists, with physicians practicing 60 or more hours per week having an 11 percentage points lower rate of using hospitalists, and female physicians (who we assumed to have less professional time available) having a 9 percentage point greater fraction of their patients cared for by hospitalists.

Finally, in our test of admission probability, physicians reporting one third or more of total payments being for Medicare patients (who we viewed as being at increased risk of hospitalization because of their age) reduced the use of hospitalists by 12 percentage points.

In summary, all these results are consistent with our hypotheses. Communication costs and travel both increase total costs of the hospitalist model and render it less favorable to general internists, other things being equal. Greater professional time available increases the relative cost of hospitalist practice and reduce its use among general internists. Finally, higher probability of having patients admitted to the hospital imply greater coordination and switching costs, and also reduce the advantages of hospitalist practice compared to traditional general internist practice.

IV. Conclusions

In this paper, we find strong support for a diverse set of predictions derived from a theoretical model of the division of labor that views the use of hospitalists as balancing the costs of coordinating care across physicians and the costs of physicians in switching between the provision of care in ambulatory versus hospital settings. As suggested by the model, we find that the use of hospitalists is greater as coordination costs fall and switching costs rise. We also find support for more subtle predictions, such at that hospitalists become more advantageous as total physician work hours decline. The advantages of hospitalists are also found to depend on the rate of clinic visits compared to the rate of hospitalization, with hospitalists tending to be less advantageous when the rate of hospitalization is low compared to the rate of clinic visits.

Our findings have a diverse set of implications for the division of labor in medical care. First, our findings have implications for understanding why the use of hospitalist has grown so greatly in recent decades. Specifically, our finding that the use of hospitalists is more attractive as the rate of hospitalization falls relative to ambulatory visits, suggests that the use of hospitalists may have grown partially because hospital utilization has been declining relative to ambulatory utilization, which has been the case for at least the past several decades (Meltzer and Chung, 2010). The exact reasons for this are unclear, but reflect some combination of decreasing use of hospitalization that may be due to greater ability to manage some conditions in ambulatory settings and shorter hospital lengths of stay, and increasing use of ambulatory services, at least partially driven by increasing attention to prevention. It is also possible that the growth of women in medicine and greater attention to work-life balance among both male and female physicians have encouraged the growing use of hospitalists.

Our findings also have implications for the future patterns in the division of labor within medicine. For example, if admission rates continue to decline and physician willingness to work long hours continues to lessen, then the growth of hospitalists would be expected to increase. Similarly, if electronic health record systems and convergence to universal health informatics standards succeed in reducing communication and coordination costs, the use of hospitalists would be expected to continue to increase. These forces would suggest that continuing growth in the use of hospitalist is likely.

While this line of reasoning would seem to suggest that the decline of traditional models of internal medicine combining ambulatory and hospital will continue, there are reasons for caution about this trend. Indeed, no matter how much effort goes into better communication, the greater use of hospitalists is likely to entail some loss for patients who have close relationships with their ambulatory physicians and find themselves hospitalized, and especially those for whom hospitalization is a frequent event. This suggests that a group of patients who have high rates of hospitalization may continue to benefit from traditional models of general medical care. Indeed, this may provide a way forward for physicians wishing to continue to provide such integrated care – to focus on patients at high risk of hospitalization, providing a sufficient number of patients hospitalized to allow the physician to justify a daily presence in the hospital, and eliminating the need for much costly communication about the patients care and providing true integrated care for these patients. For patients at lower risk of hospitalization, models in which care is divided between ambulatory-based and hospital-based physicians would be chosen. The predictive models needed for such a model to be implemented already exist to a large extent and suggest that a large enough group of patients at high enough risk to make such a model feasible could indeed be identified (Meltzer and Chung, 2010).

The model we have developed also suggests that efforts to reduce transport costs might be a valuable strategy to increase the ability of physicians to care for patients in both ambulatory and hospital settings. For example, clinics could be located in hospitals or directly adjacent to hospitals. This might create some inconvenience for patients since hospitals may be further away from their home than nearby clinics, and because parking and distances from parking to clinic offices may be greater, but for patients who are at great risk of hospitalization and who wish to have a doctor with whom they are more familiar treat them in the hospital, these may be acceptable inconveniences. Alternatively, telemedicine options might allow physicians to be directly involved in the care of their patients when they are hospitalized even if the physician is located remotely. Such care would surely require some onsite presence of physicians or nurses to complement the activities of the clinic physician working remotely, and blurs the distinction between transport and communications costs. Nevertheless, it is an important reminder that the optimal division of labor can be strongly influenced by changes in the technology of production, including both communication and switching costs that can affect the costs of coordination.

REFERNCES

Becker Gary S. and Kevin M. Murphy. 1992. "The Division of Labor, Coordination Costs, and Knowledge." *Quarterly Journal of Economics*. 107:285-326.

Coleman, James S. 1990. *Foundations of Social Theory*. Cambridge, MA: The Belknap Press of Harvard University Press.

Jerslid, Arthur. 1927. "Mental Set and Shift." *Archives of Psychology*. 14:1-81.

Klemperer, Paul. 1987. "Markets with Consumer Switching Costs." *The Quarterly Journal of Economics*. 102:375-394.

Klemperer, Paul. 2008. "Network Effects and Switching Costs." In *New Palgrave Dictionary of Economics*, ed. Steve N. Durlauf and Lawrence E. Blume. New York: Palgrave Macmillan.

Meltzer, David. 2001. "Hospitalists and the Doctor-Patient Relationship." *Journal of Legal Studies*. 30:589-606.

Meltzer, David and Jeanette Chung. 2010. "U.S. Trends in Hospitalization and Generalist Physician Workforce and the Emergence of Hospitalists." *Journal of General Internal Medicine*. In press.

Peabody Francis W. 1927. "The Care of the Patient." *Journal of the American Medical Association*. 88:877.

Forbes. 2009. "America's Most Congested Cities." http://www.forbes.com/2009/02/24/traffic-congested-cities-lifestyle-real-estate_congested_cities.html. (accessed 04 September 2009).

Smith Adam. 1965. *The Wealth of Nations*. New York: Modern Library.

Wachter Robert M. and Lee Goldman. 1996. "The Emerging Role of 'Hospitalists' in the American Health Care System." *New England Journal of Medicine*. 335:514-7.

Wachter Robert M. and Lee Goldman. 2002. "The Hospitalist Movement 5 Years Later." *Journal of the American Medical Association*. 287:487-494.

Table 1. Frequencies of Variables in the Analysis

Variable	Percent	Weighted N
Communication Costs		
Lack Qualified Specialists	53%	56,611
Lack Timely Report	76%	80,529
Hospital Errors	57%	60,813
MD Reported 2 or More Communication Costs	65%	69,377
Switching (Transportation) Costs		
MD Practice in Top 25 Most Congested MSAs	34%	35,972
Probability of Hospital Admission		
33% or More Total Payments from Medicare	50%	52,908
MD Hours		
MD Practiced 60+ Hours in Last Week of Work	37%	39,368
MD Female	29%	31,049
Control Variables		
Practice Type		
Solo/2 Physician	40%	42,042
Group Practice (3+ Physicians)	25%	26,274
HMO	6%	6,593
Medical School	5%	5,068
Hospital-Based	12%	12,988
Other	12%	13,147

Data Source: Center for Studying Health System Change *Community Tracking Study Physician Survey, 2004-5 Restricted Use Data File.* All frequencies were weighted to produce U.S. population estimates. The total weighted population size in our analyses was 106,113 generalist physicians.

Table 2. Summary of Estimates from Fractional Logit Models

Variable	Coef.	S.E.	P	95% C.I.		Avg. Marginal Effect (AME)	S.E. of AME
Communication Costs							
Lack Qualified Specialists	-0.29	0.14	0.04	-0.57	-0.02	-0.06	0.03
Lack Timely Report	-0.31	0.16	0.06	-0.63	0.01	-0.07	0.04
Hospital Errors	-0.40	0.16	0.01	-0.71	-0.08	-0.09	0.04
MD Reported 2 or More Communication Costs	-0.47	0.17	0.01	-0.80	-0.14	-0.11	0.06
Switching (Transportation) Costs							
MD Practice in Top 25 Most Congested MSAs	0.49	0.16	0.00	0.18	0.80	0.11	0.04
Probability of Hospital Admission							
33% or More Total Payments from Medicare	-0.55	0.14	0.00	-0.81	-0.28	-0.12	0.03
MD Hours							
MD Practiced 60+ Hours in Last Week of Work	-0.50	0.15	0.00	-0.81	-0.20	-0.11	0.03
MD Female	0.39	0.16	0.01	0.08	0.71	0.09	0.04

Data Source: Center for Studying Health System Change *Community Tracking Study Physician Survey, 2004-5 Restricted Use Data File.* All frequencies were weighted to produce U.S. population estimates. The total weighted population size in our analyses was 106,113 generalist physicians.