The Impact of Diversification on Task Performance: Evidence from Kidney Transplant Centers

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ABSTRACT

Research Summary: Even when diversification is beneficial, entry into a new business can negatively affect the performance of the firm's existing business(es). We examine transplant centers that diversified from kidney transplants into liver transplants, focusing on how patient age can affect the costs associated with diversification. We find that diversification into liver transplants resulted in worsened quality performance in kidney transplants for younger patients, whose cases were less likely to be unexpectedly complex. For older patients, whose cases were more likely to have complications, the negative effect of diversification was offset. Our findings suggest that in health care the costs of diversification can be sensitive to patient characteristics, making focused organizations desirable when task complexity is low, while favoring diversified organizations for more complex tasks.

Managerial Summary: When firms diversify into new activities, the increased coordination may worsen performance in their original, pre-diversification activities. We show how this change in performance depends on characteristics of the work itself. We examine kidney transplant centers that diversified into liver transplants. Young patients, who are typically less complex to treat, had worse outcomes when centers diversified. However, for the oldest patients—generally the most complex to treat, with the greatest chance of complications--diversification was associated with slightly *improved* performance. This suggests that while coordination is difficult, organizations that diversify may be able to acquire coordination skills that can be applied to more complex tasks. Simpler tasks are unlikely to benefit from these skills, and thus we find worsened performance in these tasks after diversification.

INTRODUCTION

How does a firm's entry into a new business affect the performance of its existing businesses? The research literature has demonstrated that firms that can put the advantages from their new business to work in their original businesses can reap ample benefits. But the new increase in scope is naturally accompanied by increases in coordination and bureaucratic costs. Thus, an increase in scope can have negative repercussions for a firm's existing businesses, potentially offsetting any gains from the new business and reducing overall firm performance.

Increasingly, scholars are turning their attention to organizational characteristics that can determine whether the benefits of diversification outweigh the costs. The existing scope (Clark and Huckman, 2012) or complexity (Zhou, 2011) of firm operations, as well as organizational rigidity (Rawley, 2010), have all been shown to affect whether a firm's performance in their original business will be helped or harmed by diversification, or will deter a firm from diversifying at all. We contribute to this literature by examining how characteristics of the work itself—specifically, task complexity—can affect the costs associated with diversification. We analyze the performance of organ-transplant centers that diversified from kidney transplants into the related area of liver transplants. The surgery setting is a useful one in which to test the effects of diversification at the task level. Data on patient outcomes (mortality rates) provide a strong measure of quality performance. In addition, there exist a bevy of well-tested clinical indicators to measure how complicated a surgery will be, which all transplant centers are required to record.

We find that, on average, diversification into liver transplants worsened quality performance in kidney transplants for younger patients, whose cases were likely to be comparatively routine. This negative effect of diversification for younger patients is almost entirely offset for older patients, who experienced no negative consequences from diversification on quality performance. We argue that in our hospital setting, diversification detracted from organizational focus but may have offered benefits in organizational responsiveness. Thus, we show that the calculus of diversification can depend on the nature of the work within the organization itself.

We begin by reviewing the prior literature on the costs associated with diversification and how these are affected by firm and task characteristics. We then give detailed background on the transplant center setting and a brief explanation of our empirical strategy. After presenting the results, we discuss the implications for the nature of a firm's work, and diversification more generally. We conclude with implications for research on corporate strategy and organization, and for public policy.

Effects of Diversification on Performance of the Firm's Existing Businesses

For decades, strategic management scholars have highlighted the superior gains from related diversification (Rumelt, 1982; Palepu, 1985). From the outset, diversification research has emphasized understanding the benefits of diversification: ensuring continuity (Teece, 1980); enhancing organizational learning (Markides and Williamson, 1994); or making use of excess capabilities or resources that cannot be sold, but which could be put to use via diversification (Penrose, 1959).

Firms must balance any economies of scope with the concomitant diseconomies that arise from managing a larger, more varied firm (Chandler, 1969; Rumelt, 1982). The greater the degree of sharing of resources and activities between the units in a diversified firm, the greater the potential for coordination costs. As relatedness in diversification is typically measured by the degree of interdependencies between business units, it is logical to expect that coordination costs will be greater in related diversification (Jones and Hill, 1988; Hill *et al.*, 1992; Nayyar, 1992; Zhou, 2010). As Levinthal and Wu (2010) point out, many intangible resources that firms hope to leverage by diversifying, such as managerial know-how, necessitate a degree of coordination that does not exist in a single-segment firm. As Rawley (2010) notes, when firms diversify, "resources that were optimized *ex ante*, with respect to maximizing business unit performance, may be underutilized [or over-utilized] *ex post*, as business unit decisions are sublimated to serve the greater good of the overall firm." Conversely, by focusing on a single business, the firm can avoid the coordination and organizational conflicts that arise from sharing resources across different activities with potentially incompatible goals (Simon, 1962; Cyert and March, 1963; Ethiraj and Levinthal, 2009; Bresnahan, Greenstein, and Henderson, 2011).

Despite coordination costs, most firms add new businesses over time (Christensen and Montgomery, 1981; Hill, Hitt, and Hoskisson, 1992), and much research in the strategic management literature has emphasized the potential benefits of expanding corporate scope. In contrast, researchers in finance and operations often argue that value is generated by restructuring organizations in the opposite direction. Diversified firms tend to be valued at a discount in financial markets (Rajan, Servaes, and Zingales, 2002; Mazur and Zhang, 2015), and stock prices typically rise following the spinout or divestment of businesses (Miles and Rosenfeld, 1983; Jain, 1985).

In the operations management literature, pursuing focus—that is, *narrowing* the activities performed by a firm or productive unit—as a strategy for improving operational performance was first introduced by Skinner (1974). In settings as diverse as manufacturing (Berry *et al*, 1991), professional service firms (Dierdonck and Brandt, 1988), and health care (Hyer *et al.*, 2009), studies have shown that focused organizational units tend to exhibit superior cost and quality performance. Indeed, the "law of factory focus" is regarded as an important element of received wisdom in the field of operations management (Schmenner and Swink, 1998; Clark and Huckman, 2012).

Strategy scholars have increasingly been delving into operational details to better understand coordination costs and the implications of complexity. Rawley (2010) demonstrates that organizational rigidity combined with related diversification hurts financial performance in the original activity; that is, firms that lack the flexibility needed to incorporate new activities can worsen their performance in their original task. Similarly, Zhou (2011) examines how complexity can deter diversification entirely: for firms that are already managing complexity, the higher degree of coordination that related diversification would introduce discourages firms from diversifying. Chen et al (2019) take these insights further, using simulations to demonstrate a curvilinear relationship between firm complexity and a diversification disadvantage. They note that while complexity does amplify the constraints imposed by coordination, this disadvantage arises even at middling levels of firm complexity, and additional complexity has little additional effect.

All of these papers find that organizational characteristics—independent from or in addition to the relatedness of the diversification—substantially affect the firm's ability to benefit from diversification. Such recent studies in corporate strategy address the drivers of costs associated with diversification to better understand the conditions under which diversification or focus will result in superior performance.

Tasks and Diversification

The nature of an organization's tasks can affect the coordination that the sharing of resources from diversification entails. Following the definitions proposed by Wood (1986), tasks may be complex because they require many pieces of information and actions to complete (component complexity), because they require coordination (coordinative complexity), or because the nature of the task is changing (dynamic complexity).

Diversification increases coordinative complexity across the board. Prior research has shown that coordination is even more costly and difficult when work is both complex and dynamic, as interdependencies may shift, particularly when they are unpredictable (Wood, 1986; Faraj and Xiao, 2006). Thus, coordination costs from diversification increase with task complexity. The more complex (and particularly, the more dynamically complex) the task, the less firms can rely on routines, because the nature of the interdependency to be coordinated may change midtask (Brown and Duguid, 2001; Hoffer Gittell, 2002). In these types of settings, the potential for scope economies can be considerable but easily outweighed by the substantial coordination costs.

Given the dynamics of organizational learning, coordinative complexity may temporarily increase immediately after diversification but become more manageable as the firm adapts. One of the key arguments for focus is repetition: focus allows the development of routines that can be repeated, and through this repetition workers' efficacy will be improved. Hence, the negative effects of diversification could diminish over time, as new routines develop to manage an increase in coordinative complexity. Staats and Gino (2012) found that firms that diversify into new tasks suffer from temporary performance reductions as they learn to manage their new tasks. On the other hand, Chen et al (2019) demonstrate theoretically that in highly related, complex businesses, diversification results in a long-term performance reduction, even in the presence of short-run synergies. Thus, it is important to assess whether any decline in performance after diversification might be of limited duration.

Diversification in Health Care

While the benefits of focus have been shown in a variety of industries, many recent studies have examined the health care sector due to its economic and policy significance, and to the richness of the available data. In a study of clinical trials, Huckman and Zinner (2008) found that focused firms had higher output and productivity than unfocused firms. Within a hospital setting, Clark and Huckman (2012) found that focus had a positive effect on quality performance, which they attributed to reduced complexity, lower uncertainty, and the development of specialized expertise. KC and Staats (2012) showed that experience on related tasks improved cardiac surgeons' performance on their focal tasks, but that "excessive variety" in task experience led to worsened performance. In a study of cardiac care departments, KC and Terwiesch (2011) found quality benefits of focus leading to reduced mortality and length of stay. They concluded that "general hospitals may be better equipped for treating the 'harder-to-treat' patients, whereas focused hospitals are more effective with 'easy-to-treat' patients," suggesting an optimal division of labor based on patient characteristics.

Task-level metrics for performance include quality (Lapré *et al*., 2000; Huckman and Zinner, 2008; Clark and Huckman, 2012), timeliness (Argote and Darr, 2000), and customer satisfaction (Lapré and Tsikriktsis, 2006). The standard clinical indicator of performance for transplant centers is patient mortality within a year. This is not only the *de facto* measure of quality—each center's mortality rates are made public to enable patients to compare centers—and most would argue that patient survival is the first-order priority for any hospital. Even so, it is important to note that we do not observe financial performance of the transplant centers.

Contribution of This Study

We contribute to the literature on optimal scope by examining how characteristics of the work itself can affect the costs associated with diversification. Similar to Rawley (2010) and Clark and Huckman (2012), we consider how diversification into a new activity affects performance in the organization's original activity. Rather than looking at how organizational characteristics may influence the benefits or costs of diversification, we examine the characteristics of the organization's activity itself—namely, how complexity in the work undertaken affects whether diversification at the organization level will help or harm task-level performance. As discussed in Zhou (2011), the more related the diversification, the greater degree of coordination that will be necessary, increasing coordination costs even for those activities in which the firm was originally engaged.

SETTING AND SAMPLE

In this paper, we contrast transplant centers that perform kidney but not liver transplants with centers that perform both transplant types. While centers may perform as many as eight kinds of transplants, livers and kidneys account for 80 percent of all transplants. We compare the addition of liver programs because it is the most highly related type of diversification within a transplant center. The technologies and skills needed to perform liver transplants are more similar to kidney transplants than to other types of transplants; for instance, laparoscopic techniques are common in kidney transplants, but they have recently been deployed in liver transplants as well. Thus, this type of diversification is more likely to result in benefits from related diversification as well as coordination costs from sharing facilities, equipment, and staff. [1]

Market Characteristics

Each transplant center receives organs for transplant from a geographically designated organ procurement organization (OPO), which is overseen by the United Network for Organ Sharing (UNOS); each of these are independent from the hospitals they supply. OPOs allocate kidneys to the various transplant centers within an OPO's coverage area to minimize the incidence of mismatch between recipient and donor—OPOs evaluate human leukocyte antigens first, then blood type, etc. Waitlisted patients are ranked by a computer algorithm that assigns points to relevant characteristics: time on waitlist, quality of the match, child or not, availability of the patient, etc. To be placed on the waitlist, patients must meet minimum acuity requirements, presumably to prevent them from "gaming the system," as happens in the liver-allocation market (Snyder, 2010). The allocation of kidneys (unlike livers) considers only fairness (e.g., time on waitlist) and match quality, and not the severity of the illness. Because organs are allocated primarily based on the match between donor and recipient, and because what organs will become available cannot be anticipated, it is virtually impossible for centers to "game" their waitlists by

[1] In Appendix C: Other Measures of Diversification, we also look at transplant centers that diversify into the next-largest transplant program, heart transplants. The results here are replicated for centers that diversify into both liver and heart transplants; however, for the subset of centers that diversify only into heart transplants but not livers, the results are too noisy (due to the small sample size) for this subset of centers to draw any meaningful conclusions about generalizability.

selectively enrolling patients.

Firm Characteristics

Our data cover 293 kidney centers, of which 244 were still performing transplants in 2007; of these, 150 also performed liver transplants. Among the transplant centers we observed, only one liver-transplant center did not also perform kidney transplants (due to a legal dispute); thus, generally speaking, the pool of transplant centers that perform kidney transplants can be viewed as the set of potential entrants to the liver-transplant market. To be eligible to receive Medicare reimbursement for kidney transplants, centers must perform at least 15 transplants per year. (All patients with end-stage renal disease are eligible for Medicare, regardless of age.)

When a center decides to expand into liver transplants, the start-up costs are nontrivial: nursing coordinators must be retrained, and centers often hire a separate liver-transplant surgeon. Concerns about volume must also be addressed. While the largest centers may have sufficient volume to support separate facilities (separate operating rooms, clinicians, and support staff) for different transplant programs, smaller centers have to coordinate these resources across the different transplant programs within their centers. We spoke with clinicians at three diversified transplant programs; in discussing the motivating factors for diversifying into liver transplants, none of them mentioned patient well-being. None of them believed that adding a new transplant program would have an impact, either positive or negative, on patients in the original transplant program.

Demand Characteristics

For kidneys, patients contact one or more transplant centers for evaluation (some transplant centers require referring physicians to contact the center, others allow patients to refer themselves). Patients deemed suitable for a transplant will be placed on that center’s waitlist.

When a kidney becomes available, it will be offered first to the most preferred patient within that OPO; if no suitable patient is on that waitlist, it will be offered to the preferred patient in that OPO's larger region. For all types of patients, the time between the organ becoming available (either the organ's removal from or the death of the donor) and the transplant is critical; as a result, immediate patient availability plays a role in the assignment of transplants and organizational speed will have an important impact on survival.

Task Characteristics

Liver transplants are more complex than kidney transplants. Kidney transplant surgeries typically take a single surgeon less than two hours, while liver transplants typically take about three and a half hours and allow for a second surgeon. Liver patients are typically sicker than kidney patients at the time of transplant because there is no substitute for a functioning liver (while a patient with kidney failure can live on dialysis for many years). This is reflected in the relevant patient mortality rates: currently, the one-year rate is 2.9% for kidney transplants and 8.8% for liver transplants.

Both liver and kidney transplants are subject to a variety of complications. Some are common to both transplant types, such as blood clots, hemorrhage, infection, and acute rejection of the transplanted organ (Akbar *et al.*, 2005; Moreno and Berenguer, 2006); others are transplant-specific. While complications are on average more likely to occur for liver than kidney transplants, complication rates for both types of surgery have been falling over time. Individual patient characteristics also exert a strong effect on the risk of complications developing (see Empirical Strategy).

Appendix D contains more details about the transplant setting, including market, firm, demand, and task characteristics.

Sample Selection

Our analysis deals with liver and kidney transplants performed by U.S. transplant centers from 1988 to 2007. The data set provided by UNOS is not a sample, but rather the universe of patients in the United States who were ever registered on a waitlist or received a transplant, and contains the clinical details of every patient and transplanted organ, in our study period. To isolate the impact of diversification, we simplify the setting as much as possible: waitlisted patients who did not receive transplants are omitted, as are observations for which the center performed fewer than 15 kidney transplants (the minimum volume to be eligible for Medicare).[2] Liver data were aggregated to the center level and were merged into the kidney-transplant data, using UNOS's unique center-identification codes. The resultant data comprises the universe of kidney transplants at centers that are or would be federally accredited between 1988 and 2007. Nationwide, 89 centers diversified during this period.

Performance

Performance by organ-transplant centers is measured on clinical indicators, primarily mortality rates with risk-adjustment indicators within one year of transplant; this is the only metric that UNOS makes publicly available to all physicians and patients. We discuss our approach to risk adjustment in the description of our empirical strategy, as well as in Appendix B. Quality performance is a common and conceptually tidy measure for task-based performance. It is particularly relevant in this setting, as transplant centers are typically not-for-profit organizations. Even at a for-profit hospital, however, quality in the form of patient survival is of first-order importance.

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[2] A center need only meet the minimum volume threshold in accreditation years, and accreditation does not (usually) happen annually. This exclusion omits centers that would not have been accredited in a given year, if they are evaluated. While the mortality at these centers is higher, we cannot say that they are statistically significantly different from Medicare-qualified centers—the estimates from these centers are very noisy due to small sample size. The results we present here are robust to the inclusion of these centers.

Though quality performance is of first-order importance in hospital-level decision-making, our research does not address whether the effect of diversification on financial performance will play out in the same way. For instance, transplant centers are popularly viewed as a source of prestige for hospitals (Levine, 2006), particularly centers with multiple transplant types (DHHS Report, 2003). Centers do not make available any financial data (separate from that of the hospital as a whole) that would allow us to test the impact on financial performance; we leave that for future research.

EMPIRICAL STRATEGY

To test the impact of diversification on performance, we use a linear-probability model with post-kidney-transplant mortality within one year as the dependent variable.[3] Over our sample period, this mortality rate steadily declined, 0.17% per year on average, reflecting advances in surgical techniques and technologies. To account for this trend, all specifications include transplant-year fixed effects.

We use a binary indicator for diversification, equal to one beginning on the day that a center does its first liver transplant; UNOS does not report the physician who performed the surgery, so all measures of diversification are at the level of the transplant center. A simple indicator of diversification's effect on quality is the average change in kidney patient mortality following diversification. Without any risk adjustment, the average mortality rate for centers was 4.9% before diversifying, and 5.4% after diversifying (among centers that diversified between 1988 and 2008). Although an increase of 0.5% may seem small, we infer that absent diversification the

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[3] Although the binary dependent variable suggests a probit estimator, the large number of fixed effects would lead to highly biased estimates, due to the incidental-parameter problem (Lancaster, 2000). The main issues with using OLS with a binary dependent variable are heteroskedastic errors and an unconstrained dependent variable. We deal with heteroskedasticity by using robust standard errors. 2.7% of our observations yield probability estimates below zero in the fully specified model; our results are robust to a specification using a trimmed OLS estimator that omits these, as suggested in Horrace and Oaxaca (2006), and are available on request.

unadjusted mortality rate of these centers would have *declined* by about 0.5% due to the time trend. Combining these figures gives an increase in mortality of 1% on a base level of 4.9%. Thus, the raw data imply that the mortality rate for centers that diversified increased by roughly 20% (1% divided by 4.9%).

Above, we discussed the importance of controlling for a variety of firm-specific effects. To control for unobservable center quality, we include time-invariant center-level fixed effects in every specification. We also control for center-level characteristics that may vary over time: volume, supply volatility, competition, and clinical risk adjustments for the patients seen by the center. Table 1 describes each of these characteristics in detail.

Insert Table 1 Here

Our primary interest is in the complexity of the tasks a center performs, and how this complexity interacts with diversification. In this setting, the degree of complexity is dictated by patients and their attendant medical needs. Naturally, a patient who requires both a kidney and a liver transplant will receive additional value from a diversified center. We are also interested in how patient-level complexity affects the likelihood that diversification will improve or worsen quality performance.

The lead transplant surgeon at a large academic medical center stated that the four main factors that influence the difficulty of a surgery are (1) the patient's age; (2) the patient's use of life-support equipment, such as a ventilator or dialysis; (3) prior surgery on the same site; and (4) severity of the disease. For each of these factors, "you're less likely to tolerate complications but you're more likely to have them."

We rely on age as our proxy for complexity. Unfortunately, we are not able to operationalize the other sources of unanticipated complications, due to limitations of the data.[4] Clinicians are certainly aware of the increased risk when operating on an older patient, but they cannot anticipate which complications (e.g., blood clots, hemorrhage, electrolyte imbalance, infection, undiagnosed comorbidities) are most likely to occur; age increases the risk of all of these (Aakhus *et al*., 1999; Grundy *et al*., 1999; Meier-Krische *et al*., 2001; Pinto *et al*., 2017). Age is highly correlated with subclinical comorbidities; that is, another disease or condition that is "asymptomatic, presymptomatic, atypically symptomatic, or simply undiagnosed" (Newman *et al.*, 2008). There is a large degree of heterogeneity, particularly among older adults, where risk from subclinical disease burden can range from very low to very high (Newman *et al*., 2008). Advanced age is also correlated with disabilities such as frailty that are not captured in standard preoperative assessments (Makary *et al*., 2010). Geriatric-specific risk predictors may be more difficult to detect using standard protocols (Kim, Brooks, and Groban, 2015). This results in a higher degree of complexity for older patients—from previously unknown comorbidities that may complicate the transplant (Guralnik, Everett, and Lacroix, 1989), and from the physiologic reserves necessary to recuperate from the surgery. Both are difficult to identify using standard evaluation protocols, resulting in a higher rate of complications (both mid- and postprocedure) for older patients (e.g., Meier-Kriesche *et al*., 2000; Polanczyk *et al*., 2001). In kidney transplants specifically, renal failure in older patients is more likely to result from "lifestyle diseases" such as diabetes, which are highly correlated with multiple comorbidities that may not

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[4] For life-support equipment, over 90% of our sample is on dialysis at the time of transplant; this is the only type of life-support equipment used in our data. UNOS tracks prior kidney transplants (7% of our sample) but not other types of abdominal surgeries that would also affect difficulty. And while UNOS began collecting data on measures of disease severity (such as serum creatinine) as of 1994, these data are not recorded for most transplants until the mid-2000s. For each of these measures of difficulty, the results are much the same as our analysis for age (diversification associated with a significant increase in mortality on average, but diversification interacted with the measure of complexity decreases mortality) with the exception of the significance of the interaction with the diversification term ($p < 0.14$ for dialysis, $p < 0.38$ for prior kidney transplants, $p < 0.20$ for serum creatinine at time of transplant). While the prevalence of dialysis in this context will likely make it difficult to identify the effect of diversification for the foreseeable future, this may be a fruitful avenue of future research, once more data are collected on measures of severity.

have been diagnosed; the subclinical comorbidities include major mortality risks such as heart disease (Grundy *et al*., 1999). Any given complication increases the component complexity of the operation; the broad range of potential complications and the difficulty in identifying them ahead of time using standard evaluation protocols also increase dynamic complexity.

Table 1 summarizes the controls and proxies for complexity used in our specifications. The baseline specification for patient *i* at center *c* in year *t* in OPO market *m* is

$$Outcome_{ictm} = \beta_0 + \beta_1 Diversified_{ct} + Complexity_i + SupplyVolatility_{ct} + Volume_{ct} + Concentration_{mt} + ClinicalRiskAdjustment_i + Year_t + Center_c + \varepsilon_{ictm}.$$

To understand the role of task-level complexity on the impact of diversification, we will add the interaction between task complexity (measured by patient age) and firm-level diversification.

Selection: Finally, we take steps to ensure that our estimation will be robust to empirical issues that commonly plague the estimation of diversification. The primary issue that needs to be addressed in such a setting is selection. As demonstrated in the diversification discount literature, notably Villalonga (2004), selection into diversification may in fact lead to the overestimation of a negative effect of diversification on firm-level performance. Our hospital setting faces the same selection problem, in that diversification is not randomly assigned among firms but rather is selected as a firm strategy. To the extent that diversified and undiversified firms differ systematically in characteristics that would affect mortality, this will create a selection bias in results and will

necessitate an empirical model that addresses this bias.

Empirically addressing the impact of diversification on mortality is a thorny issue, because mortality may be endogenous to the diversification decision. One might expect that firms that perform kidney transplants well would be more likely to diversify into liver transplants. In this setting, we might also expect that the prestige associated with a multiorgan transplant center would enhance performance of the hospital overall, in the form of increased access to resources, which could create an incentive for centers to stay in the transplant market when their performance is relatively poor. Thus, there could be a direct incentive to enter this market for centers with either low or high kidney-transplant mortality rates. Although we are agnostic on the direction of selection, clearly the initial choice of diversification may not be exogenous to kidney-transplant performance, so we must control for selection.

The inclusion of firm-specific fixed effects will control for any time-invariant unobservable differences that could drive selection. There will continue to be a problem, however, if some firm characteristics that vary over time—such as competition within an OPO—influence both the diversification decision as well as patient outcomes. Accordingly, we will employ an inverse-probability weight treatment, which is similar to propensity score matching but allows for time variation.

Inverse-probability weighting, also called propensity-score weighting, is a common method in other disciplines for dealing with problems caused by selection on observable characteristics (e.g., Robins, Hernan, and Brumback, 2000; Wooldridge, 2007). In short, we use a probit model to estimate the probability that a given center will be diversified in a given year, based on characteristics of both the firm and its market: competition, slack resources, and experience. Appendix B provides details on the measures used to predict diversification and the results of this probit model. Each observation is assigned a weight equal to the inverse of the probability that the center will be diversified in that year, so that observations from centers we would expect to be diversified will be weighted less than observations from centers we would not expect to be diversified. Variables that may affect both the probability of entry and the kidney-transplant mortality rate will be included in both the main specifications as well as the calculation of the probability weights. Our results include these weights as a selection correction.[5]

The inverse-probability weights address selection on observables, while the firm fixed effects help to control for time-invariant unobservables (Villalonga, 2004; Appendix A provides additional detail on the observable characteristics of centers that diversify). These specifications do not address time-varying unobservable characteristics that may affect both the decision to diversify as well as quality performance for different types of patients. The primary concern for selection on unobservables in health care is patient selection: patients who are treated at diversified centers may be unobservably sicker than those who are treated at focused centers, perhaps due to the prestige associated with being a diversified medical provider. We address patient selection in Appendix B by examining all available measures of patient severity, and we do not find systematic differences; however, this phenomenon will bias our results only if sorting occurs differently for young and old patients (which again, we do not find evidence for). That is, if diversification results in (or occurs at the same time as) unobservably healthier young patients and/or sicker older patients choosing focused transplant centers, our results may be biased. If sicker patients prefer diversified centers[6] in a way that does not systematically differ by age, the negative effect of diversification will be overstated on average but will have no impact on our analysis of task complexity. To test for transient effects of diversification such as those found by Staats and Gino (2012), we add a measure of time since diversification for those centers that did diversify into liver transplants (see Table 4).

RESULTS

Summary Statistics

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[5] All findings are robust to the omission of these weights; the unweighted results are available from the first author on request.

[6] NB: although strategic patient selection by centers is a concern in other settings, the logistics of transplant allocation and survival make it essentially useless in this setting (see Appendix B). Thus, we are only concerned with the unobserved preferences of patients.

Table 2 summarizes the key variables used to measure patient outcomes. On a non-risk-adjusted basis, patient mortality does not differ much between diversified centers and the population overall.

Insert Table 2 about here

Diversified centers are larger than undiversified centers in terms of transplant volumes, with an average of 230 transplants over three years at diversified centers, compared with only 112 at undiversified centers. Nearly all transplant centers perform kidney transplants, and may later add additional transplant programs. Liver transplants were still deemed an experimental treatment until 1983, while kidney transplants had become common as early as the 1960s, with the advent of immunosuppression (Manzarbeitia *et al.*, 2015). Thus, while it is natural for larger, more established kidney programs to be more diversified than relatively smaller centers, this difference in size highlights the importance of controlling for the center characteristics that may affect performance.

Results

Table 3 presents the basic results. For the sake of length, we do not report coefficients on the control variables described above; the full results are reported in Appendix Table B3. Model 1 demonstrates the main effect of diversification on performance. In the simple binary breakdown of diversified vs. undiversified firms, diversification is associated with a 0.68-percentage-point increase in patient mortality, but is not significant ($p = 0.121$). As such, the main effect of diversification is unclear in a simple comparison. The subsequent estimations, in which we decompose the effect of diversification by the complexity of patients, suggest that this noisiness comes from the averaging of divergent trends within diversified centers. In the subsequent estimations in Table 3, we interact diversification with different measures of task complexity.

When we interact the effect of diversified centers with complexity (where advanced age is a proxy for a high risk of a broad range of complications), the results are striking. Age on its own is a highly significant predictor of mortality (point estimates range from a 0.18% to 0.20% increase in mortality per year of age, $p < 0.0001$ in all specifications). The diversification coefficient in the second regression in Table 3 implies that diversifying into liver transplants raised kidney patient mortality by 2.1% ($p = 0.003$). This is offset by the effect that for each additional year of age, diversification into livers reduced kidney patient mortality by 0.03% ($p = 0.028$). Thus, for younger patients the estimates show a strong increase in mortality linked to diversification. However, for older patients, who are more likely to have complications, there are benefits to being treated at a center that does more diverse, complicated procedures. For instance, these estimates imply that a 75-year-old patient would have a marginally higher expected mortality rate at an undiversified center (10.7%) than at a diversified center (10.4%).[7] By comparison, a 25-year-old patient receiving a transplant at a diversified center would have nearly triple the expected mortality rate (2.0%) compared to receiving a transplant at an undiversified center (0.7%). The magnitude of this increase is higher than the mortality risk from a primary antigen mismatch (1.13%; this is the leading cause of organ rejection, and the first factor UNOS considers when allocating organs). This suggests that for a 25-year-old patient, the increased mortality from being treated at a diversified center is approximately equivalent to an additional 3.4 years on the waitlist for a transplant.

These effects of age are robust to the inclusion of additional controls, as shown in the subsequent columns of Table 3. We add three-way interactions with comorbidities and drug-treated hypertension, both of which are correlated with age; these additional interactions have

[7] These comparisons are done using the margins command in Stata, which holds all other variables at their average level.

either no effect (comorbidities) or increase the magnitude and significance of the age-diversification interaction (for drug-treated hypertension). When we break age into cohorts, we find that the effect of diversification is approximately linear in age—the beneficial effect of diversification increases with age. The age results are also robust to an alternative specification of the diversification measure. Using the continuous measure of focus (Appendix Table C1), the results are similar in magnitude to those in Table 3, but the age-diversification interaction is even more statistically significant.

Insert Table 3 here

Table 4 repeats the specifications of Table 3, supplementing the diversification dummy with a measure of the years since a center first diversified. These specifications show that the increased mortality effect of related diversification does not decline over time. On the contrary, the mortality-increasing effect of diversification *increases* over time when we control for the effect of age interacted with diversification. Beyond the effect of time since diversification, Table 4 largely replicates the results of Table 3. Similar results were obtained when the time since diversification is broken down into five-year periods to allow for the possibility of nonlinear trends (see Appendix E). These findings contrast with those of Staats and Gino (2012) for the banking industry, where task-level performance reductions due to diversification were found to be transitory.

Insert Table 4 about here

Although the coefficients reported here are small, they are sizeable relative to the base rate. The effects are particularly salient given that the base rate is mortality - it is important to be mindful that the performance we are discussing is human life. Holding all other effects and clinical determinants of mortality constant, had younger[8] patients gone to undiversified centers and older patients gone to diversified ones, our model predicts that the mortality rate would have dropped 0.6% (which is 13.0% of the observed mortality rate of 4.6%), or one additional life saved per 167 surgeries. Applied to the 271,179 transplants during our study period, this would amount to 1,267 fewer deaths. In reality, of course, a center cannot hold everything constant and change only their patients, so this is a hypothetical conclusion in order to illustrate the magnitude of these findings.

DISCUSSION

Our data are limited to assessing the performance of an existing business (a kidney-transplant center) that diversifies into a related business (liver transplants). Therefore, we limit our discussion to the potential impact of diversification on the original business. Overall, we find that diversification had a negative effect on quality performance, consistent with other work demonstrating that when firms diversify, performance in the original activity may suffer (Huckman, 2008; Rawley, 2010).

Our findings with respect to task complexity, the key element of our study, are more nuanced. Our empirical results contradict the general idea that in an organization, greater task complexity leads to worsened performance from diversification. Indeed, our findings within a hospital setting show that post-diversification performance declined for younger patients, for whom unexpected complications were the least likely. That is, after hospitals diversified, their performance worsened in treating cases where complexity was relatively *low*. In contrast, we find offsetting effects for older patients, for whom a diversified setting may have offered benefits in terms of organizational responsiveness to a broad range of problems that increase in likelihood

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[8] Our model implies that the age at which diversification switches from a negative to a positive effect is 66; this calculation assumes all patients under 66 go to undiversified centers while those over 66 go to diversified centers.

with age.

These findings are perhaps best interpretable in the context of the operations management literature on the benefits of “factory focus,” based on Skinner (1974) and subsequent work. The increase in mortality that we observe following diversification is concentrated among younger patients, whose cases tend to be less complex. These are precisely the patients most likely to benefit from a facility where workers develop routines through the repeated performance of specific tasks—in this case, focused on kidney (but not liver) transplantation. The movement of kidney-transplant centers away from this narrow focus on a single type of operation was harmful to at least some of these patients. On the other hand, diversification appears to have been beneficial (or less harmful) to older patients, whose transplant operations had more complexity, particularly complexity that may have been difficult to anticipate. While we cannot directly test the mechanism that leads this increase in center-level complexity to impact task-level performance, these results are suggestive of a link with routines. We present here a possible explanation for them as an avenue for future research: that routines for managing coordination in a diversified center may also be useful for managing coordination of complexity in patient care. Prior work has shown that the routines that develop for maximizing the output of multiple units, tasks, etc., will necessarily be different than those designed to maximize performance for only a single task (Rawley, 2010; Natividad and Rawley, 2015). These new routines that develop to maximize the use of resources across multiple tasks will likely lead to performance declines in the original task, since employees are able to perform these routines more effectively when they have fewer routines to learn (Edmondson et al, 2001). Where transplant centers had developed routines for optimizing performance for kidney transplants, after diversifying they must develop new routines that accommodate liver transplants, and the attendant needs of a new set of patients, as well. When transplant centers diversify into liver transplants, they are adding a more complex, riskier surgery into their practice. Introducing a riskier surgery requires transplant centers to deal with: (a) increased coordination over shared resources, such as staff and equipment; (b) patients with more diverse diagnoses and needs (including simultaneous transplant patients); and (c) a new and more diverse set of known comorbidities among the patients they treat.

But not all tasks may be negatively affected by changes in the organization's routines. Staats and Gino (2012) find that while specialization improves productivity in the short run, intra-firm variety actually improves long-run productivity as workers became better at managing changeovers between activities—this skill may be especially valuable for managing rapid changeovers within a single activity, i.e., operating on a patient who is likely to experience complications. Straightforward cases will have limited ability to take advantage of these benefits, however, and will likely experience only the increase in coordination costs.

To be sure, the increased mortality that we find following diversification may not have been a universal phenomenon. Some facilities in our sample may have avoided problems associated with loss of focus after they diversified into liver transplantation. Indeed, Skinner (1974) introduced the idea of a "plant within a plant," where two or more focused facilities can coexist within a single unit. Such organization may have been feasible for the larger transplant facilities in our sample. For example, the Ronald Reagan Hospital at UCLA maintains kidney- and liver-transplant centers on separate floors, thereby allowing each center to pursue greater operational focus than would be possible if they operated jointly within a single, multifunction unit.

Finally, our focus on quality performance in the firm's original business, and our lack of financial data on the combined set of businesses, mean that we have only a partial picture of the benefits and costs of diversification. The simple fact that virtually all the entrants into liver transplantation in the United States had prior experience in kidney transplantation signifies economies of scope. Such economies justify diversification by at least some kidney-transplant organizations, given the (private and social) value of performing liver transplants. However, these scope economies do not mean that all kidney-transplant centers should diversify. Rather, as we have argued, understanding the costs of diversification for existing units is essential to making good diversification decisions from both private and public policy perspectives.

CONCLUSIONS

We find that when kidney-transplant centers diversify into liver transplants, quality performance in kidney transplants declines on average. Specifically, diversification has a negative effect on younger patients, whereas for older patients the negative effect is offset by gains from organizational responsiveness. We infer that relatively simpler surgeries may suffer a performance reduction from related diversification while more complex surgeries do not. Moreover, we find that this phenomenon cannot be attributed to a period of adjustment immediately following diversification—the effect becomes only more pronounced over time.

In service businesses such as health care, where one of the primary inputs is the customer, the interplay between complexity and predictability can strongly affect performance. The fact that quality performance varies in response to diversification highlights the need for research that examines not only the portfolio of the firm overall but also the nature of the work itself.

This returns to the tension between the benefits of focus, emphasized in the operations literature, and those of diversification, traditionally examined in the strategy literature. Focus is predicated on the idea that "simplicity, repetition, experience and homogeneity of tasks breed competence," i.e., a narrow scope of activities enhances performance (Skinner, 1974). The strategic diversification literature has emphasized firms' ability to enhance their competence by applying their skills to, and learning from, related businesses. Our study posits that both phenomena may hold, even within the same organization, depending on the complexity of the task. Our results imply that focus offers the greatest benefit when complexity is relatively low.

This finding has important policy implications within the health care industry. The idea of improving health care providers' organizational performance by narrowing their scope has become a subject of much debate in recent years. Related diversification is essentially the status quo in the hospital industry, where specialty hospitals are still relatively rare, and most hospitals provide most types of health services. Increasingly research has supported the idea that hospitals may improve health outcomes by specializing. Our study supports the gains from specialization on average; however, the fact that an identifiable patient population may benefit from diversification is an important qualification. Our findings indicate a substantial opportunity for saving lives by sorting patients into the appropriate facility; based on our estimates, sorting patients by age into diversified or focused facilities could save a life for every 167 surgeries performed. Organizing services around the *characteristics* of patients, such as age, is rarely done outside children's hospitals; our results suggest that substantial gains could be had by considering the characteristics of patients in decisions of organizational scope.

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REFERENCES

Aakhus, S., K. Dahl, and T. Widerøe. 1999. "Cardiovascular Morbidity and Risk Factors in Renal Transplants." *Nephrology, dialysis, transplantation: official publication of the European Dialysis and Transplant Association-European Renal Association.* 14 (3): 648-654.

"Annual Report." 2009. Annual Report. Richmond, VA: United Network for Organ Sharing. https://unos.org/wp-content/uploads/unos/AnnualReport2009.pdf.

Argote, Linda, and Eric Darr. 2000. "Repositories of Knowledge in Franchise Organizations: Individual, Structural and Technological." In *The Nature and Dynamics of Organizational Capabilities*, edited by Giovanni Dosi, Richard Nelson, and Sidney Winter. Oxford University Press.

Berry, William L., Jay E. Klompmaker, Cecil C. Bozarth, and Terence J. Hill. 1991. "Factory Focus: Segmenting Markets from an Operations Perspective." *Journal of Operations Management*, Special Issue on Linking Strategy Formulation in Marketing and Operations: Empirical Research, 10 (3): 363–87. https://doi.org/10.1016/0272-6963(91)90074-8.

Bresnahan, Timothy F., Shane Greenstein, and Rebecca M. Henderson. 2011. "Schumpeterian Competition and Diseconomies of Scope: Illustrations from the Histories of Microsoft and IBM." NBER Chapters. National Bureau of Economic Research, Inc. https://ideas.repec.org/h/nbr/nberch/12354.html.

Brown, John Seely, and Paul Duguid. 2001. "Knowledge and Organization: A Social-Practice Perspective." *Organization Science* 12 (2): 198–213. https://doi.org/10.1287/orsc.12.2.198.10116.

Chen, Mo, Aseem Kaul, and Brian Wu. 2019. "Adaptation across multiple landscapes: Relatedness, complexity, and the long run effects of coordination in diversified firms." *Strategic Management Journal* 40 (1): 1791-1821. https://doi.org/0.1002/smj.3060

Chandler, Alfred D. 1969. *Strategy and Structure: Chapters in the History of the American Industrial Enterprise*. Reprint edition. Cambridge, Mass: The MIT Press.

Christensen, H. Kurt, and Cynthia A. Montgomery. 1981. "Corporate Economic Performance: Diversification Strategy versus Market Structure." *Strategic Management Journal* 2 (4): 327–43. https://doi.org/10.1002/smj.4250020402.

Clark, Jonathan R., and Robert S. Huckman. 2011. "Broadening Focus: Spillovers, Complementarities, and Specialization in the Hospital Industry." *Management Science* 58 (4): 708–22. https://doi.org/10.1287/mnsc.1110.1448.

Cyert, Richard Michael, and James G. March. 1963. *A Behavioral Theory of the Firm*. Prentice-Hall International Series in Management. Prentice-Hall,.

Dierdonck, R. van, and G. Brandt. 1988. "The Focused Factory in Service Industry." *International Journal of Operations & Production Management* 8 (3): 31–38. https://doi.org/10.1108/eb054823.

Ethiraj, Sendil K., and Daniel Levinthal. 2009. "Hoping for A to Z While Rewarding Only A: Complex Organizations and Multiple Goals." *Organization Science* 20 (1): 4–21. https://doi.org/10.1287/orsc.1080.0358.

Faraj, Samer, and Yan Xiao. 2006. "Coordination in Fast-Response Organizations." *Management Science* 52 (8): 1155–69. https://doi.org/10.1287/mnsc.1060.0526.

Grundy, Scott M., Ivor J. Benjamin, Gregory L. Burke, Alan Chait, Robert H. Eckel, Barbara V. Howard, William Mitch, Sidney C. Smith, and James R. Sowers. 1999. "Diabetes and Cardiovascular Disease A Statement for Healthcare Professionals From the American Heart Association." *Circulation* 100 (10): 1134–46. https://doi.org/10.1161/01.CIR.100.10.1134.

Guralnik, Jack Michael, and National Center for Health Statistics (U.S.). 1989. *Aging in the Eighties: The Prevalence of Comorbidity and Its Association with Disability*. http://purl.fdlp.gov/GPO/gpo33200.

Hill, Charles W. L., Michael A. Hitt, and Robert E. Hoskisson. 1992. "Cooperative Versus Competitive Structures in Related and Unrelated Diversified Firms." *Organization Science* 3 (4): 501–21. https://doi.org/10.1287/orsc.3.4.501.

Hoffer Gittell, Jody. 2002. "Coordinating Mechanisms in Care Provider Groups: Relational Coordination as a Mediator and Input Uncertainty as a Moderator of Performance Effects." *Management Science* 48 (11): 1408–26. https://doi.org/10.1287/mnsc.48.11.1408.268.

Horrace, William C., and Ronald L. Oaxaca. 2006. "Results on the Bias and Inconsistency of Ordinary Least Squares for the Linear Probability Model." *Economics Letters* 90 (3): 321–27. https://doi.org/10.1016/j.econlet.2005.08.024.

Huckman, Robert S., and Darren E. Zinner. 2008. "Does Focus Improve Operational Performance? Lessons from the Management of Clinical Trials." *Strategic Management Journal* 29 (2): 173–93. https://doi.org/10.1002/smj.650.

Hyer, Nancy Lea, Urban Wemmerlöv, and John A. Morris. 2009. "Performance Analysis of a Focused Hospital Unit: The Case of an Integrated Trauma Center." *Journal of Operations Management* 27 (3): 203–19. https://doi.org/10.1016/j.jom.2008.08.003.

Jain, Prem C. 1985. "The Effect of Voluntary Sell-off Announcements on Shareholder Wealth." *The Journal of Finance* 40 (1): 209–24. https://doi.org/10.1111/j.1540-6261.1985.tb04945.x.

Jones, Gareth R., and Charles W. L. Hill. 1988. "Transaction Cost Analysis of Strategy-Structure Choice." *Strategic Management Journal* 9 (2): 159–72. https://doi.org/10.1002/smj.4250090206.

Kc, Diwas S., and Christian Terwiesch. 2009. "Impact of Workload on Service Time and Patient Safety: An Econometric Analysis of Hospital Operations." *Management Science* 55 (9): 1486–98. https://doi.org/10.1287/mnsc.1090.1037.

Kc, Diwas Singh, and Bradley R. Staats. 2012. "Accumulating a Portfolio of Experience: The Effect of Focal and Related Experience on Surgeon Performance." *Manufacturing & Service Operations Management* 14 (4): 618–33. https://doi.org/10.1287/msom.1120.0385.

Kim, Sunghye, Amber K Brooks, and Leanne Groban. 2014. "Preoperative Assessment of the Older Surgical Patient: Honing in on Geriatric Syndromes." *Clinical Interventions in Aging* 10 (December): 13–27. https://doi.org/10.2147/CIA.S75285.

Kristensen, T., N. Grunnet, M. Madsen, J. Solling, O. Fjeldborg, T. S. Olsen, and F. Kissmeyer-Nielsen. 1976. "Hyperacute Rejection of a Kidney Allograft May Be Caused by Cytotoxic

Lymphocytes.” *Acta Pathologica Et Microbiologica Scandinavica. Section C, Immunology* 84 (4): 304–12.
Lancaster, Tony. 2000. “The Incidental Parameter Problem since 1948.” *Journal of Econometrics* 95 (2): 391–413. https://doi.org/10.1016/S0304-4076(99)00044-5.
Lapré, Michael A., and Nikos Tsikriktsis. 2006. “Organizational Learning Curves for Customer Dissatisfaction: Heterogeneity across Airlines.” *Management Science* 52 (3): 352–66.
Lapré, Michael A., Amit Shankar Mukherjee, and Luk N. Van Wassenhove. 2000. “Behind the Learning Curve: Linking Learning Activities to Waste Reduction.” *Management Science* 46 (5): 597-743.
Levine, Susan. 2006. “Organ Transplant Centers Face Federal Scrutiny.” Transplant Connect. October 6, 2006. http://www.transplantconnect.com/news_detail.php?id=25.
Levinthal, Daniel A., and Brian Wu. 2010. “Opportunity Costs and Non-Scale Free Capabilities: Profit Maximization, Corporate Scope, and Profit Margins.” *Strategic Management Journal* 31 (7): 780–801. https://doi.org/10.1002/smj.845.
Luft, H S, J P Bunker, and A C Enthoven. 1979. “Should Operations Be Regionalized? The Empirical Relation between Surgical Volume and Mortality.” *The New England Journal of Medicine* 301 (25): 1364–69. https://doi.org/10.1056/NEJM197912203012503.
Makary, Martin A., Dorry L. Segev, Peter J. Pronovost, Dora Syin, Karen Bandeen-Roche, Purvi Patel, Ryan Takenaga, et al. 2010. “Frailty as a Predictor of Surgical Outcomes in Older Patients.” *Journal of the American College of Surgeons* 210 (6): 901–8. https://doi.org/10.1016/j.jamcollsurg.2010.01.028.
Markides, Constantinos C., and Peter J. Williamson. 1994. “Related Diversification, Core Competences and Corporate Performance.” *Strategic Management Journal* 15 (S2): 149–65. https://doi.org/10.1002/smj.4250151010.
Mazur, Mieszko, and Shage Zhang. 2015. “Diversification Discount over the Long Run: New Perspectives.” *Finance Research Letters* 15 (November): 93–98. https://doi.org/10.1016/j.frl.2015.08.008.
Meier-Kriesche, Herwig-Ulf, Friedrich K. Port, Akinlolu O. Ojo, Steven M. Rudich, Julie A. Hanson, Diane M. Cibrik, Alan B. Leichtman, and Bruce Kaplan. 2000. “Effect of Waiting Time on Renal Transplant Outcome.” *Kidney International* 58 (3): 1311–17. https://doi.org/10.1046/j.1523-1755.2000.00287.x.
Miles, James A., and James D. Rosenfeld. 1983. “The Effect of Voluntary Spin-off Announcements on Shareholder Wealth.” *The Journal of Finance* 38 (5): 1597–1606. https://doi.org/10.1111/j.1540-6261.1983.tb03843.x.
Nayyar, Praveen R. 1992. “On the Measurement of Corporate Diversification Strategy: Evidence from Large U.S. Service Firms.” *Strategic Management Journal* 13 (3): 219–35. https://doi.org/10.1002/smj.4250130305.
Neild, Guy H. 2009. “Primary Renal Disease in Young Adults with Renal Failure.” *Nephrology Dialysis Transplantation*, December, gfp653. https://doi.org/10.1093/ndt/gfp653.
Newman, Anne B., Robert M. Boudreau, Barbara L. Naydeck, Linda F. Fried, and Tamara B. Harris. 2008. “A Physiologic Index of Comorbidity: Relationship to Mortality and Disability.” *The Journals of Gerontology: Series A* 63 (6): 603–9. https://doi.org/10.1093/gerona/63.6.603.
Office of the Inspector General. 2003. “Variation in Organ Donation Among Transplant Centers.” Department of Health and Human Services. https://oig.hhs.gov/oei/reports/oei-01-02-00210.pdf.
Palepu, Krishna. 1985. “Diversification Strategy, Profit Performance and the Entropy Measure.” *Strategic Management Journal* 6 (3): 239–55.

Penrose, Edith, and Christos Pitelis. 2009. *The Theory of the Growth of the Firm*. 4 edition. Oxford ; New York: Oxford University Press.
Pinto, H., R. Leal, L. Rodrigues, L. Santos, C. Romaozinho, F. Macario, R. Alves, C. Bastos, A. Rosseiro, F. Costa, M. Campos, A. Mota, A. Figueiredo. 2017. "Surgical Complications in Early Post-transplant Kidney Recipients." *Transplantation Proceedings* 49 (4): 821-823.
Polanczyk, C. A., E. Marcantonio, L. Goldman, L. E. Rohde, J. Orav, C. M. Mangione, and T. H. Lee. 2001. "Impact of Age on Perioperative Complications and Length of Stay in Patients Undergoing Noncardiac Surgery." *Annals of Internal Medicine* 134 (8): 637–43. https://doi.org/10.7326/0003-4819-134-8-200104170-00008.
Rajan, Raghuram, Henri Servaes, and Luigi Zingales. 2000. "The Cost of Diversity: The Diversification Discount and Inefficient Investment." *The Journal of Finance* 55 (1): 35–80. https://doi.org/10.1111/0022-1082.00200.
Ramanarayanan, Subbu. 2008. "Does Practice Make Perfect: An Empirical Analysis of Learning-by-Doing in Cardiac Surgery." *SSRN ELibrary*, April. http://papers.ssrn.com/Sol3/papers.cfm?abstract_id=1129350.
Rawley, Evan. 2010. "Diversification, Coordination Costs, and Organizational Rigidity: Evidence from Microdata." *Strategic Management Journal* 31 (8): 873–91. https://doi.org/10.1002/smj.838.
Robins, James M., Miguel Ángel Hernán, and Babette Brumback. 2000. "Marginal Structural Models and Causal Inference in Epidemiology." *Epidemiology* 11 (5): 550–60.
Rumelt, Richard P. 1982. "Diversification Strategy and Profitability." *Strategic Management Journal* 3 (4): 359–69.
Schmenner, Roger W, and Morgan L Swink. 1998. "On Theory in Operations Management." *Journal of Operations Management* 17 (1): 97–113. https://doi.org/10.1016/S0272-6963(98)00028-X.
"Significance of the Positive Crossmatch Test in Kidney Transplantation | NEJM." n.d. New England Journal of Medicine. Accessed April 9, 2018. http://www.nejm.org/doi/10.1056/NEJM196904032801401.
Simon, Herbert A. 1962. "The Architecture of Complexity." *Proceedings of the American Philosophical Society* 106 (6): 467–82.
Skinner, Wickham. 1974. "The Focused Factory." *Harvard Business Review*.
Staats, Bradley R., and Francesca Gino. 2012. "Specialization and Variety in Repetitive Tasks: Evidence from a Japanese Bank." *Management Science* 58 (6): 1141–59. https://doi.org/10.1287/mnsc.1110.1482.
Teece, David J. 1980. "Economies of Scope and the Scope of the Enterprise." *Journal of Economic Behavior & Organization* 1 (3): 223–47. https://doi.org/10.1016/0167-2681(80)90002-5.
Wood, Robert E. 1986. "Task Complexity: Definition of the Construct." *Organizational Behavior and Human Decision Processes* 37 (1): 60–82. https://doi.org/10.1016/0749-5978(86)90044-0.
Wooldridge, Jeffrey M. 2007. "Inverse Probability Weighted Estimation for General Missing Data Problems." *Journal of Econometrics* 141 (2): 1281–1301. https://doi.org/10.1016/j.jeconom.2007.02.002.
Yang, Shitao, Curtis P. McLaughlin, Robert W. Vaughan, and John J. Aluise. 1992. "Factory Focus in Hospital-owned Ambulatory Surgery." *International Journal of Service Industry Management* 3 (4): 63–75. https://doi.org/10.1108/09564239210019496.
Zhou, Yue Maggie. 2011. "Synergy, Coordination Costs, and Diversification Choices." *Strategic Management Journal* 32 (6): 624–39. https://doi.org/10.1002/smj.889.

TABLES AND FIGURES

Table 1: Variables Used in Empirical Estimations

Phenomenon	Measure	Details
Firm learning	Log of the lagged cumulative kidney transplants performed by a center	Learning by doing is a critical determinant of performance (Luft, Bunker, Enthoven, 1979; Ramanarayanan, 2008). This control is included in addition to a firm fixed effect. so this control measures the effect of changes in volume, rather than the absolute effect of volume.
Supply volatility	Standard deviation in the quarter-to-quarter transplants in the year in which a given transplant takes place	Some hospital executives have noted that when the supply of transplantable organs is volatile, centers may accept transplants of lower quality. Volatility in the kidney supply may also allow diversified centers to make use of otherwise slack resources by providing liver transplants.
Competition	Herfindahl index for kidney transplants for centers within a given OPO	Competition in the organ-allocation market will affect a center's organ supply; competition has also been alleged to increase the need to accept lower-quality organs.
Clinical controls/ Patient riskiness	B-antigen mismatch level, DR-antigen mismatch level, known comorbidities, hypertension, BMI, time on the waitlist, peak panel-reactive antibodies, whether the kidney came from a live donor, and the time that the transplanted organ spent in cold storage (cold ischemic time)	To ensure a meaningful comparison across patients, it is necessary to include clinical controls for risk adjustment. We omit multiorgan transplants, which are higher-risk surgeries performed only by diversified centers (although all results are robust to their inclusion as a control).
Task complexity	Patient age (additional measures in Appendix G)	See text.

Table 2: Patient Descriptive Statistics

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Patient mortality	271,179	0.046	0.210	0	1
Diversified centers patient mortality	*169,908*	*0.045*	*0.206*	*0*	*1*
Focused centers patient mortality	*101,271*	*0.049*	*0.216*	*0*	*1*
White	271,179	0.620	0.485	0	1

Black	271,179	0.216	0.411	0	1
Asian	271,179	0.036	0.185	0	1
Hispanic	271,179	0.116	0.320	0	1
Age	271,179	43.713	15.092	0	90
Days on waiting list	271,179	425.118	538.546	0	7,915
B-antigen mismatch level	269,081	1.217	0.737	0	2
DR-antigen mismatch level	267,979	0.981	0.722	0	2
Number of previous kidney transplants	271,178	0.095	0.315	0	5
Live donors	271,179	0.320	0.466	0	1
Cold ischemic time	225,414	15.154	11.759	0	187
Hypertension	271,179	0.529	0.499	0	1
Comorbidity	271,179	0.030	0.172	0	1
Peak panel-reactive antibodies	196,934	13.040	24.953	0	100
Body Mass Index (BMI)	209,373	25.873	5.812	0	100

Table 3: Effect of Diversification on Mortality
Dependent variable: mortality within one year of transplant
p-values are in italics

	Baseline	**Age**	**Age and Comorbidity**	**Age and Hypertension**	**Age Cohorts**
Diversification (Indicator)	0.0068	0.0206	0.0199	0.0276	0.0143
	0.1211	*0.0034*	*0.0049*	*0.0021*	0.0085
Age	0.0018	0.0020	0.0020	0.0023	
	0.0000	*0.0000*	*0.0000*	*0.0000*	
Comorbidity	0.0171	0.0171	-0.0671	0.0177	0.0168
	0.0107	*0.0106*	*0.1067*	*0.0086*	0.0114
Hypertension	-0.0071	-0.0070	-0.0070	0.0139	-0.0060
	0.0005	*0.0005*	*0.0005*	*0.1237*	0.0025
Diversification * Age		-0.0003	-0.0003	-0.0005	
		0.0278	*0.0400*	*0.0090*	
Diversification * Comorbidity			0.0547		
			0.2644		
Comorbidity * Age			0.0016		
			0.0746		
Diversification Comorbidity * Age			-0.0010		
			0.3355		
Diversification * Hypertension				-0.0134	
				0.2171	
Hypertension * Age				-0.0005	
				0.0122	

Diversification Hypertension * Age				0.0004 *0.1040*	
Patient Age 25-40					0.0098 *0.0068*
Patient Age 40–55					0.0328 *0.0000*
Patient Age 55–65					0.0649 *0.0000*
Patient Age 65+					0.0991 *0.0000*
Diversified * Patient Age 25–40					-0.0046 *0.2807*
Diversified * Patient Age 40–55					-0.0088 *0.0657*
Diversified * Patient Age 55–65					-0.0112 *0.0825*
Diversified * Patient Age 65+					-0.0177 *0.0484*
Constant	-0.0825 *0.0004*	-0.0901 *0.0002*	-0.0890 *0.0002*	-0.1017 *0.0000*	-0.0437 *0.0573*
R^2	0.0301	0.0302	0.0303	0.0304	0.0310
N	102,679	102,679	102,679	102,679	102,679

Notes:
Patient characteristics included in the specification but not reported here: DR- and B-antigen mismatch, live donor, peak panel-reactive antibodies, days on waitlist, race, gender, BMI, cold ischemic time, multiorgan transplant, primary kidney diagnosis.
Firm characteristics included in the specification but not reported here: annual volume quartile, quarterly volatility.
Market (OPO) characteristics included in the specification but not reported here: kidney concentration, number of liver transplant centers in the previous period.
All specifications include year and center fixed effects. Standard errors are robust and clustered at the center level, and are reported in parentheses.
All specifications include inverse-probability weights to control for probability of selection.
Diversification is an indicator variable equal to 1 beginning on the date that the center performed its first liver transplant.

Table 4: Effect of Time Since Diversification on Mortality

Dependent variable: mortality within one year of transplant
p-values are in italics

	Baseline	**Age**	**Age and Comorbidity**	**Age and Hypertension**
Diversification (Indicator)	0.0063 *0.1476*	0.0060 *0.1687*	0.0061 *0.1620*	0.0061 *0.1637*
Years Since Diversification	0.0008 *0.1295*	0.0025 *0.0003*	0.0025 *0.0004*	0.0037 *0.0002*
Years Since Diversification * Age		0.0000 *0.0043*	0.0000 *0.0033*	-0.0001 *0.0003*
			0.0033	

Years Since Diversification * Comorbidity				
			0.4543	
Comorbidity * Age			0.0013	
			0.1113	
Years Since Diversification Comorbidity * Age			0.0000	
			0.7085	
Years Since Diversification * Hypertension				-0.0026
				0.0141
Hypertension * Age				-0.0005
				0.0038
Years Since Diversification * Hypertension * Age				0.0001
				0.0067
Age	0.0018	0.0020	0.0020	0.0022
	0.0000	*0.0000*	*0.0000*	*0.0000*
Comorbidity	0.0172	0.0173	-0.0539	0.0178
	0.0105	*0.0100*	*0.1341*	*0.0082*
Hypertension	-0.0070	-0.0068	-0.0068	0.0156
	0.0005	*0.0007*	*0.0007*	*0.0567*
Constant	-0.0808	-0.0870	-0.0867	-0.1002
	0.0006	*0.0003*	*0.0003*	*0.0000*
R^2	0.0301	0.0302	0.0303	0.0304
N	102,679	102,679	102,679	102,679

Patient characteristics included in the specification but not reported here: DR- and B-antigen mismatch, live donor, peak panel-reactive antibodies, days on waitlist, race, gender, BMI, cold ischemic time, multiorgan transplant, primary kidney diagnosis.
Firm characteristics included in the specification but not reported here: annual volume quartile, quarterly volatility.
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All specifications include year and center fixed effects. Standard errors are robust and clustered at the center level, and are reported in parentheses.
All specifications include inverse-probability weights to control for probability of selection.
Diversification is an indicator variable equal to 1 beginning on the date that the center performed its first liver transplant.