UNIT-LEVEL TURNOVER: THE PROCESS BY WHICH TURNOVER, HIRING, AND JOB DEMANDS AFFECT UNIT PERFORMANCE

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ABSTRACT

We present a dynamic approach to understanding how and why unit-level turnover impacts unit performance over time. To this purpose, we introduce unit-level hiring and expand the current unit-level turnover construct to include employee transfers. In doing so, we explore unit-level turnover effects on job demands and ultimately unit performance. We explore this system of interrelated constructs (turnover, hiring, job demands, and performance) in a dynamic manner allowing for reciprocal prediction while hypothesizing about the mutual impact of these variables over time. Our sample covers 12 nursing units in a major hospital over 72 monthly observations.

Keywords: Turnover; Hiring; Human capital resource; Patient Satisfaction; Panel Vector Autoregression; Transfers; Job demands; Unit performance
The human capital resource can be the most important unit asset (e.g., Pfeffer, 1994), and a source of sustained competitive advantage (Shaw, Gupta, & Delery, 2005; Wright, Dunford, & Snell, 2001; Wright & McMahan, 1992). Yet knowledge of the processes regarding how changes in that resource affect unit performance is underdeveloped (Ployhart & Moliterno, 2011). Turnover is the primary causal process affecting human capital resource degradation (Gardner, Wright, & Moynihan, 2011), and is integral to understanding the relationship between the human capital resource and sustained competitive advantage (Coff, 1997; Delery & Shaw, 2001). However, this complex system of influences is not well understood and requires greater theoretical and empirical exploration to build our understanding of how and why turnover is associated with unit performance. In the current manuscript, we develop and test such a theory describing how unit-level turnover, often measured as turnover rates (e.g., Hausknecht & Trevor, 2011; Shaw, 2011), relates to unit outcomes. We identify it as a key element in a dynamic system in which turnover is influenced by and influences other system elements.

Research has begun to explore the performance ramifications of unit-level turnover (e.g., Batt, 2002; Glebbeek & Bax, 2004; McElroy, Morrow, & Rude, 2001; Shaw, Duffy, Johnson, & Lockhart, 2005), generally finding a negative or an inverted U relationship with performance (Hancock, Allen, Bosco, McDaniel, & Pierce, in press). However, ten years after Dess and Shaw (2001) asserted that a theory of unit-level turnover is needed, research in this domain has still not fully integrated the causal mechanisms that influence unit-level turnover’s impact on unit performance (Hausknecht, Trevor, & Howard, 2009). Hausknecht and Trevor (2011) forcibly make this point when they conclude that the existing literature lacks “…a rigorous analysis of

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1 We use the term unit to signify aggregates of individual employees (e.g., groups, departments, business units, organizations, etc.).
its major antecedents and consequences, as well as its key emergent themes and implications” (p. 353). Shaw (2011) further highlights this, “Perhaps the most rapidly growing and arguably the most important area of knowledge development concerns the relationship between turnover rates and dimensions of organizational performance.” (p. 188). The current manuscript builds on recent efforts to understand the direct effects of unit-level turnover on unit-level performance (e.g., Hancock et al., in press; Shaw, Delery, Jenkins, & Gupta, 1998; Shaw et al., 2005; Shaw, Dineen, Fang & Vellella, 2009). It aims to advance understanding of the role that employees play in the relation. In order to explore the processes through which turnover (including the rarely considered role of transfers) and hiring (employee arrivals including transfers) lead to unit performance, we employ a dynamic modeling approach in which unit-level turnover play a key part that affects the human capital resource and ultimately unit performance over time.

We attempt to make five key contributions. First, we posit theory describing how unit-level turnover affects unit performance. We posit that a key turnover effect is its influence on changes in average job demands and its relationship with future hiring.

The human capital resource is socially complex, path dependent, and contributes to unit performance through causally ambiguous processes. These features have been highlighted as the cornerstones of sustained competitive advantage (Barney, 1991; Peteraf, 1993; Rumelt, 1987). At the same time, these desirable features pose a number of challenging dilemmas to human resource managers (Coff, 1997). Along this line, a second contribution is that our work may also integrate the Human Resource Management and Strategy literatures more closely.

A third contribution is the assertion that unit-level turnover studies should also consider hiring and transfers. Unit-level turnover effects are closely related to replacement efforts and we assert that turnover and hiring are likely to operate uniquely and interdependently over time. A
transfer is defined by an employee who leaves a position to take a similar level position in a different unit within the same organization (Dineen, Ling, & Soltis, 2011). Transfers are a common human resource practice, but are rarely studied (Barber, 1998; Dineen et al., 2011). We include them because they have similar effects as traditional turnover or hiring (Dalton, 1997; Dineen et al., 2011) to the unit losing or gaining the employee.

A fourth innovation is the dynamic systems approach and its focus on mechanisms through which the human capital resource affects unit performance. We model these mechanisms in two distinct ways. First, we describe changes in the human capital resource through turnover and hiring, as affecting average job demands and ultimately unit performance. Second, we recognize the non-recursive nature of the constructs in the system over time. We reason that job demands and performance, for example, may also impact future unit-level turnover and hiring.

A final contribution is our focus on differences across time in the system. We reason that unit-level turnover and hiring may have different effects on unit performance at different times. If turnover results on performance are studied prior to rehiring (or prior to the point where new employees are fully functioning), results may exaggerate the turnover impact and miss key elements of the process. We develop distinct explanations about the short-and long-term effects of these influences to the human capital resource on both job demands and unit performance.

We first provide a brief summary of existing unit-level turnover research, noting that extending research to the unit-level is a recent development. Our summary is focused and brief because this research has been recently and thoroughly reviewed (i.e., Hancock et al., in press; Hausknecht & Trevor, 2011; Shaw, 2011). Next, we introduce and explain the processes that compose the unit-level turnover model. We then test the model through examining twelve nursing groups over a six year period, resulting in 826 useable group level observations.
THEORETICAL RATIONALE AND HYPOTHESES DEVELOPMENT

Turnover History

The recent increase in unit-level turnover research (e.g., McElroy et al., 2001; Shaw et al., 1998; Shaw et al., 2005; Shaw et al., 2005) has led to examining the relationships between unit-level turnover and sales growth (e.g., Batt, 2002), net performance (e.g., Glebbeek & Bax, 2004), efficiency (e.g., Kacmar, Andrews, Van Rooy, Steilberg, & Cerrone, 2006), productivity (e.g., Shaw et al., 2005), and various moderators of the turnover-unit performance relationship, such as percentage of hires (e.g., Hausknecht et al., 2009), and labor segment (e.g., Siebert & Zubanov, 2009). A few studies have also examined antecedents to unit-level turnover such as co-worker demographics (e.g., Sacco & Schmitt, 2005); co-worker embeddedness (e.g., Felps, Mitchell, Hekman, Lee, Holtom & Harman, 2009); organizational citizenship behaviors (e.g., Podsakoff, Blume, Whiting, & Podsakoff, 2009), and downsizing (Trevor & Nyberg, 2008).

However, despite research describing the importance of retaining valuable employees (e.g., Sturman, Trevor, Boudreau, & Gerhart, 2003), the direct and indirect costs of turnover (Cascio, 2000), the potential “snowball effects” or “turnover contagion” where one departure leads to additional departures (Felps et al., 2009; Krackhardt & Porter, 1986), the negative ramifications to social capital (Leana & Van Buren, 1999), and the loss of institutional and operational knowledge that can occur along with the potential damage to the unit’s social network (Dess & Shaw, 2001), turnover researchers have not yet put forth an integrated model regarding the unit-level turnover – unit performance relationship (Hausknecht & Trevor, 2011; Shaw, 2011) that incorporates the essential roles of hiring, job demands, and time.

Challenges to Theorizing about Unit-level Turnover

One difficulty with developing a unit-level turnover model is that it involves complex,
interactive activities that occur within a dynamic system, meaning that the environment being studied is fluid - the constructs and the relationships among them are continually evolving. Thus, attempts at describing or measuring these relationships in any static period may capture the relationships at that moment, but may miss the true essence of how and why the relationships exist (Steel, 2002). Understanding the interrelatedness among variables in a persistently changing set of relationships is particularly challenging because time, potential non-recursiveness (the likelihood of feedback loops where variables are the cause and effect of each other over time), and multiple interactions continually alter the relationships (Sims, 1980). Consequently, we know relatively little about the influences that affect the change in the human capital resource and the resulting outcomes of such system dynamics.

**Human Capital as a Resource**

It is common to hear human resources practitioners talk about people as their company's most important asset. The human capital resource influences unit performance and competitive advantage because it is one of the key enablers of business processes and among the most difficult resources for competitors to replicate (Collins & Clark, 2003; Collins & Smith, 2006; Hatch & Dyer, 2004; Wright & McMahan, 1992; Wright, McMahan & McWilliams, 1994; Wright et al., 2001). Employee turnover is one mechanism that can erode the human capital resource (Coff, 1997). If the resource is eroded to the point where the resource is inadequate, it can lead to declining unit performance. If turnover does not erode the human capital resource to a meaningful degree, such as in the case of a unit which only loses disruptive workers, then it is less likely that turnover will negatively impact unit performance.

The erosion of the human capital resource due to turnover may also be offset. Evaluating employee flow into as well as out of a unit (i.e., micro-mechanisms) is necessary to
understanding the total human capital resource system (Felin & Hesterly, 2007; Abell, Felin, & Foss, 2008). Since the effects of flows will depend on the extent to which the unit’s human capital stock changes (quantitatively and qualitatively), the effects on unit performance are likely to be smaller in situations where the human capital resource is replenished. Anticipating our empirical setup, we posit that using nursing units of a large hospital system is particularly appropriate for examining these issues because there is a sufficient and regular flow of employees both into and out of each unit such that the dynamism in the system can be more readily detected over time, and the role of the employees in determining performance is clearer.

**Job Demands**

The job demands construct provides one mechanism to observe how unit-level turnover and hiring are interrelated. Job demands captures the degree to which employees have workloads relative to the amount of time necessary to accomplish the work (Ganster & Fusilier, 1989). Job demands is similar to productivity measures (e.g., Shaw, 2005), but represents the amount of work required of an employee whereas productivity represents output. Capacity is also similar. Capacity is “the proportion of human and social capital utilization achieved by a given collective in a given period” (Hausknecht & Holwerda, forthcoming: p. 19). This construct is related to job demands because it represents a potential level of productivity. However, like productivity, capacity does not specifically address the average work requirements for each employee.

We introduce job demands into the unit-level turnover – unit performance relationship because it shows why changes to the human capital resource can influence unit performance. In general, it is anticipated that the mechanisms influencing turnover’s impact on performance may be the job demands placed on employees. When fewer employees are asked to perform the same amount of work that had been done by more employees, average job demands increase, leading
to a likely decline in quality and/or an increase in employee stress. The nursing setting is especially useful for looking at the role of job demands because within the units nurses are doing very similar jobs. The job homogeneity enables us to view the departure or hiring of a nurse as having a similar effect on job demands across units and across time.

**Unit-level Turnover and Performance**

*Unit-level turnover.* The consequences of unit-level turnover may be more complex than the simple loss of manpower. For example, Shaw et al. (2005) found that social capital losses explained unit performance declines beyond what would be expected purely from turnover rates, and that these were more pronounced when turnover rates were low, due in part to disruptions to communication. In these situations, members may lose ability or motivation to share information or effectively challenge each others’ ideas, potentially leading to decreased performance.

Turnover also impacts the ability of units and teams to coordinate. As members leave the unit, the unit has to learn to develop new working relationships (George & Bettenhausen, 1990). As members within units spend more time together, the common experiences that they share help to establish a shared language and trust (Eisenhardt & Schoonhoven, 1990; Jones, Hesterly, & Borgatti, 1997). These shared experiences lead to increased cooperation (Collins & Smith, 2006; Leanna & Van Buren, 1999), which often lead to increased unit performance (Cohen & Levinthal, 1990; Taylor & Greve, 2006). The extent to which teams can beneficially use transactive memory systems has also been shown to be affected by turnover in teams (Lewis, Belliveau, Herndon & Keller, 2007; Prichard & Ashleigh, 2007; Ren, Carley, & Argote, 2006; Zhang, Hempel, Han, & Tjosvold, 2007) such that teams experiencing turnover attempt to rely on incomplete memory systems and performance suffers.

In addition to impacting communication and coordination, unit-level turnover can also
affect the unit’s ability to function due to changing capabilities. As the human capital resource is diminished, unit functionality can be lost or severely reduced, particularly if the diminished aspect is scarce and unique (i.e., strategically valuable). For instance, a loss of functional expertise can create a skills gap (e.g., an academic department that loses many or even all of its strategy teachers), reducing the ability to deliver service.

Some turnover may be beneficial by keeping units from becoming too static, bringing in new ideas, removing low performers, etc. (Abelson & Baysinger, 1984; Dalton & Todor, 1979; Dalton, Todor, & Krackhardt, 1982; March, 1991). Several researchers (e.g., Argote & Kane, 2003; Ziller, Behringer, & Goodchilds, 1962) have found that change related to turnover has beneficial effects on the creativity of group outcomes. In contrast, units with low turnover rates can have too much shared experience, which is linked to stagnation and ineffective communication (Katz, 1982; Kim, 1997).

Supporting the assertions that some turnover may be positive for innovation, there may be an inverted U relationship between turnover and performance (e.g., Glebbeek & Bax, 2004; Hancock et al., in press; Hausknecht & Trevor, 2009). Similarly, Shaw et al. (2005) found an attenuated negative curvilinear effect. While prior research has found limited circumstances in which low turnover rates may have a positive effect, the overriding impact of unit-level turnover is expected to be negative. Further, this should be more prevalent when employee interrelatedness in terms of communication and coordination are critical and when repeated and trustful interaction is integral to the performance of the unit (Collins & Smith, 2006; Hausknecht et al., 2009). In these cases, the disruption of the network is likely to hinder group efficiency and thus the potential benefits (e.g., new ideas, increased energy). This will be accentuated in contexts where customer satisfaction, which can be influenced by employee cohesion, is critical.
to the group’s mission. Our sample of nurses who work in teams to care for patients is just such a context. This theorizing is consistent with the negative relationship found between nursing turnover and hospital efficiency (Alexander, Bloom, & Nuchols, 1994).

The existing unit-level turnover research has found that turnover is associated with reduced efficiency (e.g., Shaw et al., 2005), longer customer wait times (e.g., Kacmar et al., 2006), higher accident rates (e.g., Shaw et al., 2005), lower sales (e.g., McElroy et al., 2001), and reduced profits (e.g., Morrow & McElroy, 2007). In line with these findings and in accord with our rationale that turnover will reduce the human capital resource, disrupt social capital (Dess & Shaw, 2001; Shaw et al., 2005), damage communication, unit knowledge, knowledge flow, coordination, teamwork, and increase costs associated with turnover (Cascio, 2000), we expect that unit-level turnover will be negatively related to unit performance.

**Unit-level turnover and unit performance over time.** It is unclear how turnover effects on performance evolve over time because the relationship between unit-level turnover and performance has been primarily tested using single snapshots in time (Hausknecht & Trevor, 2011). By considering temporal effects, we can expand our theoretical knowledge regarding why and how relationships exist (George & Jones, 2000; Roe, 2008). Although a few studies have examined turnover rates longitudinally (e.g., Kammeyer Mueller, Wanberg, Glomb, & Ahlburg, 2005), time remains largely unexplored in unit-level turnover research (Hausknecht and Trevor, 2011; Shaw, 2011), and to date, researchers have not explored the duration of the effects.

We predict that unit-level turnover will negatively impact unit performance both in the short- and long-term, but propose that the drivers of that relationship will differ over time. In the short-term, the shock to the system associated with a turnover event and the changes in job demands for the remaining employees will severely impact the functioning and the performance
of the unit. As the shock effect wears off over time and employees begin to adjust, there is a slight possibility that employees could become accustomed to changed job demands by creating new processes that could lead to greater efficiencies and improved unit performance. More likely, however, the unit will not be able to improve efficiency or create new processes and routines that are fully sufficient to account for the increased job demands, and either total unit output or quality will be permanently diminished. In such situations, the duration of the negative effects of unit-level turnover will depend on how long it takes to replace employees and how well employees are replaced (e.g., competence levels, social capital roles, etc.).

_Hypothesis 1. Unit-level turnover is negatively associated with unit performance over time._

**Hiring and Performance**

_Hiring_. In line with recognizing the importance of modeling the dynamic system, we assert that considering replacement employees is an integral aspect to understanding the relationship between unit-level turnover and unit performance. While unit-level turnover can deplete the human capital resource, hiring is one means for accreting the human capital resource.² Hiring increases the human capital resource through increasing quantity, i.e., the number of employees in the unit (although, the change in the average human capital will depend on the relative quality of the new employees versus those who are already in the unit – an important issue beyond the scope of this study).

In addition to reducing average employee job demands, hiring can bring new ideas, new energy, and new competencies. These additions can further benefit the unit by setting positive examples (e.g., increased enthusiasm) and increasing efficiency (e.g., new ideas that streamline work practices). In combination, these suggest that hiring will benefit unit performance.

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²Alternative paths exist to human capital resource accretion (e.g., training), but our focus is on hiring.
**Hiring and unit-level performance over time.** Differences may also exist between the short- and long-term effects of hiring. In the short-term, new hires require time to acclimate to the unit. They also are likely to require training (e.g., on specific job-related procedures), and may be disruptive to the existing social network. While new members can eventually be beneficial to the group, their transition into the social fabric of the existing group may be uncomfortable and distracting. This disruption to operations can lead to inefficiencies and poorer communication and coordination. New hires can also harm performance by diverting current employee attention due to additional necessary support activities (e.g., training). Coordination difficulties associated with new hires also affect teamwork. As new members join, the unit has to learn to develop new working protocols and relationships, which take time to smooth out (George & Bettenhausen, 1990). In the short term, the negative effects associated with new employee integration are expected to overwhelm the positive effects of hiring.

In the long-term, the short-term difficulties outlined above are expected to diminish and the positive benefits of reduced job demands should positively impact performance. It is possible that some employees could become accustomed to reduced average job demands leading to lower effort such that unit output could stay steady even with increasing employee costs, and some new employees may never acclimate to the unit, leading to personality conflicts and social deterioration. However, overall, we expect most new hires to eventually acclimate to the system and social network, resulting in a long-term positive effect of hiring on unit performance.

*Hypothesis 2a. Hiring is negatively associated with unit performance in the short-term*

*Hypothesis 2b. Hiring is positively associated with unit performance in the long-term.*

**Job Demands**

To gain a more complete picture of how unit-level turnover and hiring are intertwined, it
is useful to consider their relationship with job demands. The relationship between unit-level turnover and job demands is such that, in general, turnover (holding hiring constant) will lead to greater average job demands for the remaining employees. For instance, in the nursing context, if six nurses are accustomed to caring for a total of twenty-four patients per shift (four each), then unit-level turnover involving three employees will mean that the remaining three nurses will see their job demands increase (to a total of eight patients each). This increase in work is likely to be more pronounced than the simple linear combination of the changed workflow due to the potential changes in group dynamics, reduction in slack resources, group knowledge, etc.

In contrast, hiring, which increases employees, should either increase the quantity of unit output or reduce the average job demands of each employee. That is, if each remaining employee continues at the same productivity level, adding employees should increase total output. If total unit output remains constant, however, then average employee output must be reduced, and each employee produces less. One reason for increased unit performance due to reduced job demands is that with reduced job demands employees have the opportunity to engage in a greater range and depth of activities with the increased time available (Penrose, 1959; Barnard, 1938; Katz, 1964). Returning to the nursing example, if the six nurses are once again accustomed to handling a total of twenty-four patients (four each), hiring involving two nurses will either make it possible for the hospital to add an additional eight patient beds (if the quality of the new nurses is equivalent to those already there) or reduce the responsibilities of each nurse to only three patients, which could increase their ability to provide assistance and support for their fellow colleagues (Organ, Podsakoff, & MacKenzie, 2006) and pay greater attention to patient needs.

Hypothesis 3. Unit-level turnover is positively associated with average job demands.

Hypothesis 4. Unit-level hiring is negatively associated with average job demands.
While unit-level turnover and hiring affect job demands, there are unit-level performance consequences of those job demand changes. Changes in job demands have physiological as well as attitudinal effects (Fox, Dwyer, & Ganster, 1993), including an increased likelihood of employee burnout (Cordes & Dougherty, 1993) which is especially likely in the context of emotional labor (Glomb, Kammeyer-Mueller, & Rotundo, 2004; Rafaeli & Sutton, 1987). Hence, if unit-level turnover increases job demands for the remaining employees, those employees are more susceptible to burnout or dissatisfaction with the job. These attitudinal changes may further be associated with reduced performance and increased turnover intentions (Chen, Ployhart, Thomas, Anderson, & Bliese, 2011). Employees also begin to lessen their interaction with and psychological attachment to fellow team members (Maslach, 1976). For example, employees may have less time to perform extra-role or citizenship activities (Podsakoff et al., 2009), which negatively influences their interactions with co-workers and customers (Jackson & Schuler, 1983). This decrease in employee relationships is stronger the less autonomous the job (Van Yperen & Hagedoorn, 2003), and the degradation of unit cohesiveness can be particularly problematic for units where teamwork is useful for maximizing unit performance. To the contrary, reducing job demands (via hiring) can have the opposite effect (Krackhardt, McKenna, Porter, & Steers, 1981).

As the reliance on fellow unit members increases, the importance of communication and the ability to function cohesively increases (Gully, Devine, & Whitney, 1995). As team members lose time and thus cannot provide as much assistance to each other, the trust and confidence in each other can erode, leading to increased stress levels that can further damage team member relationships (Fox et al., 1993). Overall, as average job demands within the unit increase, employees cannot provide as much support, help, back-up assistance, or training for each other,
and the performance of the entire unit will suffer.

The importance of job demands on performance is likely to be particularly strong in service settings, where employee interactions with customers have a strong influence on customer satisfaction (such as nursing interactions with patients). In these situations, reducing the average job demands per employee should increase the opportunity for employee–customer interaction, resulting in increased customer satisfaction.

*Hypothesis 5. Average job demands are negatively associated with unit-level performance over time.*

**Antecedents to Hiring**

The preceding discussion leads to modeling turnover, hiring, job demands and unit performance as a system where each influences the others over time. Within this system, it is possible and useful to examine system effects on hiring. In many organizations, budgeting rules and history dictate resource allocation including the decision to hire. Thus, when human resource depletion occurs, units are more likely to hire. For instance, in academic departments (budgets permitting), a common antecedent to a new hire is a departure. When a faculty member leaves, departments often desire to quickly rehire for fear of losing the institutional resource allocation if they fail to act, regardless of whether job demands necessitate a new hire.

Additionally, given that unit level turnover leads to greater job demands, employee attitudes associated with increased job demands should spur future hiring. Increasing job demands will lead to more discouraged employees as they are expected to do more with less. This changing dynamic will contribute to institutional pressure toward future hiring.

*Hypothesis 6a. Unit-level turnover is positively associated with hiring.*

*Hypothesis 6b. Average job demands are positively associated with hiring.*
Antecedents to Unit-level Turnover

Average job demands affect unit-level turnover. Finally, we identify two potential antecedents to unit-level turnover. First, in addition to negatively influencing unit performance, job demands also influence future unit-level turnover. This occurs both directly and indirectly. As stated, increased job demands can increase job dissatisfaction and the likelihood of burnout (Cordes & Dougherty, 1993; Krackhardt et al., 1981). Both attitude changes are associated with increased turnover intentions (Chen et al., 2011). Job demands also impact future turnover through changes in unit performance. As increased job demands lead to lower unit performance (e.g., lower customer satisfaction), the lower customer attitudes can lead to increased pressure on employees, a less desirable working environment, and greater stress, which can all affect changes in employee attitudes, including reduced job satisfaction (Ryan, Schmit, & Johnson, 1996). Since reduced job satisfaction is associated with increased turnover at the individual level (Lee, Gerhart, Weller, & Trevor, 2008; Mobley, Griffeth, Hand, & Meglino, 1979; Price, 1977), this suggests that increased job demands should also lead to increased unit-level turnover.

Hypothesis 7. Average job demands are positively associated with unit-level turnover.

Unit-level turnover affects future turnover. There are also at least three reasons to expect that unit-level turnover will lead to additional future unit-level turnover. First, snowball (Krackhardt and Porter 1986) and contagion effects (Felps et al., 2009) suggest that turnover should make it more likely for others to leave. Second, in recent years there has been a shift in employee loyalty from the unit to that of their colleagues (Capelli, 2000), which further leads to the likelihood that turnover will beget turnover. A similar explanation is that turnover affects the job embeddedness of remaining employees, such that turnover may lead to additional turnover as the departure of network ties leads others to value their place in the unit less, further increasing
the likelihood of leaving (Lee, Mitchell, Sablynski, Burton, & Holtom, 2004). Finally, turnover events provide critical and negative information to incumbents, and create “shocks” that make it more likely that the remaining employees will reevaluate their roles in the units, and then also decide to leave (Lee & Mitchell, 1994).

_Hypothesis 8. Unit-level turnover is positively associated with future unit-level turnover._

**DATA AND METHODS**

**Research Setting**

To more closely examine causal mechanisms we focus on unit-level turnover in moderate sized units (i.e., between 52 and 203 nurses). Examining effects in these conditions provides insights into the relationship between unit-level turnover and performance by allowing a more visible line-of-sight between the actors and the unit’s performance than in larger units. Additionally, exploring a homogeneous set of job types (i.e., every employee is a nurse), in a single organization allows us to garner a clearer understanding of the implications resulting from human capital resource changes. We also avoid concerns that arise in heterogeneous samples (i.e., differing policies, practices, and culture influence outcomes). When samples include units in different industries, effects can also be clouded due to external institutional pressures.

Data were collected from a major University hospital system in the Midwestern United States. Data were collected from twelve nursing units, which provide a broad range of services, from general medicine to pediatric oncology. Monthly data were collected for each unit over a period of six years (from 2003 to 2008). On average, each unit employed 91 nurses (average within-unit SD = 7.90). Measures were collected by the hospital as part of their normal human resources reporting systems. We transformed the hospital’s individual-level data into a panel format, and then constructed monthly aggregate unit variables.
Measures

Unlike many studies, the variables in our study are not strictly classified as either dependent or independent. In the analysis, each variable is allowed to impact future values of every other variable. However, as described below, the model does impose some ordering, in that variables affect each other instantaneously (i.e., in the same time period) only selectively.

Unit performance. Unit performance was measured by identifying patient satisfaction through a questionnaire administered to patients at the end of their hospital stay. The specific items were taken from a broader patient satisfaction survey (Hospital Consumer Assessment of Healthcare Providers and Systems; HCAHPS) that serves as a national standard for measuring consumer impressions of hospital care. The survey is widely used by hospitals; for instance, it was used by 3,774 hospitals in July 2010 (Centers for Medicare & Medicaid Services, 2011).

Consistent with the host organization’s use of the instrument for assessing nursing performance, we limited our analysis to the six (of 27) items that focused on nursing services. Patients reported on aspects of nursing care such as nurses’ attitudes and attentiveness. Scores on this measure were aggregated to the unit-level by a simple average on a monthly basis to arrive at a single patient satisfaction score for each unit-month. While scores theoretically ranged from 0 to 100, the observed range was considerably smaller (64.5 to 98.5).

The six items for inpatient nursing evaluations include: friendliness/courtesy; promptness of response to call button; attitude toward requests; attention to special/personal needs; kept you informed; nurse skill. The reliability of means (Cronbach’s Alpha) aggregated across patients is .94. This precise survey and these six questions are a primary component of the nursing evaluation within the hospital and a marker for unit performance. As described by senior hospital executives, the survey is considered heavily in dealing with employees as well as when
considering overall unit performance and strategic decisions. Moreover, the items show strong content validity. For example, the item “promptness of response to call button” is likely to be theoretically related to job demands (i.e., the amount of time available for each nurse).

**Unit-level turnover.** Unit-level turnover was calculated as the total monthly number of workers who left the unit, including voluntary and involuntary departures and workers who transferred to another unit. Voluntary and involuntary turnover are unique constructs (McElroy et al., 2001). In individual level turnover research, voluntary turnover is often considered more important than involuntary turnover (e.g., Maltarich, Nyberg, & Reilly, 2010; Trevor, Gerhart, & Boudreau, 1997; Williams & Livingstone, 1994) because units have less control over voluntary than involuntary turnover (Dalton et al., 1982). Thus, most individual level research focuses on exploring the predictors of voluntary turnover (Holtom, Mitchell, Lee, & Eberly, 2008). In this study, however, we combine voluntary and involuntary turnover. Unit-level turnover as theorized and measured in this study is relevant to the extent that it changes the human capital resource to affect unit performance. Despite being different constructs, the effects on performance are often very similar (Batt & Colvin, in-press). As such, because we consider the overall effects of employee flow on job demands our theory is concerned with the combined effects on turnover.³

³ We recognize that voluntary turnover and involuntary turnover are different constructs, and that the correlation between the two will likely be modest. Further, each type may have unique influences on some outcomes. For example, voluntary turnover may lead others to reconsider their role in the unit. In contrast, involuntary turnover may result in reduced voluntary turnover among higher performing employees (e.g., General Electric’s use of actively removing lower performing employees; Nyberg, 2010). However, because our intention is to understand the full effects of unit-level turnover, we believe that considering all turnover is most consistent with our theory. In practical terms, when there are few involuntary turnover events it is acceptable to include all turnover events into one measure (e.g., Shaw, Gupta, & Delery, 2005); in our case involuntary turnover represented less than 8% of all leavers, and Batt and Colvin (in press) recently found that there was minimal difference between the effects of voluntary and involuntary turnover on unit performance. Additionally, robustness checks showed that results with and without involuntary turnover were substantively unchanged.
for stable size difference across units, and because unit size was relatively stable over time.

Another area where our measure extends the conceptualization of unit-level turnover is our handling of employees who transfer out of a unit. Traditional turnover research focuses on employees who are severed from the organization, but has not considered employees who have stayed in the organization, but left the unit. It may be that leaving the unit regardless of where one goes (e.g., another part of the organization or to a different organization entirely) similarly impacts the employees left behind. Employees may transfer for a variety of reasons ranging from wanting to get away from the current unit (e.g., discomfort with co-workers, supervisors, etc.), to wanting to be with a different unit (e.g., more desirable hours, different type of work, etc.).

When employees transfer out, they create a situation similar to voluntary turnover. First, they leave the unit with a smaller staff. Second, they take with them the knowledge, skills, and abilities that had been part of the unit’s total human capital resource. Third, they alter the social landscape including changing how teams function as they have to figure out ways to make up for the change in team members and this can affect unit cohesiveness. Fourth, the transfer out of employees can also disrupt the social network, making communication and knowledge transfer more challenging. Consequently, we believe that it is appropriate to capture this group of departures that may also affect unit attitudes and performance. Conversations with senior nursing and hospital HR professionals supported this contention by revealing that transfers out were exclusively voluntary and from the hospital administrator’s perspective, impacted units the same as other voluntary turnover events (with the exception that there is no severance pay or increases to unemployment compensation). Thus in our unit-level turnover measure, in addition to capturing those who voluntarily (0.62% per month in the sample) and involuntarily (0.12% per month) left the entire organization, we also included employees that transferred out of the unit to
join a different unit within the same hospital system (0.91% per month).

**Hiring.** Hiring was calculated by using the total number of employees who were added to the unit’s employment in a given month (i.e., new hires or transfers in). One mechanism for increasing the critical mass of the human capital resource is to bring in new employees from outside of the organization. Additionally, similar to unit-level turnover, transfers in represent a group of new employees to the unit who are likely to change unit dynamics in many similar ways as other new hires. Transfers in can have the benefits associated with new hires (e.g., reduced average job demands). Like other new hires, they can also disrupt the social network, (although, some ties may already exist due to cross-unit relationships). Additionally, transfers in should take somewhat less time than hires new to the organization to acclimate (because of having some shared norms and greater familiarity with the systems and practices common throughout the organization). Just as in unit-level turnover, we are concerned about the total aggregate effects of hiring on the human capital resource. Hence, we combine transfers and external hires to create one hiring construct and use the total number of new employees.

**Job demands.** The job demands variable was generated from two measures of patient load as tracked by the hospital: patient-days and observation hours. Patient-days are the number of patients treated by a unit multiplied by the number of days that they were patients. Observation hours capture patients that were transitory in a unit, and did not spend an entire 24-hour period under its care. To calculate job demands, we divided monthly observation hours by 24, added the patient days, and divided the result by the number of employees at the beginning of the month.

**ANALYSIS**

Panel vector autoregressive (PVAR) model overview.
We tested our hypotheses using a reduced form version of the panel data vector autoregression (PVAR) model (Holz-Eakin, Newey, & Rosen, 1988). The primary feature of a PVAR model is that it estimates a system of equations in which current values of all variables are predicted by past values of all variables. It treats a set of variables as mutually predictive and co-evolving over time. Our PVAR model is an extension of vector autoregressive (VAR) modeling to panel data, and is based on the simultaneous estimation of several general method of moments (GMM) equations.

VAR is an econometric model used for evaluating systems with variables that may not be exogenous, and may be autocorrelated over time (Enders, 1995; Wooldridge, 2002). VAR models are commonly used in finance and marketing to examine the short- and long-term effects of dynamic relationships (see Pauwels, Silva-Risso, Srinivasan, & Hanssens, 2004, for a detailed account). Indeed, the 2011 Nobel Prize was awarded to an economist in part due to his extensive use and writing about dynamic models, including VAR (Sims, 1972, 1980, 1992). VAR has only infrequently been used in the management literature (for two exceptions, see Makadok & Walker, 1996, and Nair & Filer, 2003), but is very useful for exploring dynamic systems.

While VAR models estimate relationships among variables in a single unit of observation (e.g., in one country, see Pauwels et al., 2004), panel VAR (or PVAR) models are commonly used to pool results across several units of analysis. For instance, it has been used in economics to model relationships such as public spending and revenues (Noy & Nualsri, 2011), firm investments and country-level financial development (Love & Zicchino, 2006), financial development and economic growth (Blanco, 2009), and market structure and economic growth (Rousseau & Wachtel, 2000).

*Modeling short- and long-term effects.* The relationships of each variable with the
values of all other variables in the immediately following period are estimated by system (or “extended”) GMM models (Arellano & Bover, 1995), which produces a matrix of coefficients and standard errors. These month-to-month relationships are estimated according to the following equation:

\[ Y_{it} = c_0 + A_{t-j}Y_{it-j} + D\alpha + \lambda t + \varepsilon_{it} \]

In this estimation, each \( i \) is an individual unit of observation, and \( c \) indicates a vector of constants. For each \( j = [0, 1] \), \( Y_{it-j} \) is a vector of variables evaluated at time \( t - j \), \( A_{t,j} \) is a matrix of the corresponding coefficients to be estimated, and \( D \) is a vector of coefficients for \( \alpha \) unit dummy variables. \( \lambda \) represents a vector of time effects, and \( \varepsilon_{it} \) is a vector of error terms for unit \( i \) in period \( t \). We examined scatterplots of each unit to evaluate the possibility of seasonal effects across years for admissions and for workload, but saw no evidence for them.

The long-term relationships of each variable with others in the system are modeled in a PVAR using impulse response functions (IRF; Hamilton, 1994; Koop, Pesaran, & Potter, 1996; Pesaran & Shin, 1997). An IRF describes what would happen if an exogenous shock was introduced to the system such that just a single variable experienced a one standard deviation increase at one point in time. The IRF uses the GMM coefficients to trace the effects of a shock on each variable during several subsequent time periods as the system responds to the change. The magnitude of each of these effects on the system as a whole is reflected in a set of impulse response coefficients (IRCs), calculated for each variable at each point in time.

For example, in the case of unit-level turnover, the GMM provides estimates of the relationship between departures in one month and the levels of hiring, job demands, and unit performance in the following month. The IRF enables us to model these effects (and also the turnover impact on subsequent turnover) up to six months in the future as the system responds.
and adjusts to the shock we modeled. This is accomplished with a Monte Carlo simulation that repeatedly draws effects among variables from a distribution based on the system GMM estimates and their standard errors (Love & Zicchino, 2006). These estimates improve insight into the long-term effects of change by incorporating the idea that any change in a system has complex effects on all variables within the system over time.

**PVAR in the current context.** PVAR is especially well suited to the present study because of some unique features of our theory and data. First, our theoretical development allows for relationships that are not simple and recursive, but instead allow each variable to influence each other over time. We view this as a more realistic reflection of the workplace system than a static model that treats isolated relationships between pairs of variables, or a model that treats causal effects as unidirectional (see Sims, 1980). For instance, hiring is often one result of unit-level turnover. Hiring, in turn, has a unique effect on unit performance that unfolds over time differently than the effect of turnover (Gelade & Ivery, 2003), and both work through job demands. However, because new hires also impact performance in ways not influenced by job demands, it is also necessary to examine the direct effects of unit-level turnover and hiring on unit performance. At the same time, job demands and unit performance, over time, are also likely to lead to additional unit-level turnover through stress and dissatisfaction (Begley & Czajka, 1993; Dwyer & Ganster, 1991; Healy & McKay, 2000) as well as hiring.

Second, our data allow us to pool results across a number of nursing units. Third, we are interested in the overall impact (given the complex causal dynamics) of changes in one variable on others over time. PVAR analysis exploits this data structure by evaluating and examining the separate effects for each variable on all other variables with multiple time lags.

**Model specification.** To generate an identified model in which the residual effects are
orthogonal, the order entry of variables into the model should be chosen according to theory (Love & Zicchino, 2006). The model is specified according to a sequence of causal steps such that each variable predicts future values of all variables in the system, but is allowed to predict immediate (i.e., same-period) values of only those variables that follow it in the sequence. We specified unit-level turnover as the most exogenous variable, followed by job demands, hiring, and performance. We modeled performance as the most endogenous variable because it is likely to be directly affected by the other variables, and because in practice, performance scores were reported back to the unit in the month following the actual performance occurrence. Thus, performance is unlikely to have an immediate impact on the other variables in the system.

We also conducted two robustness checks for our main analysis. First, we tested an alternative model that separately estimated the effects of hires and transfers. The system GMM coefficients for hires and transfers were not statistically significantly different from each other. Similarly, we tested a model that separated the effects of those who left the employment of the hospital from those that transferred to another unit. These effects were also not statistically significantly different from each other.

**Fixed effects.** We accounted for mean differences across units by using a fixed effects model, fixing on unit. However, PVAR models use lagged variables as instruments, and simply accounting for mean differences in this context results in biased coefficients (Holtz-Eakin et al., 1988; Nickell, 1981). Therefore, we used forward mean differencing (i.e. using only future observations), also known as the “Helmert procedure” (Arellano & Bover, 1995; Love & Zicchino, 2006), to preserve the prior observations as instrumental variables and produce unbiased coefficient estimates.

**Lag length selection.** To properly estimate a PVAR system, a crucial analytical choice involves
the number of lags of each variable to be included as predictors (Chen, De, & Hu, 2009; Kireyev, 2000). Including more lags than necessary consumes degrees of freedom, requires the estimation of additional coefficients, and increases the complexity of the model needlessly. Not including enough lags can lead to biased estimates because the unused lags are omitted variables that may have a causal role in the system. Typically, the choice is determined by the use of a statistical criterion such as AIC or SIC. In the PVAR context, the statistical criteria are calculated for each unit of observation separately, and the results aggregated (see Kireyev, 2000). We examined four information criteria (Final Prediction Error, AIC, Hannan-Quinn Information Criterion, and Schwarz Criterion) for each of our 12 units to determine the appropriate lag length. Based on the predominance of the evidence, and in the interest of parsimony, we selected a lag length of 1 month.

**Confidence intervals and variance explained.** To assess the effects represented by the impulse response functions, we generated estimates of their confidence intervals by subjecting the data to 1,000 Monte Carlo simulations based on the estimated coefficients and the variance-covariance matrix (Arias & Escudero, 2007; Blanco, 2009; Love & Zicchino, 2006; Noy & Nualsri, 2011). We also report variance decompositions, which show the percent of total variance in one variable that is accounted for by system shocks from each other variable.

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Insert Tables 1 and 2 about here

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**RESULTS**

**PVAR Analysis**

Descriptive statistics for the study variables are presented in Table 1. Table 2 presents
correlations among variables and their 1-period lagged values, both within- and between units. Our main analysis is based on the estimation of a series of related equations. The system GMM coefficients are reported in Table 3. They indicate that job demands are immediately and statistically significantly related to both unit-level turnover (b = .10; SE = .03; p<.001) and hiring (b = -.10; SE = .02; p<.001), but the only statistically significant immediate predictor of performance in the system is job demands (b = -1.57; SE = .43; p<.001).

Perhaps more telling than the immediate relationships among variables, the PVAR results also include impulse response functions for a six month period after the shock. Consistent with prior research (e.g., Love & Zicchino, 2006), we estimated the total variance explained in each variable by other system variables. Total variance explained includes all of the variance attributable to other variables in the system, so the residual term includes both unexplained variance and variance owing to prior values of the focal variable. Overall, shocks to the system were able to explain about 18% of the variance in unit performance (Table 4).

Formal Hypothesis Tests

Our first hypothesis predicted that unit-level turnover would negatively impact unit performance. Table 5 reports the response of performance to a turnover shock in the same month through sixth month (i.e., months 0-6). The effect in the immediate period of turnover was not
statistically significant (IRC = -0.30; 90% CI [-0.61, 0.02]). However, the total response of performance to a shock in unit-level turnover was negative and statistically significant two months after the turnover shock (IRC = -0.15; 90% CI [-0.30, -0.01]), and remained statistically significantly up to 6 months after the shock (IRC = -0.10; 90% CI = [-0.23, -0.01]). These results partially support Hypothesis 1. The response of performance over time to a shock in unit-level turnover, with a 5% confidence band on each side, is shown graphically in Figure 1.

The second hypothesis predicted that unit-level hiring would negatively impact unit performance in the short term (H2a), and positively affect it in the long-term (H2b). Table 5 reports the total response of performance to a shock in hiring at months 1-6. The response in the immediate period of hiring was negative but not statistically significant (IRC = -0.26; 90% [CI = 0.54, 0.04]), failing to support H2a. However, the response became positive and statistically significant in the second month after the hiring shock (IRC = 0.29; 90% CI [0.16, 0.41]), and remained so through the six month estimation period (IRC = 0.23; 90% CI [0.12, 0.38]). Hypothesis 2b was thus supported. The response of performance over time to a shock in unit-level hiring, with a 5% confidence band on each side, is shown in Figure 2.

Our third and fourth hypotheses predicted that unit-level turnover would increase job demands, and unit-level hiring would reduce job demands. The response of job demands to a shock in unit-level turnover during the immediate period was not statistically significant (IRC = 0.02; 90% CI [-0.03, 0.07]). One month after the turnover event, the response was positive and statistically significant (IRC = 0.13; 90% CI [0.04, 0.22]), and remained positive and statistically
significant throughout the period of analysis (see Table 5). Hypothesis 3 was supported. The response of job demands to a shock in unit-level hiring was constrained to zero in the immediate period. After one month, the response was negative and statistically significant (IRC = -0.21; 90% CI [-0.28, -0.14]), and remained so through the sixth month (see Table 5). Hypothesis 4 was also supported. The response of job demands over time to shocks in unit-level turnover and unit-level hiring, with a 5% confidence band on each side, are shown graphically in Figures 3 and 4.

The fifth hypothesis posited that average job demands would negatively impact unit performance. The response of unit performance over time to a shock in job demands is detailed in Table 5, and displayed in Figure 5. In the immediate period of the shock, the response of performance was negative and statistically significant (IRC = -1.37; 90% CI [-1.64, -1.08]). It remained negative and statistically significant through month six (IRC = -0.71; 90% CI [-1.10, -0.40]), providing support for Hypothesis 5.

Hypothesis 6a predicted that unit-level turnover would positively impact hiring. In the month of a turnover shock, the response of turnover was positive and statistically significant (IRC = 0.30; 90% CI [0.19, 0.41]). After six months, the response was dampened (IRC = 0.05; 90% CI [0.01, 0.13]), but remained statistically significant and positive. The results are detailed in Table 5 and shown in Figure 6a, and provide support for hypothesis 6a.

Hypothesis 6b predicted that job demands would positively impact hiring. The response of hiring to a shock in job demands was positive and statistically significant during the month of a shock (IRC = 0.88; 90% CI [0.77, 0.99]), and remained so through the sixth month (IRC = .33;
90% CI [0.13, 0.67]). The results are detailed in Table 5 and shown in Figure 6b.

Hypothesis 7 predicted that job demands would positively impact turnover at the unit-level. Hypothesis 7 was not supported. Results are detailed in Table 5 and shown in Figure 7.

Hypothesis 8 predicted that unit-level turnover would predict subsequent unit-level turnover. The response of turnover to a prior shock in turnover (detailed in Table 5 and shown graphically in Figure 8), was positive and statistically significant in the first month following the shock (IRC = 0.35; 90% CI [0.06, 0.66]), and through the second month (IRC = 0.10; 90% CI [0.00, 0.30]; the confidence interval rounds to, but does not include zero), but not thereafter. Hypothesis 8 was partially supported.

Practical Effects over Time

While hypothesis testing can provide some information about the conceptual viability of our theory, assessing the practical significance of our results requires some additional interpretation of the size of the effects we observe in the data. In this section, we report the practical size of the impact exerted by unit-level turnover, hiring, and job demands.

**Unit-level turnover effects.** Our analysis estimated the system’s response to an exogenous shock of losing employees at the rate of one standard deviation above normal in a given month. In our data, that corresponded to 1.45 employees. The response of performance
peaked during the immediate month of a turnover shock (see Table 5). During this month, a turnover shock of one standard deviation resulted in a decrease of about 0.30 points on the patient satisfaction scale. This equates to 0.06 standard deviations in unit performance. In the sixth month, the effect of a loss of two nurses translated to a decrease in performance of 0.10 points, or 0.02 standard deviations.

In practical terms, changes of this magnitude in performance seem rather small, as the patient satisfaction scale theoretically ranges from 0 to 100, and observed scores ranged from 64.5 to 98.5. However, we interpret our findings not as an indication that turnover is meaningless to performance, but instead that the lion’s share of the effect of unit-level turnover on performance is driven by job demands – units perform more poorly when they are shorthanded.

This result is consistent with prior analyses. Units with higher rates of turnover may be characterized by chronic shortages of human capital, and this could account for between-unit or between-firm findings when turnover is aggregated over longer periods of time.

**Hiring effects.** A shock in hiring of one standard deviation represents hiring 1.61 nurses more than usual. The response of performance to a hiring shock peaked in the first month after the shock. At that point, the shock resulted in a performance increase of .31 points on the patient satisfaction scale. This equates to 0.07 standard deviations in the performance measure. The effect of this hiring shock after six months was 0.23 points, or 0.05 standard deviations.

**Job demands effects.** Our analysis estimated the impact of an exogenous shock in job demands of one standard deviation. In our data, this corresponded to a change of 0.93 patients per nurse per month. The response of performance to such a shock peaked in the initial month of the shock, resulting in a decrease of 1.37 points on the patient satisfaction scale. This represents 0.29 standard deviations of performance. Six months after the workload shock, the impact was a
.71 point decrease in performance, representing 0.15 standard deviations.

**DISCUSSION**

Through examining the role of job demands, we showed a mechanism by which unit-level turnover impacts unit performance. The model also examines the longitudinal consequences of unit-level turnover in a nuanced manner, and shows that over time unit-level turnover effects evolve dynamically. Combined, these contributions address a theoretical gap between unit-level turnover and the human capital resource, and increase our understanding of the role that employees play in unit performance over time.

**Unique Value of PVAR Analysis**

Because it allows for dynamic and reciprocal effects among variables, we argue that PVAR analysis more closely resembles patterns observed in reality for our variables than other possible methods (see Sims, 1980). PVAR results are essentially correlational, and do not provide strict support for causation. However, to the extent that the relationships among variables are truly mutually causative, such an analysis helps us to better understand the true impact of changes in theoretically important variables like human capital. As an example, we highlight differences in our findings between the system GMM results and impulse response functions with regard to turnover and hiring.

Results of the more static GMM analysis (Table 3) reveal that the simple positive effect of turnover on job demands (b = .10; SE=.03; p<.001) is nearly identical in absolute value to the comparable negative effect of hiring (b = -.10; SE = .02; p<.001). Based on our measure of job demands (patients per nurse per month), this is entirely expected, since equal amounts of turnover and hiring change the number of nurses by identical amounts. However, when dynamic effects are taken into account, a different picture emerges. IRF results show that the effect of
hiring on job demands is somewhat larger than that of turnover. We ascribe this difference to the additional causal pathways in the system, which are captured by PVAR analysis, but not by simple effects in the GMM: turnover leads to greater hiring (see Table 3), but hiring does not lead to greater turnover (IRCs at all time periods are not statistically significant). The effect of turnover on hiring appears to mitigate the impact of turnover on job demands over time.

**Implications for Theory**

Our model bridges the gap between micro- and macro-level human capital changes by identifying turnover and hiring as key drivers of change in job demands and unit performance. Our work demonstrates that researchers should consider both unit-level hiring and turnover jointly, and particularly their dynamic and reciprocal relationship over time (similar to research such as Sacco & Schmitt, 2005 and Van Iddekinge, Ferris, Perrewé, Perryman, Blass, and Heetderks, 2009). Examining the dynamic relationships between unit-level hiring and unit-level turnover is vital for understanding unit-level turnover's consequences because these two concepts are inextricably linked via their effects on the human capital resource. For example, part of the causal mechanism through which unit performance effects are realized for both unit-level turnover and unit-level hiring is through changes in job demands. To the extent that unit-level turnover reduces the human capital resource and thus increases average job demands, the effect on unit performance is negative, and vice versa. Additionally, because hiring often occurs in response to unit-level turnover, each aspect of the system influences the others.

*Mediation in the turnover model.* In developing hypotheses one and two, we used different rationale to motivate long-term versus short-term effects for both turnover and hiring, suggesting that the causal mechanisms driving the effects on performance would be different over time. In the short-term, the primary performance effects are expected through the reduced
unit output due to increased average job demands. However, in the long-term, even if the unit overcomes issues associated with increased average job demands, it will still have experienced the loss of institutional knowledge and experience, and the increased average job demands are likely to lead to greater stress and burn-out. Thus, the mediating influence of job demands is expected to be stronger in the short-term for both turnover and hiring than in the long-term.

Limiting attention to the GMM results allows us to test this mediation model. Using the coefficient estimates for the relationship between unit-level turnover and unit-level hiring on job demands, and the relationship between job demands and performance, we can test for the statistical significance of an indirect effect (MacKinnon & Fairchild, 2009; MacKinnon, Fairchild, & Fritz, 2007; Sobel, 1982). Consistent with Hancock and her colleagues (in press), our GMM model results support the view that job demands mediate the effects on performance of both unit-level turnover (a*b = -.15; SEa*b = .06; tsobel = -2.60; p<.01) and hiring (a*b = .16; SEa*b = .05; tsobel = 3.02; p<.01).

Our IRF results are also consistent with the expectation that job demands mediate the unit-level turnover – unit performance relationship and that this mediation will be stronger in the short-term than in the long-term. For example, the unit-level turnover effect on performance was not statistically significant immediately after the turnover shock, but the effect of job demands on performance was negative and statistically significant. At the same time, our results are consistent with the expectation that the mediation effect of job demands in the hiring-performance relationship will also be stronger in the short-term than the long-term.

Implications for Practice

The findings in this manuscript also offer opportunities for influencing managerial behavior. One obvious conclusion is that unit-level turnover is negatively related to unit
performance. It is similarly unsurprising, however seldom demonstrated, that hiring is positively related to unit performance. Less obviously, conventional wisdom suggests hiring replacement workers soon after turnover; however, our results suggest that there may be other factors to consider. One suggestion is that managers should bring in hires prior to turnover whenever possible. While this would incur additional cost in terms of salaries (e.g., paying two people for the same job), it could help reduce the performance declines associated with both hiring and unit-level turnover. This is likely to be more important for more complex or team-oriented tasks.

Another implication concerns the timing and the degradation of unit-level turnover effects. Managers may want to consider ways to mitigate the expected increased average job demands prior to unit-level turnover. If managers are capable of reducing average job demands prior to, or immediately in response to unit-level turnover, the negative performance effects resulting from increased average job demands may be substantially mitigated.

Limitations and Future Research Directions

One limitation, that also presents a research opportunity, is that we were unable to incorporate individual differences in the human capital resource into our model. While the quantity of unit-level turnover and unit-level hiring is important, the quality of employees either coming or going is likely to matter too (Hancock et al., in press). For instance, our model, which is based on quantity of employees and job demands, explains about 12% of the variance in performance. While this is not trivial, 88% of the variance remains unexplained (or explained by prior values of performance). Much of this share may have more to do with who leaves or joins the unit (e.g., their capabilities), and less to do with how many leave or join the unit. Future research should attempt to quantify the quality of the human capital resource involved in these relationships. Further, it is likely to be useful to examine the trade-off of quality versus quantity
in explaining the effects of unit-level turnover. It may well be that if the quality/quantity ratio is small enough (an empirical question that may also be context dependent) that the quality does not matter. In other situations (or when there is a higher ratio), quality may be the dominant issue. Similarly, going forward, it will be beneficial to explore the role of task and social complexity in determining the effects of unit-level turnover and hiring on job demands and the subsequent performance effects.

Another limitation is that our data was drawn from a single hospital. While there are advantages to using homogeneous data sets (they can rule out external factors that may influence the relationships of interest), it also limits generalizability. Similarly, our time period may not generalize, and we may not have been sufficiently fine-grained in our analysis. It could be that we would see stronger effect sizes and a greater performance lag if we could have used weeks instead of months. There may also be differences depending on the job type or task complexity. One additional limitation is that we have a relatively small sample (12 units). While our statistical tests are based on substantially more observations ($N = 826$), the small number of units presents the usual power problems associated with small samples, and may mask relationships.

Additionally, PVAR has limitations. While it is efficient and (we believe) provides the best mechanism for testing our theory, it prevents us from testing some aspects that we would like to test. For instance, PVAR does not permit accurate statistical coefficient comparisons across time. We get results that indicate some effects are stronger in the long-term than the short-term (e.g., the effect sizes for unit-level turnover on hiring). However, we cannot determine if the long-term effects are statistically significantly different from the short-term effects.

**Different Types of Turnover.** Traditional turnover research has focused on employees who have been separated from the firm and ignored employees who remained with the firm, but
left the unit. It may be that leaving the unit regardless of where one goes (e.g., another unit within the firm, or to an entirely different firm) has similar effects on the left unit. If this is the case, then there may be unintended (and possibly unrecognized) consequences associated with rotation plans (e.g., firms purposely rotate employees for cross training, exchange of ideas, etc.). Thus, there may be an opportunity to extend research by examining unit turnover, even when employees remain in the firm. These turnover events may have the same antecedents and consequences of traditional turnover, or it may be that transfers have unique properties that lead to new insights into how units function and cope with employee mobility.

**Conclusion**

By its nature unit-level turnover is a construct that influences employees and units, but not necessarily in the same manner. We examine turnover at the unit-level and generate theoretically driven explanations for how and why unit-level turnover impacts unit performance. We theorize about and examine the effects of unit-level turnover on unit performance, and include unit-level turnover relationships with hiring and job demands. Overall, we find that unit-level turnover, hiring, and job demands all comprise a dynamic, evolving system that individually and together influence unit performance.
REFERENCES


Ren, Y., Carley, K. M., & Argote, L. (2006). The contingent effects of transactive memory: When is it more beneficial to know what others know? *Management Science*, 52, 671-


### TABLE 1
Descriptive Statistics for System Variables

<table>
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<tr>
<th></th>
<th>Average Within-Unit Mean</th>
<th>Average Within-Unit SD</th>
<th>Average Within-Unit Range</th>
<th>Grand Min</th>
<th>Grand Max</th>
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<tbody>
<tr>
<td>Unit-Level Turnover</td>
<td>1.45</td>
<td>1.40</td>
<td>6.92</td>
<td>0.00</td>
<td>26.00</td>
</tr>
<tr>
<td>Job Demands</td>
<td>9.15</td>
<td>0.93</td>
<td>4.04</td>
<td>4.96</td>
<td>14.30</td>
</tr>
<tr>
<td>Unit-Level Hiring</td>
<td>1.61</td>
<td>1.51</td>
<td>6.38</td>
<td>0.00</td>
<td>14.00</td>
</tr>
<tr>
<td>Unit performance</td>
<td>79.89</td>
<td>4.70</td>
<td>23.25</td>
<td>64.50</td>
<td>98.50</td>
</tr>
</tbody>
</table>

Note: 864 observations of 12 units over 73 months. Mean, standard deviation and range are calculated within unit and then averaged (no weighting by unit size).
**TABLE 2**

Correlations among System Variables and their Lagged Values

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<td>.20</td>
<td>- .20</td>
<td>.05</td>
<td>.63</td>
<td>- .02</td>
<td>- .16</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>.32</td>
<td>.05</td>
<td>- .05</td>
<td>.10</td>
<td>.18</td>
<td>.16</td>
<td>- .01</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>- .01</td>
<td>- .29</td>
<td>- .03</td>
<td>.02</td>
<td>- .16</td>
<td>.02</td>
<td>.06</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>.34</td>
<td>- .07</td>
<td>.34</td>
<td>.03</td>
<td>- .04</td>
<td>.11</td>
<td>- .01</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>- .09</td>
<td>.87</td>
<td>.04</td>
<td>- .27</td>
<td>- .12</td>
<td>.20</td>
<td>- .19</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>.27</td>
<td>- .07</td>
<td>.39</td>
<td>.02</td>
<td>.33</td>
<td>.05</td>
<td>- .05</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>.01</td>
<td>- .27</td>
<td>.01</td>
<td>.17</td>
<td>- .01</td>
<td>- .29</td>
<td>- .03</td>
<td></td>
</tr>
</tbody>
</table>

Note: 864 observations of 12 units over 73 months. Correlations below the diagonal are overall correlations between units. Correlations above the diagonal represent the average within-unit correlations. Correlations of ± 0.07 or stronger are statistically significant at p < .05.
### TABLE 3

System GMM Results for the impact of each lagged system variable on other system variables

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Independent Variable&lt;sup&gt;1&lt;/sup&gt;</th>
<th>b</th>
<th>SE</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit-level turnover</td>
<td>Unit-level turnover</td>
<td>.20†</td>
<td>.11</td>
<td>1.80</td>
</tr>
<tr>
<td></td>
<td>Job demands</td>
<td>.05</td>
<td>.14</td>
<td>.36</td>
</tr>
<tr>
<td></td>
<td>Hiring</td>
<td>.07</td>
<td>.06</td>
<td>1.17</td>
</tr>
<tr>
<td></td>
<td>Unit performance</td>
<td>.03</td>
<td>.06</td>
<td>.57</td>
</tr>
<tr>
<td>Job demands</td>
<td>Unit-level turnover</td>
<td>.10***</td>
<td>.03</td>
<td>3.71</td>
</tr>
<tr>
<td></td>
<td>Job demands</td>
<td>1.13***</td>
<td>.07</td>
<td>15.04</td>
</tr>
<tr>
<td></td>
<td>Hiring</td>
<td>-.10***</td>
<td>.02</td>
<td>-5.42</td>
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<tr>
<td></td>
<td>Unit - performance</td>
<td>.11***</td>
<td>.03</td>
<td>3.83</td>
</tr>
<tr>
<td>Hiring</td>
<td>Unit-level turnover</td>
<td>.25***</td>
<td>.06</td>
<td>4.44</td>
</tr>
<tr>
<td></td>
<td>Job demands</td>
<td>.68***</td>
<td>.15</td>
<td>4.47</td>
</tr>
<tr>
<td></td>
<td>Hiring</td>
<td>.22***</td>
<td>.05</td>
<td>4.58</td>
</tr>
<tr>
<td></td>
<td>Unit performance</td>
<td>.21***</td>
<td>.06</td>
<td>3.85</td>
</tr>
<tr>
<td>Unit performance</td>
<td>Unit-level Turnover</td>
<td>-.09</td>
<td>.10</td>
<td>-.85</td>
</tr>
<tr>
<td></td>
<td>Job Demands</td>
<td>-1.57***</td>
<td>.43</td>
<td>-3.64</td>
</tr>
<tr>
<td></td>
<td>Hiring</td>
<td>.14</td>
<td>.11</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>Unit performance</td>
<td>-.23</td>
<td>.15</td>
<td>1.58</td>
</tr>
</tbody>
</table>

<sup>1</sup> Independent variables are lagged one period. Two tailed tests for statistical significance.

† p<.10
* p<.05
** p<.01
*** p<.001
**TABLE 4**

Table of Variance Explained by other Variables in the Unit-level Turnover System

<table>
<thead>
<tr>
<th></th>
<th>Unit-level Turnover</th>
<th>Hires</th>
<th>Job Demands</th>
<th>Unit performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit-level Turnover</td>
<td>(.02)</td>
<td>.00</td>
<td>.00</td>
<td>.01</td>
</tr>
<tr>
<td>Hires</td>
<td>.06</td>
<td>(.53)</td>
<td>.25</td>
<td>.23</td>
</tr>
<tr>
<td>Job Demands</td>
<td>.01</td>
<td>.05</td>
<td>(.25)</td>
<td>.19</td>
</tr>
<tr>
<td>Unit performance</td>
<td>.00</td>
<td>.01</td>
<td>.17</td>
<td>(.18)</td>
</tr>
</tbody>
</table>

Note: values on the diagonal represent total variance explained by all other variables in the system over the prior 6 months. Non diagonal values are percent of variance explained in the row variable by the column variable. For example, row 3, column 2 shows that 5% of job demands are explained by hiring. Because this is an aggregation of variance explained after the shock, there is not a meaningful statistical significance measure.
### TABLE 5

**PVAR Analyses Results of the Impact of One Variable on another over Time**

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Unit-level Turnover on Performance</td>
<td>-.30 (-.61 to .02)</td>
<td>-.07 (-.39 to .20)</td>
<td>-.15* (-.30 to -.01)</td>
<td>-.13* (-.25 to -.01)</td>
<td>-.12* (-.24 to -.01)</td>
<td>-.11* (-.24 to -.01)</td>
</tr>
<tr>
<td>2a/2b</td>
<td>Hiring on Performance</td>
<td>-.26 (-.54 to .04)</td>
<td>.31 (-.07 to .66)</td>
<td>.29* (.16 to .41)</td>
<td>.28* (.16 to .42)</td>
<td>.27* (.14 to .40)</td>
<td>.25* (.13 to .39)</td>
</tr>
<tr>
<td>3</td>
<td>Unit-level Turnover on Job Demands</td>
<td>.02 (-.03 to .07)</td>
<td>.13* (.04 to .22)</td>
<td>.12* (.04 to .21)</td>
<td>.10* (.02 to .20)</td>
<td>.09* (.01 to .20)</td>
<td>.09* (.01 to .20)</td>
</tr>
<tr>
<td>4</td>
<td>Hiring on Job Demands</td>
<td>-</td>
<td>-.21* (-.28 to -.14)</td>
<td>-.22* (-.31 to -.14)</td>
<td>-.22* (-.31 to -.14)</td>
<td>-.20* (-.31 to -.13)</td>
<td>-.20* (-.31 to -.11)</td>
</tr>
<tr>
<td>5</td>
<td>Job Demands on Performance</td>
<td>-1.37* (-1.64 to -1.08)</td>
<td>-.99* (-1.38 to -.60)</td>
<td>-.94* (-1.22 to -.59)</td>
<td>-.88* (-1.16 to -.55)</td>
<td>-.82* (-1.13 to -.51)</td>
<td>-.76* (-1.11 to -.46)</td>
</tr>
<tr>
<td>6a</td>
<td>Unit-level Turnover on Hiring</td>
<td>.30* (.19 to .41)</td>
<td>.45* (.28 to .62)</td>
<td>.26* (.13 to .39)</td>
<td>.13* (.06 to .24)</td>
<td>.08* (.03 to .18)</td>
<td>.06* (.01 to .15)</td>
</tr>
<tr>
<td>6b</td>
<td>Job Demands on Hiring</td>
<td>.88* (.77 to .99)</td>
<td>.52* (.36 to .68)</td>
<td>.46* (.26 to .67)</td>
<td>.41* (.21 to .66)</td>
<td>.38* (.18 to .66)</td>
<td>.35* (.15 to .67)</td>
</tr>
<tr>
<td>7</td>
<td>Job Demands on Unit-level Turnover</td>
<td>-</td>
<td>.06 (-.07 to .17)</td>
<td>.05 (-.07 to .20)</td>
<td>.04 (-.07 to .21)</td>
<td>.04 (-.07 to .21)</td>
<td>.04 (-.06 to .21)</td>
</tr>
<tr>
<td>8</td>
<td>Unit-level Turnover on Unit-level Turnover</td>
<td>-</td>
<td>.35* (.06 to .66)</td>
<td>.10* (.00 to .30)</td>
<td>.04 (-.00 to .15)</td>
<td>.02 (-.01 to .09)</td>
<td>.01 (-.01 to .06)</td>
</tr>
</tbody>
</table>

*N (observations) = 826; *p < .05; Values in parentheses are 90% confidence intervals. Hypothesis tests are the impact of one variable on another in the absence of other shocks. Missing coefficients are not causally determinative in the model.*
FIGURE 1

The Response of Unit Performance over Six Months to a Shock in Unit-level Turnover.

Note: The solid line indicates impulse response coefficient values. Dashed lines indicate upper and lower confidence intervals (5% on each side based on Monte Carlo simulations with 1,000 repetitions).
FIGURE 2

The Response of Unit Performance over Six Months to a Shock in Hiring.

Note: The solid line indicates impulse response coefficient values. Dashed lines indicate upper and lower confidence intervals (5% on each side based on Monte Carlo simulations with 1,000 repetitions).
FIGURE 3:

The Response of Job Demands over Six Months to a Shock in Unit-level Turnover.

Note: The solid line indicates impulse response coefficient values. Dashed lines indicate upper and lower confidence intervals (5% on each side based on Monte Carlo simulations with 1,000 repetitions).
FIGURE 4

The Response of Job Demands over Six Months to a Shock in Hiring.

Note: The solid line indicates impulse response coefficient values. Dashed lines indicate upper and lower confidence intervals (5% on each side based on Monte Carlo simulations with 1,000 repetitions).
FIGURE 5

The Response of Unit Performance over Six Months to a Shock in Job Demands.

Note: The solid line indicates impulse response coefficient values. Dashed lines indicate upper and lower confidence intervals (5% on each side based on Monte Carlo simulations with 1,000 repetitions).
FIGURE 6a

The Response of Hiring over Six Months to a Shock in Unit-Level Turnover.

Note: The solid line indicates impulse response coefficient values. Dashed lines indicate upper and lower confidence intervals (5% on each side based on Monte Carlo simulations with 1,000 repetitions).
FIGURE 6b:

The Response of Hiring over Six Months to a Shock in Job Demands.

Note: The solid line indicates impulse response coefficient values. Dashed lines indicate upper and lower confidence intervals (5% on each side based on Monte Carlo simulations with 1,000 repetitions).
FIGURE 7

The Response of Unit-level Turnover over Six Months to a Shock in Job Demands.

Note: The solid line indicates impulse response coefficient values. Dashed lines indicate upper and lower confidence intervals (5% on each side based on Monte Carlo simulations with 1,000 repetitions).
FIGURE 8

The Response of Future Unit-level Turnover over Six Months to a Shock in Unit-level Turnover.

Note: The solid line indicates impulse response coefficient values. Dashed lines indicate upper and lower confidence intervals (5% on each side based on Monte Carlo simulations with 1,000 repetitions).