

Diversity and Productivity in Teams

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Workplace diversity is often claimed to be one of the most important challenges facing managers today. Demographic trends, changing labor supply patterns, immigration, and increased globalization imply a much more heterogeneous group of employees for firms to manage. Recently, partially in response to the weakening of affirmative action programs in states like California, a number of firms and business executives have proposed a “business case for diversity,” which argues that a more diverse workforce is not necessarily a moral imperative, but is in fact a source of competitive advantage. The “business case for diversity” may be summarized by two major arguments. First, a more diverse customer base may be better served by a more diverse workforce that can effectively communicate with customer subgroups. Second, some assert that “diverse teams produce better results”¹ arguing that heterogeneous teams will provide a broader range of ideas and potential solutions to a given problem. Unfortunately, few formal arguments and empirical research have explored the business case for diversity.

In this paper, we investigate the second claim that “diverse teams produce better results.” Lazear (1998a, 1998b) asserts that a diverse team can generate productivity gains if three factors are present. First, team members must have different skills or information. In this way the team may gain from the complementarities among the skills of its members. Second, the different skills of team members must be relevant to one another. Obviously, little complementarity occurs if the skills of one team member are not relevant to the production of a teammate. Third, communication is necessary for team members to perform the relevant joint tasks and engage in knowledge transfer to enhance productivity. Increases in communication costs reduce the gains achievable from skill

¹ Quote from Lew Platt, former CEO of Hewlett-Packard, to the Diversity Research Network, Stanford Business School, March 18, 1998, reported in Kochan et al (2002).

diversity. These factors suggest that at least two aspects of diversity should be considered when analyzing teams: (1) diversity in the skills, ability, and information sets of team members; and (2) diversity in other factors that may enhance or inhibit within-team communication. In fact, Lazear's argument implies that productive teams should be diverse along the skill dimension, but homogeneous in other dimensions, such as demographics, that reduce communication costs or what he calls "costs of cross-cultural dealing."

Lazear's argument concerning within team communication costs resonates with other research in economics and organizational behavior. For instance, Arrow (1974) was one of the first to focus on the effects of within team communication costs on performance. More recent research suggests that demographic differences are likely to increase communication costs. Zenger and Lawrence (1989) find that age differences within teams reduce technical communication. Lang (1986) shows that language differences and racial and gender diversity increase communication costs. Others argue that if workers in the same demographic group are more likely to belong to overlapping social networks, peer pressure may be more effective in mitigating free-riding to achieve a group norm within the team (Kandel and Lazear (1992)). In sum, this research suggests that more demographically diverse teams may be less productive, holding skill diversity constant.

While workers may prefer more demographically homogeneous groups in order to reduce communication costs and increase productivity and pay, Becker's (1957) model of co-worker discrimination suggests that demographically diverse teams also may reduce worker utility. If workers are prejudiced, then they may choose to segregate themselves within the workplace and form teams with similar individuals, even if these teams generate less pay for their members.

Consequently, Becker's model implies that increasing demographic diversity within teams at the firm may increase turnover if employees have preferences for working with similar individuals.

We formally explore the effect of diversity on team productivity and team-member turnover. We provide a theoretical framework that allows us to jointly analyze the impacts of both skill diversity and demographic diversity on productivity. First, we confirm Lazear's argument that output is higher when there are significant skill diversity and benefits of collaboration. Second, we identify three channels through which demographic diversity affects productivity and turnover: (1) diversity could inhibit knowledge transfer among team members; (2) diversity could reduce peer pressure by weakening social ties and trust among team members; and (3) "tastes for discrimination" create non-pecuniary disutility of joining a demographically diverse team. These three channels collectively imply that demographic differences should harm team productivity and raise team-member turnover.

Empirical analysis of the relationship between diversity, productivity, and turnover in teams faces many challenges. Demographic characteristics may be correlated with worker skill. While characteristics such as age and race are typically collected in most data sets, worker ability generally is not. Consequently, it is difficult to empirically separate the role of skill diversity from communication costs induced by demographic diversity in teams. Moreover, team membership is often not available. Researchers then are often forced to examine the role of demographic heterogeneity at the firm or plant level. However, diversity at the plant level may mask substantial segregation among teams within a particular location, which will bias productivity and turnover estimates. In addition, more diverse plants or firms may differ in other ways that are not observed by the econometrician, but which also affect productivity and turnover, contaminating estimates of the impact of diversity.

Our approach to the empirical analysis of diversity in teams attempts to address these issues by utilizing the personnel records of workers employed between 1995 and 1997 at a garment factory operated in Napa, California, by the Koret Company, first studied by Hamilton, Nickerson and Owan (2003). The facility initially used progressive bundling system production, in which sewing is divided into independent tasks and seamstresses are paid piece rates. Between 1995 and 1997, the facility changed the organization of its sewing activity to module production, in which autonomous work teams of typically six to seven workers receive a group piece rate and perform all sewing tasks. Because we observe productivity in individual production for almost all workers that eventually join a team, we are able to construct measures of both skill level and skill diversity for each team. We are therefore able to distinguish between the roles of skill and communication costs, as measured by team demographics, on productivity and turnover. Similarly, because we focus on teams operating side-by-side within in the same factory, our results will not be biased by other variations in human resource practices across plants that may bias the results of other studies.

Our findings are largely consistent with our formal model. First, our results indicate that more heterogeneous teams in terms of worker abilities are more productive. Second, holding the distribution of team ability constant, teams with greater diversity in age are less productive, and those composed only of one ethnicity (Hispanic workers in our case) are more productive, but these findings are not robust to alternative specifications of the regression model. Finally, workers on all Hispanic teams are less likely to leave the team, even after accounting for lagged team productivity, indicating some preference for segregation among these workers.

The paper proceeds in six sections. In the first section we introduce our formal analysis of the effects of worker diversity on team productivity and team-member turnover. The next two

sections describe production at Koret and our data. Sections IV and V describe our empirical results on the effects of diversity on productivity and turnover, respectively. We discuss our findings and conclude in the final section.

1. Theoretical Background

We develop a model which captures two different consequences of diversity that seem to be relevant to team production in the context of the garment factory we analyze. First, diversity in the skills and ability may enhance the productivity of a team because more skilled workers help and teach less skilled ones. Second, demographic diversity potentially inhibits within-team communication and thus reduces the effectiveness of collaboration and peer pressure, and the non-pecuniary benefit of joining the team. Our model is built on the work of Kandell and Lazear (1992), but also includes the benefit of collaboration between workers with difference skill levels and psychological payoff from team participation.

The Model

Consider a team with N workers where workers are indexed by $i \in \{1, 2, \dots, N\}$. Assume that the team operates over an infinite number of discrete time periods. In each period, each worker makes a decision about how much total effort, e_i , to exert by incurring personal cost of $c_i(e_i)$. e_i is measured in efficiency units and differences in $c_i(e_i)$ equate to skill heterogeneity. Let $\mathbf{e} = \{e_1, e_2, \dots, e_N\}$. Assume that effort can be allocated to perform assigned tasks, called *individual effort*, and to help the other workers and coordinate team activities, called *collaborative effort*. It is collaborative effort that could make team production (e.g., module production) more productive than individual production (e.g., straight-line production). We

assume that the mean of \mathbf{e} in the prior period, m , becomes the standard or *team norm* in the current period.

We further assume that a worker's collaborative effort becomes more productive than her individual effort only when her total effort exceeds the average effort of the other members. The intuition behind this assumption is that a worker can teach and help others and coordinate activities well only when her work pace is at least the average of the others'. In addition, we assume that the benefit of the worker's collaborative effort is greater as her skill increases. The total output of worker i is given by:

$$q_i = e_i + \frac{g}{2} \left(\left[e_i - \frac{\sum_{j \neq i} e_j}{N-1} \right]_+ \right)^2 \quad (0.1)$$

where g , the factor relating collaborative effort to increased output, is greater than 0 and $[x]_+$

denotes $\max\{x, 0\}$. Consequently, $\frac{g}{2} \left(\left[e_i - \frac{\sum_{j \neq i} e_j}{N-1} \right]_+ \right)^2$ is the additional output created by the worker's collaborative effort.²

A worker's utility depends on his wage w_i and the disutility of total effort $c_i(e_i)$. Utility also depends on psychological payoffs such as disutility from peer pressure and utility from socialization. We assume peer pressure arises when the workers performs below the team mean and is proportional to the deviation. Utility from peer pressure takes the form $-k[m - e_i]$ whereas utility from socialization is represented by b . Hence, team-member i 's utility is:

$$u_i(w_i, e_i, m) = w_i - c_i(e_i) - k[m - e_i]_+ + b \quad (0.2)$$

² Some readers may feel that eventually, as $e_i - \frac{\sum_{j \neq i} e_j}{N-1}$ increases, the marginal benefit will begin to diminish. We simply assume that diminishing returns are not in the relevant range. We chose the quadratic form because it ensures the existence of steady-state equilibrium we define later.

$-k[m - e_i]$ is a psychological disutility and individuals treat k and m as given. Workers are boundedly rational in the sense that they do not choose e_i 's strategically taking into account their impact on m in the future periods. A worker's pay is an equal portion of the team pay, which

depends on the piece rate, w , and the team output, $Q = \sum_{i=1}^N q_i = \sum_{i=1}^N (e_i + \frac{g}{2} ([e_i - \frac{\sum_{j \neq i} e_j}{N-1}]_+)^2)$. Namely,

$$w_i = \frac{w}{N} \sum_{i=1}^N (e_i + \frac{g}{2} ([e_i - \frac{\sum_{j \neq i} e_j}{N-1}]_+)^2).$$

Let τ be the non-skill-related heterogeneity in such characteristics as ethnicity and age. We assume that g , k , and b are parameters that depend on team characteristics and the team norm:

$g = g(\mathbf{t})$, $k = k(m, \mathbf{t})$, and $b = b(\mathbf{t})$. g , k , and b are all decreasing in \mathbf{t} , and k is increasing in m .

A couple of comments about our assumptions are in order. First, the value of collaborative effort increases at an increasing rate as the skill difference and the resultant difference in effort choices among the workers increases. This relationship implies that know-how shared by a highly skilled worker has more value when there are many workers who possess little skill. Second, the dependence of k on m implies that greater cooperation in the last period leads to a higher marginal disutility of defecting in the current period. In other words, a high effort in the last period generates positive feedback to the workers' incentives in the current period. Third, an increase in non-skill-related heterogeneity works against the benefit of collaboration, from peer pressure and from the utility of socialization, because differences in personal background or language hinder communication and development of trust among team members which are the backbones of collaborative activities.

Finally, we assume the quadratic cost function $c_i(e_i) = \frac{e_i^2}{2c_i}$ to simplify our notation. In

order to make effort choices bounded, we set the following parametric assumptions.

Assumption 1 $k(m, \mathbf{t})$ is bounded from above in m and $\frac{1}{c_i} > \frac{wg(\mathbf{t})}{N-1}$ for all \mathbf{t} and i .

This assumption ensures a bounded range of feasible team norm m and is necessary to apply the fixed-point theorem to prove the existence of equilibrium.

Worker i solves

$$\max_{e_i} u_i(\mathbf{e}, m, \mathbf{t}) = \frac{w}{N} \sum_{i=1}^N \left(e_i + \frac{g(\mathbf{t})}{2} \left(\left[e_i - \frac{\sum_{j \neq i} e_j}{N-1} \right]_+ \right)^2 \right) - \frac{e_i^2}{2c_i} - k(m, \mathbf{t})[m - e_i]_+ + b(\mathbf{t}) \quad (0.3)$$

Equilibrium

We can assume $c_1 < c_2 < \dots < c_N$ without loss of generality. Let e_i^* and m^* be the steady-state level of effort and team norm. Then,

$$\begin{aligned} u_i(\mathbf{e}^*, m^*, \mathbf{s}, \mathbf{t}) &\geq u_i(\mathbf{e}_{-i}^*, e_i, m^*, \mathbf{s}, \mathbf{t}) \text{ for all } i \text{ and } e_i, \\ m^* &= \text{mean}(\mathbf{e}^*). \end{aligned} \quad (0.4)$$

This definition is equivalent to the *morale equilibrium* defined in Kandori (2003) except that Kandori uses median to define the norm. In the rest of the paper, we simply call \mathbf{e}^* the *steady-state equilibrium*. We can uniquely determine e_i^* as a function of m^* by solving the first-order conditions.

Lemma 1

$$\begin{aligned}
e_i^* &= c_i \left(\frac{w}{N} + k(m^*, \mathbf{t}) \right) \text{ when } m^* > c_i \left(\frac{w}{N} + k(m^*, \mathbf{t}) \right), \\
e_i^* &= m^* \text{ when } \frac{c_i w}{N} \leq m^* \leq c_i \left(\frac{w}{N} + k(m^*, \mathbf{t}) \right), \text{ and} \\
e_i^* &= m^* + \frac{N-1}{N} \frac{c_i w - N m^*}{N-1 - c_i w g(\mathbf{t})} > \frac{c_i w}{N} \text{ when } m^* < \frac{c_i w}{N}.
\end{aligned}$$

Proof: Note that
$$e_i^* - \frac{\sum_{j \neq i} e_j^*}{N-1} = \frac{(N-1)e_i^* - \sum_{j \neq i} e_j^*}{N-1} = \frac{N e_i^* - \sum_{i=1}^N e_j^*}{N-1} = \frac{N}{N-1} (e_i^* - m^*).$$

We consider three cases: $e_i^* < m^*$, $e_i^* = m^*$ and $e_i^* > m^*$. The first-order conditions are

$$\begin{aligned}
\frac{w}{N} - \frac{e_i^*}{c_i} + k(m^*, \mathbf{t}) &= 0 \text{ when } e_i^* < m^*, \\
\frac{w}{N} - \frac{e_i^*}{c_i} + k(m^*, \mathbf{t}) &\geq 0, \text{ and } \frac{w}{N} - \frac{e_i^*}{c_i} < 0 \text{ when } e_i^* = m^*, \\
\frac{w}{N} [1 + g(\mathbf{t}) \frac{N}{N-1} (e_i^* - m^*)] - \frac{e_i^*}{c_i} &= 0 \text{ when } e_i^* > m^*.
\end{aligned}$$

The result may be obtained by solving for e_i^* in each of the cases. In the last case, $c_i w - N m^* > 0$

or $\frac{w}{N} - \frac{m^*}{c_i} > 0$ because the first-order condition evaluated at $e_i = m^*$ should be positive.

Assumption 1 also gives $N-1 - c_i w g(\mathbf{t}) > 0$. They together imply

$$m^* + \frac{N-1}{N} \frac{c_i w - N m^*}{N-1 - c_i w g(\mathbf{t})} - \frac{c_i w}{N} = \frac{c_i w - N m^*}{N} \left(\frac{N-1}{N-1 - c_i w g(\mathbf{t})} - 1 \right) > 0. \blacksquare$$

Figure 1 illustrates the optimal choice of effort given the team norm for a team of six members. Workers 1 and 2 are the least productive workers in the team and they continue to receive peer pressure to work harder. Workers 3 and 4 are mediocre workers who are productive enough to achieve the team norm but cannot provide additional collaborative efforts. They are motivated by piece rate and threat of peer pressure. Worker 5 and worker 6 are the most

productive workers whose collaborative efforts are so effective that piece rate alone gives them additional incentives to choose effort levels that are higher than the team norm.

Now, we derive the steady-state team norm. Let $M(m^*)$ be the mean of $\{e_1^*, e_2^*, \dots, e_N^*\}$, which are obtained as functions of m^* in Lemma 1. The steady-state equilibrium can be found by solving $M(m^*) = m^*$.

Proposition 1 There exists an equilibrium e^* .

Proof: From Lemma 1,

$$e_i^* = \max\left\{\min\left\{c_i\left(\frac{w}{N} + k(m^*, \mathbf{t})\right), m^*\right\}, \frac{c_i w}{N}\right\} + \frac{c_i w}{N} \frac{[c_i w - N m^*]_+}{(N-1) - c_i w g(\mathbf{t})}. \quad (0.5)$$

Since the right-hand terms are all continuous in m^* , $M(m^*) = \sum_{i=1}^N e_i^*$ also is a continuous function of

m^* . Choose a sufficiently large number \bar{M} such that $m^* < \bar{M}$. For example, choose any \bar{M} such that $\bar{M} > c_i\left(\frac{w}{N} + k(\bar{M}, \mathbf{t})\right)$. There exists such \bar{M} because k is bounded by Assumption 1. Then, by

applying the fixed point theorem to the mapping $M: [0, \bar{M}] \rightarrow [0, \bar{M}]$, the existence of the equilibrium is obtained. See Figure 2. ■

In order to show uniqueness of the equilibrium, we need to show that $M(m)$ does not cross the 45 degree line more than once, which is true when workers are heterogeneous enough and peer pressure does not rise too much as the team norm increases. For example, if

$$c_1\left(\frac{w}{N} + k(m, \mathbf{t})\right) < \frac{c_N w}{N} \text{ and } c_i k_m < 1 \text{ for all } m, \frac{de_i^*}{dm} < 1 \text{ for any } m. \text{ This implies that } \frac{dM(m)}{dm} < 1,$$

which is sufficient to ensure the uniqueness.

To avoid tedious notation, *we assume that the equilibrium is unique in the rest of the paper*. However, this assumption is not essential because our results are easily extended to the case of multiple equilibria by replacing the unique equilibrium with the most productive or the least productive equilibrium.

Analyses

Now, we analyze how heterogeneity affects the equilibrium.

Corollary 1 m^* is decreasing in τ .

Proof: From (0.5), e_i^* is decreasing in τ . Hence, $M(m)$ shifts down as τ increases. As Figure 2 shows, m^* decreases as τ increases. ■

The impact of a change in skill heterogeneity is challenging to analyze because we have to assess the change in the profile $\mathbf{c} = \{c_1, c_2, \dots, c_N\}$. Since it is difficult to derive a general result for a particular dispersion measure of \mathbf{c} , we only consider the following mean-preserving change in variance of $\{c_1, c_2, \dots, c_N\}$. Suppose workers are heterogeneous enough so that not all workers choose the same effort level. Take i and j such that $c_i(\frac{w}{N} + k(m^*, t)) < m^* < \frac{c_j w}{N}$. How will the incremental change from (c_i, c_j) to $(c_i - \Delta c, c_j + \Delta c)$ affect m^* ? We take the derivatives of e_i^* and e_j^* with respect to Δc fixing m^* to assess this change.

$$\begin{aligned}
\frac{\Delta e_i^*}{\Delta c} + \frac{\Delta e_j^*}{\Delta c} &= \underbrace{-\left(\frac{w}{N} + k(m^*, \mathbf{t})\right)}_{\text{Change in peer pressure effect}} + w \underbrace{\frac{N-1}{N} \frac{N-1 - Ng(\mathbf{t})m^*}{(N-1 - c_j w g(\mathbf{t}))^2}}_{\text{Change in the effect of collaborative effort}} \\
&> -\left(\frac{w}{N} + k(m^*, \mathbf{t})\right) + w \frac{N-1}{N} \frac{1}{N-1 - c_j w g(\mathbf{t})} \\
&= -k(m^*, \mathbf{t}) + \frac{w}{N} \frac{c_j w g(\mathbf{t})}{N-1 - c_j w g(\mathbf{t})}
\end{aligned}$$

where the inequality is derived from $m^* < \frac{c_j w}{N}$.

This derivative implies that an increase in skill heterogeneity is likely to have a positive impact on team productivity when the team norm is low (*i.e.* $k(m^*, \mathbf{t})$ is low), the piece rate w is high, the increase takes the form of an increase in the skill of the most productive worker (*i.e.* c_j is high), and the value of collaborative effort is high (*i.e.* $g(\mathbf{t})$ is high).

Because participation in teams was at least initially voluntary in the Koret factory, Hamilton, Nickerson and Owan (2003) asked who was more likely to join a team first. If worker i produces $q_i = e_i$ and faces the same piece rate w under straight-line production, she will choose $e_i^* = c_i w$ and her equilibrium payoff will be $u_i^* = w e_i^* - c_i (e_i^*) = \frac{c_i w^2}{2}$ before joining a team. The worker should not join a team unless the expected payoff in the team exceeds this payoff. Our initial expectation was that less productive workers should have joined teams first because they could free-ride on the work of more productive workers. Surprisingly, the results in Hamilton, Nickerson and Owan (2003) indicate that more productive workers tend to join teams first. This result may imply that $k(m, \mathbf{t})$ was expected to be high, which discouraged less able workers to join teams, or that psychological utility of joining a team $b(\mathbf{t})$ was systematically higher for more productive workers.

In this paper, we ask the question of who is more likely to switch teams. Since the earlier result indicates that demographic diversity reduces the equilibrium payoff by reducing team productivity, team pay, and non-pecuniary benefits of working in team, greater demographic differences also should raise the team-member turnover. When team diversity in skills and ability is great, the most productive worker is more likely to switch teams because she will be able to enjoy a higher pay by switching teams. How skill diversity affects the turnover of least productive workers is less clear. On the one hand, the least productive worker is likely to experience disutility from strong peer pressure. But, on the other hand, the least productive worker benefits from the productivity gain derived from skill diversity.

To summarize, our formal model argues that diversity in skill level and ability enhances the team productivity if there is significant mutual learning and collaboration within the team. In contrast, demographic diversity along such dimensions as age and ethnicity is likely to harm productivity by making learning and peer pressure less effective. Demographic diversity also should lead to increased levels of team-member turnover.

2. Production at Koret

Our empirical context for analyzing these predictions is weekly productivity reports from a Koret Corporation garment manufacturing facility in Napa, California. The facility produces “women’s lowers” including pants, skirts, shorts, etc. These garments are mid-priced clothes purchased and distributed by department stores. Along with many other firms in the garment industry, a major reason for the introduction of team production over the 1995 – 1997 period at Koret is the demand by retailers that apparel companies make just-in-time deliveries. As noted by Berg et al. (1996), such demands required more flexible production systems, and pushed manufacturers like Koret to replace traditional individual production methods with more flexible

teams. Because module production was expected to decrease costs through reductions in inventory, manufacturing space, supervisory and service functions, quality inspections, and rework, many apparel manufactures were willing to adopt a team system even if worker productivity fell.

Garment production at the plant is segmented into three stages. First, cloth is cut into pieces that conform to garment patterns. Finished garments may contain anywhere between 2 and 10 individual pieces including pockets, fronts, backs, waistbands, belt-loops, etc. Second, garments are constructed by sewing together pieces. Third, garments are finished by pressing, packaging, and placing them into a finished goods inventory where they await delivery to a storage warehouse or to customers. Our study focuses on the sewing operation.

Progressive bundling system production

Historically, the plant used a Taylorist progressive bundling system (PBS) (e.g., Dunlop and Weil (1996)) for production. In PBS production, sewing operations are broken down by management into a number of distinct and separate operations (usually totaling between 10 and 30) depending on the complexity of the garment. Management, in consultation with the union, assigns an expected sewing time or “standard” (in minutes) for each operation such that the amount of effort required to sew a standard minute is equivalent across tasks. The standard, which typically ranges between 0.5 and 2.0 minutes per operation, makes comparison of productivity across tasks and garments feasible and represents the central measure against which productivity is evaluated. Workers without any sewing background require little training (approximately 2 weeks of on-the-job training). Sewing stations with one worker sitting at each station are evenly spaced in a grid on the shop floor and one sewing operation is assigned to each station. Two floor supervisors assign sewing tasks and deliver batches of material (stored on movable carts that hold between 30

and 50 garments or pieces of cloth) to sewing stations. Workers take garments from an input cart, execute their single sewing operation and re-stack the garments on an output cart. These carts hold the work-in-process (WIP) and remove any possibility of production externalities.³

Seamstresses are paid based on individual piece rates according to the standard set for the operation they undertake. In addition to the piece rate standard, workers also receive an hourly wage, or variance pay, when work is interrupted. Variances include the lack of work, machine breakage, job transfer, extra handling other than specified in the prescribed method, rework for which the seamstress is not responsible, making samples, and jury duty.⁴

Quality inspections during sewing occur two times: when the garment is half completed and again when it is fully completed. Supervisors record the seamstress' name for each batch sewn to track the source of such problems. Quality is evaluated by randomly selecting six out of the 30 to 50 garments in a bundle. Quality problems include non-uniform stitching, crooked stitching, etc. Reworking garments due to one's poor quality is a variance that is unpaid—workers must correct their own quality problems without pay.

During the transition from PBS to module production, the plant manager used PBS production for garment orders with long lead times and large production volumes such as those before a selling season begins, in which quantities of greater than 50,000 units are common.

³ One exception to this independence is that workers may compete against each other to gain the favor of their supervisor so that they receive sewing tasks when production is slack. The supervisor acknowledged that an estimated 25% of the workers behave strategically to insure a steady supply of work during slow production periods (the supervisor called these interactions "greedy problems").

⁴ During these interruptions, the union contract specifies that workers are paid either the minimum wage or an average wage, which is calculated for each worker based on their take home wage over the preceding 13 weeks. For the first two variances, workers receive a minimum wage for the first half-hour and average wage thereafter. Job transfers receive minimum or average wages depending on the situation. Extra handling, rework, and sample making are paid with an average wage. Jury duty is paid at the minimum wage less jury pay. Variance wages, on average, are approximately 10 to 11% of total garment standard (for a total of 111% when total garment standard is included). Also, supervision and management accounts for approximately 5% of total garment standard (for a total of 116%).

Production time from receipt of order is approximately 5 weeks with materials in the sewing operation for approximately 2 weeks. Cumulative sewing time per garment is between 5 and 20 minutes depending on garment style. At any time, the sewing operation may have 10,000 garments in WIP.

Module Production

In the winter of 1994 the plant manager began experimenting with the use of flexible work teams known in the garment industry as module production. The general manager handpicked the first team. The manager began to rely on module production in earnest by setting up eight teams in 1995. However, instead of hand picking teams, he asked for volunteers. After joining a team, seamstresses could return to PBS production if they preferred it or if other team-members voted a worker off the team. This option was available until mid-1996 when the manager decided to convert the entire plant to module production. When initially interviewed in the fall 1995, the manager had no plans to convert the entire plant to module production.

In module production at Koret each team typically is comprised of six or seven team-members⁵ who work in a U-shaped work space approximately 12' x 24'. Contiguously located around the partitioned workspace are 10 to 12 sewing machines mounted on wheels so that the ordering of machines is easily changed.⁶ Unlike seamstresses in floor production, module team-members sew standing up. Instead of storing WIP on carts, WIP is held on small dowels jutting out between each workstation. The dowel acts as a kanban⁷ where team-members take pieces

⁵The manager stated that he experimented with the number of workers on a team. He believed that 10 workers were too many for the team to effectively make joint decisions and less than five was too few because cooperation broke down.

⁶ A variety of different sewing machines, which are specialized for different types of operations, exist.

⁷ Kanban is a Japanese production concept whereby a queue between workstations is kept low by rule. In the limit where only one item is allowed in the queue, the upstream worker is not to perform her task and place WIP in the queue until it is empty.

from the right and place sewn pieces into the left kanban. By rule, kanbans may hold no more than three to five garments, depending on the length of sewing operations (long operation times have smaller queues while short production times have larger queues). The use of a kanban introduces a production externality among workers as each worker's productivity depends on adjacent workers' output. The kanbans and close proximity of workers and machines reportedly facilitate team-members quickly identifying bottleneck operations and changes in worker productivity. Also, workers are cross-trained on all sewing machines and receive training on the use of the kanban production rule.

Modules are compensated with a group piece rate—the team receives a piece rate for the entire garment as opposed to a piece rate for each operation. The team's net receipts are divided equally. Group piece rates for modules have two additional differences from individual piece rates. First, each worker on the floor must unbundle and bundle the stack of garments when it arrives and leaves the workstation. Bundling and unbundling time accounts on average for five percent of the standard time for sewing an entire garment and is included in the PBS standard. With the module's kanban system, bundling and unbundling is not needed between operations—only when raw material bundles first arrive and finished goods bundles finally leave the work area. Thus, the standard for an entire garment is five percentage points lower for modules because of the elimination of intermediate unbundling and bundling steps, which means that teams should be able to increase garment production by 5%, *ceteris paribus*. However, worker productivity of PBS and module production is measured in comparison to standard minutes, not garments, meaning that worker productivity measures for each are directly comparable. Second, whereas floor workers receive variance wages averaging approximately 10 to 12% of standard, module team-members receive no such variance wages. Instead, team-members receive piece-rate wages

approximately 11% above the module-adjusted standard, which provides a small increase in incentive intensity. Quality, which the plant manager stated was at least as good and perhaps better than quality provided by PBS production, is monitored upon completion of the garment using same inspection method found in PBS production.

Initially, module production was used in response to three trigger events: small order quantities or need to replenish inventories, special short-term deliveries for customers, or small volumes. The characteristics of these orders is that they have very short lead times and small volumes ranging from 100 to 10,000 garments with an average of approximately 2,000 garments. The manager asserted that an important advantage of module production is that it can sew a batch of 300 garments within eight hours whereas conventional production would in the best scenario require at least two days of sewing and the efforts of up to two-dozen workers to sew the same number of garments. The plant manager also stated that just-in-time stocking by retailers had been a trend that had increased the need for small production runs with little forewarning.

While modules essentially use the same labor, capital, and material inputs as PBS production, modules differ in that the team is empowered to make an array of production decisions. Workers from one team described some of these decisions as well as the advantage and disadvantages of module production. Workers reported that they could produce faster with higher quality in modules. They claimed they learned all production tasks, had more information about production tasks, and were able to shift tasks, share tasks, and “figure our easier ways to sew” garments. They stated that they found working in a team to be more interesting and fun, they enjoyed the friendships they developed in the team, and they preferred standing to sitting because it avoided backaches. They reportedly pushed each other to work hard, which often involved joking around. They also stated that other team members quickly caught quality problems, which allowed

the team to quickly identify and correct the source of quality problems. Team members claimed that the biggest difficulty of module production is that workers hold a “variety of attitudes”, which can lead to “communication problems and misunderstandings”. The manager added that workers were more aggressive than management at disciplining team-members.

3. The Koret Data

This paper utilizes a novel data set constructed from the personnel records of employees at Koret over the time period covering January 1, 1995 until December 31, 1997. The data consists of weekly information on worker pay, hours worked, and team membership for all individuals employed at Koret over this period. In addition, the ethnicity and birth date of each worker also was obtained, although further data on education, training, and so forth was not available to us. Finally, productivity is measured at the individual level when the worker is operating under the PBS system and at the team level for workers engaged in module production. The productivity variable is measured as efficiency relative to the standard described above, with values greater than 100 indicating performance above the standard level.

Figure 3 plots median weekly productivity at the plant from the first week of 1995 (week 0) to the last week in 1997 (week 156). In addition, the fraction of plant workers engaged in team production is also presented. The figure shows that median productivity at Koret increases after the bulk of Koret workers are working in teams after week 70. However, the plot also shows substantial cyclical variation in productivity, which is accounted for by the inclusion of month and year dummies in the subsequent regression analysis. Table 1 presents summary statistics for the team-week data, indicating substantial variation in weekly team productivity across teams and over the 1995-1997 period. These productivity differentials translate into substantial variation in worker pay. Comparing team productivity with the average productivity in individual production

of the team members, both the 50th and 75th percentiles suggest that teams increased productivity, while the difference at the 25th percentile suggests that for at least some teams and/or weeks, teams were less productive. Finally, there appears to be substantial variation in the ethnic composition of teams over time.

Measuring Diversity in Teams

The model in Section I suggests that the most able worker on a team at Koret will have a strong influence on team productivity due to the help she can provide to other less able members. Similarly, the least able member may require substantial help to achieve the team norm level of output. Consequently, following Hamilton, Nickerson, and Owan (2003), we measure skill diversity within the team by the ratio of the maximum to the minimum average individual productivity levels of the team members. To measure the demographic diversity of the team, we use the standard deviation of the natural logarithm of the ages to measure age diversity. The standard deviation of $\ln(\text{age})$ implies that percentage rather than absolute differences in the age of team members affect communication among individuals. For example, one might argue that communication may be more difficult between a 20 and 25 year old than between a 40 and 45 year old.⁸ Our second measure of demographic diversity considers the ethnic/racial composition of the team. Nine ethnic/racial groups are represented at Koret.⁹ 54% of the workers are Hispanic, followed by 12% who are Vietnamese. More importantly, the only ethnically homogenous teams are Hispanic, and virtually all the teams that have at least two-thirds of team members belonging to the same ethnic group are largely Hispanic. Given that this group shares a common language,

⁸ Leonard and Levine (2002) argue that the standard deviation of $\ln(\text{age})$ provides a better measure of social distance than the standard deviation of age.

⁹ These ethnic/racial groups include Hispanics, whites, blacks, Filipinos, Chinese, Japanese, Vietnamese, Indians, and Koreans.

Spanish, we measure ethnic/racial diversity of each team by the fraction of the team that is Hispanic.

Columns (1) – (4) of Table 2 summarize the skill and demographic characteristics of teams at the date of formation, including average worker productivity for individuals prior to joining the team and the level of skill and demographic diversity. The table describes four notable findings. First, column (1) shows that teams formed in 1994 and 1995 not only tend to be comprised of more able workers, but they also have greater diversity in skill, perhaps in an attempt to capture the benefits of mutual learning. By contrast, teams formed in 1996 and 1997, when team participation was less voluntary generally, have lower average skill and are less diverse in terms of ability. Second, later teams tend to be more diverse in terms of age, as evidenced by column (3). Again, the earlier teams may have been more able to reduce communication costs due to their ability to “hand-pick” their teammates. Third, column (4) provides relatively little evidence of substantial worker segregation across teams. Only team three is comprised completely of Hispanic workers, and 9 of 25 are comprised of two-thirds or more Hispanics. Moreover, with the exception of team 8, no team has over half of its members belong to one of the other ethnic/racial groups. Finally, comparison of columns (1) and (5) indicate productivity increases in 14 of the 23 teams for which we have valid pre- and post-team data. Teams formed in 1995 are the most likely to show a productivity increase, while teams formed in August 1996 and later (when team participation was less voluntary) experience declines. As discussed in Hamilton, Nickerson, and Owan (2003), it may be the case that workers with greater collaborative skills joined the early teams.¹⁰

¹⁰ Table 2 shows that Team 21, which consisted primarily of new hires with no Koret experience, was highly productive. We suspect that this team was “hand-picked” by management, since it consisted of young workers in their early twenties from a range of ethnic backgrounds (as judged by the workers’ names). Because no pre-team productivity data is available, Team 21 is excluded from the team regressions reported in Table 3 and 4 below.

4. The Impact of Diversity on Productivity

In this section, we investigate the impacts of skill heterogeneity and demographic diversity on productivity in teams at Koret. The theory outlined in Section I suggests that teams with more diverse skills will be more productive, all else equal, when highly productive workers can substantially increase the production of the least able workers on the team by helping, teaching or coordinating activities (*e.g.*, g is high enough). Conversely, our model suggests that if demographic diversity increases communication costs, more heterogeneous teams in terms of age and/or ethnicity should be less productive. A particular advantage of the Koret data is that we are able to observe individual productivity prior to team membership for many workers, and so we are able to distinguish between diversity in skill and diversity in demographic characteristics.

To examine the impact of team composition on team productivity, let y_{jt} be the natural logarithm of the productivity of team j in week t at Koret. A team's weekly productivity is modeled as:

$$(4.1) \quad y_{jt} = M_{jt}\mathbf{a} + D_{jt}\mathbf{b} + X_{jt}\mathbf{d} + \mathbf{e}_{jt},$$

where the vector M_{jt} consists of measures of the productivity of team j 's members in week t , such as the average individual productivity level and the spread in individual abilities. The vector D_{jt} consists of measures of the demographic characteristics of team j 's members in week t , including the average $\ln(\text{age})$, the standard deviation of $\ln(\text{age})$, and indicators of whether the team consists of two-thirds Hispanic employees, or whether all the workers on the team were Hispanic. X_{jt} includes variables thought in the literature to affect team productivity: team size ($SIZE$); the length of time the team has been in operation ($TEAM\ TENURE$) and its square; the length of time the current members of the team have worked together ($LINEUP\ TENURE$) and its square; and whether the team includes a new hire with no previous Koret experience ($NEWHIRE$). To account

for possible selection effects, a variable indicating that the team was formed in April 1996 or later (*LATER TEAM*) is also included. Figure 1 indicated that output at Koret exhibited substantial seasonal variation. To account for this factor, we obtained monthly data on U.S. women's retail apparel sales over the period from the Bureau of Economic Analysis. We include period t retail sales as well as sales up to 6 months in the future as regressors in the X_{jt} vector, since such future sales may translate into current period demand for Koret output. Because the retail sales variable is seasonally adjusted, month dummies are also incorporated into X_{jt} to account for cyclical factors. Finally, we do not have complete data on Team 1, and Team 21 initially consisted entirely of outsiders for whom we have no pre-team productivity data. Consequently, these two teams are not included in the regression analysis described below.

The first column of Table 3 present random effect estimates of equation (4.1), where the error term is specified as:

$$(4.2) \quad \mathbf{e}_{jt} = \mathbf{q}_j + \mathbf{h}_{jt},$$

to account for correlation in \mathbf{e}_{jt} over time. The results in column (1) exhibit four notable features. Not surprisingly, teams with more able members, on average, are more productive. More striking is the finding that holding ability constant, teams with more diverse skills also tend to be more productive. This result holds in our median regression model shown in column (2) that is more robust to outliers in the dependent variable. The positive estimated relationship between the spread in skill and productivity is consistent with the case of high $g(\mathbf{t})$ in the model in Section I, which argued that a team with a greater spread in ability will be more productive when the value of collaborative effort is high. Moreover, Hamilton, Nickerson, and Owan (2003) suggest that the most skilled workers may be able to increase the team norm level of output by threatening to quit the team.

The coefficient estimate in the fourth row of column (1) indicates that teams with more diversity in age are significantly less productive. This finding is consistent with those of Leonard and Levine (2002), who find that retail stores with greater age diversity among its employees tend to be less profitable. However, Leonard and Levine are not able to determine the extent to which employees in their study firm work together in teams. A variety of studies in the Organizational Behavior literature find similar negative impacts of age diversity on alternative measures of team performance (see Reskin et al. (1999)). For example, Zenger and Lawrence (1989) find that age homogeneity enhances technical communication. However, these papers typically do not distinguish between the roles of diversity in skill versus heterogeneity in the demographic characteristics of team members.

Estimates of our second measure of demographic diversity, the team's ethnic composition, provides mixed support for the view that demographically homogeneous teams have lower communication costs that may lead to higher productivity. Column (1) shows that teams comprised entirely Hispanics are 10% more productive than more ethnically diverse teams at Koret. However, the magnitude and significance of this coefficient estimate falls in the median regression in column (2). Moreover, teams of two-thirds or more Hispanic members (e.g., a six person team with four or five Hispanic members) are no more productive than more diverse teams.

One concern about the estimates described above is that there are unobserved team characteristics correlated with the diversity measures that also affect productivity. For example, Hamilton, Nickerson, and Owan (2003) show that more able workers joined teams first at Koret, and the negative coefficient estimate for teams formed in 1996 or 1997 shown in Table 3 suggests that early teams may have had higher levels of collaborative skills. We take two approaches to attempt to account for the potential confounding role of team-level unobserved factors. First, we

estimate fixed effect models of equation (4.1), so that the impact of diversity on productivity is identified by within-team changes in team composition. After including team fixed effects in the regression, column (3) of Table 3 shows that increasing the average skill level of the team increases productivity, as was the case in the random effects and median regressions. Moreover, increasing the skill diversity of the team, holding the average constant, continues to positively affect team productivity, although the impact is moderated somewhat by the inclusion of the team fixed effects.

The coefficient estimates of the demographic diversity measures shown in column (3) do not appear to be robust to the inclusion of team fixed effects. The estimated impact of diversity in the age of team members becomes positive but insignificant, while the productivity of teams composed solely of Hispanics is not significantly different from that of more ethnically diverse teams. In fact, teams comprised of two-thirds or more (but not all) Hispanics are actually less productive than more diverse teams once team dummies are included in the model. Overall, the results from Table 3 suggest that teams with more diverse skills and abilities are more productive at Koret, but the role of demographic diversity is less clear and may in fact not play a significant role in explaining productivity differences across teams.

The fixed effects specification assumes that unobservables affecting changes in team membership are uncorrelated with changes in productivity, which may be questionable. While managers at Koret did not randomly choose team members, recall that membership in teams was voluntary in 1995, but became less voluntary as the firm changed to full-scale modular production in mid-1996. While workers could still choose to leave the firm in 1996 and later, team formation during this period appears to be closer to the ideal of a natural experiment in which team membership is randomly assigned. Consequently, we re-estimate the productivity regressions for

the subset of teams formed between 1994 and March 1996, and those formed in April 1996 and later.

Comparison of columns (1) and (3) of Table 4 shows that diversity in skill continues to have a significantly positive impact on team productivity, regardless of when the team was formed. Demographic heterogeneity has a mixed impact on productivity. Teams with more diversity in age are less productive, although this finding is only significant for the teams formed later at Koret. In contrast, all Hispanic teams are no more productive than those that are ethnically diverse. Similar results are found in the median regressions. To summarize the results from this section, skill diversity raises team productivity as predicted by our model, and this finding is robust across specifications. There is evidence, although it is less robust, regarding the role that demographic diversity plays, since the results are sensitive to assumptions regarding unobserved factors that may be correlated with team formation. This may not be too surprising, given that the relative simplicity of the production work at Koret suggests that communication may be less important.

5. The Impact of Diversity on Turnover

We now turn to the questions of whether more diverse teams suffer greater turnover, and whether individuals that are more “isolated” on teams are more likely to leave. Participation in teams may offer non-pecuniary benefits, such as less repetitive work and more social interaction than in individual production. However, it has been argued that these benefits may be reduced if the worker is not part of the majority group on the team, due to tastes for discrimination or isolation (Becker (1957)).

To analyze the impact of diversity on turnover at Koret, we construct team employment spell data for 189 workers who spent at least one week on a team during 1995-1997. Some workers either switched teams or had more than one stint on a given team, yielding a total of 355

spells of team participation. Figure 4 shows the fraction of founding team members remaining on the team at the end of our sample period. Team membership is surprisingly stable. For example, five of the seven members of team 1, founded in 1994, are still on the team as of December 1997, as are five of the original seven members of team 8. On the other hand, there are a few teams that have experienced substantial turnover, such as teams 6 and 19, which have no original members. In some cases, workers from these teams left the firm altogether, while others joined another team at Koret, sometimes as a founding member.

To investigate worker turnover on teams more closely, we examine how the conditional probabilities of leaving the team over the course of the worker's team spell. To do this, we construct the empirical transition intensity for destination r , $I_r(t)$, which describes the fraction of team spells that last exactly t weeks and end for reason r , given that the team spells are at least t weeks long.¹¹ We distinguish between two possible reasons for exiting the team: Leaving to join another team (denoted by $r = o$); and exit from the firm or a return to individual production (denoted by $r = e$). Very few workers leaving a team return to individual production, so the vast majority of $r = e$ exits represent an employee leaving the firm completely.

Figure 5 plots the empirical transition intensities for workers leaving their teams to join another team ($I_o(t)$) or to leave Koret ($I_e(t)$), over the first six months on the team. The figure indicates that the conditional probability of leaving a team for any reason is initially declines after the first few weeks on the team. One interpretation of the negative duration dependence observed in Figure 5 is that match quality or learning about teammates' attributes is important in forming a team. Poor matches of the individual worker with the team end relatively quickly. Of course, it

¹¹The empirical transition intensity is defined as $I_r(t) = (\# \text{ of job spells lasting exactly } t \text{ weeks and ending for reason } r) / (\# \text{ of job spells lasting at least } t \text{ weeks})$.

may also be the case that a worker may temporarily participate on one team while waiting for a space on another team to open. However, this argument cannot explain why the conditional probability of leaving firm, as opposed to switching teams, declines roughly monotonically from week one.

To examine the impact of covariates on the conditional probability of leaving a team at Koret, we estimate an independent competing risks model. The transition intensity for worker i associated with leaving the team after t weeks for reason r follows the proportional hazards specification:

$$(5.1) \quad \mathbf{I}_r(t | M_{jt}, D_{jt}, X_{jt}, Z_{ijt}, W_t) = \exp(M_{jt}\mathbf{g}_r + D_{jt}\mathbf{m}_r + X_{jt}\mathbf{p}_r + Z_{ijt}\mathbf{r}_r + W_t\mathbf{w}_r)\mathbf{I}_{0r}(t), \quad r=e, o,$$

where M_{jt} , D_{jt} , and X_{jt} are time-varying covariate vectors defined as above. The vector Z_{ijt} includes worker i 's individual characteristics, in most cases measured relative to the team j average at time t .¹² Finally, over the course of the three year period under study, there were an increasing number of teams available for a Koret worker to switch to. To measure the impact of the changing team opportunity set for the individual, the vector W_t consists of dummy variables indicating whether week t of the spell occurred during particular periods defined by the number of teams in operation at the plant.¹³

The specification in equation (5.1) allows us to determine whether workers that differ from their teammates are more likely to leave the firm or switch teams. $\mathbf{I}_{0r}(t)$ represents the baseline transition intensity. Several parametric and non-parametric methods are available to estimate the baseline hazard (see Lancaster (1990)). We seek a flexible form for the baseline transition

¹² There may be some concern about the potential endogeneity of the M_{jt} and D_{jt} variables as they vary over the course of the spell. We re-estimated the models shown in Table 5 measuring the covariates included in M_{jt} and D_{jt} at the time the worker joined the team. This approach yielded very similar results to those reported in Table 5.

intensity since misspecification of $I_{0r}(t)$ may lead to biased parameter estimates (Heckman and Singer (1984)). To avoid such problems, we adopt a Cox proportional hazard specification in which the baseline hazard is estimated non-parametrically. This approach allows us to capture the features of the empirical hazard functions for each risk as shown in Figure 5.

Table 5 presents the estimates for the duration model outlined above, where a positive coefficient indicates that an increase in the variable is associated with an increase in the transition intensity. The base specification estimates are shown in columns (1) and (4) for the conditional probability of leaving the team to exit the firm and switching teams, respectively. We first focus on the transition intensity associated with workers exiting the firm. Workers at Koret do not appear to exit the firm in response to participation in a more diverse team in terms of skill or age. With regard to ethnicity, there are no exits from the firm among individuals on all Hispanic teams, and membership on a two-thirds Hispanic team reduces the transition probability. It is the case that membership in a larger team significantly reduces the probability of exit, perhaps because team size is endogenously determined. If the management knew that someone in a six-person team is likely to leave, they would add one more worker to avoid disruption. In contrast, if a six-person team has been very successful, the management would not risk hurting high team norm by adding one more individual to the team. With regard to the individual variables, following studies such as Leonard and Levine (2002), we measure individual isolation on the team as the absolute value of the distance between the worker's characteristics and the average of those for the team. We also distinguish in many cases whether the worker was above or below the team average, due to potential asymmetries in response implied by our theoretical model. The results in the bottom half

¹³ From Table 2, we define a set of dummy variables indicating whether period t of the spell fell during: (a) weeks 32 to 67, when teams 1 – 9 were operating; (b) weeks 68 – 101, when teams 1 – 20 were operating; (c) weeks 102 – 135, when teams 1 – 23 were operating; (d) weeks 136 – 155, when all teams were operating at Koret.

of column (1) indicate that distance from a worker's teammates in terms of age or skill does not affect the decision to leave the team and the firm. Hispanics are less likely to leave the firm, although somewhat surprisingly this effect is moderated by being in the majority on a two-thirds Hispanic team.

More intriguing results are found in column (4) for the transition intensity associated with switching from one team at Koret to another. More highly skilled teams experience less switching, perhaps because, as shown in Table 3, such teams are more productive and hence more highly paid. All Hispanic teams also experience less switching. This could reflect either worker preferences for segregation, or recognition that such teams may have lower communication costs or greater ability to exert peer pressure, both of which may increase productivity. While the estimates of the individual variables in the bottom half of column (4) suggest that workers with above average skills on the team are more likely to switch, perhaps due to poaching, the estimate is not statistically significant. Age and ethnicity (outside of participation on an all Hispanic team) play an insignificant role in the decision to change teams.

The model in Section 1 suggested that workers may prefer to remain on teams that are more demographically homogeneous, both because of the reduction in communication costs that enhances the value of collaboration and hence output in team production, and because individuals like working with similar employees. In order to distinguish between these two explanations for turnover, our second specification of the transition intensities includes a covariate measuring lagged team productivity.¹⁴ Holding this factor constant, the demographic variables are likely to reflect preferences toward working with similar individuals. In addition, although it is difficult to measure peer pressure within the team, it may be reasonable to assume that peer pressure is

¹⁴ The measure of lagged team productivity used in the duration model is the average productivity over the previous four weeks. The results are not sensitive to changes in the lag length.

related to the difference between the worker's individual productivity and the productivity of the team. Workers whose individual productivity was low may find it difficult to raise effort enough to meet the team norm, and so may face additional peer pressure that reduces the utility associated with remaining on the team.

Columns (2) and (5) present estimates of the transition intensities including measures of team productivity. Workers on more productive teams are less likely to switch to another team, although this finding is only moderately significant. Similarly, the significant coefficient found for the average productivity of team members in column (4) appears to reflect the fact that more skilled teams are more productive and earn higher wages. Workers on teams with more diverse skills are more likely to switch, although it is difficult to interpret this coefficient. It may be the case that other teams at Koret attempt to poach workers from more successful teams, which from Table 3 tend to more diverse in terms of skill. We note that workers on all Hispanic teams continue to be significantly less likely to switch teams, suggesting that participating in a homogeneous workgroup yields some utility gain to these workers, as suggested by Becker (1957). Finally, we find little evidence that workers whose individual productivity is above or below the team level are more likely to quit the firm or switch teams. It remains unclear what role peer pressure plays in team turnover.

In our last specification, we assess the prediction from the model in Section 1 that the most productive member of the team will be more likely to switch teams in order to increase her income. Moreover, it may be the case that the most able team member is more subject to being poached away by other teams at Koret. For the least able member on the team, two factors may be at work. The worker will want to stay on the team because she gains substantial monetary benefit from team membership. However, she may be subject to intense peer pressure due and hence be

more likely to leave the firm. In columns (3) and (6) of Table 5, we estimate the model including indicators of whether the worker was most skilled (Max on Team) or least skilled (Min on Team) on the team, interacted with the difference between the worker's production and the team average. The coefficient estimates indicate the most highly skilled worker is not significantly more likely to switch teams, either due to poaching or the desire to increase her income, and the least skilled worker is not significantly more likely to leave Koret. Overall, the results from this section suggest that there is relatively low cost to the firm in terms of turnover of diverse work teams, although support is found for the view that some workers prefer homogeneous groups.

6. Discussion and Conclusion

This paper evaluates the “business case for diversity.” The popular press often touts workforce demographic (e.g., ethnicity and age) diversity as profit enhancing. For instance, diversity may reduce the firm's communication costs with particular segments of customers and may yield greater team problem solving abilities. On the other hand, diversity also may raise communication costs in teams thereby retarding problem-solving ability and slowing productivity growth. Unfortunately, the effect of team diversity on productivity has not been studied formally and little empirical evidence concerning the impact of team diversity on productivity is found in the literature.

This paper formally and empirically explores the impact of diversity in the abilities and demographics of a firm's workforce on the productivity of teams and worker turnover. Our formal model argues that diversity in skill level and ability enhances the team productivity if there is significant mutual learning and collaboration within the team, while demographic diversity is likely to harm productivity by making learning and peer pressure less effective and to increase

team-member turnover. To evaluate these propositions we use a novel data from a garment plant that shifted from individual piece rate to group piece rate production over three years. Because we observe individual productivity data, we are able to econometrically distinguish between the impacts of diversity in worker abilities and demographic diversity. Consistent with our formal model, our results indicate that more heterogeneous teams in terms of worker abilities are more productive. Holding the distribution of team ability constant, teams with greater diversity in age are less productive, and those composed only of one ethnicity (Hispanic workers in our case) are more productive, but the findings for team demographics are not robust to alternative specifications of the regression model. Finally, workers on all Hispanic teams are less likely to leave the team, even after accounting for team productivity, indicating some preference for segregation among these workers.

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TABLE 1
DISTRIBUTIONS OF TEAM PRODUCTIVITY, PAY, AND COMPOSITION

Variable	Quantile		
	.25	.50	.75
Productivity	80.30	98.24	114.02
Weekly Earnings per Member	\$219.04	\$294.65	\$361.52
Average Team Skill ¹	83.61	91.31	102.49
Average Team Age	33.4	35.7	39.2
Fraction Hispanic	0.33	0.50	0.80
Number of Team-Week Observations	2012		

¹ Average team skill measured as average productivity of team members under individual production.

TABLE 2
DATES OF TEAM FORMATION, INITIAL TEAM CHARACTERISTICS, AND
AVERAGE WEEKLY TEAM PRODUCTIVITY

Team	Date of Team Formation	Mean Individual Productivity ¹	Min/Max Individual Productivity	S.D. of ln(Age)	Fraction Hispanic	Team Productivity (Weeks 21+) ²
		(1)	(2)	(3)	(4)	(5)
1	Mar. 12, 1994	97.8	1.57	0.22	0.71	114.3
2	Jan. 7, 1995	82.9	4.36	0.09	0.71	122.6
3	Jan. 28, 1995	79.4	2.45	0.22	1.00	97.6
4	Jan. 28, 1995	94.0	2.09	0.26	0.36	106.0
5	Jan. 28, 1995	117.8	1.50	0.38	0.21	118.9
6	Jan. 28, 1995	89.4	2.40	0.18	0.42	88.3
7	Apr. 29, 1995	89.6	2.95	0.23	0.83	107.8
8	Oct. 7, 1995	122.6	1.79	0.23	0.00	115.6
9	Oct. 28, 1995	127.4	2.15	0.27	0.29	131.3
10	Apr. 13, 1996	85.6	1.46	0.32	0.44	83.6
11	Mar. 30, 1996	100.4	1.78	0.27	0.21	111.8
12	Apr. 13, 1996	87.3	2.10	0.25	0.48	109.3
13	Apr. 13, 1996	94.6	3.18	0.16	0.17	106.1
14	Apr. 13, 1996	85.6	1.64	0.19	0.37	91.2
15	May 18, 1996	78.3	1.25	0.33	0.67	76.8
16	June 22, 1996	81.1	3.17	0.43	0.67	82.6
17	July 20, 1996	81.7	1.41	0.26	0.80	122.9
18	Apr. 13, 1996	92.6	1.62	0.28	0.00	95.5
19	Apr. 13, 1996	86.1	1.95	0.38	0.60	79.7
20	Aug. 10, 1996	127.5	2.10	0.39	0.33	114.4
21	Dec. 7, 1996	- ³	-	0.18	0.50	139.1
22	Jan. 18, 1997	94.0	1.50	0.35	0.57	80.0
23	Feb. 1, 1997	89.2	1.30	0.30	0.83	70.9
24	Mar. 15, 1997	92.1	1.85	0.20	0.80	61.2
25	Sep. 6, 1997	76.9	6.45	0.12	0.57	-

¹ Entries in column (1) are calculated by averaging the individual person-week productivity values of workers who subsequently join the particular team (individuals are weighted by the length of time they spent on the team).

² Team averages in column (5) calculated after excluding the first 20 weeks the team is in operation.

³ Team 21 consisted of almost all new hires and so pre-team productivity data is not available.

TABLE 3
EFFECT OF TEAM COMPOSITION ON TEAM PRODUCTIVITY
Dependent Variable is $\ln(\text{Productivity}_{it})$ For Team in Each Week

Variable	Specification		
	Random Effects (1)	Median (2)	Fixed Effects (3)
Average Productivity	0.004 (0.0008)	0.004 (0.0005)	0.005 (0.001)
Ratio of Max/Min Productivity	0.050 (0.011)	0.051 (0.016)	0.031 (0.016)
Mean $\ln(\text{Age})$	0.113 (0.102)	0.203 (0.060)	-0.062 (0.162)
S.D. $\ln(\text{Age})$	-0.360 (0.119)	-0.430 (0.070)	0.049 (0.216)
All Hispanic	0.100 (0.044)	0.045 (0.026)	-0.032 (0.082)
2/3 Hispanic	-0.021 (0.028)	-0.013 (0.016)	-0.149 (0.049)
<i>TEAM TENURE</i>	0.0033 (0.0016)	0.002 (0.0006)	0.0015 (0.0011)
<i>TEAM TENURE</i> ²	-0.0002 (0.00007)	-0.0002 (0.00004)	-0.0002 (0.00007)
<i>LINEUP TENURE</i>	0.011 (0.002)	0.007 (0.001)	0.008 (0.002)
<i>LINEUP TENURE</i> ²	-0.0015 (0.003)	-0.0010 (0.0002)	-0.0011 (0.003)
<i>SIZE</i>	0.003 (0.011)	-0.002 (0.006)	0.003 (0.014)
<i>NEWHIRE</i>	-0.006 (0.025)	-0.005 (0.015)	0.076 (0.037)
<i>LATER TEAM</i>	-0.072 (0.038)	-0.108 (0.022)	-

Note: N = 2012 observations. Standard errors in parentheses. Robust standard errors for Random and Fixed Effect regressions. Standard errors for median regressions are block bootstrapped with 500 replications. Each regression also includes a constant, dummies for each month, and cyclical variables measuring women's retail garment sales.

TABLE 4
EFFECT OF TEAM DIVERSITY ON TEAM PRODUCTIVITY, BY YEAR OF TEAM
FORMATION

Dependent Variable is $\ln(\text{Productivity}_{it})$ For Team in Each Week

Variable	Teams Formed Prior to April 1996		Teams Formed April 1996 and Later	
	Random Effects (1)	Median (2)	Random Effects (3)	Median (4)
Average Productivity	0.0027 (0.0015)	0.0036 (0.0007)	0.0090 (0.0012)	0.0082 (0.0005)
Ratio of Max/Min Productivity	0.048 (0.016)	0.028 (0.007)	0.038 (0.014)	0.056 (0.006)
Mean $\ln(\text{Age})$	-0.624 (0.205)	-0.289 (0.090)	-0.057 (0.127)	-0.146 (0.056)
S.D. $\ln(\text{Age})$	-0.275 (0.197)	-0.468 (0.086)	-0.332 (0.152)	-0.412 (0.066)
All Hispanic	0.047 (0.071)	-0.028 (0.061)	0.063 (0.077)	0.088 (0.064)
2/3 Hispanic	0.061 (0.048)	0.023 (0.041)	-0.096 (0.045)	-0.040 (0.040)

Note: Standard errors in parentheses. Robust standard errors for Random Effect regressions. Standard errors for median regressions are block bootstrapped with 500 replications. Each regression also includes a constant, dummies for each month, and cyclical variables measuring women's retail garment sales.

TABLE 5
TRANSITION INTENSITY ESTIMATES FOR LEAVING TEAM
Independent Competing Risks, Unrestricted Baseline Hazard

	Exit Event					
	Leaves Firm			Switches Teams		
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Team-Level Variables</i>						
Avg. Prod.	-0.017 (0.012)	-0.009 (0.012)	-0.010 (0.011)	-0.018 (0.008)	-0.004 (0.011)	-0.001 (0.011)
Ratio of Max/Min Prod.	-0.021 (0.191)	0.025 (0.181)	0.016 (0.180)	0.112 (0.098)	0.207 (0.107)	0.249 (0.108)
Mean ln(Age)	0.375 (1.627)	0.044 (1.417)	0.081 (1.410)	-0.473 (1.085)	0.026 (1.100)	0.075 (1.106)
S.D. ln(Age)	-0.385 (2.978)	0.104 (3.025)	0.141 (3.007)	0.977 (1.543)	0.820 (1.577)	0.779 (1.574)
All Hispanic Team	-	-	-	-2.039 (0.731)	-1.913 (0.770)	-1.894 (0.758)
2/3 Hispanic Team	-1.456 (0.698)	-1.321 (0.656)	-1.297 (0.659)	-0.726 (0.502)	-0.487 (0.532)	-0.494 (0.531)
Team Prod. ¹		-0.012 (0.011)	-0.011 (0.011)		-0.013 (0.007)	-0.015 (0.006)
Team Size	-0.354 (0.154)	-0.398 (0.140)	-0.403 (0.152)	0.079 (0.104)	0.058 (0.113)	0.058 (0.115)
Team Formed April 1996 or Later	-1.242 (0.631)	-0.247 (0.421)	-1.131 (0.747)	0.619 (0.453)	0.553 (0.469)	0.540 (0.467)
<i>Individual Variables</i>						
Individual – Avg. Prod. Above Avg. Prod.	0.004 (0.011)			0.010 (0.007)		
Individual – Avg. Prod. Below Avg. Prod.	0.009 (0.014)			0.003 (0.007)		
Individual – Team Prod. Above Team Prod. ²		-0.003 (0.007)			0.006 (0.005)	
Individual – Team Prod. Below Team Prod. ³		-0.001 (0.012)			0.003 (0.006)	
Individual – Avg. Prod. Max on Team			-0.006 (0.010)			0.004 (0.007)
Individual – Avg. Prod. Min on Team			0.002 (0.013)			-0.006 (0.007)
Individual – Mean ln(Age)	-0.480 (1.178)	-0.431 (1.180)	-0.439 (1.185)	-0.428 (0.717)	-0.352 (0.769)	-0.300 (0.765)
Individual is Hispanic	-1.610 (0.601)	-1.480 (0.607)	-1.482 (0.588)	0.321 (0.238)	0.362 (0.247)	0.391 (0.257)
Hispanic on 2/3 Hispanic Team	1.264 (0.940)	1.062 (0.920)	1.052 (0.923)	0.126 (0.539)	-0.024 (0.545)	-0.034 (0.552)
Team Founder	-0.739	-1.135	-0.236	0.246	0.239	0.238

	(0.397)	(0.743)	(0.427)	(0.260)	(0.275)	(0.277)
Log-Likelihood	-164.1	-158.9	-158.9	-539.1	-491.6	-491.8

Note: Based on N = 355 Worker-Team Spells. Robust Standard Errors in Parentheses. Each model includes team tenure and team tenure squared, indicators for week during sample period as defined in footnote 13, month dummies, and cyclical variables measuring women's retail garment sales.

¹Team productivity measured by average team productivity in previous four weeks.

²Variable is the value of Individual – Team Productivity if it is positive, zero otherwise.

³Variable is the (absolute) value of Individual – Team Productivity is negative, zero otherwise.

Figure 1: Optimal Effort Choice Given Team Norm m^*

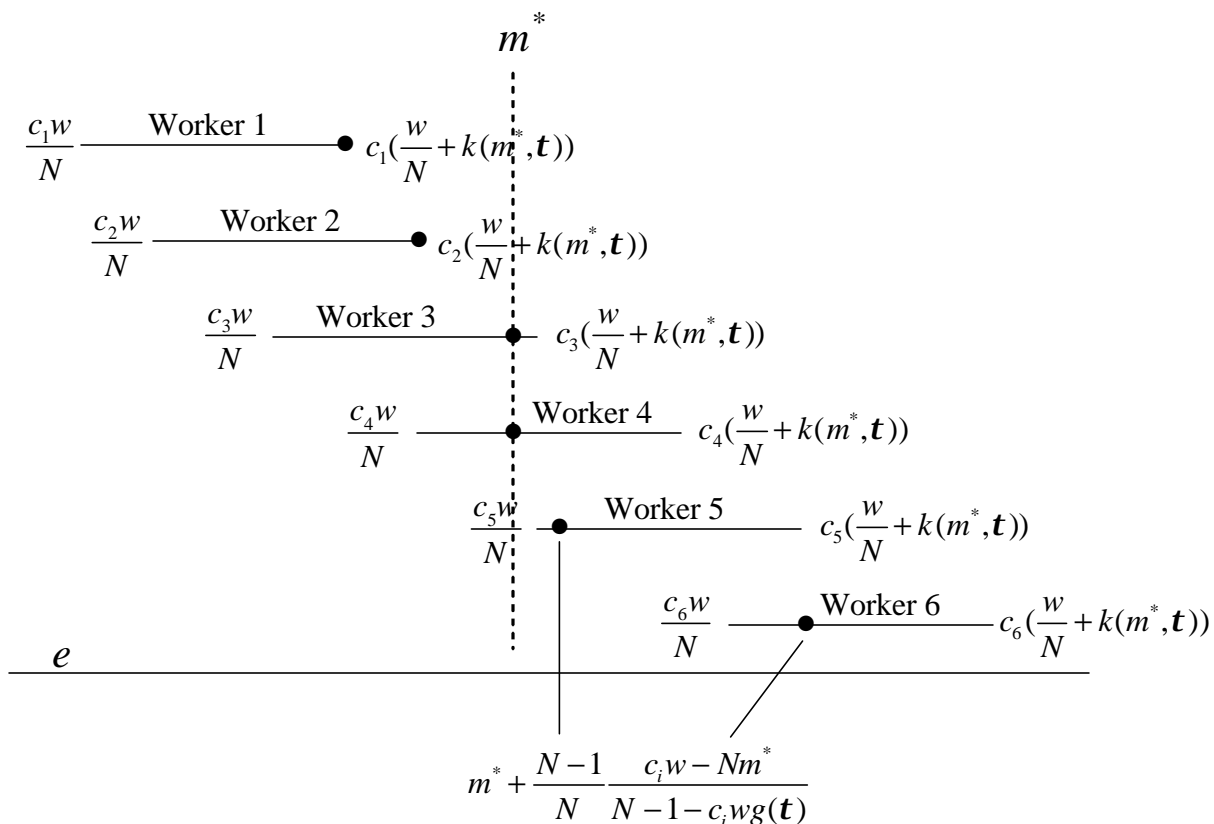
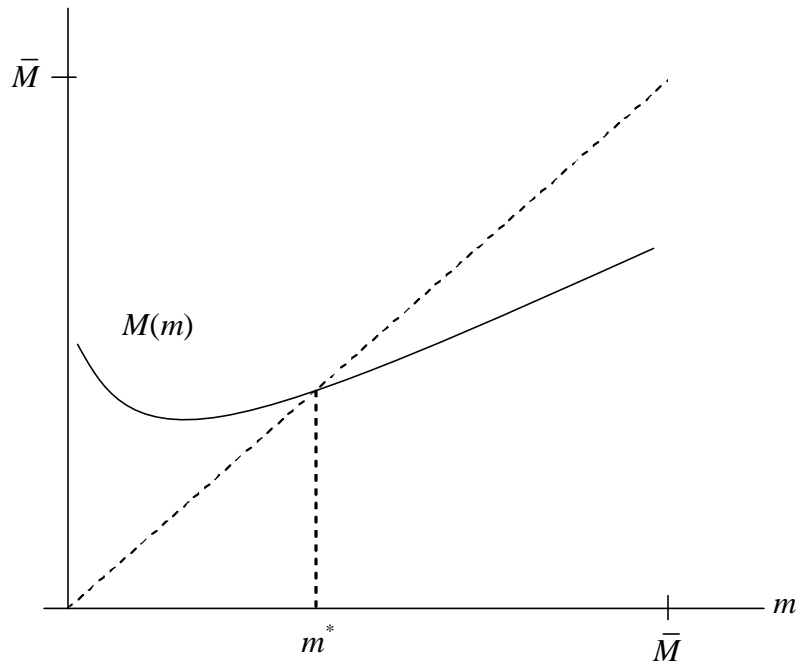


Figure 2: Existence of the Equilibrium



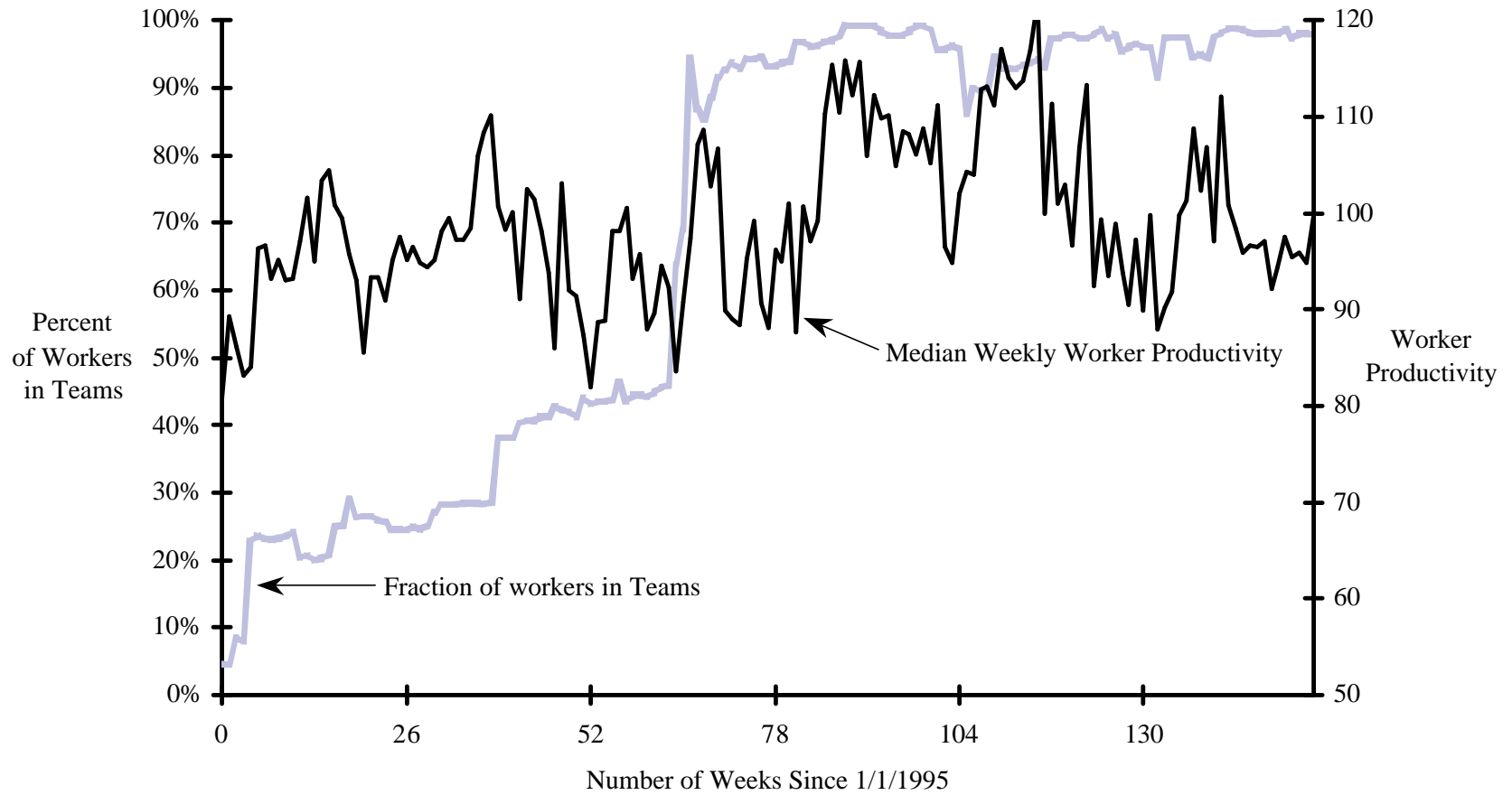


FIGURE 1: MEDIAN WORKER PRODUCTIVITY AND TEAM PARTICIPATION

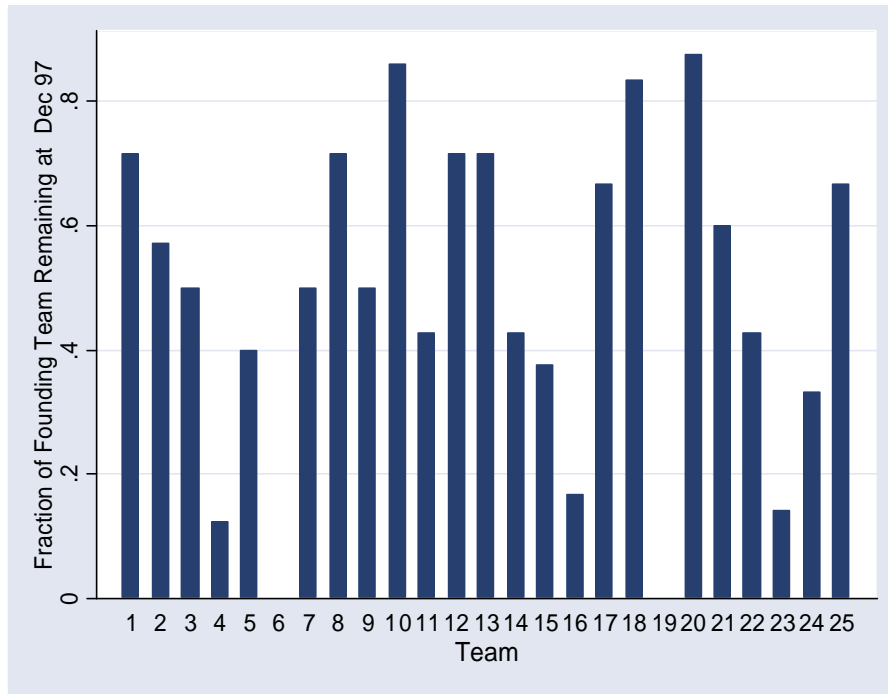


Figure 4: Fraction of Founding Team Members Remaining as of 12/31/97

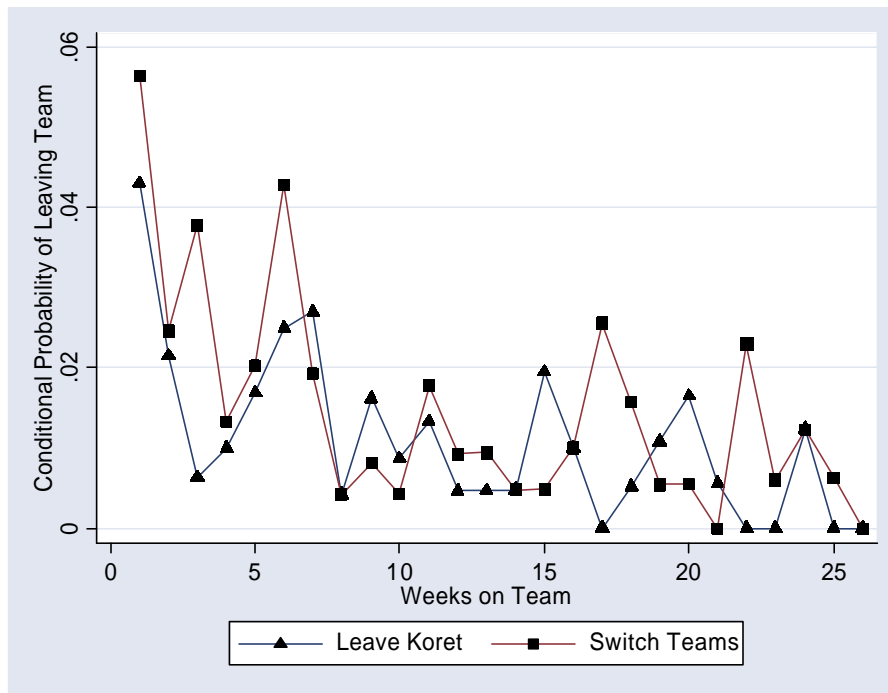


Figure 5: Empirical Transition Intensities