Internal Labor Markets in Equilibrium*

(Job Market Paper)

Timothy N. Bond†
Boston University, Department of Economics

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Abstract

Traditional models of promotion have difficulty explaining why many firms do not favor their own workers for advancement. I develop a new model which seeks to explain this phenomenon. My model generates an equilibrium in which some firms, but not all, commit to promote ex-ante. These "promotion" firms are able to attract higher quality employees to the lower ranks of the firm, which in turn makes them more likely to get skilled workers in upper level jobs. Non-promotion firms benefit from paying lower wages. This divergence in strategies is due to the scarcity of high quality workers. My model generates several testable predictions: first, workers at entry-level jobs will be paid higher wages at promotion firms, both because they are better workers and because they capture some of the quasi-rents that promotion firms earn after workers are promoted. Second, the observed return to tenure in a cross-section of entry-level job workers will be higher at non-promotion firms because the best workers in all firms will advance over time to higher jobs, either inside or outside the firm. Third, there will be no wage differences between workers at promotion and non-promotion firms among the most senior employees at entry-level jobs, since only low ability workers will remain at entry-level jobs at any firm. Finally, workers at supervisorial jobs will earn higher wages at promotion than non-promotion firms, because committing to promote yields better candidates for these jobs in equilibrium. I confirm these predictions empirically using a matched employer-employee dataset from the UK.

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†Boston University; email: timbond@bu.edu

1 Introduction

Typical models of promotion focus on the provision of incentives within the firm. In the classic tournament setting of Lazear and Rosen (1981), workers are motivated to exert the optimal effort by a prize that goes to the worker who produces the highest output. However, these models have difficulty explaining the empirical finding that many firms do not favor their own workers for advancement. In my data set, 71% of workers are employed by a firm that gives no preference to internal candidates, in spite of the fact that such favoritism is necessary in order to effectively incentivize employees in a tournament setting (Chan, 1996).

I develop a model in which some firms choose to promote internally because this helps them attract better quality candidates into entry-level jobs. Promotion also allows these firms to avoid hiring higher-level workers from a frictional market. This synergy drives the formation of internal labor markets given available talent. The fact that talent is scarce limits the viability of this strategy. In equilibrium the number of firms that make this commitment is determined by the number of workers in the labor pool who appear promising *ex ante*. This model produces several predictions about how the labor force and wages of promotion and non-promotion firms differ, which I test and confirm in the empirical section.

The intuition behind the model is quite simple. Imagine a world where talent is both scarce and valuable. Because firms can extract rents from workers, they would like to hire the most talented employees and place them in their most productive positions. However, due to the scarcity of talent, some firms will be forced to fill their best positions with lower quality workers. By "locking in" a promising young worker and guaranteeing promotion regardless of whether he actually develops into a highly skilled worker, the firm can increase the probability of eventually having a high-quality worker at an upper-level position. The worker benefits by getting a chance to work at a higher wage position regardless of whether he develops into a premium talent. Of course, many firms would like to adopt this strategy and competition will bid up the wages for promising young workers. Given this, some firms choose to wait and attempt to hire workers who, although initially less promising, turned

out to be high quality.

I model an overlapping generations economy in which there are two types of workers who differ in their productivity across all jobs. Workers' true type is unknown, but a fraction of these workers give off a publicly observable signal that makes them more likely to be the good (i.e. more productive) type. Firms are ex-ante identical and employ workers in entry-level and supervisory positions. Search frictions allow firms to extract rents from their supervisory positions. All experienced workers are more productive in the supervisory position, but the firm is slot constrained and may employ only one supervisory worker at any given time. The firm employs two young workers at the entry-level job and may commit to promote the highest skilled of these workers to the supervisory position when they are old.[1] This commitment is part of the entry-level contract and, in equilibrium, firms never offer a contract that includes this commitment to a low-signal worker.[2] These "promotion" firms are then more likely to place a talented worker in their supervisory position than those who fill the position by hiring from the frictional market. Competition for these workers causes their wages to be bid up above their marginal products, allowing the worker to extract the benefits of this strategy.

Consequently, entry-level workers at promotion firms initially earn higher wages than those at non-promotion firms. This difference is short lived; because talent is scarce, the best workers at all firms eventually move to supervisory jobs either inside or outside their original firm. The most senior employees at entry-level jobs earn identical wages, regardless of their firm's promotion strategy, because all long-tenured entry-level employees are of low quality. Therefore, in a cross-section of *entry-level* workers, we should observe a lower return to tenure at promotion firms than at non-promotion firms. These predictions are confirmed using a matched employer-employee data set from the UK.

This paper expands on the already vast literature on promotions and internal labor

[1] Fixed firm hierarchies and slot constraints for higher level jobs is a common assumption in the tournament literature. See, for example, Waldman (2003), DeVaro and Waldman (2009) and Waldman (2011).

[2] Technically, the firm offers a contract to low-signal workers, but the wage is so low that it is never accepted.

markets.[3] Much of the literature has focused on the value of promotions as incentives within the firm. In this tournament literature, worker effort is costly and hidden, and firms optimally design a payment hierarchy where promotions act as prizes to the best-performing worker. Typically, these papers ignore the option of the firm to hire externally. One exception to this is a series of papers by Chan (1996, 2006). He shows that acknowledging that firms can fill a higher level job with an outside worker causes the number of players in a promotion tournament to expand dramatically, lowering the incentives of the internal employees. The solution is to use lower requirements when evaluating, and thus give preference to, the internal employees for promotion. He finds support for this theory using personnel records from a U.S. financial company. Zabojnik and Bernhardt (2001) considers a tournament where the prizes are determined by the offers from outside workers that a firm receives. Promotion acts as a signal which increases the markets beliefs on a worker's productivity.[4] Tsoulouhas, Knoeber, and Agrawal (2007) theoretically model cases where insider and outsider candidates differ in ability, and firms care about both the output of the promoted worker and the effort levels of their workers in lower positions. They find that firms should favor insiders for promotion except in cases where the outside candidates are significantly better than the insiders. Waldman (2003) analyzes the commitment problem where the *ex post* optimal hiring rule over-hires outsiders and thus provides inefficient incentives relative to the *ex ante* optimal rule.

More closely related to this paper are the learning and job assignment models of promotion. The canonical models by Gibbons and Waldman (1999, 2006) were designed to explain a wide array of empirical regularities in analyses of firm personnel records.[5] In these models, there is initial uncertainty about the quality of a worker when he enters the firm. As this uncertainty is resolved, the worker is assigned to a more efficiently matched job within

[3] For good recent surveys of the promotion literature, see Lazear and Oyer (2009) and Waldman (2007)

[4] Other recent papers which study market-based tournaments include Zabojnik (forthcoming), Ghosh and Waldman (2009), and Waldman (2011). For the classic promotions as signals model in a non-tournament setting, see Waldman (1984) and DeVaro and Waldman (2009).

[5] The most famous of these studies are Baker, Gibbs, and Holmstrom (1994a,1994b). Other prominent examples include Medoff and Abraham (1980), Gibbs (1995), and Lazear (2000).

the firm. High ability workers will be promoted to jobs that have high marginal returns to ability, while low ability workers will remain in jobs that have limited returns to ability.[6] Unlike my model, these models typically treat the firm in a vacuum, ignoring turnover and the decision of whether to consider outside workers for positions within the firm. One exception is Ghosh (2007) who derives a model where turnover is driven by match quality and firm-specific capital acquisition.

The question of what causes differences in the promotion preferences across firms has received little attention. Using survey data from Spanish industrial plants, Bayo-Moriones and Ortin-Angel (2005) find that firms that are likely to rely on specific capital and to have better information about their employees than outsider candidates are more likely to promote internally. They find little evidence that promotions are used more frequently in firms where providing individual incentives appears more important. DeVaro and Morita (2009) study how firm heterogeneity drives the promotion decision. Higher levels of managerial productivity cause a firm to employ a more bottom-heavy hierarchy.[7] This increases the number of internal candidates, which increases the probability that the best candidate for a upper-hierarchy position is located internally. They find empirical support using a questionnaire of managers included in the data set I use. My approach is different in that I model identical firms and promotion arises as a market equilibrium outcome due to commitment. In their model, promotion is a probabilistic outcome and appears as a left-hand side variable in their empirical specification. Finally, my predictions are on the wage profiles of workers and I test this by matching employee data with the manager survey. To my knowledge, this is the first empirical study of differences between workers who are inside or outside of active internal labor markets.

[6] Another key piece of these models is the development of human capital over time. While I ignore this in my analysis, instead constraining supervisory jobs to only be manned by older workers, I could easily modify my model to include this, by stipulating that a human capital gain with experience makes workers who were previously more productive at the entry-level job now more productive at the supervisory job.

[7] Specificially, firms with more productive managers employ more workers because this increases the number of individuals who learn to be managers and thus increases the quality of the most skilled managers in the distribution. Their predictions also hold under an alternative model where firms with higher levels of managerial productivity employ more workers at the bottom of the hierarchy in order to learn the value of more workers' match-specific managerial quality.

The rest of the paper is outlined as follows. In section 2, I formally derive my model of promotion and internal labor market creation. Section 3 describes the data. In section 4, I empirically test the predictions of my model. Section 5 concludes.

2 General Model

2.1 Primitives

I use a simple overlapping generations framework. A continuum of heterogenous workers of Lebesgue measure 2 are born each period. Each cohort is identical. Workers live two periods and have an unknown (to both the worker and the market) type that determines their productivity. This type is either good (G) or bad (B), and, conditional on their type and job, workers are equally productive at all firms. A good worker has base productivity θ_G, while a bad worker has base productivity θ_B, where $\theta_G > \theta_B > 0$. While individual workers' types are initially unknown, the market and worker observe a signal of their quality. A worker with a high signal (H) has probability $p_H < 1$ of being a good worker, while a worker with a low signal (L) has probability $p_L < p_H$ of being a good worker. A fraction $g > 0$ of the workers have high signals, and this fraction is known *ex ante* by all firms and workers. During the second period of their life span, the true type of all workers is revealed.

Firms are infinitely lived and *ex ante* identical, and consist of a two types of jobs: entry-level and supervisory. At the entry-level job, workers produce θ_i $(i \in G, B)$, while at the supervisory job workers produce $\lambda\theta_i$ $(\lambda > 1)$. Thus, all workers are more productive at the supervisory job than at the entry-level job but good workers more so than bad workers. Workers must first work at the entry-level job to learn the supervisory job, so only old experienced workers may be hired as supervisors. Firms are constrained by a fixed-hierarchy and are thus able to employ no more than one supervisory worker and no more than two young entry-level workers at any given time. For convenience, the latter restriction is relaxed for old workers. The firm can hire as many old workers for entry-level jobs as they choose.[8]

[8] Constraining the number of old entry-level workers a firm can hire would not impact the results.

The set of potential entrant firms is of large measure greater than 1.

Each firm must additionally purchase a factory for its supervisor to produce. A continuum of identical factories of measure 1 are born each period and fully depreciate at the end of the period. Factories cost r, which is endogenously determined by the market.[9]

Firms offer a series of contracts to attract entry-level employees. Included in these contracts is the method by which the firm will fill its supervisory vacancy in the next period. A contract either commits the firm to fill the supervisory job the following period from one of the entry-level hires, or to hire the supervisor from the market.[10] Frictions cause hiring from the market to be done randomly. First, all good experienced workers who were not promoted internally, including workers from non-promotion firms who turned out to be good, are matched with random supervisory vacancies. Any vacancies that remain after this process are matched with random experienced bad workers.[11]

Each contract is a signal-, coworker-, and promotion policy-conditional wage offer. Workers observe all offered contracts and accept the contract which maximizes their expected lifetime utility. The firms' type is thus determined by which of its offered contracts are accepted. Firms whose accepted contracts include promotion promises will be referred to as promotion types, while firms whose accepted contracts do not will be non-promotion firms.

Firms and workers are risk neutral and do not discount the future. Multi-period employment contracts are not permissible. Unfilled job vacancies generate 0 for the firm, and unemployed workers and unutilized factories earn 0, as well.

[9] The inclusion of factories is simply a device to allow for a free-entry equilibrium with zero profits. It can be viewed as analogous to an endogenous sunk cost of capital acquisition for vacancy creation in a search model context. Alternatively, I could allow firms to make profits without altering my results.

[10] This does not allow for a contract in which the firm commits to hire from the market only if the outside candidates are expected to be of higher quality than the internal candidates. This assumption is done for simplicity. Allowing for this option would create three new equilibrium wages to determine, while only serving to increase the value to the firm of options without a full promotion commitment. The main results of the model should still hold in this scenario.

[11] These frictions allow firms to extract rents from supervisory positions. In the absence of such rents, competitive wages eliminate any benefits that could be gained by manipulating employee composition to improve the future quality of supervisory jobs. Frictions for supervisory jobs are consistent with empirical work by Burdett and Cunningham (1998) which suggests that vacancies for positions with higher requirements take longer to fill. A similar assumption was also made by Waldman (2003) to model incomplete information on workers outside the firm.

To summarize the timing of the model:

1. Firms purchase factories
2. Old worker types revealed
3. Promotion firms are matched with their highest entry-level job worker from the previous period. Ties are broken by coin flip.
4. Unmatched (experienced) good workers matched one for one with random unmatched (non-promotion) firms for supervisory job
5. Unmatched (non-promotion) firms matched one for one with random unmatched (experienced) bad workers for supervisory job
6. Matched workers and firms Nash bargain over supervisory job wages
7. Firms offer a series of signal-, co-worker, and promotion policy-conditional entry-level contracts
8. Workers accept contracts which maximize their lifetime utility
9. Production takes place, wages are paid
10. Death and depreciation

2.2 Equilibrium

First, I will define equilibrium in this economy. Essentially, this concept of equilibrium is that contracts are accepted optimally, and that the firm-entry market clears.

Definition 1 *Equilibrium is set of period-specific contract outcomes* Δ *and a vector of period-specific factory costs* r *such that*

1. *Participation: The set of contracts in* Δ *that generate negative expected profits for firms or negative expected utility for workers is of measure* 0

2. *Contract Optimality: There does not exist a contract outside of Δ that would increase both the expected lifetime profits of a positive-measure set of firms and the expected lifetime utility of a positive-measure set of workers*

3. *Factory Market Clearing: The excess supply and excess demand for factories is non-positive in all periods, conditional on Δ*

The contract optimality condition ensures both utility maximization by the workers conditional on the set of offered contracts, and profit maximization by firms with respect to the series of contracts they choose to offer. The prevailing wage is a market clearing wage, and given that both entry-level market and the market for supervisory capital is competitive, Lemma 2 follows.

Lemma 2 *In any equilibrium, firms make zero expected lifetime profits.*[12]

While many of the characteristics of equilibria depend on the parameters, three properties of all equilibria are immediately apparent. First, since there are no limits on the number of old workers a firm can hire for entry-level jobs, and since there is no future possibility of promotion that would cause the value of old workers to differ in entry-level jobs across firms, the competitive wage must prevail for old workers at entry-level jobs. All old workers are paid their marginal product at entry-level jobs, regardless of their own type, their firm's type, and their coworker's type. This means that one can ignore old entry-level job workers when looking at the promotion and hiring strategies of the firms. Further, this defines the outside option in the supervisory-job wage-bargaining for the worker to be his base production (i.e. θ_G for good workers, and θ_B for bad workers). The outside option for the firm is 0, since it earns nothing from an unfilled vacancy, and cannot fill this vacancy with any worker other than the one with whom it has been matched.

Lemma 3 states a second property of all equilibria. In each period all factories are consumed. This follows from Lemma 2. Any r that is greater than 0 would generate a

[12] Proofs of all results can be found in the appendix.

supply 1 of factories, and a $r = 0$ would generate positive profits to firms. This defines the set of firms active in the economy to be of measure 1 in each period.[13]

Lemma 3 *In any equilibrium, all factories are consumed in every period.*

Another property of all equilibria is stated in Lemma 4. Unemployment does not exist in this economy essentially because employing a worker always creates a surplus.

Lemma 4 *In any equilibrium, there is no unemployment in any period.*

Lemma 5 characterizes a final property of all equilibria. Entry-level workers at non-promotion firms are paid their marginal product because there is large set of potential employers for entry-level positions.

Lemma 5 *In any equilibrium, the wage of any entry-level worker employed at a non-promotion firm is equal to their base productivity*

In order to help characterize the equilibrium I will be looking at, I will introduce the following two definitions.

Definition 6 *A steady state equilibrium is an equilibrium in which the set of firms whose accepted contracts vary over time is of measure zero.*

As is standard in these types of dynamic models, I will be looking only for steady state equilibria, for simplicity. This will allow me to consider whether my equilibrium conditions hold in just one period of the model.

Definition 7 *A trivial equilibrium is an equilibrium in which, in some period, the set of firms that promote or the set of firms that do not promote is of measure zero.*

[13] Technically, this defines the set of firms with supervisors that are active in each period. Firms that do not have factories offer non-promotion contracts. Since workers are indifferent between a non-promotion contract at a firm with a supervisor and one without, I assume these contracts are never accepted in equilibrium.

While trivial equilibria exist, they are not of empirical interest. In my data set I observe heterogeneity in promotion practices, so I will not consider any equilibria which cannot replicate this fact.

Definition 8 *A talent-scarce equilibrium is an equilibrium in which the set of bad workers who are employed in supervisory jobs at non-promotion firms has positive measure in every period.*

Talent scarcity is controlled by two parameters. The first is the total number of good workers that exist in the economy. The second, as will be seen in Proposition 9, is the number of workers with high signals, as this determines the number of non-promotion firms. If an equilibrium existed with just a small measure ε set of non-promotion firms then, no matter how low the probability that a worker with a given signal will be realized as good, the equilibrium would not be talent scarce by the law of large numbers.

In order to simplify notation, let ψ be the share of the surplus from supervisory jobs that goes to the firms during bargaining. I will define $\bar{\theta}_i^F = \psi(\lambda - 1)\theta_i$ as the firm's revenue from employing a worker of type i at a supervisory job. Likewise, I will define $\bar{\theta}_i^W = (1-\psi)(\lambda-1)\theta_i$ as the worker of type i's wages at a supervisory job above what they would earn at an entry-level job. Recall the set of high-signal workers in each period is measure g, and p_i $i \in \{H, L\}$ represents the probability of being a good worker conditional on signal. Proposition 9 establishes an equilibrium in this economy.

Proposition 9 *A steady-state talent-scarce equilibrium in which the set of low-signal workers employed at entry-level jobs at promotion firms is of measure* 0*, and the set of high-signal workers employed at entry-level jobs at non-promotion firms is of measure* 0 *exists under the following conditions*

1. $(2p_H p_L - p_H^2(1 + \frac{g}{1-g}))(\bar{\theta}_G^F - \bar{\theta}_B^F) \geq (1 - p_H)(1 - p_L + p_H - p_L)(\frac{1}{2(1-g)(1-p_L)+g(1-p_H^2)})\bar{\theta}_B^W$
2. $(p_H^2 \frac{g}{1-g} + p_L^2)(\bar{\theta}_G^F - \bar{\theta}_B^F) \geq (1 - p_L)^2(\frac{1}{2(1-g)(1-p_L)+g(1-p_H^2)})\bar{\theta}_B^W$
3. $(2(p_H - p_L) - p_H^2(1 + \frac{g}{1-g}))(\bar{\theta}_G^F - \bar{\theta}_B^F) \geq -(1 - p_H)^2(\frac{1}{2(1-g)(1-p_L)+g(1-p_H^2)})\bar{\theta}_B^W$

4. $2p_L + p_H^2 \frac{g}{1-g} < 1$

Proposition 9 establishes the equilibrium I will be focusing on. The first two conditions ensure that promotion contract attracts the optimal worker composition. These essentially require that good workers are sufficiently more productive at the supervisory job than bad workers. If this is not the case, it may be optimal for the firm to offer a contract that would entice low-signal workers, who are willing to accept very low wages for an increased opportunity at getting a supervisory job when they are revealed as bad. The first condition also requires p_L to not be too low, otherwise a high-signal worker would be willing to take a substantial pay cut in order to work with a low-signal worker, which could increase the profits of the promotion firm. The third condition establishes that the high-signal workers prefer to work at promotion jobs rather than non-promotion jobs. This requires that the promotion strategy is sufficiently profitable relative to a non-promotion strategy because the future profits of the promotion firm are passed back to the entry-level workers when they are young. This condition is automatically satisfied when the promotion strategy yields better candidates for supervisory jobs than the non-promotion strategy, which is the case I will be studying for my testable implications. The final condition is the requirement that not all non-promotion firms hire good supervisory workers, and thus that the equilibrium is talent scarce.

The proposition describes a perfect sorting equilibrium. In this equilibrium, the number of promotion firms is perfectly determined by the number of high-signal workers and all high-signal workers are employed at promotion firms. As I will describe in more depth in the next subsection, as long as the signals are sufficiently different and the high-signal workers are sufficiently scarce, the motivation of the promotion firms is to get workers who are likely to be good in house at the lower ranks of the career ladder. The use of internal promotion allows them to bypass the friction involved in hiring from the market and actually get a better quality worker in their supervisory job in expectation.

Corollary 10 *For any set of parameters* $p_H, p_L, \psi, \lambda, \theta_B$, *and* g,*there exists some* θ_G^*, *such*

that for all $\theta_G \geq \theta_G^*$, there exists a talent-scarce equilibrium in which the set of low-signal workers employed at entry-level jobs at promotion firms is of measure zero, and the set of high-signal workers employed at entry-level jobs at non-promotion firms is of measure zero provided

1. $2p_H p_L - p_H^2(1 + \frac{g}{1-g}) > 0$
2. $2(p_H - p_L) - p_H^2(1 + \frac{g}{1-g}) > 0$
3. $2p_L + p_H^2 \frac{g}{1-g} < 1$

While this equilibrium does not exist for all parameters, the corollary shows that this equilibrium can exist for a large range of parameters. In the appendix, I discuss in more depth why focusing on this equilibrium is appropriate. First, the trivial equilibrium clearly does not match the data. Equilibria that are not talent-scarce can exist. But as I show in the appendix, these equilibria can never be the solution to a social planner's problem. On the other hand, for any social welfare function there is a set of transfers for which the equilibrium in Proposition 9 will solve the social planner's problem.

Further, talent scarcity is a more accurate reflection of the labor market. Discussions with employers on hiring strategies often focus on how to find and retain talent at the firm. Although other types of talent scarce equilibria exist, experimentation has suggested that these equilibria are generally unstable. These equilibria also require complicated coordination strategies by the workers which balance the number of high-signal entry-level workers at non-promotion firms, whereas in the equilibrium in Proposition 9 workers strictly prefer the contract they accept over all other types offered.[14]

2.3 Testable Predictions

My model seeks to explain the heterogeneity in promotion practices that is observed in the data as a mechanism that is used to attract, and based on the amount of, talent in the labor

[14] One other stable pooling equilibrium can exist, and has similar properties to the one in Proposition 9. I discuss this equilibrium in more depth in the appendix.

market. Condition 11 states the parameter values under which this is the case.

Condition 11 $p_H(2-p_H) > (\frac{g}{1-g}p_H^2 + 2p_L)$

This condition ensures that the *ex ante* probability of drawing a good worker from two high-signal workers is greater than the probability of drawing a good worker from the market in the equilibrium described in Proposition 9. Thus if Condition 11 is satisfied the promotion strategy yields better supervisory workers on average than the non-promotion strategy. There are a couple reasons to expect this condition holds in the data. First, the condition is a sufficient condition to rule out trivial equilibria in which no firms promote. Since I do not observe any industries which have homogenous promotion practices, it is likely this condition is satisfied. Second, when the expected quality of the candidate hired from the market, which is represented by the right hand side of the inequality, is high, firms may find it very profitable to renege on their promotion promise. While I do not model the commitment problem, the temptation to cheat should be highest when the condition is not satisfied.

Proposition 12 analyzes the observed wage differences among young entry-level workers. Young entry-level workers are paid more at promotion firms.

Proposition 12 *Suppose the equilibrium is as described in Proposition 9. Under Condition 11, young entry-level workers at promotion firms are paid more on average than young entry-level workers at non-promotion firms*[15]

This effect is partially due to the sorting that we observe in equilibrium. Promotion firms hire exclusively high-signal workers for their entry-level jobs in equilibrium and non-promotion firms hire exclusively low-signal workers, so we would expect to see entry-level workers earn more at promotion firms. However, this is also due to labor market competition over talent. Since the promotion strategy yields better supervisory workers, firms bid up the right to hire the workers necessary to employ it. The future supervisory revenues are passed

[15]For Propositions 12 and 14, Condition 11 is a sufficient condition with a clear interpretation. The necessary condition is $(p_H - p_L)(\theta_G - \theta_B) + \frac{1}{2}(p_H(2-p_H) - (\frac{g}{1-g}p_H^2 + 2p_L)(\bar{\theta}_G^F - \bar{\theta}_B^F)) > 0$ which takes into account that wages may still be higher at promotion firms due only to entry-level job productivity differences.

back to the entry-level workers at promotion firms in the form of higher wages when young. Workers at promotion firms are actually paid a *premium* over what they could earn in the non-promotion sector.

However, as shown in Proposition 13, this wage difference disappears for old entry-level workers. Old entry-level workers receive identical wages across firm types.

Proposition 13 *Suppose the equilibrium is as described in Proposition 9. There will be no differences in average wages for old entry-level workers between promotion and non-promotion firms.*

This is for two reasons: first, since the market for old entry-level workers is perfectly competitive, workers are paid their marginal product. Second, because talent is scarce and old worker types are known, the only workers who we will observe at entry-level jobs will be bad workers. Good workers leave their entry-level jobs and take supervisory jobs, either through internal promotion or by moving to a different firm. Therefore, the average wage at entry-level jobs in the second period will not depend on the firm's type.

Combining the previous two propositions, Proposition 14 tells how the wages of entry-level workers evolve in the two different types of firms. In a cross-section of entry-level workers, the return to tenure should be higher at non-promotion firms.

Proposition 14 *Suppose the equilibrium is as described in Proposition 9. Under Condition 11, the observed return to tenure of entry-level workers is higher at non-promotion firms.*

This effect is due mainly to the change in composition over time at entry-level jobs. At a promotion firm, initially the average worker's ability is fairly high, since only high-signal workers are employed. However, the fact that they are observed to be still working at the entry-level job in the second period indicates that, despite their high signal, they were revealed to be a bad worker. All the low-signal workers who remain at entry-level jobs are also bad workers. But since they started with a lower expected productivity, this composition change will affect their observed average wages less dramatically. Moreover,

experienced entry-level workers do not receive the wage premium paid to young workers at promotion firms because old workers provide no future profits to the firm.

Finally, since the promotion strategy yields better supervisory job workers, we should expect to see supervisory workers at promotion firms earn higher wages on average than supervisory workers at non-promotion firms.

Proposition 15 *Suppose the equilibrium is as described in Proposition 9. Under Condition 11, supervisory job workers are paid more on average at promotion firms than at non-promotion firms. However, conditional on type there are no differences in wages*

This is due entirely to sorting. Since wages at high jobs are determined by Nash bargaining and firm-type does not affect either party's threat points, if one could control for worker type (good or bad) there would be no wage difference between supervisory job workers at promotion and non-promotion firms.

To summarize these main predictions and translate them into my data, in a cross-section of workers I should observe the following:

1. Workers in entry-level jobs at promotion firms should have higher wages conditional on promotion-policy specific tenure.

2. The observed return to tenure in a sample of entry-level job workers should be higher at non-promotion firms than promotion firms.

3. There should be no differences associated with the promotion policy of the employing firm in the wages of entry-level job workers with high seniority.

4. Supervisory job workers at promotion firms should have higher observed wages. However, this would not hold if I were able to condition on ability.

3 Data

The data come from the Worker Employment Relations Survey (WERS) 2004, a matched employer-employee data set from the UK. The survey was conducted by the Department of

Trade and Industry, the Economic and Social Research Council, the Advisory, Conciliation and Arbitration Service, and the Policy Studies Institute. It is the fifth such survey in this series, which aims to study conditions in the workplace throughout Great Britain.

The survey of each establishment took place in four parts. First, the Management Questionnaire (MQ) was administered in a roughly two-hour face-to-face interview with a management representative. The Employee Representative Questionnaire (ERQ) was conducted in person with both a union and non-union employee representative, when available. This interview typically lasted 45 minutes. The Supplemental Employee Questionnaire (SEQ) was distributed to 25 employees at the firm to gather basic information on the establishment's employees. This questionnaire was self-administered. In establishments with fewer than 25 employees, all of the establishment's employees were surveyed. Finally, a Financial Questionnaire (FQ) was completed by the establishment's financial manager on the establishment's recent financial performance. For this paper, data from the MQ and SEQ are linked to form a sample of employees matched with characteristics of their employing establishments, as reported by management.

One shortcoming of the SEQ is that many of the variables are categorical. This is particularly problematic for the wage and income data. The survey asks the workers for their weekly income, hourly wage, and number of hours they work per week. Workers are given the choice of 14 weekly income categories, but only 4 wage categories. The wage categories are also very unbalanced. The third highest (second lowest) category is for hourly wages between $£4.50 - £5.00$, while the second highest category has a range of £5.00-£15.00.

I handle this in two different ways. First, I impute hourly wages by dividing the midpoint of the weekly income categories by the continuously measured weekly hours variable. For the unbounded category, which is weekly income £871 or more, I use the value 950. I include an indicator in any regression that involves wage for whether the wage was imputed from a top-coded income.[16] Second, I use interval regressions. These regressions are ordered probits

[16] In practice, this affects only 6.5% of my final weighted sample, and less than 1.5% of my final weighted sample of "entry-level" workers.

but with the cut points constrained to match the actual (log) income categorical cutoffs in the survey. I exploit the fact that $\ln(\text{Wage}) = \ln(\text{Weekly Income}) - \ln(\text{Hours})$, by controlling for the log of hours worked and constraining the coefficient on this variable to be equal to one. Thus all coefficients are identified and are marginal wage effects. The two approaches require different assumptions to be valid. The first requires that the measurement error due to the categorical transformation is orthogonal to the estimated value, so that the mean is roughly equal to the midpoint of each category, and that hours worked is orthogonal to any deviations in income from the midpoint. The second requires that the errors in wage are distributed log-normally. Both assumptions are strong but commonly made, and the two approaches yield similar results. I present the results using the midpoint-imputed wages as the main results, while including the ordered probit approach as a robustness check.

The data consist of 22,451 workers surveyed from 2,295 unique establishments. Included in these data are 4-digit occupation and industry codes, as well as a variety of questions in the MQ that are linked to the specific 1-digit occupation codes within that establishment. In order to focus on establishment practices, rather than the results of collective bargaining, I drop all union members from the data set.[17] I also eliminate all workers who work less than 30 hours per week or whose imputed wages are less than £1/hour. I drop all workers who do not have a valid response for race, gender, age, education, occupation, and supervisor status, and anyone employed at an establishment that does not have a valid industry code. After modifying my sample in this way, I am left with 9,348 unique workers from 1,533 different establishments.

A key variable of interest taken from the MQ has to do with the company's internal promotion practices. The question asks "Which of these statements best describes your approach to filling vacancies at this workplace?" Managers then chose whether internal candidates or external candidates were given preferences for vacancies, or whether both types of candidates were given equal opportunity. Roughly 93% of the establishments, weighted by

[17] I do this as it is the finest definition of union membership that I have, and therefore will allow me to keep the most observations. Using alternative definitions of union influence, as well as including all union members in my regressions, does not meaningfully affect the results.

employment, in the survey reported that they either gave preference to internal candidates or gave both types of candidates equal opportunity. Throughout the paper I will interpret establishments that report favoring internal candidates as following a policy of internal promotion, as in the model. This same question was previously used by DeVaro and Morita (2009) to ascertain an establishment's promotion practices.

Table 1 provides summary statistics for these data using the weights provided by the survey makers for the SEQ. Education in the survey is given in terms of certificates earned through the UK schooling system. In the table I reduce the seven categories given in the survey to five, though I use all seven as controls in regressions that use worker characteristics.[18] While worker characteristics are somewhat different between promotion and non-promotion establishments, the distribution of occupations is quite similar. Workers at promotion establishments are more educated. I can reject the equality of the distribution of education using a Kolmogorov-Smirnov test. Workers at promotion establishments also earn higher wages. The differences in worker occupations appears to be small, though the workers at promotion firms are less likely to be classified as Skilled Trades and Personal Service, which encompasses occupations such as nurses, hairdressers, and travel agents. Non-promotion workers are statistically more likely to be supervisors, but this difference is only 2 percentage points in magnitude.

The model's predictions are focused only on a subset of the jobs that are observed at a firm. In order to test these, I divide this sample into two categories. I classify "entry-level" jobs as non-managerial and non-supervisorial jobs, while managers and supervisors correspond to my model's supervisory job.[19] Table 2 provides summary statistics for these

[18] Workers were asked to check each of the categories of education certifications they possessed. The seven categories are: no academic qualifications, GCSE grades D-G and equivalents, GCSE grades A-C and equivalents, 1 GCE 'A' level grades A-E or 1-2 SCE Higher grades A-C or AS levels, 2 or more GCE 'A' levels A-E or 3 or more SCE Higher grades A-C, First Degree, and Higher (Postgraduate) Degree. Respondents were also given the option to choose "other academic certification." I do not use that category since it is indeterminate whether that certification is higher or lower than the others chosen by the respondent.

[19] This is slightly different from DeVaro and Morita (2009). They classify professionals as high level jobs, and do not have access to information on supervisors, since it is only available at the worker level. My classification is more appropriate in this setting, since it is unlikely that one would be promoted into the position of lawyer, while one could be promoted from a lawyer to a managing partner. Reclassifying professionals as supervisorial jobs yields similar results.

data by subsample, using the weights provided by the survey makers for the SEQ. As with the full sample, both subsamples of promotion-establishment workers are more educated and earn higher wages than their counterparts at non-promotion establishments, despite working similar jobs. Among non-managerial, non-supervisorial jobs, the biggest differences in occupation are at the level of professionals, skilled trades, and personal service. Entry-level workers at promotion establishments are more likely to be professionals, while workers at non-promotion establishments are more likely to be the latter two. In the supervisorial job sample, workers at promotion establishments are more likely to be classified as managers, while those at non-promotion establishments are more likely to be supervisors in the skilled trades. As expected, in the supervisorial sample, workers at promotion establishments are less likely to have tenure of less than 1 year, and more likely to have tenure in the middle bracket, between 2 and 5 years.

Looking at the establishment characteristics themselves, Table 3 shows descriptive statistics at the establishment level, using weights designed to be representative of the average worker's place of employment.[20] Consistent with previous studies (DeVaro and Morita, 2009), promotion establishments are larger and appear to be part of firms which employ more people in the United Kingdom. This latter difference is not statistically significant. There is no difference in the age of the company across promotion types, suggesting that the decision to promote is not related to being part of a newer, more innovative establishment. The percentage of the establishment's employees who are trade union members is also identical across both promotion types. Promotion establishments are much more likely to offer incentive pay to at least some employees. The table lists the distribution for the largest non-managerial 1-digit occupation code at the establishment. While these statistics vary between the promotion and non-promotion establishments, there is no single type of occupation that is unrepresented in one of the promotion strategies. The lowest representation is for the Personal Service category in promotion establishments, which makes up 4%

[20] The alternative set of establishment weights, which are designed for analysis of the average establishment, weight small workplaces much more highly due to their prevalence in spite of the low fraction of employment they represent.

of that type.

Table 4 shows the distribution of industries by establishment promotion strategy, defined using their section in the UK Standard Industry Classification 2003 (SIC2003) system. There are differences between promotion and non-promotion establishments in industry classification, as one would expect if each industry is a separate labor market in a separate equilibrium. Promotion establishments are more likely to be involved in manufacturing or financial services, while non-promotion establishments are more likely to be in the fields of health and education. However, I observe both promotion and non-promotion establishments in each industry.

4 Empirical Results

4.1 Main Results

I first test whether entry-level job workers at promotion establishments earn higher wages initially and have a lower observed return to tenure. I estimate the following equation

$$\ln \text{Wage}_i = \beta_0 + \beta_1 X_i + B_2 * \text{Promotion} + \beta_3 * \text{Tenure} + \beta_4 * \text{Promotion} * \text{Tenure} \qquad (1)$$

where X_i is a vector of controls and promotion is an indicator for whether the establishment practices internal promotion.[21] My prediction is that $\beta_2 > 0$ and $\beta_4 < 0$. I transform the tenure categories into a continuous variable using the medians of the bins, and include a dummy variable for those who are in the top bin.[22] For this regression, I use my sample of entry-level job workers, which consists of non-managerial and non-supervisorial workers.

Table 5 shows the results of this regression. The first column contains only the promotion dummy, tenure, and the tenure interaction with no additional controls. The coefficients on both promotion and the interaction match up with the prediction, though the latter is not

[21] For estimates of my main predictions using ordered probit interval regressions, see section 4.2.

[22] The results are robust to using both the upper or lower bounds of the bin, alternatively, to define tenure. Similiar results are obtained when using dummy variables for tenure categories and interactions.

statistically significant. Non-managerial, non-supervisorial workers at establishments that promote earn on average 14% more than those at establishments that do not promote, conditional on tenure. The relevant comparison for the model, however, is for workers at identical jobs. Therefore, column 2 controls for 2-digit occupation code from the UK Standard Occupation Classification 2000 system (SOC2000) and 2-digit industry code from the UK Standard Industry 2003 system (SIC2003). Examples of the specificity of these codes are given in the data appendix. Consistent with the predictions, the premium paid by promotion establishments is 7%, but these non-managerial, non-supervisorial workers have a 0.9 percentage point lower observed return to tenure and both coefficients are statistically significant. The return to tenure at promotion establishments is roughly half that at non-promotion establishments.

Since my predictions reflect both equilibrium sorting and a wage premium paid at promotion establishments, one would expect they would also hold when controlling for worker characteristics.[23] In column 3, I replace the industry and occupation codes with controls for education, race, gender, and a quadratic in age.[24] Both coefficients of interest have the right sign and are significant. Column 4 adds the industry and occupation codes back into the regression with the worker controls. The worker controls do not substantially alter the results when compared to the regression with just the industry codes, though the tenure interaction is now somewhat more significant. If these controls are reducing the sorting effect, we would expect the coefficients on both promotion and the interaction to decrease. This is indeed the case for the promotion coefficient. Comparing column 3 to column 1 and column

[23] Technically, in my model, there is only one observable worker characteristic, the pre-market signal, and there is perfect sorting on that signal. Therefore, the effects of that characteristic and being at a promotion establishment are not seperately identifiable. However, one would expect that in the data there will be some mixing of worker types across establishment, and a more robust model would allow for this prediction.

[24] The education controls include 6 dummies to represent, from lowest to highest achievement: No academic qualifications, GCSE grade D-G equivalent, GCSE grade A-C equivalent, 1 GCE A-level equivalent, 2 or more GCE A-level equivalents, Bachelor's degree equivalent, and graduate degree. The race controls are 16 dummies that represent British, Irish, other white, white and Black Carribbean, white and Black African, white and Asian, other mixed, Indian, Pakistani, Bangladeshi, other (South) Asian, Carribbean, African, other Black, Chinese, other ethnic group, and those who coded multiple of these.

I define age using the midpoints of the age categoris in the SEQ and include a dummy variable for whether the age was in the unbounded set.

4 to column 2, the observed effect of being at a promotion firm is smaller, and significantly so in the former case at the 10% level. The coefficient on the interaction moves in the wrong direction when comparing column 1 to column 3, though this change is not significant. There is virtually no change in the interaction term when comparing 2 to 4.

Finally, in column 5, I add a control for the number of workers at the employee's establishment. The establishment-size wage premium has been well documented and, as seen in the descriptive statistics, establishments that promote are larger on average than those who do not. One concern is that the promotion variable is simply proxying for establishment size. Though establishment size does appear to have a positive impact on wages, adding this control has little effect on the coefficients of interest.

Another concern is that the industry and occupation codes may be too sparse. If, within a code, only higher paying jobs offered internal promotion opportunities while simultaneously offering lower returns to tenure, this would bias my result. The first two columns of Table 6 test this, switching to 3-digit occupation and industry codes. The result is robust to these finer codes. The observed promotion premium does decrease in magnitude compared to estimates using 2-digit codes, but these changes are not statistically significant. The coefficient on the interaction term remains virtually unchanged.

It is also likely that there is something outside the model that would cause differences in return to tenure at the industry and occupation level. Since there are some differences in the industry and occupational make-up between promotion and non-promotion establishments it could be that the interaction is picking up these differences rather than the predictions of my model. In columns 3 and 4 of Tables 6, I add in tenure interactions to the 2-digit and 3-digit codes, respectively. Adding these interactions has little effect on my results.

My model makes a specific prediction about the wages of the most senior entry-level job workers. The higher wages at promotion firms are due to both the higher productivity of their workers and a premium paid due to the higher expected future value they will bring the firm upon promotion. Old workers who are of high ability, however, leave the entry-level jobs due either to internal promotion or to taking a higher position at a competing firm.

Further, old workers die at the end of the period; they provide no future value to the firm once the possibility of promotion is removed. Thus, there is no premium above marginal product paid to old entry-level workers at promotion firms. The wages paid to workers at entry-level jobs, then, should be identical at both types of firms.

In Table 7, I test this using the sample of non-managerial, non-supervisorial workers who are in the highest tenure bin, which is 10 years or higher.[25] Column 1 estimates this equation without any controls and shows that high seniority entry-level job workers at promotion establishments earn 14 percent more on average than those at non-promotion establishments. However, when adding 2-digit industry and occupation codes, the result becomes smaller in magnitude, though not significantly, than for the full sample of entry-level job workers, and is statistically insignificant. Column 3 adds worker characteristics as controls which has little impact on the point estimate for working at a promotion establishment. This is largely to be expected, since in my model the true productivity of a worker is represented in the long run by her job, and not by her initial observable characteristics. Adding a control for establishment size in column 4 reduces the magnitude of the point estimate on the promotion premium. Although the estimates are not statistically significant, this has much to do with the imprecision of their estimation. In the columns 5, 6 and 7, I repeat columns 2, 3, and 4, but using 3-digit occupation and industry effects instead of 2-digit. These point estimates are, again, insignificant, and much closer to zero in magnitude than those with two digit fixed effects. This suggests that the differences in occupation and industry within the 2-digit category is partially masking the differences in wages across establishment promotion policy types. In the final column, with 3-digit codes and a full set of controls, the point estimate of the effect of being at a promotion establishment is only 0.019, with a t-statistic of 0.49.

The fourth prediction of the model is that workers in supervisorial jobs should have higher observed wages at promotion establishments, which is entirely due to sorting. The first column of Table 8 estimates the effect of establishment promotion policy on the wages of managers and supervisors. The coefficient on being at a promotion establishment is posi-

[25] Results are similar when a high seniority worker is defined as 5 years of tenure or more.

tive and significant. On average, managers and supervisors at establishments that promote earn 7.4 percent more than at establishments that do not promote. Again, the relevant comparison to be made is between establishments in the same industry, and workers at the same occupation. Column 2 adds in 2-digit occupation and industry codes. Adding these codes decreases the magnitude of the point estimate, but the result remains significant. In column 4, I add controls for worker characteristics and establishment size. One would expect that the effect would be eliminated if I could control for ability. The worker characteristics are correlated with ability. However, since they are all characteristics that are observable ex-ante, they are likely also correlated with the pre-market signal of the worker's quality. In equilibrium, entry-level workers perfectly sort on their observables, but only remain partially sorted on observables at the supervisorial level. This is because some workers will leave the promotion establishments and fill vacancies for supervisory positions at non-promotion establishments. Therefore, they should reduce the sorting effect less than in the previous regressions on entry-level workers. The results are consistent with this. The coefficient on promotion remains positive and significant and is only slightly lower in magnitude than in the regressions without these controls. While it should be stressed that adding worker characteristics and establishment size does not have a statistically significant impact on the coefficient on promotion in either subsample of workers relative to regression with just occupation and industry controls, the decrease in magnitude on the coefficient is larger for entry-level workers. On that sample, adding worker characteristics decreases the magnitude of the coefficient by 14%, compared to just 5% for the managerial and supervisorial sample. This is suggestive, at least, that sorting on observables is more important in entry-level jobs than supervisorial ones.

Up until this point, I have not included tenure in any of my regressions on supervisory job workers. This is because in my model the effect of tenure at supervisory jobs is not separately identifiable from firm type. All supervisory job workers at promotion firms have a tenure of one, while all supervisory job workers at non-promotion firms have a tenure of zero. Column 5 of Table 8 adds a control for tenure and tenure interacted with establishment

promotion policy. As expected, adding tenure controls substantially increases the standard error of my estimate of the observed effect of being at a promotion establishment. The point estimate remains positive, though (not significantly) smaller than in the regressions without tenure, and is no longer statistically significant. Column 5 and 6 repeat columns 3 and 4, but using 3-digit occupation and industry codes instead of two. As with the non-managerial, non-supervisorial sample, it appears that there is correlation between promotion policy and high-paying industries and occupations within each broader classification code. The point estimate on promotion in column 5 is still positive, but not significantly so. Adding controls for tenure, again, decreases the magnitude of the point estimate while increasing the standard error. The estimate, however, continues to have the right sign.

In Table 9, I repeat the specifications of Table 8, but excluding managers from the regressions. In some ways, my model may be better representative of moving from entry-level to supervisor than entry-level to management, since the job of supervisor requires more similar skills to that of an entry-level worker at the same occupation. The results largely mirror those of Table 8. One notable difference is in the last column. Including 3-digit occupation and industry indicators as well as worker characteristics reverses the sign on promotion from the theoretical prediction, though this coefficient is insignificant with a t-statistic of .41. However, it should be noted that the interaction between tenure and promotion is large, positive, and significant, so that workers in supervisory jobs at promotion establishments with two or more years of tenure will outearn those at non-promotion establishments. Given that, in my model, all workers in supervisory jobs at promotion firms have an additional year of tenure than those at non-promotion firms, this does not appear to be an inconsistency.

To further address the question of sorting, Table 10 shows ordered logit estimates for the workers' highest educational certification. This variable has seven categories in the WERS. If one could observe the signal received by the market in my model, the entry-level jobs at promotion establishments would be entirely populated by workers with the high signal, while those jobs at non-promotion establishments would be entirely populated by workers with the low signal. Workers at supervisory jobs in promotion establishments would also all

have had the high signal, since they are chosen only from the population of lower workers at such establishments. However, supervisory jobs at non-promotion establishments would be populated by both kinds of workers, since some of the workers who had high signals and were realized to be good migrate to supervisory jobs at non-promotion establishments. There is no such question, unfortunately, in the survey. Instead, I look at sorting on education, an observable variable that is correlated with higher levels of productivity and, presumably, a better market signal. The first column looks at all workers controlling only for the employer's promotion policy type. Workers at promotion establishments are significantly more likely to have higher levels of education than those at non-promotion establishments. Adding controls for industry, occupation, and worker characteristics does not change this result. The third and fourth columns of Table 10 break the sorting down by job type. Both supervisory and entry-level job workers are more likely to have higher levels of education at promotion establishments. Although the difference in the sorting is not statistically significant, the coefficient on the interaction between working at a supervisory job and being at a promotion establishment is negative when using an ordered logit which fully nests both supervisory and entry-level jobs. This is consistent with the theory.

4.2 Discussion and Robustness Checks

Since promotion policy and establishment size are correlated, one might be concerned that the observed tenure effect is simply proxying for size-differences in the return to tenure. Column 1 of Table 11 addresses this concern. Adding an interaction between establishment size and tenure has no substantive effect on the results. Another concern might be that establishment size is not the relevant measure for the size-wage effect, but rather the overall size of the firm. In columns 2 and 3, I replace the establishment size variable with a measure for the total number of workers who are employed by the firm in the United Kingdom.[26] This variable does not appear to have much effect on wages, and the main results remain

[26] This measure was constructed by taking the midpoints of the categorical variables for this question in the MQ. I include a dummy variable for whether the establishment was in the unbouded set.

quantitatively similar. Column 5 controls for both firm and establishment size, and their interactions with tenure. The main variables of interest remain significant and of similar magnitude to my previous estimates.

As discussed previously, there are some problems with using midpoints of income and hours worked to impute wages. One particular concern is that a correlation between establishment promotion policy and hours worked could bias my results. Tables 12, 13, and 14, re-estimate my main results using interval regression ordered probits. These specifications constrain the ordered probit cutpoints to match the actual (log) income categorical cutoffs and include log hours on the left-hand side with a coefficient constrained to 1. Thus the coefficients are identified and can be interpreted as marginal wage effects. While the significance levels vary somewhat relative to the estimates using OLS with imputed wages, these results retain the same sign and are similar in magnitude.

Another concern is that promotion could be proxying for some sort of establishment productivity differences. The WERS FQ offers three different measures of establishment level productivity: profits, value added, and the capital/labor ratio. Capital/labor ratio and profitability, in particular, have been shown to be positive correlates of the wage, at least at the industry level (Dickens and Katz, 1986). Unfortunately, the response rate to the FQ was much lower than the other parts of the survey; less than half of the participating companies filled out a FQ. This severely reduces the sample size. Only 1,791 of my non-managerial non-supervisorial workers work at an establishment with a valid entry for capital/labor ratio.

There are a few theoretical problems with adding firm productivity measures to a wage regression. In a competitive market, wages are equal to marginal product. If the production function is Cobb-Douglas, log wage is a linear function of just the log of capital labor ratio. Value added (revenue - variable cost) divided by labor is just a linear transformation of the capital labor ratio, as is profits less fixed costs divided by worker. In this setting, this type of regression would simply be of wage on wage. My model's setting is slightly different, in that young promotion firm workers at entry-level jobs earn wages above their marginal product in equilibrium, but this rent disappears for old workers and it is still unclear what further

controls in the regression could account for. Despite these concerns, this is a regression which is frequently estimated, and can still provide some insight into the robustness of my main results.

Table 15 shows the results of adding these controls to the log wage regressions of non-managerial, non-supervisorial workers. Interestingly, profitability and value added appear to negatively affect the wage, though these coefficients are never significant. The productivity controls do not substantially alter the results. While the promotion coefficient loses its significance when controlling for value added or the capital labor ratio, this is mainly due to the loss of power because of the smaller sample size. The magnitude of the coefficient is similar to that in the full sample of entry-level workers without these extra controls. The interaction between being at a promotion establishment and tenure is always significant and is larger, though not significantly so, than estimates seen without these controls in Tables 5 and 6.

So far the results I have shown have been consistent with the implications of the model. They also may seem somewhat consistent with a story of promotions as incentives. In a typical promotions as tournaments model, those who do not get promoted receive lower wages as a punishment to induce higher effort in the initial period. A lower return to tenure from promotion "losers" is consistent with this. It is more difficult to explain the higher initial wages at a promotion establishment from this perspective.

One way to do so would be through a promotions as signals story. Suppose that firms have private information on the quality of their workers, and that promotion serves to signal the quality of the promoted worker to the market. Market forces then cause an increase in that individual's wages. Promotion losers will be paid less, since Bayesian updating implies they must be of lower average productivity than before. Workers at promotion firms are then paid a premium to account for risk aversion. This premium is acceptable to the firm because the incentives cause higher effort and thus higher productivity. However, the fact that long-tenured non-managerial, non-supervisorial workers appear to be paid equally across promotion strategy types is inconsistent with this approach. The workers in the non-

promotion firms should be of the same average ability as the market initially viewed them. Any hiring away from this pool would have to have been done randomly and would not affect the market's beliefs. The workers at the non-promotion firms have been identified as being of lower than average skills since they lost the tournament. Since the uncertainty has been resolved, they no longer must be compensated for risk. This signals model predicts *lower* wages for long-tenured workers at promotion firms than similar workers at non-promotion firms, which is inconsistent with the results of Table 7.[27]

To further address the idea of incentives, in Table 16 I control for non-promotion related establishment-level pay incentives. In the MQ, managers were asked to identify work groups at the 1-digit SOC2000 code level that were eligible for merit pay or pay-by-results. I match this with the workers' 1-digit SOC2000 codes to define whether the worker is eligible for "incentive pay." The theoretical interaction between incentive pay and promotion incentives is unclear. If the two types of incentives are substitutes, then one should not observe tenure effects for workers at establishment which use incentive pay rather than promotion incentives. However, recent theoretical and empirical work (Kwon, 2006, Frederiksen and Takats, 2011) has suggested that the optimal set of incentives includes both promotion and other monetary bonuses. Indeed this is also suggested by the fact that a significantly larger share of promotion establishments offer incentive pay to at least some of their workers in my sample. If incentive pay and promotion incentives are complements then tenure effects related to tournament prizes should only be seen at establishments which also use incentive pay. My test is agnostic with respect to these two theories. If the observed tenure effect is related to the sorting and wage premium in my theory then I should observe a lower return to tenure at promotion

[27] This argument is based on the wage structure in Zabojnik and Bernhardt (2001), where the existence of sufficient amounts of firm specific capital prevent a market unraveling due to the asymetric information with simulatenous wage offers. In the offer matching context of Ghosh and Waldman (2010), it is unclear how a non-promotion firm could attract any workers. In the second period, workers are paid the wage of the productivity of the lowest type of worker, and in the first period competition sends these expected rents back to the workers. Since the promotion rule is designed to maximize rents, wages at promotion firms would be strictly higher in the first period, independent of effort choice, and identical in the second, meaning that workers would strictly prefer to work at a promotion firm. A perhaps larger problem with allowing for non-promotion firms in these models is the lack of equilibrium turnover from which a non-promotion firm could hire.

establishments regardless of what incentive compensation is used.

In the first two columns of Table 16, I control for incentive pay and its interactions with promotion policy and tenure. While it appears that the negative return to tenure is stronger at promotion establishments that offer pay incentives than those that do not, the general tenure effect at promotion establishments remains negative and is not substantially lower than my previous estimates. In the second two columns, I instead use a measure of incentive pay at the individual level. Managers were asked what outcomes incentive pay was related to. For the 1-digit SOC2000 codes for which managers reported incentives were tied to individual and team (as opposed to company-wide) performance, I recorded those workers as having individual incentives. Despite being more directly tied to individual performance, these types of incentives do not appear to be associated with differential returns to tenure. The general promotion-tenure correlation is significant and unchanged from the main results.

5 Summary and Conclusion

In this paper, I developed a new model of promotions in equilibrium, which sought to explain heterogeneity in promotion practices across firms. My model is based on ex-ante identical firms committing to eventually promote one of their workers to a more valuable task before workers are hired, in order to attract talented workers into low level jobs and increase their probability of eventually obtaining a highly productive worker at the valuable task. Internal promotion allows firms to avoid the uncertainties of hiring from a frictional labor market. The viability of this strategy is limited by the scarcity of talented workers in the initial labor pool.

My model predicted that workers at entry-level jobs at firms that promote would have higher wages, but lower observed returns to tenure. This was due to two effects. First there is a sorting effect. Workers with good future prospects were initially employed only at promotion firms, but the best workers at entry-level jobs left those jobs for better opportunities, either internally or externally. Second, initial labor market competition bid up the wages of

workers with good future prospects above their marginal product. Once the uncertainty has been resolved, this promotion premium disappears. There are no differences in the wages of the most senior workers in jobs that differ only in their firm's promotion policy. I confirmed these predictions in the data. Also consistent with my model, workers in supervisory jobs at promotion establishments earn higher wages and there is sorting on observables, where educated workers are more likely to be employed at promotion establishments than non-promotion establishments. These results are somewhat inconsistent with the conventional promotions as incentives models and are not driven by differences in establishment-level productivity.

While my model does not incorporate any incentive structure, it is compatible with the tournament literature. Firms' promotion decisions were based simply on hiring the most productive worker. One could imagine an extension which incorporated intra-firm competition for human capital in order to determine the promotion. However, the decisions of the non-promotion firms must also be taken into account. If workers differed in both their expected ability and their expected return on human capital investment, similar to the job assignment literature (Gibbons and Waldman, 1999, 2006), then sorting may still be possible. This is certainly an avenue for future study.

My model also provides a potential explanation for inequality outcomes. Workers at promotion firms, who all have good observables in equilibrium, have a higher chance of earning a high-paying job even when they are revealed to not be of high ability. Applying this to the statistical discrimination literature, if blacks have poorer characteristics than whites that are observable to employers but not to the econometrician then, even conditional on other observables and ability, blacks may perform poorer than whites in the long run. This is consistent with evidence presented by Altonji and Pierret (2001).

Overall, while incentives may play an important role in the labor market within a firm, incentivizing workers to enter the firm is important when looking between firms that do and do not promote. The quality of the labor pool is a constraint on the number of firms who can profitably implement an internal labor market.

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A Theoretical Appendix

A.1 Proofs of Main Results

A.1.1 Proof of Lemma 2

Proof. Suppose in some period there was a contract in Δ that would generate positive profit given r_t . Then all firms demand a factory at price r_t. Since the supply of factories is fixed at 1, there is excess demand for factories. This violates Factory Market Clearing. ■

A.1.2 Proof of Lemma 3

Proof. Suppose there was a period t in which some factories were not consumed. Then it must be that r_t is greater than the expected benefit of hiring a supervisory worker from the market. Otherwise, firms could make positive lifetime profits by entering in t only and hiring a supervisory worker from the market, which is not possible via Lemma 2. Since $\theta_B > 0$, all workers have positive production, and since $0 < \psi < 1$, the expected benefit to the firm of hiring a supervisory worker is positive, this means there is excess supply of factories at the price r_t. This violates Factory Market Clearing. ■

A.1.3 Proof of Lemma 4

Proof. Suppose there was unemployment in some period among old workers. Then it must be that the wage for old entry-level workers is 0, otherwise there is an excess supply of old workers. However, since $\theta_B > 0$, this implies that firms can make positive profit in that period by hiring only old entry-level workers. This violates Lemma 2.

Suppose there was unemployment in some period among young, low-signal workers. If the wage of low-signal workers at non-promotion firms in that period gives positive utility, then there is some contract outside of Δ with a lower wage that would increase the profits of a firm and the utility of an unemployed worker.

Suppose the wage gives 0 utility to low-signal workers in entry-level jobs at non-promotion firms in some period, and some low-signal workers are unemployed. Since low-signal workers generate positive production in expectation for the firm, there is some contract outside of Δ that offers a slightly higher wage, would generate higher utility for the unemployed workers and profits for firms that do not employ entry-level workers (non-entrant firms). This violates Optimal Contracts. An analogous argument holds for high-signal workers. ■

A.1.4 Proof of Lemma 5

Proof. Suppose in some period there is a contract in Δ that has no promotion promise and a wage above the worker's base productivity. The the firm takes a loss on the contract which violates Participation. Suppose in some period there is a contract in Δ that has no promotion promise and a wage below the worker's base productivity. Then there exists a higher wage contract which would increase the utility of the worker and the profits of a (non-entrant) firm which does not employ entry-level workers. This violates Optimal Contracts. ■

A.1.5 Proof of Proposition 9

Proof. By Lemma 4 there is no unemployment, so the set of promotion firms must be of measure g. By Lemma 3, all factories are consumed, so there then must be $1-g$ non-promotion firms who each employ 2 low-signal workers at entry-level jobs. Now consider the expected quality of hiring a supervisory worker. Given this allocation of workers and firms, there is excess demand for good workers at supervisory jobs at non-promotion firms because

$$1-g > gp_H^2 + 2(1-g)p_L \tag{2}$$

where the first term on the right-hand side is the measure of the set of good workers who do not get supervisory jobs at promotion firms and the second term is the measure of the set of good workers who were previously employed at entry-level jobs in the non-promotion firms. Rearranging these terms, the probability of hiring a good worker for a supervisory job at a non-promotion firm is

$$\frac{g}{1-g}p_H^2 + 2p_L \tag{3}$$

Condition 4 states that this must be less than 1, and ensures talent scarcity.

Given this, and that the wage of entry-level workers at non-promotion firms is equal to marginal product (Lemma 5), Lemma 2 determines the price of factories r. The expected profits for a non-promotion firm are

$$\pi^{np} = \bar{\theta}_B^F + (\frac{g}{1-g}p_H^2 + 2p_L)(\bar{\theta}_G^F - \bar{\theta}_B^F) - r \tag{4}$$

Setting $\pi^p = 0$ and rearranging terms determines r.

Finally, the wage for the high-signal workers at entry-level jobs at promotion firm must induce zero profits by Lemma 2. The expected output from entry-level workers is $2(p_H\theta_G + (1-p_H)\theta_B)$, and the expected probability of getting a good worker for the supervisory job is $p_H(2-p_H)$. The promotion firm must pay $\bar{\theta}_B^F + (\frac{g}{1-g}p_H^2 + 2p_L)(\bar{\theta}_G^F - \bar{\theta}_B^F)$ to purchase a factory. Denote w^{HH} as the wages paid by promotion firms to high-signal workers with a high-signal coworker. The promotion firm's expected profits from hiring two high-signal workers are

$$\pi^p = 2(p_H\theta_G + (1-p_H)\theta_B) + (p_H(2-p_H) - (\frac{g}{1-g}p_H^2 + 2p_L)(\bar{\theta}_G^F - \bar{\theta}_B^F)) - 2w^{HH} \tag{5}$$

Setting expected profits equal to 0 and rearranging terms, the equilibrium wage w^{HH} must be

$$w^{HH} = (p_H\theta_G + (1-p_H)\theta_B) + \frac{1}{2}(p_H(2-p_H) - (\frac{g}{1-g}p_H^2 + 2p_L)(\bar{\theta}_G^F - \bar{\theta}_B^F)) \tag{6}$$

In order for this to be an equilibrium, it must be that there are no other contracts that would be strictly preferred by both a worker and a firm. I will show this by finding the lowest wage that would be accepted by a worker at each job, and finding under which conditions the firm would not be willing to offer that wage.

There are two other entry-level worker combination contracts offered by the promotion firm. The first mixes one high-signal worker with one low-signal worker. The second employs two low-signal workers. A worker will always get a supervisory job when she is revealed to

be good, due to talent scarcity, but her probability of getting a supervisory job when she is revealed to be bad varies with the job. Since ties are broken by coin flip, workers at a promotion firm with one low- and one high-signal entry-level job worker have probability $\frac{1}{2}(1-p_L)(1-p_H)$ of getting a promotion internally as a bad worker. That probability is $\frac{1}{2}(1-p_L)^2$ and $\frac{1}{2}(1-p_H)^2$ for two high-signal and two-low signal entry-level job workers, respectively. Workers also have a chance of getting a supervisory job on the market when they are bad because of talent scarcity. Denoting this probability as χ, and denoting U^p_{ij} as the expected utility of worker at a promotion firm with signal i and a coworker of signal j, and similarly for the wage, w^{ij}, the expected utilities for the worker under the various possible promotion job opportunities are

$$U^p_{HH} = w^{HH} + p_H(\theta_G + \bar{\theta}^W_G) + (1-p_H)\theta_L + \frac{1}{2}(1-p_H)^2(1+\chi)\bar{\theta}^W_B + p_H(1-p_H)\chi\bar{\theta}^W_B \quad (7)$$

$$U^p_{HL} = w^{HL} + p_H(\theta_G + \bar{\theta}^W_G) + (1-p_H)\theta_L + \frac{1}{2}(1-p_H)(1-p_L)(1+\chi)\bar{\theta}^W_B + p_L(1-p_H)\chi\bar{\theta}^W_B \quad (8)$$

$$U^p_{LH} = w^{LH} + p_L(\theta_G + \bar{\theta}^W_G) + (1-p_L)\theta_L + \frac{1}{2}(1-p_H)(1-p_L)(1+\chi)\bar{\theta}^W_B + p_H(1-p_L)\chi\bar{\theta}^W_B \quad (9)$$

$$U^p_{LL} = w^{LL} + p_L(\theta_G + \bar{\theta}^W_G) + (1-p_L)\theta_L + \frac{1}{2}(1-p_L)^2(1+\chi)\bar{\theta}^W_B + p_L(1-p_L)\chi\bar{\theta}^W_B \quad (10)$$

A worker at a non-promotion firm has probability χ of getting a high job when they are revealed to be a bad worker. Workers at non-promotion firms are paid their marginal product. Denoting U^{np}_i as the expected utility of a worker at a non-promotion firm with signal i, the expected utilities for the two signal-typed workers at non-promotion jobs are

$$U^{np}_H = p_H\theta_H + (1-p_H)\theta_L + p_H\bar{\theta}^W_G + (1-p_H)\theta_L + (1-p_H)\chi\bar{\theta}^W_B \quad (11)$$

$$U^{np}_L = p_L\theta_H + (1-p_L)\theta_L + p_L\bar{\theta}^W_G + (1-p_L)\theta_L + (1-p_L)\chi\bar{\theta}^W_B \quad (12)$$

Setting $U^p_{HH} = U^p_{HL}$ will solve for $\tilde{w}^{HL}$, the lowest wage that a worker with a high signal will accept to work at a promotion firm with a low-signal coworker

$$\tilde{w}^{HL} = w^{HH} - \frac{1}{2}(1-p_H)(p_H-p_L)(1-\chi)\bar{\theta}^W_B \quad (13)$$

Likewise, setting $U^{np}_L = U^p_{LH}$ will solve for $\tilde{w}^{LH}$, the lowest wage that a worker with a low signal will accept to work at a promotion firm with a high-signal coworker

$$\tilde{w}^{LH} = w_L - \frac{1}{2}(1-p_H)(1-p_L)(1-\chi)\bar{\theta}^W_B \quad (14)$$

A promotion firm that hires one high- and one low-signal worker has probability $(p_H + p_L - p_Hp_L)$ of hiring a good worker for its supervisory job. Thus, using the above two wages, the firm's expected profits from this strategy, π^p_{HL}, are

$$\pi^p_{HL} = (p_H+p_L)\theta_G + (2-p_H-p_L)\theta_B + (p_H(1-p_L) - \frac{g}{1-g}p_H^2 - p_L)(\bar{\theta}^F_G - \bar{\theta}^F_B) - (w^{HL}+w^{LH}) \quad (15)$$

For this to be an equilibrium, it must be that the profits at the lowest wages workers are

willing to accept are less than zero for a promotion firm to hire one high-signal and one low-signal worker. Substituting for $\tilde{w}^{HL}$ and $\tilde{w}^{LH}$, this is true if and only if

$$\frac{1}{2}(1-p_H)(p_H-p_L+1-p_L)(1-\chi)\bar{\theta}_B^W-(p_Hp_L+\frac{1}{2}(1+\frac{g}{1-g})p_H^2)(\bar{\theta}_G^F-\bar{\theta}_B^F)\leq 0 \quad (16)$$

The hereto undefined parameter, χ, represents the probability of finding a supervisory job in the market conditional on being a bad worker. There is an oversupply of bad workers for good jobs because

$$g(1-p_H^2)+2(1-p_L)(1-g)>(1-g)(1-\frac{g}{1-g}p_H^2-2p_L) \quad (17)$$

where the first term on the left-hand side is the measure of the set of bad workers at promotion firms who are not promoted, the second term on the left-hand side is the measure of the set of bad workers that were previously at entry-level jobs at non-promotion firms, and the right-hand side is the measure of the set of supervisory vacancies that are not filled by good workers at non-promotion firms. Re-arranging,

$$\chi=\frac{(1-g)(1-\frac{g}{1-g}p_H^2-2p_L)}{g(1-p_H^2)+2(1-p_L)(1-g)} \quad (18)$$

Substituting in for χ the above inequality is condition 1 in the proposition.

Focusing now on the second alternative contract offered by a promotion firm, when it hires two low-signal workers it has a probability of $p_L(2-p_L)$ of obtaining a good worker for its supervisory job in the second period. Its expected profits, π_{LL}^p, given a wage w_{LL}, then, are

$$\pi_{LL}^p=p_L\theta_G+(1-p_L)\theta_B-(p_L^2+\frac{g}{1-g}p_H^2)(\bar{\theta}_G^F-\bar{\theta}_B^F)-2w^{LL} \quad (19)$$

To find the lowest wage a low-signal worker will accept at a promotion firm with a low-signal coworker, $\tilde{w}_{LL}$, set $U_{LL}^p=U_L^{np}$

$$\tilde{w}^{LL}=w_L-\frac{1}{2}(1-p_L)^2(1-\chi)\bar{\theta}_B^W \quad (20)$$

This can only be an equilibrium if the firm is unwilling to employ the workers at this wage, which occurs if and only if

$$(1-p_L)^2(1-\chi)\bar{\theta}_B^W-(p_L^2+\frac{g}{1-g}p_H^2)(\bar{\theta}_G^F-\bar{\theta}_B^F)\leq 0 \quad (21)$$

which is condition 2 of the proposition.

Finally, a non-promotion firm could, alternatively, employ two high-signal workers at wage w_H. The firm's expected profits, π_{HH}^{np} are,

$$\pi_{HH}^{np}=2(p_H\theta_G+(1-p_L)\theta_B)-2w_H \quad (22)$$

The lowest wage a high-signal worker would accept to work at a non-promotion firm, $\tilde{w}_H$,

can be found by setting $U^p_{HH} = U^{np}_H$

$$\tilde{w}_H = w_{HH} + \frac{1}{2}(1-p_H)^2(1-\chi)\bar{\theta}^W_B \tag{23}$$

This can only be an equilibrium if the firm is unwilling to offer a contract for the lowest wage the worker would accept, which occurs if and only if $\tilde{w}_H$ is less than the marginal product of the high-signal worker. This is the case if and only if

$$-((1+\frac{g}{1-g})p_H^2 - 2(p_H - p_L))(\bar{\theta}^F_G - \bar{\theta}^F_B) - (1-a)^2(1-\chi)\bar{\theta}^W_B \leq 0 \tag{24}$$

which is the third condition of the proposition.

Taken together these four conditions assure that the wages w^{HH} and w_L, and factory price r, as defined above, represent a market clearing factory price and a characterize a set of contracts that both give nonnegative benefits to all firms and workers and cannot be mutually improved upon. Since the parameters do not change over time, it is a steady-state equilibrium. ■

A.1.6 Proof of Corollary 10

Proof. This corollary follows directly from Proposition 9. The first two conditions are sufficient to make all the left-hand sides of Proposition 9's inequalities to be strictly increasing in θ_H. The right-hand side of the inequalities are unaffected by θ_H. Holding the right hand side fixed, there must by some θ_H large enough to make the left hand side's larger. The third condition just repeats condition 4 of Proposition 9, and guarantees that the equilibrium will be talent scarce. ■

A.1.7 Proof of Proposition 12

Proof. As shown in Proposition 9, the only observed wage at promotion firms for young entry-level workers, is

$$(p_H\theta_G + (1-p_H)\theta_B) + \frac{1}{2}(p_H(2-p_H) - (\frac{g}{1-g}p_H^2 + 2p_L)(\bar{\theta}^F_G - \bar{\theta}^F_B)) \tag{25}$$

Non-promotion firms pay entry-level workers their marginal product, and employ only low-signal workers, so

$$w_L = p_L\theta_G + (1-p_L)\theta_B \tag{26}$$

Taking the difference proves the proposition. ■

A.1.8 Proof of Proposition 13

Proof. The market for old entry-level workers is perfectly competitive, so all workers are paid their marginal product. The equilibrium is talent scarce, so no good workers are employed at entry-level jobs. Therefore, all old entry-level workers received the same wages, regardless of employer. ■

A.1.9 Proof of Proposition 14

Proof. Proposition 12 shows that entry-level workers are paid more when they are young at promotion than non-promotion firms. Proposition 13 shows that workers are paid identical wages when they are old at entry-level jobs, regardless of their firm's promotion policy. Subtracting the two wages proves the proposition. ■

A.1.10 Proof of Proposition 15

Proof. As derived in the proof of Proposition 9, the probability that a non-promotion firm is able to hire a good worker from the market is $\frac{g}{1-g}p_H^2 + 2p_L$. Condition 11 is simply that the probability that at least one of two randomly selected high-signal workers is good is higher than this. Since wages are determined by Nash bargaining, wages are identical at supervisory jobs conditional on worker type. ■

A.2 Equilibrium Properties

A.2.1 Social Welfare Properties

Proposition 16 *Suppose an allocation of firms q and workers s is talent scarce. Then for any social welfare function S, there exists some set of feasible transfers t such that this set of worker and firm allocations solves the social planner's welfare optimization problem*

Proof. Suppose that there was a talent scarce equilibrium with allocation of workers s and firms q, but that there is a social welfare function S for which no set of transfers t will maximize given s and q. Then, there must be some other allocation of workers s' and firms q' that would allow for a feasible set of transfers t' that would provide a set of agents of positive measure with higher utility. Since all utilities are linear, this could only be the case if s' and q' increased the total output in the economy, thus allowing the size of t' to be larger than t. This would require that s' and q' increase the measure of the set of good workers assigned to supervisory jobs relative to s and q. However, by definition of talent scarcity, s and q assign the maximum measure to the set of good workers to supervisory jobs. Therefore s' and q' must not be feasible. ■

Proposition 17 *Suppose an allocation of firms q and workers s is not talent scarce and is not trivial. Then there does not exist any social welfare function S, such that a set of feasible transfers t would allows this set of worker and firm allocations to solve the social planner's welfare optimization problem*

Proof. Suppose there was some equilibrium with allocation of workers s and firms q that is not talent scarce, and some social welfare function, S, that is maximized by a feasible set of transfers t given s and q. Since the equilibrium is not talent scarce and not trivial, there is an alternative allocation of s' and q', namely setting the measure of promotion firms to 0 in periods that are not talent scarce, that will increase the measure of the set of good workers assigned to supervisory jobs, and thus the output of the economy. Since all utilities are linear, there must be a vector of transfers t' that under s' and q' that would increase the utility of all agents relative to s, q, and t. Therefore S is not a social welfare function. ■

These two propositions get at the general welfare properties of equilibria in this economy. While promotion-promise contracts can create an inefficiency in this economy in the sense that total production will be lower than in an economy where all firms do not commit, this is only the case when the equilibrium is not talent scarce. In a talent scarce equilibrium, the ability of firms to promote transfers utility from those who work at non-promotion firms to those who work at promotion firms, due to the latter's increased probability of being employed at a supervisory position. However, it still achieves the maximum output possible, since all old good workers are assigned to the more productive supervisory job. Therefore, a social planner with the ability to enforce lump sum transfers can do no better than adjusting these transfers. In a equilibrium that is not talent scarce, on the other hand, some old good workers are employed at entry-level jobs, while some old bad workers are employed at supervisory jobs. Output would be increased by switching the jobs of these workers, as would happen when no firms promote. A social planner could then use transfers to increase all workers utilities. I do not allow extra-wage contracts in my model. If I did, this would likely rule out equilibria that are not talent scarce via the first welfare theorem.

A.2.2 Other Pooling Equilibria

In this section of the appendix, I explore an alternative equilibrium in which each promotion firm hires one high-signal worker and one low-signal worker for the entry-level jobs. In this equilibria, promotion firms benefit by hiring a cheaper low-signal worker at a wage below his marginal product. The high-signal worker is then able to extract all of firm's future supervisory output, as opposed to in the two high-signal worker case, where that output was split in two. Non-promotion firms retain the strategy of hiring only low-signal workers. The proposition shows that, as long as this strategy yields a better supervisory worker on average than the non-promotion strategy, the testable predictions are the same as those for the equilibrium in Proposition 9.

Proposition 18 *Suppose that, in a talent scarce equilibrium, the set of firms who promotes is of measure* $2g$*, and each promotion firm hires one high-signal entry-level worker. Then, so long* $p_H - p_L - p_H p_L > \frac{2gp_Hp_L}{(1-2g)}$*,*

1. *Young entry-level workers at promotion firms are paid more on average than young entry-level workers at non-promotion firms*
2. *There will be no differences in average wages for old entry-level workers between promotion and non-promotion firms*
3. *The observed return to tenure of entry-level workers is higher at non-promotion firms*
4. *Supervisory job workers are paid more on average at promotion firms than at non-promotion firms*

Proof. First I will derive the wages that are paid at the promotion firm and the cost of factories. The excess demand for good supervisory workers at non-promotion firms is given by

$$1 - 2g > 2gp_Hp_L + 2(1-2g)p_L \tag{27}$$

where the first term on the right hand side is the measure of the set of good workers who are not promoted internally at promotion firms, and the second term is the measure of the set of good workers who were previously employed at non-promotion firms. This can be rearranged to show the probability of getting a good worker for a supervisory job at a non-promotion firm in this environment

$$\frac{2gp_Hp_L}{1-2g} + 2p_L \tag{28}$$

Since there are no profits in equilibrium (Lemma 2), and non-promotion workers are paid their marginal product (Lemma 5), the cost of factories must be the expected revenue at non-promotion firms from hiring supervisors from the market. Therefore

$$r = \bar{\theta}_B^F + (\frac{2gp_Hp_L}{1-2g} + 2p_L)(\bar{\theta}_G^F - \bar{\theta}_B^F) \tag{29}$$

Since low-signal workers are employed at both types of firms, they must be indifferent between the two sectors. Since workers are equally productive at entry-level jobs in all firms, and since talent is scarce so all that good workers are employed at supervisory jobs, the difference in the wages must be the difference in the probability of obtaining a supervisory position when the worker is revealed to be bad. Therefore, the wage for low-signal workers at entry-level promotion jobs, w^{LH}, is

$$w^{LH} = p_L\theta_G + (1-p_L)\theta_B - \frac{1}{2}(1-p_H)(1-p_L)(1-\chi)\bar{\theta}_B^W \tag{30}$$

where χ is the probability for a bad worker of obtaining a supervisory job at a non-promotion firm.

The expected profits of the promotion firm after paying factory costs, given they pay their high-signal workers w_{HL}, are

$$\pi_{HL}^p = (p_H+p_L)\theta_G+(2-p_H-p_L)\theta_B+(p_H-p_L-p_Hp_L-\frac{2gp_Hp_L}{(1-2g)})(\bar{\theta}_G^F-\bar{\theta}_B^F)-w^{HL}-w^{LH} \tag{31}$$

Substituting for w^{HL}, and setting profits equal to zero, the equilibrium high-signal entry-level wage is

$$w^{HL} = p_H\theta_G+p_L\theta_B+(p_H-p_L-p_Hp_L-\frac{2gp_Hp_L}{1-2g})(\bar{\theta}_G^F-\bar{\theta}_B^F)+\frac{1}{2}(1-p_H)(1-p_L)(1-\chi)\bar{\theta}_B^W \tag{32}$$

Each promotion firm hires one worker at w^{HL} and one worker at w^{LH}, so the average wage of a young entry-level worker at a promotion firm is

$$\bar{w}^p = \frac{1}{2}((p_H+p_L)\theta_G + (2-p_H-p_L)\theta_B) + \frac{1}{2}(p_H-p_L-p_Hp_L-\frac{2gp_Hp_L}{1-2g})(\bar{\theta}_G^F-\bar{\theta}_B^F) \tag{33}$$

The first term is unambiguously larger than the average wage for young workers at non-promotion firms, which is the expected marginal product of low-signal workers. The second term is greater than zero so long as $p_H - p_L - p_Hp_L > \frac{2gp_Hp_L}{(1-2g)}$, in which case the average wage for young entry-level promotion firms is larger than for the same jobs at non-promotion firms. Since talent is scarce this proves statements 1-3 (see proofs of Propositions 12-14).

The condition is that the probability of getting a good worker at a promotion firm is higher in equilibrium than for a non-promotion firm drawing a worker from the market. Since wages at supervisory jobs are determined by Nash bargaining and the firm type does not affect the threat points, this proves statement 4. ■

B Data Appendix

B.1 Examples of SOC2000 Codes

- 52 Skilled Metal and Electrical Trades
  - 521 Metal Forming, Welding, and Related Trades
  - 522 Metal Machining, Fitting, and Instrument Making Trades
  - 523 Vehical Trades
  - 524 Electrical Trades
- 53 Skilled Construction and Building Trades
  - 531 Construction Trades
  - 532 Building Trades
- 54 Textiles, Printing, and Other Skilled Trades
  - 541 Textiles and Garment Trades
  - 542 Printing Trades
  - 543 Food Preperation Trades
  - 549 Skilled Trades n.e.c

B.2 Examples of SIC2003 Codes

- 17 Manufacturing of Textiles
  - 17.1 Preperation and spinning of textile fibers
  - 17.2 Textile weaving
  - 17.3 Finishing of textiles
  - 17.4 Manufacture of made-up textile articles, except apparel
  - 17.5 Manufacture of other textiles
  - 17.6 Manufacture of knitted and crocheted fabrics
  - 17.7 Manufacture of knitted and crocheted articles
- 18 Manufacture of Wearing Apparel; Dressing and Dyeing of Fur
  - 18.1 Manufacture of leather clothes

  - 18.2 Manufacture of other wearing apparel and accessories
  - 18.3 Dressing and dying of fur; manufacture of articles of fur

- 19 Tanning and Dressing of Leather; Manufacture of Handbags, Saddlery, Harness, and Footwear
  - 19.1 Tanning and dressing of leather
  - 19.2 Manufacture of luggage, handbags and the like, saddlery and harness
  - 19.3 Manufacture of footwear

Table 1: Descriptive Statistics - All Workers

	All	Promotion	Nonpromotion
Tenure			
<1 year	0.21	0.20	0.21
	(0.40)	(0.40)	(0.41)
1-2 years	0.15	0.14	0.15
	(0.36)	(0.35)	(0.36)
2-5 years	0.29	0.31	0.28
	(0.45)	(0.46)	(0.45)
5-10 years	0.18	0.19	0.17
	(0.38)	(0.39)	(0.38)
>10 years	0.18	0.16	0.18
	(0.38)	(0.37)	(0.39)
Education			
No Certification	0.17	0.13	0.19
GSCE	0.37	0.35	0.38
GCE	0.15	0.16	0.15
First Degree (BSc, BA, etc.)	0.24	0.27	0.22
Higher Degree (MSc, PhD, etc.)	0.07	0.08	0.06
Wage (Imputed)	9.69	10.47	9.29
	(4.81)	(5.00)	(4.66)
Supervisor	0.40	0.39	0.41
	(0.49)	(0.49)	(0.49)
Occupation (1-digit SOC2000)			
Managers	0.18	0.19	0.17
Professionals	0.11	0.12	0.10
Technical Operations	0.15	0.16	0.14
Administrative	0.18	0.19	0.18
Skilled Trades	0.08	0.06	0.10
Personal Service	0.05	0.03	0.06
Sales	0.08	0.09	0.07
Process and Machine Operatives	0.09	0.10	0.08
Elementary Occupation	0.09	0.08	0.10
Observations	9348	3132	6216

Source: WERS 2004 SEQ. Means and standard deviations are reported using weights provided with data.

Table 2: Descriptive Statistics - Workers, by Subsample

	Entry-Level		Supervisorial	
	Promotion	Non-Promotion	Promotion	Non-Promotion
Tenure				
<1 year	0.26	0.27	0.11	0.13
	(0.44)	(0.45)	(0.31)	(0.34)
1-2 years	0.16	0.17	0.12	0.13
	(0.37)	(0.38)	(0.33)	(0.33)
2-5 years	0.29	0.28	0.33	0.28
	(0.45)	(0.45)	(0.47)	(0.45)
5-10 years	0.17	0.14	0.21	0.21
	(0.38)	(0.35)	(0.41)	(0.41)
>10 years	0.12	0.13	0.23	0.25
	(0.32)	(0.34)	(0.42)	(0.43)
Education				
None	0.18	0.23	0.08	0.14
GSCE	0.36	0.40	0.34	0.35
GCE	0.17	0.13	0.16	0.16
First Degree (BSc, BA, etc.)	0.24	0.18	0.32	0.28
Higher Degree (MSc, PhD, etc.)	0.06	0.05	0.11	0.08
Wage (Imputed)	8.76	7.75	12.76	11.27
	(3.99)	(3.54)	(5.28)	(5.15)
Occupation (1-digit SOC2000)				
Managers			0.44	0.39
Professionals	0.13	0.09	0.10	0.11
Technical Operations	0.19	0.16	0.12	0.13
Administrative	0.24	0.22	0.12	0.12
Skilled Trades	0.07	0.11	0.04	0.08
Personal Service	0.03	0.07	0.02	0.04
Sales	0.11	0.09	0.05	0.05
Process and Machine Operatives	0.13	0.12	0.05	0.03
Elementary Occupation	0.10	0.13	0.05	0.05
Observations	1798	3591	1334	2625

Source: WERS 2004 SEQ. Means and standard deviations are reported using weights provided with data.

Table 3: Descriptive Statistics - Employers

	All	Promotion	Non-Promotion
Vacancy Policy			
Internal Only	0.00	0.01	
	(0.06)	(0.12)	
Internal Preferred	0.28	0.99	
	(0.45)	(0.12)	
No Preference	0.66		0.93
	(0.47)		(0.26)
External Preferred	0.01		0.01
	(0.09)		(0.10)
External Only	0.04		0.06
	(0.20)		(0.24)
Employees at Establishment	477.16	595.55	429.83
	(1157.40)	(1432.05)	(1024.27)
Employees in UK	8902.53	10465.74	8257.95
	(17430.74)	(18358.91)	(17000.89)
Company Age	41.21	41.28	41.19
	(60.69)	(55.48)	(62.68)
Percent Union Members	0.25	0.25	0.25
	(0.31)	(0.31)	(0.31)
Offers Incentive Pay	0.48	0.61	0.42
	(0.50)	(0.49)	(0.49)
Largest Occupation (1-digit SOC2000)			
Professionals	0.13	0.10	0.14
Technical Operations	0.14	0.09	0.15
Administrative	0.14	0.19	0.12
Skilled Trades	0.07	0.08	0.07
Personal Service	0.09	0.04	0.11
Sales	0.15	0.19	0.14
Process and Machine Operatives	0.14	0.17	0.13
Elementary Occupation	0.14	0.14	0.14
Observations	1533	422	1111

Source: WERS 2004 MQ. Means and standard deviations are reported using employment weights provided with data.

Table 4: Descriptive Statistics - Establishment Industries

	All	Promotion	Non-Promotion
Manufacturing	0.15	0.23	0.12
Electricity	0.00	0.00	0.00
Construction	0.04	0.03	0.04
Wholesale and Retail Trade, Vehicle Repair	0.16	0.18	0.15
Hotels and Restaraunts	0.04	0.03	0.05
Transport, Storage, and Communication	0.07	0.09	0.06
Finance	0.05	0.09	0.03
Real Estate and Rental	0.15	0.16	0.14
Public Administration	0.06	0.05	0.06
Education	0.08	0.02	0.10
Health and Social Work	0.15	0.08	0.18
Other Personal Service	0.05	0.03	0.06
Observations	1533	422	1111

Source: WERS 2004 MQ. Means and standard deviations are reported using employment weights provided with data.

Table 5: Entry-Level Workers - Promotion Premium and Return to Tenure

	(1)	(2)	(3)	(4)	(5)
	Log Wage	Log Wage	Log Wage	Log Wage	Log Wage
Promotion	0.136***	0.074***	0.109***	0.067***	0.064***
	(0.032)	(0.024)	(0.025)	(0.021)	(0.022)
Tenure	0.021***	0.020***	0.021***	0.015***	0.015***
	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
Promotion * Tenure	-0.010	-0.009*	-0.013**	-0.010**	-0.010**
	(0.006)	(0.005)	(0.005)	(0.004)	(0.004)
Employees/100					0.003***
					(0.001)
Worker Characteristics	No	No	Yes	Yes	Yes
2-digit Occupation FE	No	Yes	No	Yes	Yes
2-digit Industry FE	No	Yes	No	Yes	Yes
Observations	5389	5389	5389	5389	5389

Robust standard errors are clustered at the establishment level. Worker characteristics include 6 education dummies, 16 race dummies, a gender dummy, and a quadratic in age. Occupation fixed effects use the UK Standard Occuaption Classification 2000 (SOC2000) system. Industry fixed effects use the UK Standard Industry Classification 2003 (SIC2003) system. Indicators are included for all topcoded variables, including an interaction between the tenure topcode and the promotion dummy.

* p<.1, ** p<.05, *** p<.01

Table 6: Entry-Level Workers - 3-digit FEs and Tenure Interactions

	(1)	(2)	(3)	(4)
	Log Wage	Log Wage	Log Wage	Log Wage
Promotion	0.057***	0.054***	0.069***	0.058***
	(0.021)	(0.020)	(0.022)	(0.021)
Tenure	0.020***	0.015***		
	(0.003)	(0.003)		
Promotion * Tenure	-0.009**	-0.010**	-0.012**	-0.010**
	(0.004)	(0.004)	(0.005)	(0.005)
Employees/100	0.004***	0.003***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Worker Characteristics	No	Yes	Yes	Yes
2-digit Occupation FE	No	No	Yes	No
2-digit Occupation * Tenure	No	No	Yes	No
3-digit Occupation FE	Yes	Yes	No	Yes
3-digit Occupation * Tenure	No	No	No	Yes
2-digit Industry FE	No	No	Yes	No
2-digit Industry * Tenure	No	No	Yes	No
3-digit Industry FE	Yes	Yes	No	Yes
3-digit Industry * Tenure	No	No	No	Yes
Observations	5389	5389	5389	5389

Robust standard errors are clustered at the establishment level. Worker characteristics include 6 education dummies, 16 race dummies, a gender dummy, and a quadratic in age. Occupation fixed effects use the UK Standard Occuaption Classification 2000 (SOC2000) system. Industry fixed effects use the UK Standard Industry Classification 2003 (SIC2003) system. Indicators are included for all topcoded variables, including an interaction between the tenure topcode and the promotion dummy.

* p<.1, ** p<.05, *** p<.01

Table 7: Log Wage Regressions for Entry-Level Workers with 10 or More Years Seniority

	(1) Log Wage	(2) Log Wage	(3) Log Wage	(4) Log Wage	(5) Log Wage	(6) Log Wage	(7) Log Wage
Promotion	0.138**	0.051	0.052	0.044	0.030	0.023	0.019
	(0.058)	(0.040)	(0.038)	(0.038)	(0.037)	(0.039)	(0.039)
Employees/100				0.004**			0.002
				(0.002)			(0.002)
Worker Characteristics	No	No	Yes	Yes	No	Yes	Yes
2-digit Occupation FE	No	Yes	Yes	Yes	No	No	No
3-digit Occupation FE	No	No	No	No	Yes	Yes	Yes
2-digit Industry FE	No	Yes	Yes	Yes	No	No	No
3-digit Industry FE	No	No	No	No	Yes	Yes	Yes
Observations	691	691	691	691	691	691	691

Robust standard errors are clustered at the establishment level. Worker characteristics include 6 education dummies, 16 race dummies, a gender dummy, and a quadratic in age. Occupation fixed effects use the UK Standard Occuaption Classification 2000 (SOC2000) system. Industry fixed ffects use the UK Standard Industry Classification 2003 (SIC2003) system. Indicators are included for all topcoded variables

* p<.1, ** p<.05, *** p<.01

Table 8: Log Wage Regressions for Supervisory Workers

	(1) Log Wage	(2) Log Wage	(3) Log Wage	(4) Log Wage	(5) Log Wage	(6) Log Wage
Promotion	0.074***	0.056***	0.053***	0.036	0.022	0.005
	(0.025)	(0.019)	(0.018)	(0.029)	(0.017)	(0.028)
Tenure				0.007*		0.007**
				(0.004)		(0.003)
Promotion * Tenure				0.005		0.005
				(0.006)		(0.005)
Employees/100			0.002***	0.002***	0.002***	0.002***
			(0.001)	(0.001)	(0.001)	(0.001)
Worker Characteristics	No	No	Yes	Yes	Yes	Yes
2-digit Occupation FE	No	Yes	Yes	Yes	No	No
3-digit Occupation FE	No	No	No	No	Yes	Yes
2-digit Industry FE	No	Yes	Yes	Yes	No	No
3-digit Industry FE	No	No	No	No	Yes	Yes
Observations	3959	3959	3959	3959	3959	3959

Robust standard errors are clustered at the establishment level. Worker characteristics include 6 education dummies, 16 race dummies, a gender dummy, and a quadratic in age. Occupation fixed effects use the UK Standard Occuaption Classification 2000 (SOC2000) system. Industry fixed ffects use the UK Standard Industry Classification 2003 (SIC2003) system. Indicators are included for all topcoded variables, including an interaction between the tenure topcode and the promotion dummy

* p<.1, ** p<.05, *** p<.01

Table 9: Log Wage Regressions for Non-Managerial Supervisory Workers

	(1) Log Wage	(2) Log Wage	(3) Log Wage	(4) Log Wage	(5) Log Wage	(6) Log Wage
Promotion	0.076**	0.078***	0.071***	0.025	0.031	-0.016
	(0.031)	(0.021)	(0.020)	(0.037)	(0.021)	(0.039)
Tenure				0.009**		0.008**
				(0.004)		(0.004)
Promotion * Tenure				0.013*		0.013*
				(0.007)		(0.007)
Employees/100			0.002***	0.002***	0.002***	0.002***
			(0.001)	(0.001)	(0.001)	(0.001)
Worker Characteristics	No	No	Yes	Yes	Yes	Yes
2-digit Occupation FE	No	Yes	Yes	Yes	No	No
3-digit Occupation FE	No	No	No	No	Yes	Yes
2-digit Industry FE	No	Yes	Yes	Yes	No	No
3-digit Industry FE	No	No	No	No	Yes	Yes
Observations	2386	2386	2386	2386	2386	2386

Robust standard errors are clustered at the establishment level. Worker characteristics include 6 education dummies, 16 race dummies, a gender dummy, and a quadratic in age. Occupation fixed effects use the UK Standard Occuaption Classification 2000 (SOC2000) system. Industry fixed ffects use the UK Standard Industry Classification 2003 (SIC2003) system. Indicators are included for all topcoded variables, including an interaction between the tenure topcode and the promotion dummy.

* p<.1, ** p<.05, *** p<.01

Table 10: Ordered Logit Regressions on Highest Educational Attainment

	(1) All Workers	(2) All Workers	(3) Entry-Level	(4) Supervisory
Promotion	0.338***	0.204***	0.226***	0.199**
	(0.095)	(0.065)	(0.079)	(0.087)
Tenure		-0.045***	-0.046***	-0.069***
		(0.011)	(0.015)	(0.017)
Employees/100		0.021***	0.014***	0.032***
		(0.005)	(0.004)	(0.006)
Worker Characteristics	No	Yes	Yes	Yes
2-digit Occupation FE	No	Yes	Yes	Yes
2-digit Industry FE	No	Yes	Yes	Yes
Observations	9348	9348	5389	3959

Robust standard errors are clustered at the establishment level. Worker characteristics include 6 education dummies, 16 race dummies, a gender dummy, and a quadratic in age. Occupation fixed effects use the UK Standard Occuaption Classification 2000 (SOC2000) system. Industry fixed effects use the UK Standard Industry Classification 2003 (SIC2003) system. Indicators are included for all topcoded variables, including an interaction between the tenure topcode and the promotion dummy.

* p<.1, ** p<.05, *** p<.01

Table 11: Entry-Level Workers - Firm Size Tenure Interactions

	(1)	(2)	(3)	(4)
	Log Wage	Log Wage	Log Wage	Log Wage
Promotion	0.065***	0.062***	0.062***	0.059***
	(0.022)	(0.022)	(0.022)	(0.022)
Tenure	0.015***	0.015***	0.015***	0.014***
	(0.003)	(0.003)	(0.003)	(0.003)
Promotion * Tenure	-0.011**	-0.009**	-0.009*	-0.009**
	(0.004)	(0.005)	(0.005)	(0.005)
Employees/100	0.002*			0.002*
	(0.001)			(0.001)
Employees/100 * Tenure	0.000			0.000
	(0.000)			(0.000)
Firm Employees in UK/10000		-0.001	-0.004	-0.005
		(0.004)	(0.005)	(0.006)
Firm Employees in UK/10000 * Tenure			-0.000	-0.000
			(0.001)	(0.001)
Worker Characteristics	Yes	Yes	Yes	Yes
2-digit Occupation FE	Yes	Yes	Yes	Yes
2-digit Industry FE	Yes	Yes	Yes	Yes
Observations	5389	5187	5187	5187

Robust standard errors are clustered at the establishment level. Worker characteristics include 6 education dummies, 16 race dummies, a gender dummy, and a quadratic in age. Occupation fixed effects use the UK Standard Occuaption Classification 2000 (SOC2000) system. Industry fixed effects use the UK Standard Industry Classification 2003 (SIC2003) system. Indicators are included for all topcoded variables, including an interaction between the tenure topcode and the promotion dummy.
* p<.1, ** p<.05, *** p<.01

Table 12: Log Wage Interval Regressions for Entry-Level Workers

	(1)	(2)	(3)	(4)
	Log Income	Log Income	Log Income	Log Income
Promotion	0.071***	0.061***	0.053**	0.048**
	(0.025)	(0.022)	(0.022)	(0.020)
Tenure	0.021***	0.016***	0.020***	0.015***
	(0.003)	(0.003)	(0.003)	(0.003)
Promotion * Tenure	-0.008	-0.010**	-0.007	-0.008*
	(0.005)	(0.005)	(0.005)	(0.004)
Employees/100		0.003***		0.003***
		(0.001)		(0.001)
Worker Characteristics	No	Yes	No	Yes
2-digit Occupation FE	Yes	Yes	No	No
3-digit Occupation FE	No	No	Yes	Yes
2-digit Industry FE	Yes	Yes	No	No
3-digit Industry FE	No	No	Yes	Yes
Observations	5389	5389	5389	5389

Robust standard errors are clustered at the establishment level. Worker characteristics include 6 education dummies, 16 race dummies, a gender dummy, and a quadratic in age. Occupation fixed effects use the UK Standard Occuaption Classification 2000 (SOC2000) system. Industry fixed effects use the UK Standard Industry Classification 2003 (SIC2003) system. Indicators are included for all topcoded variables. Each regression includes a variable for log hours whose coefficient is constrained to be 1.

* p<.1, ** p<.05, *** p<.01

Table 13: Log Wage Interval Regressions for Entry-Level Workers with 10 or More Years Seniority

	(1) Log Income	(2) Log Income	(3) Log Income	(4) Log Income	(5) Log Income	(6) Log Income	(7) Log Income
Promotion	0.140**	0.052	0.050	0.043	0.028	0.017	0.013
	(0.061)	(0.038)	(0.037)	(0.036)	(0.033)	(0.034)	(0.034)
Employees/100				0.003*			0.002*
				(0.002)			(0.001)
Worker Characteristics	No	No	Yes	Yes	No	Yes	Yes
2-digit Occupation FE	No	Yes	Yes	Yes	No	No	No
3-digit Occupation FE	No	No	No	No	Yes	Yes	Yes
2-digit Industry FE	No	Yes	Yes	Yes	No	No	No
3-digit Industry FE	No	No	No	No	Yes	Yes	Yes
Observations	691	691	691	691	691	691	691

Robust standard errors are clustered at the establishment level. Worker characteristics include 6 education dummies, 16 race dummies, a gender dummy, and a quadratic in age. Occupation fixed effects use the UK Standard Occuaption Classification 2000 (SOC2000) system. Industry fixed effects use the UK Standard Industry Classification 2003 (SIC2003) system. Indicators are included for all topcoded variables. Each regression includes a variable for log hours whose coefficient is constrained to be 1.
* p<.1, ** p<.05, *** p<.01

Table 14: Log Wage Interval Regressions for Supervisory Workers

	(1) Log Income	(2) Log Income	(3) Log Income	(4) Log Income	(5) Log Income	(6) Log Income
Promotion	0.091***	0.069***	0.062***	0.034	0.032*	0.007
	(0.030)	(0.022)	(0.020)	(0.033)	(0.018)	(0.031)
Tenure				0.005		0.006*
				(0.004)		(0.003)
Promotion * Tenure				0.008		0.007
				(0.006)		(0.006)
Employees/100			0.004***	0.004***	0.004***	0.003***
			(0.001)	(0.001)	(0.001)	(0.001)
Worker Characteristics	No	No	Yes	Yes	Yes	Yes
2-digit Occupation FE	No	Yes	Yes	Yes	No	No
3-digit Occupation FE	No	No	No	No	Yes	Yes
2-digit Industry FE	No	Yes	Yes	Yes	No	No
3-digit Industry FE	No	No	No	No	Yes	Yes
Observations	3959	3959	3959	3959	3959	3959

Robust standard errors are clustered at the establishment level. Worker characteristics include 6 education dummies, 16 race dummies, a gender dummy, and a quadratic in age. Occupation fixed effects use the UK Standard Occuaption Classification 2000 (SOC2000) system. Industry fixed effects use the UK Standard Industry Classification 2003 (SIC2003) system. Indicators are included for all topcoded variables, including an interaction between the tenure topcode and the promotion dummy. Each regression includes a variable for log hours whose coefficient is constrained to be 1.
* p<.1, ** p<.05, *** p<.01

Table 15: Entry-Level Workers - Establishment Productivity Measures

	(1) Log Wage	(2) Log Wage	(3) Log Wage	(4) Log Wage	(5) Log Wage	(6) Log Wage
Promotion	0.068**	0.051	0.046	0.063*	0.048	0.057
	(0.031)	(0.032)	(0.034)	(0.034)	(0.032)	(0.037)
Tenure	0.017***	0.019***	0.018***	0.015***	0.016***	0.018***
	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)	(0.005)
Promotion * Tenure	-0.012**	-0.014**	-0.013*	-0.011*	-0.011**	-0.013*
	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)	(0.007)
Employees/100	0.004***	0.004***	0.004***	0.004***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Profit /1000 FT Workers	-0.002			-0.002		
	(0.005)			(0.006)		
Value Added /1000 FT Workers		-0.002			-0.000	
		(0.002)			(0.001)	
Capital / 1000 FT Workers			0.003**			0.002
			(0.001)			(0.001)
Worker Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
2-digit Occupation FE	Yes	Yes	Yes	No	No	No
3-digit Occupation FE	No	No	No	Yes	Yes	Yes
2-digit Industry FE	Yes	Yes	Yes	No	No	No
3-digit Industry FE	No	No	No	Yes	Yes	Yes
Observations	2206	2405	1791	2206	2405	1791

Robust standard errors are clustered at the establishment level. Worker characteristics include 6 education dummies, 16 race dummies, a gender dummy, and a quadratic in age. Occupation fixed effects use the UK Standard Occuaption Classification 2000 (SOC2000) system. Industry fixed ffects use the UK Standard Industry Classification 2003 (SIC2003) system. Indicators are included for all topcoded variables, including an interaction between the tenure topcode and the promotion dummy

* p<.1, ** p<.05, *** p<.01

Table 16: Entry-Level Workers - Incentive Pay

	(1)	(2)	(3)	(4)
	Log Wage	Log Wage	Log Wage	Log Wage
Promotion	0.060**	0.059***	0.066***	0.059***
	(0.023)	(0.021)	(0.022)	(0.020)
Tenure	0.014***	0.014***	0.014***	0.014***
	(0.003)	(0.003)	(0.003)	(0.003)
Promotion * Tenure	-0.007	-0.007	-0.010**	-0.010**
	(0.005)	(0.004)	(0.005)	(0.004)
Employees/100	0.003***	0.003***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Incentive Pay	0.016	-0.024		
	(0.038)	(0.042)		
Incentive Pay * Tenure	0.015*	0.015*		
	(0.008)	(0.009)		
Incentive Pay * Promotion	0.021	-0.000		
	(0.056)	(0.056)		
Incentive Pay * Tenure * Promotion	-0.024*	-0.021*		
	(0.013)	(0.013)		
Individual Incentives			0.013	-0.051
			(0.037)	(0.040)
Individual Incentives * Tenure			0.019**	0.020**
			(0.008)	(0.009)
Individual Incentives * Promotion			-0.005	-0.015
			(0.071)	(0.066)
Individual * Tenure * Promotion			-0.014	-0.009
			(0.013)	(0.013)
Worker Characteristics	Yes	Yes	Yes	Yes
2-digit Occupation FE	Yes	No	Yes	No
3-digit Occupation FE	No	Yes	No	Yes
2-digit Industry FE	Yes	No	Yes	No
3-digit Industry FE	No	Yes	No	Yes
Observations	5386	5386	5385	5385

Robust standard errors are clustered at the establishment level. Worker characteristics include 6 education dummies, 16 race dummies, a gender dummy, and a quadratic in age. Occupation fixed effects use the UK Standard Occuaption Classification 2000 (SOC2000) system. Industry fixed effects use the UK Standard Industry Classification 2003 (SIC2003) system. Indicators are included for all topcoded variables, including interactions.
* p<.1, ** p<.05, *** p<.01