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Product Market Competition and Returns to Talent

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This paper investigates how product market competition influences the wages paid to workers and the distribution of talent across industries. We develop a model where firms facing different competitive conditions bid for workers. The model predicts that wages are increasing in talent, decreasing in competition, and the interaction between talent and competition is positive. In addition, the most talented workers will be concentrated in competitive industries and talent dispersion rises with competition. We use linked employee–employer data to test these predictions.

1. Introduction

The relationship between product market competition and economic efficiency has been a topic of considerable interest in economics. Stigler (1958), for instance, defended the "survivor principle" and argued that competition has a positive impact on efficiency by weeding out the weaker firms, leaving only the more efficient in the industry. Bettignies (2006) showed that competition may change the organization of the firm, leading to leaner, vertically disintegrated, and economically more efficient, structures. And since Hart's (1983) pioneering work, a new literature emerged that focuses on the mitigating or exacerbating effects of competition on agency costs and, in turn, on efficiency. In this paper, we establish a different channel through which competition affects efficiency—worker self-selection.

We develop a model where firms facing different levels of product market competition bid for workers. Competition influences the wages offered to workers and induces self-selection. We show that the effect of competition on equilibrium wages is positive for relatively talented workers and negative for relatively untalented workers. In addition, competitive industries will end up hiring a mix of highly talented and untalented

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workers resulting in the dispersion of talent to be highest in competitive industries. We test these and other predictions using the Workplace and Employee Survey (WES), a large data set providing information at both the firm and employee levels.

Our theoretical model contributes to the literature on competition and incentives which suggests that competition may have a positive (Hart, 1983; Raith, 2003; Baggs and Bettignies, 2007), negative (Scharfstein, 1988; Martin, 1993), or ambiguous (Hermalin, 1992; Schmidt, 1997; Vives, 2008) effect on worker effort and, as a consequence, firm efficiency. But unlike this prior work which focuses on a single worker varying effort according to competition levels, here we examine how various workers differing in talent levels choose between industries of varying degrees of competition. Our main theoretical contribution is to suggest that the relationship between competition and efficiency may occur through self-selection of heterogeneously talented workers.

Recent empirical work suggests that talent is differentially rewarded across firms and industries. Mocan and Tekin (2006), for example, find differences in human capital, and how it is rewarded, between for profit and not-for-profit businesses. Freedman et al. (2009) find that software firms operating in industries with higher variation in returns are willing to pay more for "star" workers than firms in less volatile markets. They argue that firms in high-variance payoff markets value star talent the most, since those are the firms with the highest potential returns to good project selection, and the largest losses from poor selection. Assuming star employees lower the probability of selecting bad projects and raise the probability of good projects, these firms are accordingly more willing to pay more for talent than firms with less variation in returns. Gibbons et al. (2005) examine how skill determines both the wage and sectoral employment. In their model, as the firm and employees become better informed about an employee's skill level, wages adjust and employees move between sectors. In an empirical test of their model they find that high-wage sectors offer higher returns to skill. We extend this work to consider the role of competition in determining wages and attracting talent.

This paper also contributes to a small literature examining the effects of competition on wages. Guadalupe (2007) uses individual-level wage data in the United Kingdom and finds that competition increases the returns to skill. Her model takes the distribution of skills in an industry as given and predicts that wage dispersion is higher in competitive industries. In her empirical implementation, she associates skills with occupations, with managers deemed high-skilled workers and production and clerical workers being the least skilled. Her measures of competition are industry concentration indexes, the 1992 Single European Act, and the 1996 appreciation of the British Pound. Our analysis differs from Guadalupe in a number of dimensions. While as in her work, we find that competition increases the returns to skills, we consider firms in different industries competing for workers. This enables us to examine the distribution of talent across industries resulting from worker self-selection. In addition, we allow for more or less talented workers within industries by measuring talent as a function of education, whether workers were recruited, and promotion histories rather than by occupation type. Finally, our measures of competition are based on survey questions about the degree of product differentiation perceived by firms, closely matching the theoretical construct of our model.

The next section of the paper develops the theoretical model and its empirical implications. Section 3 presents the empirical analysis. In this section, we describe the unique survey data that enables us to investigate the relationship between worker talent, product market competition, and wages and discuss the empirical findings. We summarize and discuss implications of our analysis in the conclusion.

2. Theoretical Model

The first subsection specifies the model featuring two firms bidding for the services of workers with different talent levels. These firms are identical in every respect except for the degree of competition they face in the product market. The following two subsections identify the outcome of the bidding process and how competition interacts with talent to influence equilibrium wages. The final subsection examines the distribution of talent across industries and establishes the relationship between competition and the dispersion of talent.

2.1 Basic Structure

We consider two pairs of firms competing on two distinct Hotelling (1929) lines. Firms 1 and 2 compete in industry c, and are positioned at the extremities of line c, with locations $x_1 = 0$ and $x_2 = 1$, respectively. Firms 3 and 4 compete in industry d, and are positioned at the extremities of line d, with locations $x_3 = 0$ and $x_4 = 1$, respectively. We normalize the marginal costs of production for all firms to zero. Firms in each industry compete on quality q and price p to sell imperfectly substitutable products.

The owners (henceforth principals) of firms 1 and 3 are both trying to recruit a new worker. Two workers become available in the labor market, both with a reservation wage of zero: a "1st choice" worker of talent α—where α is a random variable distributed over $[1, \alpha_{\max}]$, with probability density function (pdf) $f(\alpha)$—and a "fallback" worker of slightly lower talent $\alpha - \Delta$. For simplicity, and without loss of generality, we assume $\Delta = 1$.[1] This specification presumes that candidates of roughly comparable skill levels compete for positions. For example, two MBAs will compete for a job with one having a skill edge $\Delta = 1$ over the other.[2] Firms 2 and 4 are not recruiting and their positions are filled by workers of talent $\widehat{\alpha} \leq \alpha_{\max}$. We posit that talent affects product quality and, for simplicity, assume that the product quality associated with talent α is $q(\alpha) = \alpha$.[3]

In each industry, there is a unique consumer whose location is randomly and uniformly distributed along the Hotelling line. Both firms know the distribution of the consumer's location, but not his actual location on the line. In industry c, the consumer, if located at x, incurs a transport cost $t_c x$ for traveling to firm 1, and a cost $t_c(1 - x)$ to visit firm 2. The consumer enjoys conditional indirect utility $U_1 = v + \alpha_1 - p_1 - t_c x$ from product 1 and $U_2 = v + \alpha_2 - p_2 - t_c(1 - x)$ from product 2, where v represents gross utility from consuming the product sold by either firm. To obtain the conditional indirect utilities from products 3 and 4 in industry d, simply replace subscripts 1 by 3, 2 by 4, and c by d. The consumer purchases one unit of the product that yields the highest utility (i.e., the market is covered).[4]

On a Hotelling line, the transport cost t measures the degree of horizontal product differentiation, and here we use $\theta = 1/t$ as our measure of the toughness of competition

1. Qualitatively similar results are obtained for any given $\Delta \in (0, \alpha_{\max})$, with random variable α distributed over $[\Delta, \alpha_{\max}]$.
2. This seems like a more realistic assumption than alternatives where the skill level of the job candidates for a specific position are independent and possibly very different.
3. Note that, all of the theoretical results of the paper still hold if we assume that talent enables workers to reduce the marginal cost of production instead of increasing quality, or that it affects both cost and quality.
4. We implicitly assume that gross utility v is large enough to ensure that $\max\{U_1, U_2\} > 0$, that is, that the consumer always buys the product from one firm or the other. Market coverage is a standard assumption made to simplify the analysis (e.g., Tirole, 1988, p. 279; Mas-Collel et al., 1995, p. 397; Villas-Boas, 1999; Fudenberg and Tirole, 2000).

in the industry, to use Sutton's (1992, p. 9) terminology. We assume that the transport cost is lower, and hence the degree of competition is higher, in industry c than in industry d: $t_c < t_d$ implies $\theta_c > \theta_d$. For clarity purposes, c stands for *competitive*, and d stands for *differentiated*.

The timing of the game is as follows:

(1) *At date 0*, Nature draws α. The 1st choice worker of talent α and the fallback worker become available in the labor market. Principals 1 and 3 observe α and each make a salary offer to the 1st choice worker.
(2) *At date 1*, the 1st choice worker accepts one of the offers and turns down the other. The firm turned down by the 1st choice worker then makes a salary offer to the fallback worker, which is accepted as long as it is at least equal to the zero reservation wage. The 1st choice worker and the fallback worker commercialize products of quality α and $\alpha - 1$, respectively, for their firm. Firms 2 and 4 both commercialize products of quality $\widehat{\alpha}$.
(3) *At date 2*, after observing all qualities, the principal in each firm chooses the optimal price for the product. (The result is the same if the worker is the one making the pricing decision; we give that choice to the principal for simplicity.)
(4) *At date 3*, in each industry the consumer chooses one of the products. Demands and profits are realized; salaries are paid out.

In order to provide a tractable analysis of competition for worker services across industries, we propose a stylized model, and some of our assumptions warrant explanation. We assume single-worker firms to expediently identify the effect of hiring decisions on firm quality and profits. As we show in the ensuing subsection, hiring decisions depend on the relationship between the product quality of a recruiting firm and that of its product-market rival. With a single worker per firm, the worker's talent maps directly into product quality. Allowing for additional workers would complicate the analysis but not change the fundamentally positive relationship between the talent of the recruit and the firm's relative product quality.

We also assume that in each industry, one firm is recruiting while the other is not. Here, nonrecruiting firms serve to benchmark industry talent, allowing us to examine how product market competition influences wage offers to workers with high and low levels of talent relative to this benchmark. A recruiting firm's product quality reflects the talent of the worker it hires, and the profits it earns depend on the existing level of talent in the industry. In addition, positing nonrecruiting firms captures the realistic proposition that all competitors in the same industry are unlikely to be recruiting simultaneously. Finally, assuming that the industry rival does not recruit allows us to evaluate competition for worker services *across* industries and abstracts from *within*-industry competition that is the focus of other studies.[5]

Although we make specific assumptions about demand, the Hotelling model is a natural choice here. It allows for strategic interactions, a simple derivation of profits, and provides a convenient means of representing the toughness of competition. There are other ways to model demand, product market competition, and competition for workers across industries, but we believe alternative models would provide qualitatively similar insights in a less tractable framework.

5. For example, Guadalupe (2007) examines competition for talent within a product market and performs comparative statics on the degree of competition in that industry. Unlike our approach, it precludes any analysis of workers sorting between industries and the distribution of talent across industries.

2.2 Equilibrium

Let us consider industry c first. The equilibrium of the game can be determined by backward induction as follows:

At date 3, principal i, $i = 1, 2,\ j \neq i$, receives realized payoff $\Pi_i(\alpha_i, p_i, \alpha_j, p_j, \theta_c) - w_i$, where Π_i and w_i represent realized profits and the wage paid to the worker employed by firm i, respectively.

At date 2, principal i chooses p_i to maximize her expected payoff, taking qualities as given:[6]

$$\max_{p_i} \pi_i(\alpha_i, p_i, \alpha_j, p_j, \theta_c) - w_i, \tag{1}$$

where expected profits $\pi_i(\alpha_i, p_i, \alpha_j, p_j, \theta_c) = p_i x_i(\alpha_i, p_i, \alpha_j, p_j, \theta_c)$ are the product of price and expected demand.[7] Taking the first-order conditions with respect to price for $i = 1, 2$ and solving the resulting system of two equations yields the following equilibrium price:

$$p_i = \frac{1}{\theta_c} + \frac{\alpha_i - \alpha_j}{3}. \tag{3}$$

We impose the restriction that $\theta < 3/\alpha_{\max}$ (or $t > \alpha_{\max}/3$), which is sufficient to ensure strictly positive equilibrium prices for all values of $\alpha_i, \alpha_j \in [1, \alpha_{\max}]$. Substituting equilibrium prices back into the expected demand, we obtain an expression for expected profits (gross of worker compensation) as a function of qualities/talents:

$$\begin{aligned}\pi_i(\alpha_i, \alpha_j, \theta_c) = p_i(\alpha_i, \alpha_j, \theta_c) x_i(\alpha_i, \alpha_j, \theta_c) &= \left[\frac{1}{\theta_c} + \frac{\alpha_i - \alpha_j}{3}\right]\left[\frac{1}{2} + \theta_c \frac{\alpha_i - \alpha_j}{6}\right] \\ &= \frac{1}{2\theta_c} + \frac{\alpha_i - \alpha_j}{3} + \frac{\theta_c(\alpha_i - \alpha_j)^2}{18},\end{aligned} \tag{4}$$

where $x_i = [\frac{1}{2} + \theta_c \frac{\alpha_i - \alpha_j}{6}]$ is the expected demand for firm i. Note that expected demand converges to 1/2 as θ becomes very small (t becomes very large) and the restriction $\theta < 3/\alpha_{\max}$ ensures that expected demand is always strictly positive.[8]

At date 1, two cases are possible. If the 1st choice worker accepts the offer from firm 1 and enters industry c, firm 3 hires the fallback worker at his reservation wage of zero; and firm 1's profits can be expressed, using (5), as $\pi_1(\alpha, \widehat{\alpha}, \theta_c)$. On the other hand, if the 1st choice worker accepts firm 3's offer and enters industry d, it is firm 1 that hires the

6. Throughout the paper we identify principals as female and agents (workers) are male.

7. A consumer located at x is indifferent between firm 1 and 2 if and only if $U_1 = U_2$, or $\alpha_1 - p_1 - (1/\theta_c)x = \alpha_2 - p_2 - (1/\theta_c)(1 - x)$. Solving for x yields the expected demand (purchase probability) for firm i:

$$x_i(\alpha_i, p_i, \alpha_j, p_j, \theta_c) = \left(\frac{1}{2} + \theta_c \frac{(p_j - p_i) + (\alpha_i - \alpha_j)}{2}\right). \tag{2}$$

8. Recall that the consumer buys from one firm or the other (the market is covered). As θ becomes very small and transport cost t becomes very large, qualities and prices matter little to the consumer relative to distance from the nearest firm; and the consumer will likely buy the closest product. Given that consumer location is uniformly distributed along the line, expected demands for both firms converge toward 1/2. Conversely, as θ becomes very large, differences in quality and price become paramount. The lower quality firm's expected demand could be driven to zero because the consumer would prefer to buy from the higher quality firm regardless of his location on the line. As in Raith (2003), we impose a lower bound on transport cost to simplify the analysis and ensure strictly positive demands.

fallback worker at his reservation wage of zero, and firm 1's profits can be expressed $\pi_1(\alpha - 1, \widehat{\alpha}, \theta_c)$.

The similarities between industries c and d are such that (4) can readily be used to express gross expected profits for firm $i = 3, 4,\ j \neq i$, in industry d, simply replacing subscript c by subscript d. It then follows immediately that expected profits for firm 3 at date 1 can be written as $\pi_3(\alpha, \widehat{\alpha}, \theta_d)$ or as $\pi_3(\alpha - 1, \widehat{\alpha}, \theta_d)$, depending on whether the 1st choice worker accepts firm 3's offer or not (in which case firm 3 hires the fallback worker).

At date 0, firms 1 and 3, though from different industries, compete to recruit the 1st choice worker. Clearly, the maximum salary that firm 1 is willing to "bid" for the 1st choice worker is the marginal product of talent: the difference between the expected profits if the 1st choice worker is successfully hired, and the expected profits if he is not:

$$w_1^{\max} = \Delta\pi_1 = \pi_1(\alpha, \widehat{\alpha}, \theta_c) - \pi_1(\alpha - 1, \widehat{\alpha}, \theta_c) = \frac{1}{3} + \frac{\theta_c}{9}\,(\alpha - \widehat{\alpha} - 1/2)\,. \tag{5}$$

For the same reasons, the maximum salary that firm 3 is willing to offer the 1st choice worker can be written as $w_3^{\max} = \Delta\pi_3 = \pi_3(\alpha, \widehat{\alpha}, \theta_d) - \pi_3(\alpha - 1, \widehat{\alpha}, \theta_d)$, which can be expressed as in (5), simply by replacing θ_c by θ_d. The restriction $\theta < 3/\alpha_{\max}$ (or $t > \alpha_{\max}/3$) implies that $w_1^{\max}$ and $w_3^{\max}$ are strictly positive—and hence strictly superior to the workers' (zero) reservation wages—for all $\alpha \in [1, \alpha_{\max}]$.

One can easily show that the subgame perfect Nash equilibrium of the game depends on the relative value of $w_1^{\max}$ and $w_3^{\max}$:

Proposition 1: *The subgame perfect Nash equilibrium of the game can be expressed as follows:*

If the marginal product of talent is higher in industry c ($w_1^{\max} \geq w_3^{\max}$), firms 3 offers a salary $w_3^* = w_3^{\max}$ to the 1st choice worker, and firm 1 offers $w_1^* = w_3^{\max} + \epsilon$ (with $\epsilon \to 0$). The 1st choice worker accepts firm 1's offer, while firm 3 hires the fallback worker with a salary of zero. The net expected profits for firm 1 are $\pi_1(\alpha, \widehat{\alpha}, \theta_c) - w_3^{\max}$, and the net expected profits for firm 3 are $\pi_3(\alpha - 1, \widehat{\alpha}, \theta_d$.

If the marginal product of talent is higher in industry $d(w_3^{\max} \geq w_1^{\max})$, firms 1 offers a salary $w_1^* = w_1^{\max}$ to the 1st choice worker, and firm 3 offers $w_3^* = w_1^{\max} + \epsilon$ (with $\epsilon \to 0$). The 1st choice worker accepts firm 3's offer, while firm 1 hires the fallback worker with a salary of zero. The net expected profits for firm 3 are $\pi_3(\alpha, \widehat{\alpha}, \theta_d) - w_1^{\max}$, and the net expected profits for firm 1 are $\pi_1(\alpha - 1, \widehat{\alpha}, \theta_c)$.

Proof. Follows directly from above. □

2.3 Effects of Talent and Competition on Equilibrium Compensation

Proposition 1 relates the firms' willingness to pay workers to equilibrium compensation for the two workers in the labor market. In this subsection, we examine two key factors that affect willingness to pay and equilibrium worker compensation: talent and product market competition.

2.3.1 Worker Talent

What is the impact of talent on equilibrium compensation for the 1st choice worker and for the fallback worker? Consider the 1st choice worker. A direct implication of Proposition 1 is that the 1st choice worker's equilibrium compensation can be expressed simply as $w^* = \min\{w_1^{\max}, w_3^{\max}\} + \epsilon$. Thus, the 1st choice worker's talent α affects his compensation through its effect on firms 1's and 3's willingness to pay. Consider a firm's maximum willingness to pay for the worker of talent α, given rival worker talent $\widehat{\alpha}$ and degree of competition θ, which can be obtained simply by removing subscripts in equation (5). Clearly, since $\partial w^{\max}/\partial\alpha = \theta/9 > 0$, worker talent has a positive impact on a firm's willingness to pay, and in turn on the 1st choice worker's equilibrium compensation.

As for the fallback worker's equilibrium compensation, it is his reservation wage, which is normalized to zero by assumption and hence independent of his talent $\alpha - 1$.[9] Thus, taking both workers into account, we have:

Proposition 2: *In equilibrium worker talent has a (weakly) positive impact on worker compensation.*

Proof. Follows directly from above. □

At first blush, the result that more talented 1st choice workers receive higher compensation in equilibrium appears intuitive: A more talented (higher α) 1st choice worker produces a higher quality product and generates greater profits in the firm that hires him. Firms are therefore willing to pay more to successfully hire him, and this translates into higher equilibrium compensation.

In our model, however, this is not the full story: As discussed in Section 2.1, a 1st choice worker of talent α competes in the job market with a fallback worker of similar talent $\alpha - 1$; and hence an increase in talent affects the recruiting firm's profit whether it recruits the 1st choice worker or the fallback worker. As a result, the impact of talent on willingness to pay the 1st choice worker, which can be obtained by differentiating (6) with respect to α, can be expressed as follows:

$$\begin{aligned}\frac{dw^{\max}}{d\alpha} &= \frac{d\pi(\alpha,\widehat{\alpha},\theta)}{d\alpha} - \frac{d\pi(\alpha-1,\widehat{\alpha},\theta)}{d\alpha}\\ &= \left[\frac{dp(\alpha,\widehat{\alpha},\theta)}{d\alpha}x(\alpha,\widehat{\alpha},\theta) - \frac{dp(\alpha-1,\widehat{\alpha},\theta)}{d\alpha}x(\alpha-1,\widehat{\alpha},\theta)\right]\\ &\quad + \left[\frac{dx(\alpha,\widehat{\alpha},\theta)}{d\alpha}p(\alpha,\widehat{\alpha},\theta) - \frac{dx(\alpha-1,\widehat{\alpha},\theta)}{d\alpha}p(\alpha-1,\widehat{\alpha},\theta)\right].\end{aligned} \tag{6}$$

If the level of talent of the fallback worker were independent of the talent of the (1st choice) worker being recruited, then the second terms in each of the two bracketed expressions would disappear and the positive effect would immediately obtain. We believe, however, that it is more realistic to connect the talent of the two workers as firms are likely to consider people of similar skills when filling positions.

The terms in the first square bracket reflect the rent increase effects of talent. Talent leads to higher quality, and in turn to higher prices, regardless of whether the 1st choice worker or fallback worker is hired; and the price increase is the same in both cases: $dp(\alpha,\widehat{\alpha},\theta)/d\alpha = 1/3 = dp(\alpha-1,\widehat{\alpha},\theta)/d\alpha$. But expected demand is higher in the former case, due to higher quality: $x(\alpha,\widehat{\alpha},\theta) - x(\alpha-1,\widehat{\alpha},\theta) = \theta/6 > 0$. As a result, the demand-adjusted increase in price associated with higher talent is larger when the 1st choice worker is hired than when the fallback worker is hired; and this differential rent increase effect of talent has a positive impact on willingness to pay.

9. Alternatively, we could assume a reservation wage strictly increasing in talent. The normalization to zero is made for simplicity.

The second square bracket captures the business stealing effects of talent. Talent, by increasing quality, enables the firm to "steal" business from its product-market rival, regardless of whether the 1st choice worker or fallback worker is hired; and the increase in expected demand is the same in both cases: $dx(\alpha, \widehat{\alpha}, \theta)/d\alpha = \theta/6 = dx(\alpha - 1, \widehat{\alpha}, \theta)/d\alpha$. But price is higher in the former case, due to higher quality: $p(\alpha, \widehat{\alpha}, \theta) - p(\alpha - 1, \widehat{\alpha}, \theta) = 1/3 > 0$. As a result, the price-adjusted increase in demand is larger when the 1st choice worker is hired than when the fallback worker is hired; and this differential business stealing effect of talent has a positive impact on willingness to pay.

Thus, both differential effects of talent contribute to increase firms' willingness to pay for the 1st choice worker. Of course, this result holds for both firm 1 in industry c and for firm 3 in industry d, and hence the equilibrium compensation for the 1st choice worker, $w^* = \min\{w_1^*, w_3^*\} + \epsilon$ is strictly increasing in worker talent.

2.3.2 Product Market Competition

We now turn to the impact of product market competition on equilibrium worker compensation. Consider the difference between firm 1's and firm 3's willingness to pay for the 1st choice worker's services, $w_1^{\max} - w_3^{\max}$. Using (6), we can write this expression as:

$$w_1^{\max} - w_3^{\max} = \Delta\pi_1 - \Delta\pi_3 = \frac{(\theta_c - \theta_d)(\alpha - \widehat{\alpha} - 1/2)}{9}. \tag{7}$$

Since by definition $\theta_c - \theta_d > 0$, there exists a threshold level of worker talent $\overline{\alpha} = \widehat{\alpha} + 1/2$, such that willingness to pay the 1st choice worker is higher in the competitive industry if and only if $\alpha \geq \overline{\alpha}$.[10] In other words, product market competition has a positive impact on firms' willingness to pay if and only if $\alpha \geq \overline{\alpha}$. This result, together with Proposition 1, imply:[11]

Proposition 3: *For any given $\widehat{\alpha}$, there exists a threshold level of worker talent $\overline{\alpha} = \widehat{\alpha} + 1/2$ such that: If $\alpha \geq \overline{\alpha}$, firm 1 in industry c offers the 1st choice worker higher compensation than firm 3 in industry d, and successfully hires him, with firm 3 hiring the fallback worker. If $\alpha < \overline{\alpha}$, firm 3 in industry d offers the 1st choice worker higher compensation than firm 1 in industry c, and successfully hires him, with firm 1 hiring the fallback worker.*

Proof. Follows directly from above. □

To understand the intuition for this result, consider a firm's maximum willingness to pay for the worker of talent α, given rival worker talent $\widehat{\alpha}$ and degree of competition

10. We have assumed that the talent difference between the 1st choice worker and the fallback manager equals 1. A different choice of this value in the range $(0, \alpha_{\max})$ would alter the last term in the numerator of (7) and, consequently, the critical value $\overline{\alpha}$, but not affect the fundamental insight that the difference in the willingness to pay depends on the level of α.

11. Similar results obtain if we assume industry-specific benchmark talent levels $\widehat{\alpha}_c$ and $\widehat{\alpha}_d$. In that case the willingness to pay differential can be expressed as:

$$w_1^{\max\prime} - w_3^{\max\prime} = (\theta_c - \theta_d)(\alpha - \widehat{\alpha}_c - 1/2)/9 + \theta_d(\widehat{\alpha}_d - \widehat{\alpha}_c)/9.$$

One can easily show that there exists a threshold level of talent $(\theta_c\widehat{\alpha}_c - \theta_d\widehat{\alpha}_d)/(\theta_c - \theta_d) + 1/2 \neq \overline{\alpha}$ above (resp. below) which firm 1 (resp. 3) in industry c (resp. d) successfully hires the 1st choice worker and the other firm hires the fallback worker. Thus, while we do not model the determination of benchmark talent $\widehat{\alpha}$ in the industry, our results are robust to different talent levels that could exist. We assume identical benchmark talent in the two industries for expositional convenience.

θ, as described in (5), and differentiate with respect to θ:

$$\begin{aligned}\frac{dw^{\max}}{d\theta} &= \frac{d\pi(\alpha,\widehat{\alpha},\theta)}{d\theta} - \frac{d\pi(\alpha-1,\widehat{\alpha},\theta)}{d\theta}\\ &= \left[\frac{dp(\alpha,\widehat{\alpha},\theta)}{d\theta}x(\alpha,\widehat{\alpha},\theta) - \frac{dp\,(\alpha-1,\widehat{\alpha},\theta)}{d\theta}x(\alpha-1,\widehat{\alpha},\theta)\right]\\ &\quad + \left[\frac{dx(\alpha,\widehat{\alpha},\theta)}{d\theta}p(\alpha,\widehat{\alpha},\theta) - \frac{dx\,(\alpha-1,\widehat{\alpha},\theta)}{d\theta}p(\alpha-1,\widehat{\alpha},\theta)\right].\end{aligned} \tag{8}$$

The first square bracket captures the rent reduction effects of competition (as distinct from the rent increase effects of talent discussed above) in the situations with and without the 1st choice worker. Competition has a negative impact on expected profits by reducing prices. The second square bracket represents the business stealing effects of competition: To the extent that the recruiting firm offers a product quality different than its product-market rival, competition will tend to accentuate the demand advantage (resp. disadvantage) of the firm with the higher (resp. lower) quality.

Consider the differential rent reduction effect in the first square bracket. It is easy to verify, using (4), that the negative impact of competition on prices is independent of talent, and hence is the same whether the 1st choice worker or the fallback worker is hired: $dp(\alpha,\widehat{\alpha},\theta)/d\theta = dp(\alpha-1,\widehat{\alpha},\theta)/d\theta = dp/d\theta = -1/\theta^2$. On the other hand, as discussed above, expected demand is higher in the former case than in the latter one, due to higher quality: $x(\alpha,\widehat{\alpha},\theta) - x(\alpha-1,\widehat{\alpha},\theta) = \theta/6 > 0$. Hence, we can express this differential rent reduction effect of competition simply as follows:

$$\begin{aligned}&\frac{dp(\alpha,\widehat{\alpha},\theta)}{d\theta}x(\alpha,\widehat{\alpha},\theta) - \frac{dp(\alpha-1,\widehat{\alpha},\theta)}{d\theta}x(\alpha-1,\widehat{\alpha},\theta)\\ &\qquad = \frac{dp}{d\theta}\left[x(\alpha,\widehat{\alpha},\theta) - x(\alpha-1,\widehat{\alpha},\theta)\right] = -\frac{1}{6\theta} < 0.\end{aligned} \tag{9}$$

Competition reduces prices and its impact on expected profits is greater when firm's expected demand is higher. Since output is increasing in talent, competition reduces the benefit of hiring the 1st choice worker relative to hiring the fallback worker. Equation (9) also reveals that the differential rent reduction effect is independent of worker talent, α.

Now consider the differential business stealing effect in the second square bracket. Using (4) again, one can derive the impacts of competition on expected demand with the 1st choice worker and with the fallback worker, respectively: $dx(\alpha,\widehat{\alpha},\theta)/d\theta = (\alpha-\widehat{\alpha})/6$ and $dx(\alpha-1,\widehat{\alpha},\theta)/d\theta = (\alpha-1-\widehat{\alpha})/6$. Note that, these two impacts are very similar: $dx(\alpha-1,\widehat{\alpha},\theta)/d\theta = dx(\alpha,\widehat{\alpha},\theta)/d\theta - 1/6$. Note also that these impacts of competition on expected demand could be positive or negative depending on the relative talent of the workers being recruited and the worker in the rival firm. Moreover, if the 1st choice worker is hired, the equilibrium price is higher (due to higher product quality) than if the fallback worker is hired: $p(\alpha,\widehat{\alpha},\theta) - p(\alpha-1,\widehat{\alpha},\theta) = 1/3 > 0$. Hence, we can express this differential business stealing effect of competition as follows:

$$\begin{aligned}&\frac{dx(\alpha,\widehat{\alpha},\theta)}{d\theta}p(\alpha,\widehat{\alpha},\theta) - \frac{dx(\alpha-1,\widehat{\alpha},\theta)}{d\theta}p(\alpha-1,\widehat{\alpha},\theta)\\ &\qquad = \frac{dx(\alpha,\widehat{\alpha},\theta)}{d\theta}\left[p(\alpha,\widehat{\alpha},\theta) - p(\alpha-1,\widehat{\alpha},\theta)\right]\end{aligned}$$

$$+\frac{1}{6}p(\alpha-1,\widehat{\alpha},\theta)=\frac{1}{6\theta}+\frac{2(\alpha-\widehat{\alpha})-1}{18}. \tag{10}$$

When talent α is low, the recruiting firm is at a significant product quality and demand disadvantage relative to its product market rival. In this case, competition exacerbates the recruiting firm's demand disadvantage, and this impact on expected profits is greater when the equilibrium price is higher. Since prices are increasing in talent, competition reduces the benefit of hiring the talented worker relative to hiring the fallback worker. As talent increases, however, the recruiting firm gains a product quality and demand advantage over its product market rival. In that case, competition amplifies the recruiting firm's demand advantage, and this impact on expected profits is greater when equilibrium price is higher. Thus in that case, competition increases the benefit of hiring the talented worker relative to hiring the fallback worker. In other words, the differential business stealing effect is increasing in α: it is negative at low talent levels but turns positive at higher levels of talent.

As a result, the sum of the differential rent reduction and the differential business stealing effects may be positive or negative. At low levels of talent, the differential business stealing effect of competition is too weak—and in fact may be negative—to compensate for the negative differential rent reduction effect, and the net impact of competition on firms' willingness to pay the 1st choice worker is negative: The firm in the competitive industry offers a lower wage than the firm in the differentiated industry. As talent increases, the differential business stealing effects becomes stronger, and indeed beyond the talent threshold $\overline{\alpha}=\widehat{\alpha}+1/2$, it dominates differential rent reduction. In that case, competition has a positive effect on willingness to pay; and the firm in the competitive industry offers the higher wage.[12]

The foregoing discussion, together with Propositions 1 and 3, has important implications about the effect of product market competition on equilibrium worker compensation. Consider a worker of talent $\alpha \geq \overline{\alpha}$. If this worker is observed working in industry c, then he must have been a 1st choice worker competing in the labor market with a fallback worker of talent $\alpha-1$. This 1st choice worker's equilibrium compensation in that case is $w_3^*+\epsilon$. But suppose this worker of talent $\alpha \geq \overline{\alpha}$ is observed working in industry d. In that case the implication of our model is that he must have been a fallback worker competing in the labor market with a 1st choice worker of talent $\alpha+1$, implying an equilibrium compensation of zero. Thus, a worker of talent $\alpha \geq \overline{\alpha}$ will obtain higher equilibrium compensation in more competitive industries. On the other hand, for a worker with $\alpha < \overline{\alpha}$ working in industry d, then we infer he is a 1st choice worker and receives compensation $w_1^*+\epsilon$. If this worker is employed in industry c, he is the fallback worker and receives compensation of zero.

Proposition 4: *If $\alpha < \overline{\alpha}$, product market competition has a negative effect on worker compensation in equilibrium; and if $\alpha \geq \overline{\alpha}$, competition has a positive effect on worker compensation in equilibrium: The impact of competition on worker compensation increases with worker talent.*

Proof. Follows directly from above. □

12. A similar description of the trade-off between the differential business stealing and the differential rent reduction was previously proposed in Bettignies (2006, pp. 957–959), albeit in a distinct and narrower context of firm boundaries. See also Raith (2003) and Baggs and Bettignies (2007) for somewhat related discussions in a moral hazard context.

2.4 Distribution of Talent Across Industries

Our model also has implications for the distribution of talent across industries. Consider our talent random variable α, distributed with pdf $f(\alpha)$, and the transformations $z_c(\alpha)$ and $z_d(\alpha)$ defined as follows:

$$z_c(\alpha) = \begin{Bmatrix} \alpha & \text{if} & \alpha \geq \overline{\alpha} \\ \alpha - 1 & \text{if} & \alpha < \overline{\alpha} \end{Bmatrix}$$

$$z_d(\alpha) = \begin{Bmatrix} \alpha - 1 & \text{if} & \alpha \geq \overline{\alpha} \\ \alpha * & \text{if} & \alpha < \overline{\alpha} \end{Bmatrix}. \tag{11}$$

Random variables $z_c(\alpha)$ and $z_d(\alpha)$ represent equilibrium worker talent hired in industries c and d, respectively. What is interesting here is to compare the equilibrium distributions of talent across industries; in other words, to understand how the distribution of $z_c(\alpha)$ compares to that of $z_d(\alpha)$.

Let us start by comparing mean talent across industries. By definition of a mean, we can write:

$$E(z_c) = \int_1^{\overline{\alpha}} (\alpha - 1) f(\alpha) d\alpha + \int_{\overline{\alpha}}^{\alpha_{\max}} \alpha f(\alpha) d\alpha = E(\alpha) - [1 - P(\alpha \geq \overline{\alpha})],$$

$$E(z_d) = \int_1^{\overline{\alpha}} \alpha f(\alpha) d\alpha + \int_{\overline{\alpha}}^{\alpha_{\max}} (\alpha - 1) f(\alpha) d\alpha = E(\alpha) - P(\alpha \geq \overline{\alpha}). \tag{12}$$

It then follows immediately that $E(z_c) \geq E(z_d)$ if and only if $P(\alpha \geq \overline{\alpha}) \geq 1/2$: The mean equilibrium talent is higher in the competitive industry if and only if talent is distributed such that the probability of drawing job market workers with talent superior to the threshold talent is higher than 1/2. Two points should be made here. The first point is that this result is intuitive: We know from Proposition 3 that the competitive (resp. differentiated) industry can hire the better candidate if $\alpha \geq \overline{\alpha}$ (resp. $\alpha < \overline{\alpha}$). Thus, the higher the probability that $\alpha \geq \overline{\alpha}$, the more likely is it that the competitive industry hires the better candidate and ends up with the higher talent.

The second point concerns the benchmark talent $\widehat{\alpha}$. We have made no specific assumption about it so far, but clearly its level has an impact on the distribution of talent across industries: Suppose that $\widehat{\alpha}$ is such that $\overline{\alpha} = \widehat{\alpha} + 1/2$ is lower than the median of the distribution of talent in the labor market $f(\alpha)$. Then $P(\alpha \geq \overline{\alpha})$ must be greater than 1/2, and hence mean talent is higher in the competitive industry. Conversely, if $\widehat{\alpha}$ is such that $\overline{\alpha}$ is higher than median talent in labor market, we get $E(z_c) \leq E(z_d)$. In sum:

Proposition 5: *If the benchmark level of talent in the two industries $\widehat{\alpha}$ is such that threshold talent level $\overline{\alpha}$ is lower (resp. higher) than the median level of talent in the labor market, then the mean equilibrium talent will be higher (resp. lower) in the competitive industry than in the differentiated industry.*

Proof. Follows directly from above. □

Our model can also help us understand the distribution of *particularly* talented workers across industries. Indeed, conditioning worker talent to $\alpha \geq \overline{\alpha}$, it is easy to see that the conditional mean talent in the competitive industry, $E(z_c \mid \alpha \geq \overline{\alpha}) = \int_{\overline{\alpha}}^{\alpha_{\max}} \alpha f(\alpha) d\alpha = E(\alpha \mid \alpha \geq \overline{\alpha})$, is greater than the conditional mean in the differentiated industry, $E(z_d \mid \alpha \geq \overline{\alpha}) = \int_{\overline{\alpha}}^{\alpha_{\max}} (\alpha - 1) f(\alpha) d\alpha = E(\alpha \mid \alpha \geq \overline{\alpha}) - P(\alpha \geq \overline{\alpha})$. In other words:

Proposition 6: *Restricting our attention to relatively talented workers ($\alpha \geq \overline{\alpha}$), the conditional mean talent is higher in the competitive industry than in the differentiated industry.*

Proof. Follows directly from above. □

Now let us compare the dispersion of talent across industries. Simply using definitions $\mathrm{Var}(z_c) = E[(z_c - E(z_c))^2]$ and $\mathrm{Var}(z_d) = E[(z_d - E(z_d))^2]$ for the variances of talent distributions in industries c and d, respectively, we show in the Appendix that:

Proposition 7: *For any continuous distribution of talent in the job market, the variance of the talent distribution for workers hired in the competitive industry in equilibrium is higher than the variance of the talent distribution for workers hired in the differentiated industry.*

Proof. See Appendix. □

Intuitively, Proposition 3 suggests that if Nature draws two labor market candidates of talent α and $\alpha - 1$, with $\alpha \geq \overline{\alpha}$, then the competitive industry will attract the stronger of the two candidates, leaving the fallback candidate to the differentiated industry. On the contrary, if Nature draws two labor market candidates of talent α and $\alpha - 1$, with $\alpha < \overline{\alpha}$, then the competitive industry hires the weaker of the two job candidates, while the differentiated industry attracts the stronger one. Thus, what this suggests is that in equilibrium, the competitive industry attracts the extremes of the talent distribution, while the differentiated industry attracts the center of the talent distribution.

2.5 Testable Predictions of the Model

Our model yields five key empirical implications:

- *Prediction 1: Talented workers earn higher wages.* (Proposition 2)
- *Prediction 2: The impact of product market competition on wages is increasing in employee talent.* (Proposition 4)
- *Prediction 3: For employees of relatively low talent, product market competition will reduce wages. For employees of relatively high talent, competition will increase wages.* (Proposition 4)
- *Prediction 4: Competitive industries should employ the most talented workers: Among talented workers, mean talent should be higher in more competitive industries than in less competitive ones.* (Proposition 6)
- *Prediction 5: The dispersion of talent among employees will be higher in more competitive industries than in less competitive ones.* (Proposition 7)

We test these empirical predictions in the next section.

3. Empirical Implementation

We begin this section by outlining the structure of the wage regression that we will use to test the first three model predictions. Next we describe the data. The third subsection presents the results of the wage regressions. In the final subsection, we provide evidence of the relationship between the dispersion of talent and competition.

3.1 Empirical Tests: Overview

To empirically test the model's predictions about the effects of competition and talent on wages, we estimate wage regressions of the following form:

$$WAGES = \gamma_0 + \gamma_1 TALENT + \gamma_2 COMP + \gamma_3 COMP * TALENT + \gamma_4 CONTROL + \epsilon, \quad (13)$$

where $WAGES$ represents worker compensation, $COMP$ measures the degree of competition in the industry, $TALENT$ represents worker talent, and $CONTROL$ is a vector of control variables which includes both firm- and employee-level controls. Our model predictions 1–3 imply $\gamma_1 > 0$, $\gamma_2 < 0$, and $\gamma_3 > 0$. Talent improves quality and increases wages. Competition reduces rents and wages for untalented workers. However, the returns to talent will rise with industry competition. Thus, there will be a positive interaction between talent and competition and a critical level of talent above which competition increases wages.

To implement the model, we need to measure worker talent and firm competition. As described below, our data set provides measures of competition. It contains a large amount of information on workers that we could use to measure talent and we focus on education levels, whether or not they were recruited by the employer, and the number of promotions. Because the specification interacts competition and talent, it is necessary to compile a single talent measure. To accomplish this, we follow Gibbons et al. (2005) and generate a single talent measure as the predicted wage from a first-stage wage regression where a subset of the variables in the wage equation are used to predict wages. In our case, we predict wages using the coefficient estimates on education levels, whether or not a worker was recruited by the employer, and the number of promotions he or she has received.[13] In the ensuing second-stage regression, the specification shown above, talent substitutes for the variables that comprise it.

To investigate the relationship between the dispersion of talent and competition, we calculate the 90^{th} percentile and standard deviation of our talent variable. As described below, our measures of competition take on discrete values. We use graphs to illustrate the relationship between the dispersion of talent and different levels of competition.

3.2 Data and Measurement

The WES is a data set comprised of a workplace survey of about 6,000 firms and an employee survey of approximately 20,000 employees in Canada. The former provides information on work organization and organizational change, competitive environment, business strategy, innovation, and firm performance. For the same workplaces, the latter contains information on compensation, human capital, training, work hours and arrangements, and promotions. The survey covers all industries except farming, fishing, trapping, and public administration in all regions of Canada with the exception of the Arctic territories (the Yukon, Northwest Territories, and Nunavut). Businesses are classified into 14 industries, workers into 6 occupations, and headquarter locations into 7 regions.

The WES employs sophisticated survey techniques and oversamples high-variance strata.[14] Statistics Canada has calculated survey weights for each observation based on probability of selection, sample clustering, and stratification and these weights are used

13. Gibbons et al. (2005) use education and experience variables to predict wages and call the measure a "skill index."

14. The Appendix provides details about the survey design.

in all of our analyses. Bootstrapping was used to correct the weights for the design of the survey.

The survey has a high response rate—86% for both firms and employees—and provides information that is ideal for our study such as measures of product market competition. Survey data, however, has some drawbacks. Self reports can be systematically biased, such as overreporting profits and underreporting costs. Although this may be the case, we see no reason why underreporting or overreporting will bias our results. Some survey questions require choosing numbers from a scale. Respondents may have different scaling attitudes: Some tend to consistently use higher ratings and others lower ratings; this increases the "noise" in our data and likely inflates our standard errors. Following Cooper and Emory (1995), we note that differences in scaling attitudes do not introduce a systematic bias and, if anything, by increasing standard errors, lead to more conservative results.

We use data from the 2001 survey.[15] We remove from our sample employees working less than 40 weeks per year and those 70 years old or older as well as those for whom information on education or wage is missing. We also remove employees working for firms that do not provide information on competition or number of employees. Taken together, these conditions reduce our sample from 20,169 employees to a subsample of 15,995 employees in 2001.

3.2.1 Product Market Competition

Research testing theories of product market competition is handicapped by lack of valid measures of the intensity of competition. Readily available proxies such as industry concentration indices or number of firms may be difficult to interpret as measures of actual rivalry between firms. In markets with restricted entry, an increase in the number of firms and/or a lower concentration level may be associated with increased rivalry. In markets with free entry, however, these measures are associated with decreased rivalry between firms. The WES provides us with a measure of competition that seems a close match to the theoretical construct of our model. Firms self report as to what extent different classifications of firms offer "significant" competition (on a scale of 2–6) to their business. Significant competition refers to "a situation where other firms' market products/services *similar* to your own which might be purchased by your customers."We believe this is a good proxy for the substitutability of one's products vis-a-vis those of competitors. Firms are asked to rank the significance of competition, as described above, from four types of competitors: (i) locally owned, (ii) Canadian owned, (iii) American owned, and (iv) internationally owned firms. For each type of competitor, we create $COMP$ equal to the level identified by the survey. If firms indicate they face no competition from any type of firm, $COMP = 1$. We then construct three alternative measures of competition. C_{Max} uses the maximum value of competition across the four types of competitors, C_{Sum} is the sum of competition across competitor types, and C_{Bin} is a binary variable equal to one if competition is "very important" (5) or "extremely important" (6) for at least one of the types.[16]

Table I shows average values of the three measures of competition for each of the 14 industries. Competition is highest in Finance and Insurance and Primary Product Manufacturing and lowest in Education and Health Care. The table indicates that there

15. The survey was conducted for other years and longitudinal analysis is possible between pairs of years (for example, 2001 and 2002). However, firms were not asked about competition in even years and therefore there does not exist time-series variation for a key variable of interest—competition.

16. C_{Max} ranges from 1 to 6 whereas C_{Sum} ranges from 4 to 24.

Table I.
Competition Across Industries

Industry	Number	C_{Max}	C_{Sum}	C_{Bin}
Forestry/Mining	181,158	4.7	12.8	69.5
Labor-Intensive Tertiary Mfg	545,770	4.7	12.0	67.4
Primary Product Mfg	394,247	4.9	13.4	79.0
Secondary Product Mfg	405,960	4.9	12.4	77.4
Capital-Intensive Tertiary Mfg	610,071	4.7	12.3	72.9
Construction	404,313	4.6	9.9	64.2
Transportation/Storage/Wholesale Trade	1,121,499	4.8	12.7	69.9
Communication and other Utilities	193,233	4.1	11.7	59.2
Retail Trade and Commercial Services	2,557,693	4.6	9.9	67.9
Finance and Insurance	487,466	5.1	12.6	75.6
Real Estate	160,162	4.3	10.1	63.7
Business Services	1,088,498	4.7	12.0	72.7
Education and Health Care	473,295	3.7	8.2	45.3
Information and Cultural Industries	293,505	4.8	12.2	77.0

Note: C_{Max}, C_{Sum}, and C_{Bin} are weighted means. C_{Bin} is multiplied by 100.

Table II.
Correlations Across Competition Measures

	C_{Max}	C_{Sum}	C_{Bin}
C_{Max}	1.0000		
C_{Sum}	0.6282	1.0000	
C_{Bin}	0.8092	0.5439	1.0000
Demeaned (by industry)			
C_{Max}	1.0000		
C_{Sum}	0.6254	1.0000	
C_{Bin}	0.8061	0.5411	1.0000

is considerable variation in competition across industries. Our model predicts that competition influences the level of talent in an industry. However, there could potentially exist correlations between competition and talent across industries for reasons outside our model. Some industries may be more skill-intensive due to the nature of production. For example, the Education sector will employ highly educated (talented) workers because education is a skill-intensive activity, but we observe it has low levels of competition. Therefore, we will report results for specifications with and without industry fixed effects. The industry fixed effects control for these industry influences and identify competition and talent based on within-industry variation. However, they come at the expense of reducing variation helpful for identifying effects.

Table II reports the correlations of the different measures of competition before and after the variables have been demeaned by industry averages. Demeaning has a small impact of the correlations which range from 0.54 to 0.81. In the regressions, we will use all three measures of competition.

3.2.2 Wages

Our dependent variable, wages, is measured using the log of annualized salary.

3.2.3 Talent: Education, Recruitment, and Promotion

We measure education using dummy variables indicating the employees' highest level of educational attainment. Employees are divided into nine categories (Educ1–Educ9) as follows: 1, if the employee completed less than seven grades of schooling; 2, if the employee did not graduate from high school but completed more than seven grades; 3, for high school graduates without further education; 4, if the employee had some post secondary education, but did not graduate; 5, if the employee received a trade or vocational diploma or certificate; 6, if the employee completed a college program, or a university certificate or diploma (below bachelors level); 7, if the employee had a bachelor's degree; 8, if the employee completed a master's degree or a diploma or certificate above the bachelor's level; and 9, if the employee completed a PhD or a post graduate degree in Medicine (MD), Law, Dentistry, or Veterinary Medicine. We generate a dummy variable for each education level and use the lowest level, less than seven grades of schooling, as the excluded category in the regressions.

Worker talent is also reflected in the number of promotions an employee has received. We measure the variable Promotion as the natural log of (one plus) the total number of promotions. We code a dummy variable indicating whether or not the employee was directly recruited (Recruit) for their current position.

3.2.4 Other Employee Controls

We incorporate a large set of worker-specific controls that influence wage levels but do not necessarily reflect talent. As is standard in wage equations (see, for example, Lemieux, 2006) we control for experience. We do this using a question which asks "considering all jobs you have had, how many years of full-time working experience do you have?" We include both the direct number of years of experience, as well as a squared and quartic term. Following, Card and Lemieux (2001), we include dummy variables breaking employees into 11 different 5-year cohorts based on their year of birth.[17] We also control for whether or not the employee is part of a collective bargaining agreement (Union), if the employee has dependent children (Dependent), gender (Female), whether they were born in Canada or immigrated to Canada (Immigrant), and how long they have been at this particular job (Tenure). Finally, we allow wages to vary depending on firm size, measured as the log of the number of employees (Size).

3.2.5 Industry, Occupation, and Regional Controls

As mentioned earlier, we use industry fixed effects in some specifications. Because of the nature of the WES data we are limited to 14 fairly broad industry categories (listed in Table I). We also include occupation fixed effects. WES identifies workers as belonging to six different occupations: (1) managers, (2) professionals, (3) technical or trades, (4) marketing or sales, (5) clerical or administrative, and (6) production. Finally, we add region fixed effects to control for the location of headquarters. WES identifies seven regions: (1) Atlantic, (2) Quebec, (3) Ontario, (4) Manitoba, (5) Saskatchewan, (6) Alberta, and (7) British Columbia.[18]

3.3 Empirical Results

We report estimates of the first-stage wage regressions in two tables. Table III shows the effects that competition and the variables that comprise our talent measure—education,

17. Employees born between 1950 and 1954 would be in one cohort and those born between 1955 and 1959 in another, and so on.

18. Atlantic includes Newfoundland & Labrador, Nova Scotia, New Brunswick and Prince Edward Island.

TABLE III.
FIRST-STAGE WAGE REGRESSION

CompVar:	C_{Max}		C_{Sum}		C_{Bin}	
Comp	0.002	0.004	0.005***	0.003*	0.008	0.016
	(0.006)	(0.006)	(0.001)	(0.002)	(0.018)	(0.017)
Educ2	0.084**	0.088**	0.083**	0.087**	0.084**	0.089**
	(0.039)	(0.036)	(0.039)	(0.036)	(0.039)	(0.036)
Educ3	0.148***	0.141***	0.145***	0.139***	0.148***	0.141***
	(0.038)	(0.036)	(0.038)	(0.035)	(0.038)	(0.036)
Educ4	0.201***	0.189***	0.199***	0.187***	0.202***	0.190***
	(0.042)	(0.039)	(0.042)	(0.039)	(0.042)	(0.039)
Educ5	0.249***	0.235***	0.246***	0.232***	0.249***	0.235***
	(0.040)	(0.037)	(0.040)	(0.037)	(0.040)	(0.037)
Educ6	0.281***	0.258***	0.277***	0.254***	0.281***	0.258***
	(0.040)	(0.037)	(0.039)	(0.037)	(0.040)	(0.037)
Educ7	0.444***	0.407***	0.439***	0.403***	0.445***	0.407***
	(0.048)	(0.045)	(0.047)	(0.044)	(0.048)	(0.045)
Educ8	0.552***	0.527***	0.552***	0.527***	0.552***	0.528***
	(0.056)	(0.057)	(0.055)	(0.056)	(0.056)	(0.057)
Educ9	0.625***	0.576***	0.621***	0.572***	0.625***	0.576***
	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)
Recruit	0.090***	0.080***	0.088***	0.079***	0.090***	0.080***
	(0.021)	(0.019)	(0.021)	(0.019)	(0.021)	(0.018)
Promote	0.029**	0.025**	0.027**	0.024**	0.029**	0.025**
	(0.013)	(0.012)	(0.013)	(0.012)	(0.013)	(0.012)
Ind FE	No	Yes	No	Yes	No	Yes
N	15,995	15,995	15,995	15,995	15,995	15,995
R^2	0.575	0.612	0.576	0.611	0.575	0.611

Note: Standard errors are shown by parentheses and ***, **, * indicate significance at the 1%, 5%, and 10% levels. Survey weights and structure are accounted for using Stata's survey estimation software. All regressions include region and cohort fixed effects.

whether recruited, and (log of one plus) the number of promotions—have on wages. Estimates of the control variables are displayed in Table IV. The tables report results for the three measures of competition and specifications with and without industry fixed effects. The results in Table III reveal that competition is associated with higher wages. The positive effect of competition is significant for the measure that sums the survey responses across the four ownership categories, C_{Sum}. We also observe that wages rise systematically with higher education categories. The wage premium of the highest education category, primarily medical doctors, lawyers, and PhDs, relative to an employee with less than 7 years of schooling (Educ1, our excluded group) is about 80%. The other two variables that comprise our talent measure, recruitment and promotions, have positive and significant effects on earnings. These results do not change substantially across the competition measures or whether industry fixed effects are included.

Table IV shows that the control variables are all of the expected signs and usually significant. Experience increases earnings. The effect appears to be linear as the squared and quartic terms enter insignificantly. Employees who have dependent children earn more. Female employees and immigrants earn less with the discount to female employees being about 20%. Job tenure increases salaries and firm size is associated with higher earnings. The occupational dummies reveal that managers, professionals, and technical and trade occupations earn the highest wages after controlling for observable characteristics. The omitted group is production workers. Managers and professionals

Table IV.
First-Stage Wage Regression—Controls

CompVar:	C_{Max}		C_{Sum}		C_{Bin}	
Exp	1.591***	1.543***	1.619***	1.561***	1.589***	1.537***
	(0.394)	(0.380)	(0.393)	(0.381)	(0.394)	(0.381)
Expsq	−1.598	−1.638	−1.696	−1.697	−1.590	−1.621
	(1.434)	(1.388)	(1.430)	(1.388)	(1.436)	(1.390)
Expqr	−2.705	−2.406	−2.450	−2.256	−2.710	−2.418
	(4.021)	(3.773)	(4.003)	(3.770)	(4.026)	(3.778)
Union	0.007	−0.0003	0.012	0.002	0.007	−0.0002
	(0.018)	(0.016)	(0.018)	(0.016)	(0.018)	(0.016)
Female	−0.209***	−0.187***	−0.207***	−0.184***	−0.209***	−0.184***
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
Dependent	0.047***	0.033**	0.046***	0.033**	0.047***	0.033**
	(0.016)	(0.014)	(0.015)	(0.014)	(0.015)	(0.014)
Immigrant	−0.084***	−0.056***	−0.085***	−0.057***	−0.084***	−0.056***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Tenure	0.038***	0.038***	0.038***	0.038***	0.038***	0.038***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Size	0.073***	0.064***	0.069***	0.062***	0.073***	0.063***
	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)	(0.004)
Managers	0.551***	0.544***	0.547***	0.542***	0.551***	0.543***
	(0.034)	(0.031)	(0.033)	(0.031)	(0.033)	(0.031)
Professionals	0.455***	0.415***	0.452***	0.412***	0.455***	0.414***
	(0.030)	(0.030)	(0.031)	(0.031)	(0.030)	(0.030)
Technical/trade	0.194***	0.165***	0.191***	0.163***	0.194***	0.165***
	(0.024)	(0.022)	(0.024)	(0.023)	(0.024)	(0.022)
Sales	−0.091***	−0.007	−0.094***	−0.010	−0.091***	−0.007
	(0.028)	(0.026)	(0.028)	(0.026)	(0.028)	(0.026)
Clerical	0.106***	0.053**	0.103***	0.051**	0.106***	0.053**
	(0.025)	(0.024)	(0.025)	(0.024)	(0.025)	(0.024)
Ind FE	No	Yes	No	Yes	No	Yes
N	15,995	15,995	15,995	15,995	15,995	15,995
R^2	0.575	0.611	0.576	0.611	0.575	0.611

Note: Standard errors are shown by parentheses and ***, **, * indicate significance at the 1%, 5%, and 10% levels. Survey weights and structure are accounted for using Stata's survey estimation software. All regressions include region and cohort fixed effects.

earn over 50% more than production workers and technical and trade workers about 16–19% more.

Table V reports results for a specification similar to Guadalupe (2007) that allows the effects of competition to vary according to occupation. In these regressions, competition is interacted with dummy variables identifying three occupational groupings: managers and professionals; technical and trades; and sales, clerical, and production. Similar to her, we find the effect of competition is highest for managers and professionals. The effect of competition on wages is significant, however, for only one of competition measures, C_{Sum}, the summed competition level across ownership categories. There are no cases where competition exerts significant negative effects on wages. Guadalupe also does not find significant negative effects of competition for even the lowest of the three skill types she considers. Lack of negative competition effects does not support our theoretical prediction that competition, by reducing rents, should exert downward effects on untalented worker wages.

TABLE V.
GUADALUPE SPECIFICATION

CompVar:	C_{Max}		C_{Sum}		C_{Bin}	
Managers/professionals	0.015	0.016	0.010***	0.008**	0.052	0.060
	(0.013)	(0.012)	(0.003)	(0.003)	(0.043)	(0.043)
Technical/trades	−0.006	−0.003	0.004*	0.002	−0.016	−0.008
	(0.008)	(0.002)	(0.002)	(0.002)	(0.024)	(0.021)
Sales, clerical, production	0.003	0.003	0.001	0.003	0.015	0.022
	(0.008)	(0.008)	(0.002)	(0.002)	(0.023)	(0.022)
Ind FE	No	Yes	No	Yes	No	Yes
N	15,995	15,995	15,995	15,995	15,995	15,995
R^2	0.575	0.611	0.577	0.612	0.575	0.611

Note: Standard errors are shown by parentheses and ***, **, * indicate significance at the 1%, 5%, and 10% levels. Survey weights and structure are accounted for using Stata's survey estimation software. All regressions include occupation and region fixed effects.

TABLE VI.
TALENT ACROSS INDUSTRIES

Industry	Number	C_{Max}	C_{Sum}	C_{Bin}	Tal_{Sum}
Forestry/Mining	181,158	4.7	12.8	69.5	23.9
Labor-Intensive Tertiary Mfg	545,770	4.7	12.0	67.4	19.5
Primary Product Mfg	394,247	4.9	13.4	79.0	20.8
Secondary Product Mfg	405,960	4.9	12.4	77.4	22.3
Capital-Intensive Tertiary Mfg	610,071	4.7	12.3	72.9	23.7
Construction	404,313	4.6	9.9	64.2	21.1
Transportation/Storage/Wholesale Trade	1,121,499	4.8	12.7	69.9	24.3
Communication and other Utilities	193,233	4.1	11.7	59.2	23.7
Retail Trade and Commercial Services	2,557,693	4.6	9.9	67.9	20.4
Finance and Insurance	487,466	5.1	12.6	75.6	28.2
Real Estate	160,162	4.3	10.1	63.7	24.3
Business Services	1,088,498	4.7	12.0	72.7	30.5
Education and Health Care	473,295	3.7	8.2	45.3	26.0
Information and Cultural Industries	293,505	4.8	12.2	77.0	28.0

Note: C_{Max}, C_{Sum}, C_{Bin}, and Tal_{Sum} are weighted means. Tal_{Sum} is calculated from the estimates of the education dummies and the recruit and promotion variables and multiplied by 100.

We use the estimated coefficients on the education, recruitment, and promotion variables from the first stage to construct an index of talent. Table VI shows average values of talent and the three measures of competition for each of the 14 industries. The talent measure is based on first-stage regressions using C_{Sum}.[19] The first column reports total employment in each industry in 2001. The employment figures exceed the sample size because they reflect population estimates for the proportion of the Canadian private sector represented by our sample.[20] Talent is highest in Business Services, Information and Cultural Industries, and Finance and Insurance and these industries have higher than average levels of competition. Of course, regressions that employ industry fixed effects remove the variation in talent across industries observed in the table.

19. Although competition is not part of the talent measure, talent is conditional on the measure of competition since competition is a regressor in the first-stage regression. Talent is not sensitive to the choice of competition measure.

20. Total employment in the Canadian private sector was 12.2 million 2001. Our subsample reflects about 76% of that, or 8.8 million employees.

Table VII.
Second-Stage Wage Regression—Talent and Competition Interactions

CompVar:	C_{Max}		C_{Sum}		C_{Bin}	
Comp	−0.012	−0.004	0.002	0.001	−0.043	−0.016
	(0.011)	(0.010)	(0.003)	(0.003)	(0.033)	(0.032)
Talent	0.752***	0.857***	0.858***	0.888***	0.858***	0.906***
	(0.175)	(0.196)	(0.128)	(0.147)	(0.123)	(0.132)
Tal*Comp	0.053	0.031	0.012	0.010	0.202	0.135
	(0.034)	(0.038)	(0.009)	(0.010)	(0.132)	(0.142)
Ind FE	No	Yes	No	Yes	No	Yes
N	15,995	15,995	15,995	15,995	15,995	15,995
R^2	0.575	0.611	0.576	0.612	0.575	0.611

Note: Standard errors are shown by parentheses and ***, **, * indicate significance at the 1%, 5%, and 10% levels. Survey weights and structure are accounted for using Stata's survey estimation software. All regressions include occupation and region fixed effects and the controls variables.

Table VII reports results for estimates of equation (13) where we add the interaction of talent and competition to the stage-one wage regressions. Rather than posit that talent is captured by occupations, as assumed by Guadalupe (2007) and portrayed in Table V, here talent is based on education, promotions, and recruitment. Because the first-stage regressions control for occupation, talent variation is based on variation within occupations. From model Predictions 2 and 3, we expect the base effect of competition to be negative and the interaction to be positive. Talent enters the specification in lieu of the variables it comprises.[21] As before, we present results for the three competition measures and specifications with and without industry fixed effects.

The results provide only weak support for Predictions 2 and 3. The talent*competition interaction enters positively, but is not significant. The most significant estimate of the interaction appears in column (5), entering with a 12% significance level. Including the interaction term reduces the estimate of the competition (relative to those appearing in Table III) and produces negative estimates in four of six cases. However, none of the base competition estimates are statistically significant. One explanation why the estimates of the effect of competition are not more negative is that we do not fully observe talent. If unobserved talent is positively correlated with competition, then it will upwardly bias the competition variable.[22]

The strongest results in support of the two predictions appear in column (5). This specification employs the binary measure of competition and no industry fixed effects. In specification (5), the base effect of competition is −0.043 and the interaction with talent is 0.202, implying a critical level of talent for the effect of competition to be positive of 0.22. The median level of talent for skilled workers is 0.26. This implies that competition

21. When we exclude the competition–talent interaction, the coefficient on talent is exactly 1.

22. We investigated whether it is feasible to employ worker fixed effects to control for unobserved talent for 2 years with matched employee information (2001 and 2002). However, of the variables that comprise the talent variables—the (log) number of promotions, the education level, and a dummy variable indicating whether the employee were recruited—only the first variable exhibits change over time and that variable does not change for about 75% of the observations. Even when the number of promotions changed from 2001 to 2001, it is reported imprecisely, sometimes *decreasing* over time. We observed so much noise in the data that we could not even find a significant positive relationship between the change in talent (reflecting changes in the number of promotions) and changes in salary. Therefore, we were unable to properly estimate the model using worker fixed effects.

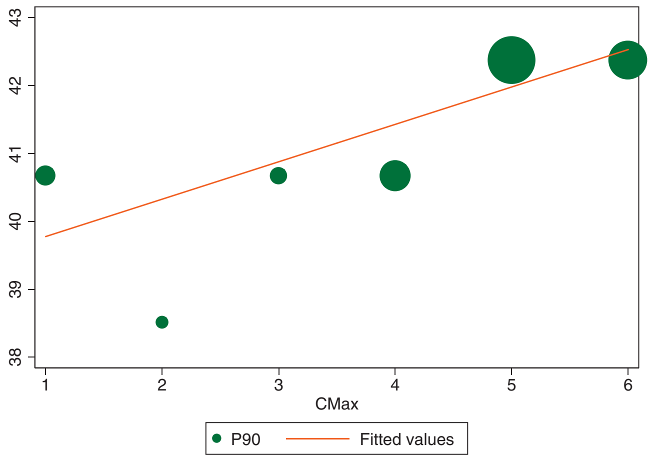

FIGURE 1. 90th PERCENTILE OF TALENT ACROSS COMPETITION LEVELS, C_{Max}

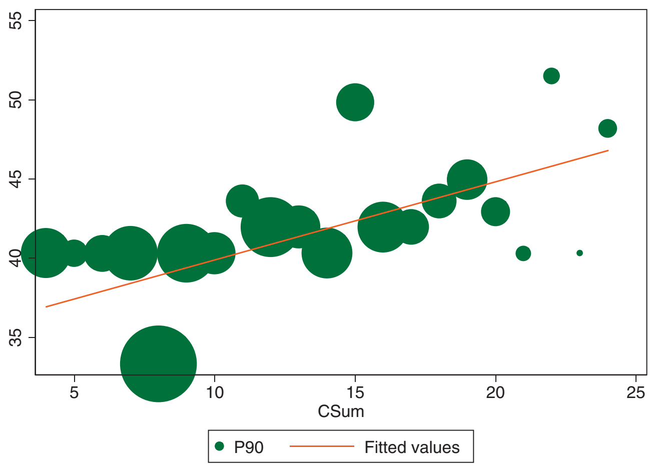

FIGURE 2. 90th PERCENTILE OF TALENT ACROSS COMPETITION LEVELS, C_{Sum}

reduces wages for somewhat less than half of all workers, those with relatively low talent levels, and raises wages for the remainder.

Our final results address the model predictions that competitive industries should employ the most talented workers (Prediction 4) and talent dispersion should increase with competition (Prediction 5). We test these predictions by examining the relationships between product market competition and the 90th percentile level of talent and the standard deviation of talent. Our competition variables provide discrete measures of competition. C_{Max} ranges from one to six, C_{Sum} from 4 to 24, and C_{Bin} is binary. We calculate the 90th percentile of talent as well as the standard deviation of talent for each level of competition.

Figures 1 and 2 portray the relationship between the 90th percentile talent level and competition for C_{Max} and C_{Sum}. The size of the dots reflect the number of observations for each competition level and the line is the ordinary least squares (OLS) fit using the observations as a weight. We observe a positive and highly significant (1% level)

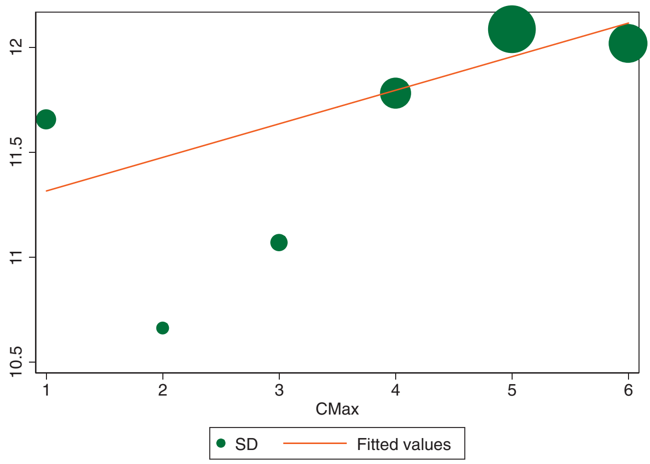

FIGURE 3. STANDARD DEVIATION OF TALENT ACROSS COMPETITION LEVELS, C_{Max}

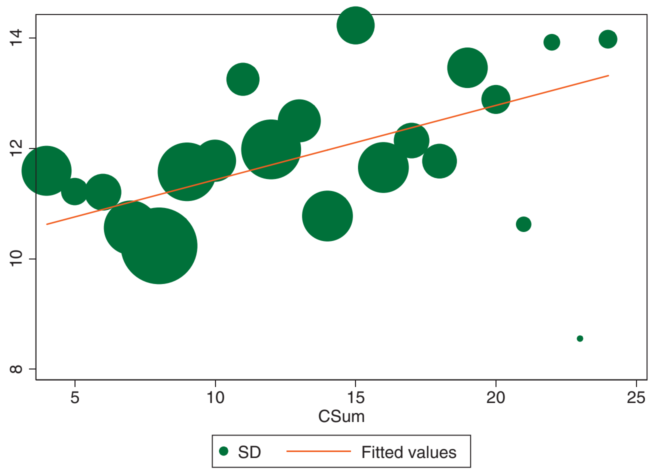

FIGURE 4. STANDARD DEVIATION OF TALENT ACROSS COMPETITION LEVELS, C_{Sum}

relationship for both competition measures. In the case of C_{Bin}, the 90$^{\mathrm{th}}$ percentile of talent for firms with the greatest competition is 42.4 whereas it is 40.7 in firms subject to less competition. These results are consistent with model Prediction 4, that talented workers will select into competitive industries.

Figures 3 and 4 reveal that the standard deviation of talent rises with competition for both C_{Max} and C_{Sum}. The relationship is significant at the 1% level for C_{Sum}. There are only six values of competition for C_{Max} and the positive relationship is only significant at the 12% level for this variable. In the case of C_{Bin}, the standard deviation of talent is 12.1 for high competition and 11.6 for low competition. These results support model Prediction 5, that the standard deviation of talent increases with competition.

4. Conclusion

Economists have theorized that product market competition influences worker effort and firm efficiency. In this paper, we extend this literature by considering how competition affects the wages and industry allocation of talented workers. Our model predicts that for highly talented workers, the marginal return to talent is increased by competition, leading firms in competitive industries to outbid firms in less competitive industries for the services of these workers. Thus, talented workers earn higher wages in competitive industries and self-select into these industries. On the other hand, competition will reduce the wages of relatively untalented workers. The model also reveals that the dispersion of talent increases with competition. The WES provides unique data enabling us to test the model predictions. In particular, a direct measure of competition is available based on question about the degree of competition that each firm faces.

The empirical results are consistent with the theoretical predictions. Competition is associated with greater dispersion of talent and the most talented workers tend to work in competitive industries. Although our estimates indicate that talent positively interacts with competition to raise wages and that competition reduces the wages of less talented workers, the estimates are not statistically significant.

Declining trade barriers and improvements in communication and transportation costs mean that firms are facing ever greater competition. Greater competition has implications for firm survival and performance. Our analysis suggests that it also affects the returns to workers and their allocation across industries.

Appendix A

Appendix: Proof of Proposition 7

Recall our talent random variable α, distributed with pdf $f(\alpha)$. Then equilibrium worker talent hired in industries c and d, respectively, can be expressed as transformations $z_c(\alpha)$ and $z_d(\alpha)$ of α, and defined as follows:

$$z_c(\alpha) = \begin{Bmatrix} \alpha & \text{if} & \alpha \geq \overline{\alpha} \\ \alpha - 1 & \text{if} & \alpha < \overline{\alpha} \end{Bmatrix},$$

$$z_d(\alpha) = \begin{Bmatrix} \alpha - 1 & \text{if} & \alpha \geq \overline{\alpha} \\ \alpha & \text{if} & \alpha < \overline{\alpha} \end{Bmatrix}. \tag{A1}$$

As discussed in the text, the mean talent in industries c and d can be written as:

$$E(z_c) = \int_1^{\overline{\alpha}} (\alpha - 1) f(\alpha) d\alpha + \int_{\overline{\alpha}}^{\alpha_{\max}} \alpha f(\alpha) d\alpha = E(\alpha) - P(\alpha \leq \overline{\alpha}),$$

$$E(z_d) = \int_1^{\overline{\alpha}} \alpha f(\alpha) d\alpha + \int_{\overline{\alpha}}^{\alpha_{\max}} (\alpha - 1) f(\alpha) d\alpha = E(\alpha) - (1 - P(\alpha \leq \overline{\alpha})). \tag{A2}$$

From this we can derive the variances in industries c and d:

$$\mathrm{Var}(z_c) = E\left[(z_c - E(z_c))^2\right] = \int_1^{\overline{\alpha}} (\alpha - 1 - E(z_c))^2 f(\alpha) d\alpha + \int_{\overline{\alpha}}^{\alpha_{\max}} (\alpha - E(z_c))^2 f(\alpha) d\alpha, \tag{A3}$$

$$\mathrm{Var}(z_d) = E\left[(z_d - E(z_d))^2\right] = \int_1^{\overline{\alpha}} (\alpha - E(z_d))^2 f(\alpha)d\alpha + \int_{\overline{\alpha}}^{\alpha_{\max}} (\alpha - 1 - E(z_d))^2 f(\alpha)d\alpha,$$

which, using (A2), simplify to:

$$\mathrm{Var}(z_c) = Var(\alpha) - 2\int_1^{\overline{\alpha}} (\alpha - E(\alpha)) f(\alpha)d\alpha + [P-1]^2 P + P^2(1-P), \tag{A4}$$

$$\mathrm{Var}(z_d) = Var(\alpha) - 2\int_{\overline{\alpha}}^{\alpha_{\max}} (\alpha - E(\alpha)) f(\alpha)d\alpha + (1-P)^2 P + (-P)^2(1-P),$$

where $P \equiv P(\alpha \leq \overline{\alpha})$. Taking the difference between $\mathrm{Var}(z_c)$ and $\mathrm{Var}(z_d)$, and simplifying, we obtain:

$$\mathrm{Var}(z_c) - \mathrm{Var}(z_d) = -2\left[\int_1^{\overline{\alpha}} (\alpha - E(\alpha)) f(\alpha)d\alpha - \int_{\overline{\alpha}}^{\alpha_{\max}} (\alpha - E(\alpha)) f(\alpha)d\alpha\right], \tag{A5}$$

or:

$$\mathrm{Var}(z_c) - \mathrm{Var}(z_d) = -2\left[\int_0^{\alpha_{\max}} (\alpha - E(\alpha)) f(\alpha)d\alpha - 2\int_{\overline{\alpha}}^{\alpha_{\max}} (\alpha - E(\alpha)) f(\alpha)d\alpha\right], \tag{A6}$$

leading to:

$$\mathrm{Var}(z_c) - \mathrm{Var}(z_d) = 4\int_{\overline{\alpha}}^{\alpha_{\max}} (\alpha - E(\alpha)) f(\alpha)d\alpha > 0. \square \tag{A7}$$

Appendix B

Appendix: The Workplace and Employee Survey

The WES was conducted annually from 1999 to 2004. Employers are sampled by physical locations, and employees are then sampled from employer-provided lists within each location. The survey covers all industries except farming, fishing, trapping, and public administration and all regions of Canada with the exception of the Arctic territories (the Yukon, Northwest Territories, and Nunavut).

Businesses in Canada were stratified into relatively homogeneous groups that formed the basis for sample selection. There are 252 strata according to 14 industry classifications, 6 regional classifications, and 3 employment size categories. The strata were constructed so as to maximize variation between strata and minimize variation within strata. Firms are sampled randomly from within each strata; however, firms are disproportionately sampled from strata with higher variances. To control for the oversampling, each sampled units is assigned a sampling weight based on its probability of selection. These weights are used to generate unbiased estimates of populations characteristics and regression parameters.[23]

References

Baggs, J. and J.-E. de Bettigines, 2007, "Product Market Competition and Agency Costs," *Journal of Industrial Economics*, 55, 289–323.

23. See the Statistics Canada *Guide to the Analysis of the Workplace and Employment Survey* for complete information.

Card, D. and T. Lemieux, 2001, "Can Falling Supply Explain the Rising Return to College for Younger Men? A Cohort Based Analysis," *Quarterly Journal of Economics*, 116, 701–746.

Cooper, D. and C. Emory, 1995, *Business Research Methods*, fifth edition, Chicago, IL: Irwin.

de Bettignies, J.-E., 2006, "Product Market Competition and Boundaries of the Firm," *Canadian Journal of Economics*, 39, 948–970.

Freedman, M., F. Andersson, J. Haltiwanger, J. Lane, and K. Shaw, 2009, "Reaching for the Stars: Who Pays for Talent in Innovative Industries?," *The Economic Journal* 119, F308–F332.

Fudenberg, D. and J. Tirole, 2000, "Customer Poaching and Brand Switching," *RAND Journal of Economics*, 31, 634–657.

Gibbons, R., L. Katz, T. Lemieux, and D. Parent, 2005, "Comparative Advantage, Learning, and Sectoral Wage Determination," *Journal of Labour Economics*, 23, 681–723.

Guadalupe, M., 2007, "Product Market Competition, Returns to Skills, and Wage Inequality," *Journal of Labor Economics*, 25, 439–473.

Hart, O., 1983, "The Market as an Incentive Mechanism," *Bell Journal of Economics*, 14, 366–382.

Hermalin, B., 1992, "The Effects of Competition on Executive Behavior," *RAND Journal of Economics*, 23, 350–365.

Hotelling, H., 1929, "Stability in Competition," *Economic Journal*, 39, 41–57.

Lemieux, T., 2006, "The Mincer Equation Thirty Years after Schooling, Experience, and Earnings," S. Grossbard-Shechtman, ed. *Jacob Mincer, A Pioneer of Modern Labor Economics*, 127–145, New York, NY: Springer Verlag.

Martin, S., 1993, "Endogenous Firm Efficiency in a Cournot Principal-Agent," *Journal of Economic Theory*, 59, 445–450.

Mas-Colell, A., M. Whinston, and J. Green, 1995, *Microeconomic Theory*, New York, NY: Oxford University Press.

Mocan, H.N. and E. Tekin, 2006, "Nonprofit Sector and Part-Time Work: An Analysis of Employer-Employee Matched Data on Child Care Workers," *The Review of Economics and Statistics*, 85, 38–50.

Raith, M., 2003, "Competition, Risk and Managerial Incentives," *American Economic Review*, 93, 1425–1436.

Scharfstein, D., 1988, "Product Market Competition and Managerial Slack," *RAND Journal of Economics*, 19, 147–155.

Schmidt, K., 1997, "Managerial Incentives and Product Market Competition," *Review of Economic Studies*, 64, 191–213.

Statistics Canada, 2003, *Guide to the Analysis of the Workplace and Employment Survey 2001*, Ottawa, Canada: Statistics Canada.

Stigler, G., 1958, "The Economies of Scale," *Journal of Law and Economics*, 1, 54–71.

Sutton, J., 1992, *Sunk Costs and Market Structure*, Cambridge, MA: MIT Press.

Tirole, J., 1988, *The Theory of Industrial Organization*, Cambridge, MA: MIT Press.

Villas-Boas, J.M., 1999, "Dynamic Competition with Customer Recognition," *RAND Journal of Economics*, 30, 604–631.

Vives, X., 2008, "Innovation and Competitive Pressure," *Journal of Industrial Economics*, 56, 419–469.