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Paying to queue: a theory of locational differences in nonunion wages

Tom Ahn and Peter Arcidiacono *

Department of Economics, Duke University Box 90097, Durham, NC 27708, USA

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Abstract

Traditional theories of the effect unions have on nonunion wages are difficult to reconcile with firm and worker mobility. We show how differences in nonunion wages can persist in a two-city search model. Nonunion wage differences across cities are driven by transition rates into the union sector. Should union queues form in the nonunion sector, union power decreases nonunion wages as workers are willing to take lower wages to line up for union jobs. However, if queues are formed in the unemployed sector, union power increases nonunion wages as nonunion firms pay premiums to induce workers to leave the queue.

JEL classification: J41; J61; R41

Keywords: Nonunion wage differentials; Search; Mobility

1. Introduction

How does a union affect wages in the nonunion sector? The economics literature is divided on the issue with two competing theories. The 'spillover' literature finds a tradeoff between union wages and employment.[1] As union wages increase, there are fewer vacancies in the union sector, and the supply of nonunion labor increases. This outward shift in the nonunion labor supply curve in turn leads to a lower equilibrium wage for nonunion workers. The implicit assumption in the spillover literature is that the market for nonunion workers is competitive. In contrast, the 'threat' literature assumes that the

* Corresponding author.
E-mail addresses: tsa4@duke.edu (T. Ahn), psarcidi@econ.duke.edu (P. Arcidiacono).

[1] See Friedman [5], Johnson [9], McDonald and Solow [12], Layard and Nickell [11], among many others.

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market for nonunion workers is not competitive.[2] As union wages increase, so too does the incentive for workers in the nonunion sector to organize. High union wages then lead to high nonunion wages as nonunion firms increase the pay of workers to deter them from forming a union.

A sizable literature in recent years has focused on empirically testing the validity of the spillover and threat theories. The standard test involves estimating a wage regression with the percent of the city or industry in a union as a regressor. With spillover effects, a more unionized workforce means a lower elasticity of demand for unionized workers as there is a lack of nonunion workers that can serve as substitutes. Hence, unions would then we willing to trade off small employment losses for high wage gains. These employment losses then translate into lower nonunion wages from the shift out of the nonunion supply curve. However, threat effects imply that a higher percentage organized is suggestive of the ease of organization itself. Nonunion firms would then pay their workers a premium to avert the threat of unionization. A negative coefficient on percent organized then implies that the spillover effect dominates while a positive coefficient indicates that the threat effect dominates. Policymakers interested in maximizing the welfare of workers may then be more supportive of unions in industries where the threat effect dominates rather than the spillover effect, because threat effects yield a distribution of profits more favorable to workers.

The empirical literature has found mixed results. Using cross-sectional variation, unionization at the industry level shows positive, though often not significant, effects of increasing percent organized.[3] This is consistent with the threat model. Percent organized at the SMSA level, however, shows negative effects though these results are even more fragile.[4] Perhaps the most comprehensive article on the empirical validity of threat and spillover effects is by Neumark and Wachter [13]. Their paper uses variation over time in percent organized while controlling for industry and city-specific fixed effects. In contrast to the previous literature, they find spillover effects dominating at the industry level and threat effects dominating at the city level. In particular, increasing the percent organized by 10% at the industry level results in a 1.5% to 1.9% drop in nonunion wages. A similar increase at the SMSA level results in nonunion wages increasing between 0.3% and 1.1%.

When firms or workers are mobile, the interpretation of the empirical findings for both theories is confounded.[5] In the long run, firm and worker mobility should undo the wage effects generated from spillover and threat sources. Workers pushed out by the spillover effect will migrate to cities[6] with higher nonunion wages while firms will enter the market to take advantage of the low wages. This entry by firms and exit by workers then leads to equalization in nonunion wages across cities. Similarly, if threat effects are present, firms will exit and workers enter until nonunion wages are again equalized.

How can persistent differences in nonunion wages exist across cities in the face of mobility? We develop a model in which how union jobs are obtained dictates the effect

[2] See Conant [3], Rosen [17], as well as many others.

[3] See, for example, Freeman and Medoff [4], Hirsch and Neufield [6], Ichniowski et al. [8].

[4] See, for example, Holzer [7] and Kahn [10].

[5] See Raphael and Riker [16] and Ross [18] for the importance of geographic mobility in explaining labor market outcomes.

[6] We use the terms 'cities' and 'different labor markets' synonymously.

union power has on nonunion wages. The key assumption is that it is easier for workers to transition into union jobs in their city of residence than into union jobs in other cities. Then, whether the transition rates into union jobs are higher from the nonunion sector or the unemployed sector determines whether nonunion wages are lower or higher in the city with the stronger union. If workers find it easier to obtain a union job from the nonunion sector, nonunion firms recognize this and demand a share of the future benefits of queueing from the nonunion job. On the other hand, if it is more difficult for workers to find a union job from the nonunion sector, firms have to pay a premium to attract workers. We develop a two-city search model that generates persistent nonunion wage differences across cities due to transition probabilities into union jobs.

In certain markets it may be easier to obtain a union job if the worker is employed in a nonunion position in the same city. The nonunion job may then allow the worker to learn more easily of union job openings and send signals to the union about his productivity or his ability to 'fit in' with union members. These signals can be formal, such as performance reviews, or informal, such as social interactions with union members. Whether the signals are formal or informal, forward looking workers choose to enter nonunion jobs with the knowledge that they are queueing for union jobs. If the queue for union jobs is in the nonunion sector, nonunion firms are able to extract some of the expected future benefits the worker has from potentially being employed by the union. Hence, lower nonunion wages result in the city with the more powerful union.

In other markets, however, it may prove easier to obtain a union job if the worker is unemployed. Being unengaged in a nonunion job allows the worker to spend more time, collect more information, and generally invest more effort into the job search than his employed counterparts. For example, budding actors and actresses move to Los Angeles or New York to queue for acting positions. Forgoing the income as a waiter or busboy will allow the actor to practice his lines more and attend more auditions. In contrast to the case where the queue is from the nonunion sector, firms must pay workers a premium to leave the queue and this premium may lead to higher nonunion wages in the city with the stronger union. Whether the queue is from the nonunion sector or the unemployed sector then dictates how nonunion wages will differ across cities.

Whether the queue for union jobs is from the nonunion sector or the unemployment sector also affects unemployment rates. If firms have to pay a premium to workers to leave the queue, firms need to be compensated with a higher probability of matching with a worker. These premiums then lead to higher unemployment rates for workers in markets where the queue for union jobs is the unemployed sector. Hence, as the queue moves from the nonunion sector to the unemployed sector, workers trade off higher probabilities of employment for higher wages.[7]

The next section presents the two-city search model. Section 3 provides comparative statics, showing how nonunion wages across cities differ due to stronger or weaker unions. Section 4 discusses the broader implications of the model.

[7] A similar tradeoff is found in Sattinger [19] where the longer consumers wait in line the lower the prices they face.

2. The model

In this section we present a two-sided search model which is designed to highlight the effect queueing has on nonunion wages. Unless otherwise noted, all proofs are in the appendix. There are two cities, with City 1 having both a union and a nonunion sector and City 2 only having a nonunion sector.[8] There are $\overline{N}$ workers born each period, and these workers live for two periods.[9]

Union jobs are allocated on a strict seniority basis: only old workers may obtain union jobs. Allowing young workers to obtain union jobs does not affect the qualitative results as long as unions first decide membership and then those who do not find union jobs search for nonunion jobs. Membership in the union is limited, and young workers must queue to obtain a union job when old.

Old workers in City 1 who do not obtain a union job and all old workers in City 2 take an outside option W_o when old. We impose a union wage, W_u, that is greater than W_o to make the union job more attractive than the outside option. Having an outside option for old workers is equivalent to assuming that there is a separate labor market for old workers and the assumption has no effect on our qualitative results but does simplify the computations.

The timing for a particular cohort of workers then follows:

(1) Young workers choose to live in City 1 or City 2.
(2) Nonunion firms and young workers search for jobs in the city where they live.[10]
(3) Matched workers negotiate a wage.
(4) The union determines membership from the pool of old employed and unemployed workers in City 1.
(5) All old workers in City 2 and old workers who did not receive a union job in City 1 take an outside option.

We assume that workers are risk neutral and endure no costs to choosing a particular location in either period. Both firms and workers have discount factors set to unity.[11] All workers have identical abilities and are solely interested in maximizing their lifetime income.[12] Young workers in City 1, N_1, and City 2, N_2, search for nonunion firms, and nonunion firms in each city search for workers. Entry by nonunion firms is endogenous with the number of vacancies posted in City 1 and City 2 denoted by J_1 and J_2. As in Pissarides [15], the number of matches in City i is Cobb–Douglas on the interior and given by

$$x_i = \min\bigl(A J_i^{\alpha} N_i^{1-\alpha}, J_i, N_i\bigr), \tag{1}$$

[8] All qualitative results hold when City 2 instead has a weaker union than City 1.

[9] See Arcidiacono [1] and Pissarides [15] for previous work on two-period overlapping generations search models.

[10] All qualitative results hold when we allow workers to search in both cities, as long as it is easier to match in the city in which they are located. See Section 4 for a detailed discussion.

[11] These assumptions do not affect the qualitative results.

[12] The comparative statics of the model do not change with heterogeneous match qualities as long as workers have ex ante identical expectations on the productivity of the match.

where $\alpha \in [0, 1]$ and A is a normalizing constant. Conditional on the city, all workers have the same probability of finding a match. The probability of a worker in city i finding a match is then given by $P_i = x_i/N_i$. All nonunion firms also have the same probability of finding a match, given by $q_i = x_i/J_i$.

Within a cohort of old workers, the probability of transitioning into a union job depends not only on the ratio of workers to union jobs, but also on whether the worker is unemployed or employed at a nonunion firm. Let δ indicate the degree of advantage an employed individual has over an unemployed individual in finding a union job. We define the probability of obtaining a union job when old conditional on being employed in City 1 when young as

$$P_{u|e} = \frac{\delta U}{\delta x_1 + (1-\delta)(N_1 - x_1)}, \tag{2}$$

where U is the size of the union. The corresponding probability of obtaining a union job when old conditional on not matching in City 1 when young is given by

$$P_{u|ne} = \frac{(1-\delta)U}{\delta x_1 + (1-\delta)(N_1 - x_1)}. \tag{3}$$

Structuring the transition probabilities in this way allows the probability of transitioning into the union job to be the same for unemployed and nonunion workers when $\delta = 0.5$. However, if $\delta > 0.5$, a worker in City 1 has a higher probability of transitioning into the union sector if he has a nonunion job than if he is unemployed. When $\delta = 1$ (0), workers transition into union jobs only from the employed (unemployed) sector.

Wages in the union sector, W_u, and the size of the union, U, are taken as exogenous from the perspective of the workers. We do not model how W_u and U are determined, and in particular do not model how the nonunion labor market influences the bargaining power of the union. While the nonunion sector undoubtedly influences the union sector, in this paper we are interested in what the general equilibrium must look like conditional on an observed union size and wage.

Wages in the nonunion sector are determined according to generalized Nash bargaining, with the worker's share of the surplus denoted β, $\beta \in (0, 1)$. The current period value of a match in city i is given by V_i. Young workers who search in City 2 and are matched with firms receive

$$W_2 = \beta V_2. \tag{4}$$

Nonunion wages in City 1 are more complex. Matches in City 1 may be worth more or less than the current period value as matching may influence the probability of getting into the union in the future. In particular, the total value of the match increases (decreases) if the probability of entering the union is higher (lower) from the nonunion sector than from the unemployed sector. It is this effect, the union queueing effect, which drives nonunion wage differences across cities, nonunion wages in City 1 are then given by

$$W_1 = \beta V_1 - (1-\beta) P_D (W_u - W_o), \tag{5}$$

where

$$P_D = P_{u|e} - P_{u|ne},$$

and $P_{u|e}$ and $P_{u|ne}$ are the probabilities of transitioning into the union job from the employed and unemployed sectors respectively.

Note that $P_D(W_u - W_o)$ is the expected gain or loss in earnings when old from being matched with a firm in City 1 when young. Should the probability of obtaining a union job increase by being employed in the nonunion sector, firms in City 1 extract a $(1-\beta)$ share of the corresponding increase in expected future earnings. However, if by working in the nonunion sector the probability of transitioning into the union sector is smaller, firms in City 1 have to pay workers a premium to take a job that lowers their expected future wages.

Young workers then choose City 1 or City 2 to maximize their life-time expected wages. For a young worker to be indifferent between choosing City 1 or City 2, we must have

$$P_1W_1 + P_1P_{u|e}W_u + (1-P_1)P_{u|ne}W_u + P_1(1-P_{u|e})W_o + (1-P_1)(1-P_{u|ne})W_o = P_2W_2 + W_o.$$

The left-hand side has the expected wages for choosing City 1. The second and third terms represent the union wage times the probability of obtaining a union job conditional on being employed and unemployed, respectively. The last terms are then the corresponding probabilities and returns conditional on not obtaining a union job. The right-hand side is the corresponding expected wages for choosing City 2: the probability of matching when young times the wage when young plus the value of the outside option when old. Rearranging the terms yields

$$P_2W_2 - P_1W_1 = P_1P_{u|e}(W_u - W_o) + (1-P_1)P_{u|ne}(W_u - W_o). \tag{6}$$

Since the term on the right hand side is positive, we know that the combination of the probability of finding a job when young in City 2 times the wage in City 2 must be higher than the corresponding combination in City 1. That is, workers in City 1 take lower expected wages when young in the hopes of acquiring a union job, and thereby a higher wage when old.

The difference in transition rates across the unemployed and nonunion sector also influences the entry decisions of nonunion firms. If $P_D > 0$, nonunion firms in City 1 are able to extract a portion of the higher future wages the worker expects from working in the nonunion sector, making City 1 attractive to nonunion firms. If $P_D < 0$, nonunion firms must pay workers a premium for the inferior queue position. Nonunion firms in both cities will post vacancies in each city until the expected profits from posting a vacancy are zero. The expected zero profit conditions for firms operating in City 1 and City 2 are then:

$$q_1(1-\beta)\big[V_1 + P_D(W_u - W_o)\big] - K = 0, \tag{7}$$

$$q_2(1-\beta)V_2 - K = 0, \tag{8}$$

where K is the fixed cost of posting a vacancy and q_i is the probability of a firm finding a match in city i.

In order to close the model, we specify how the V_is, that is, the match values, are determined. We assume that V_i is a function of the number of matches:

$$V_i = f(x_i), \tag{9}$$

where

$$\frac{\mathrm{d}[f(x_i)\cdot x_i]}{\mathrm{d}x_i} = f'(x_i)x_i + f(x_i) > 0 \qquad \text{while } x_i \leqslant \overline{N}, \tag{10}$$

$$\frac{\mathrm{d}^2[f(x_i)\cdot x_i]}{\mathrm{d}(x_i)^2} = f''(x_i)x_i + 2f'(x_i) < 0 \quad \text{while } x_i \leqslant \overline{N}. \tag{11}$$

Define the gross surplus function in city i as the value of a match in city i, $f(x_i)$, times the number of matches in city i, x_i. The assumptions above then ensure that the gross surplus function is concave in the number of matches. Hence, the more matches that occur the less surplus is available per match. This can be because of increased land prices or producing a good that is not traded across cities; in either case the surplus function is treated as outside the model. Concavity of the gross surplus function also implies downward sloping labor demand curves in each city.[13]

This last assumption on the surplus function then closes the model. Proposition 1 establishes that an equilibrium for this model does exist.

Proposition 1. *Given Eqs.* (1)–(11) *and a parameter vector* $\{K, A, \alpha, \beta, \delta, W_u, W_o, \overline{N}, U\}$, *there exists an equilibrium in* $\{N_1, N_2, J_1, J_2, W_1, W_2\}$.

3. Comparative statics

Having shown that an equilibrium exists, we now establish the comparative statics results. We show how nonunion wages and unemployment rates across the two cities differ depending upon the differences in the probabilities of finding a union job from the unemployed or nonunion sectors.

We begin by noting that if the probabilities of finding a job and nonunion wages are equal across the two cities, workers prefer to search in City 1 due to the probability of transitioning into a union job. However, if union jobs are obtained primarily through first working in the nonunion sector ($\delta > 0.5$), nonunion firms too have a preference for searching in City 1, all else equal, because firms can extract some of the expected future rents workers have from the union job. If the incentives for firms to search in City 1 are large enough, it may be possible for young workers to have a higher probability of matching in City 1 than City 2. Proposition 2 rules this out.

Proposition 2. $P_1 < P_2$ *if* $\delta < 1$ *and* $P_1 = P_2$ *if* $\delta = 1$.

Proof. Solving for q_1 and q_2 in the zero profit conditions yields

$$q_1 = \frac{K}{(1-\beta)(V_1 + P_D(W_u - W_o))} \quad \text{and} \quad q_2 = \frac{K}{(1-\beta)V_2}.$$

[13] An equilibrium that is characterized by firms and workers located in both cities in the presence of a constant returns to scale matching function when $P_D > 0$ necessitates a concave gross surplus function. Otherwise, both firms and workers would prefer to search in City 1.

Note also that $q_i J_i/N_i = P_i$. Substituting in for P_i with the function of q_i given above into the worker indifference condition (Eq. (6)) yields

$$\frac{\beta K}{1-\beta}\frac{J_1}{N_1} + \frac{(1-\delta)U(W_u - W_o)}{\delta x_1 + (1-\delta)(N_1 - x_1)} - \frac{\beta K}{1-\beta}\frac{J_2}{N_2} = 0,$$

which can be rewritten as

$$\frac{J_1}{N_1} = \frac{J_2}{N_2} - \frac{1-\beta}{\beta K}\frac{(1-\delta)U(W_u - W_o)}{\delta x_1 + (1-\delta)(N_1 - x_1)}.$$

For the special case, where $\delta = 1$, the last term is zero. Since P_1 and P_2 are proportional to J_1/N_1 and J_2/N_2 respectively, $P_1 = P_2$. Note further that the second term on the left-hand side is weakly negative, implying: $J_1/N_1 \leqslant J_2/N_2$. Therefore,

$$P_1 = A\left(\frac{J_1}{N_1}\right)^{\alpha} \leqslant A\left(\frac{J_2}{N_2}\right)^{\alpha} = P_2. \qquad \square$$

When $\delta = 1$, there is no chance of obtaining the union job in City 1 from the unemployed sector. Therefore, the second period expected income for unemployed workers in City 1 and City 2 are identical. Firms and workers in City 1 are splitting the current value of the match plus the expected benefits of the worker potentially having a union job in the future. This total value of a match in City 1 must be equal to the value of a match in City 2 when $\delta = 1$. If the match value is higher in City 1 (2) then the probability of matching from the firm's perspective must be higher in City 2 (1) for the expected zero profit conditions to hold in both cities. But if the match value is higher in City 1 (2) and the worker has a higher probability of matching in City 1 (2), then workers will move from City 2 (1) to City 1 (2) as the worker indifference condition no longer holds.

If the probabilities of matching are the same across the two cities then nonunion wages must be lower in City 1 for the worker indifference condition to hold. In fact, any time the probability of transitioning into a union job is higher from the nonunion sector, increasing the size of the union or the union wage leads to lower relative wages in City 1. Recalling that $P_D > 0$ if and only if $\delta > 0.5$.

Proposition 3. *If $\delta > 0.5$, then*

$$W_1 < W_2, \qquad \frac{\mathrm{d}[W_1 - W_2]}{\mathrm{d}W_u} < 0, \quad \textit{and} \quad \frac{\mathrm{d}[W_1 - W_2]}{\mathrm{d}U} < 0.$$

The larger union premium or union size, the larger incentive workers have to choose to live in City 1. Firms too offer more positions in City 1 because of a better possibility of a match as well as being able to extract some of the union premium, which is larger due to the larger union size or union wages. The net result of these incentives will be a lower number of matches in City 2 and a higher number of matches in City 1. However, we emphasize that the probability of employment in City 2 is still higher than the probability of employment in City 1. While City 1 does have a higher number of matches, it also has a higher number of workers searching for work. The nonunion wage in City 1 will therefore be decreasing in the strength of the union[14] as the number of matches in City 1 increases, and the nonunion wage in City 2 will be increasing in the strength of the union, as the number of matches in City 2 decreases. Nonunion workers in City 1 see their wages fall both because of the increased matches and also because of having to pay more to queue for the higher benefits of the union job. Hence, spillover-like results are found anytime the queue for union jobs come from the nonunion sector.

Since both the probability of matching and the nonunion wage are lower in City 1, we obtain results similar to the macroeconomics literature on the wage curve.[15] This literature documents lower wages being associated with *higher* unemployment rates. This is true in the nonunion sector; but results from a higher probability of transitioning into a better job in the future.

When $\delta < 0.5$, it is easier to transition to the union job from the unemployed sector than from the nonunion sector. If this is the case, firms have to pay workers a premium to leave the queue. Proposition 4 then establishes that conditions exist where nonunion wages in City 1 are higher than nonunion wages in City 2, with the gap increasing as either union wages or union size increase.

Proposition 4. *If $\delta < 0.5$, conditions exist where*

$$W_2 < W_1, \qquad \frac{\mathrm{d}[W_1 - W_2]}{\mathrm{d}W_u} > 0, \quad \textit{and} \quad \frac{\mathrm{d}[W_1 - W_2]}{\mathrm{d}U} > 0.$$

Nonunion wages may still be higher in City 2 even when $P_D < 0$. To see this, consider the zero profit condition for firms in City 1:

$$q_1(1-\beta)\big[f(x_1) + P_D(W_u - W_o)\big] - K = 0.$$

With an increase in union size or wages and $\delta < 0.5$, the second term inside the brackets becomes more negative. However, q_1 has increased as well as more workers are induced to work in City 1. The higher probability of matching may then lead to more matches in equilibrium, pulling down the surplus of the match, $f(x_1)$. The premium firms pay workers to leave the queue is then balanced against lower match values. The less sensitive the firm's probability of matching is to changes in the number of searching workers,[16] the more likely nonunion wages will be higher in City 1.

To show the tradeoff between wages and employment as δ changes, we simulate the model.[17] Figures 1 and 2 plot changes in the relative probabilities of matching in the nonunion sectors in the two cities as well as the relative wages. As δ increases, we see the expected tradeoff between wages and employment. Increasing δ increases the probability

[14] The 'strength of the union' refers to the size of the union, U, times the magnitude of the union wage premium, $W_u - W_o$.

[15] See Blanchflower and Oswald [2] and the references therein.

[16] The firm's probability of matching becomes less sensitive to the number of searching workers as the parameter α in the matching function increases.

[17] The parameters of the data generating process are: $\beta = 0.5$, $\overline{N} = 1$, $K = 0.2$, $W_u = 0.2$, $W_o = 0.075$, $A = 0.75$, $U = 0.2$, $\gamma = 0.25$; where $f(x_1) = x_1^{\gamma - 1}$.

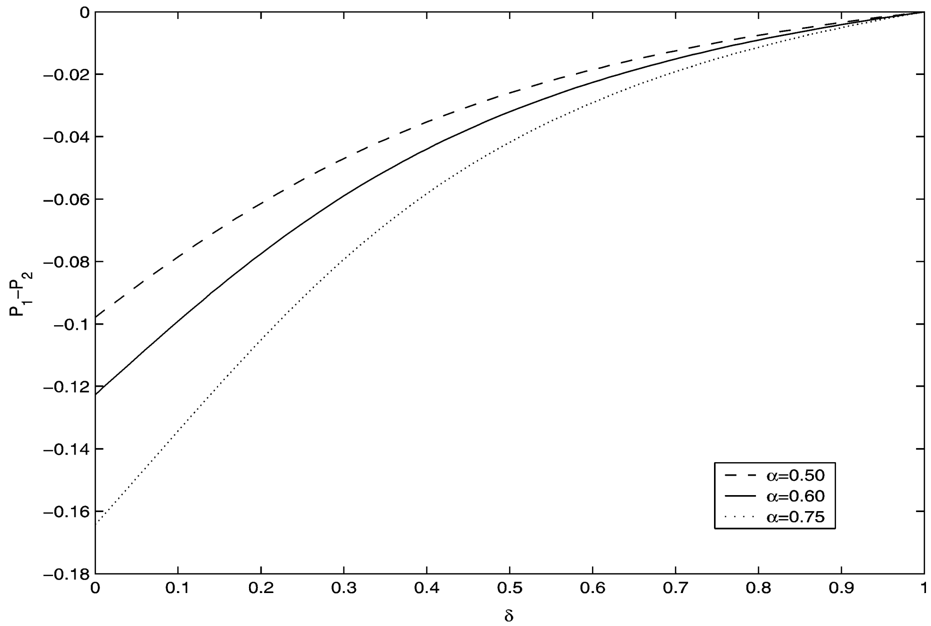

Fig. 1. $P_1 - P_2$ as a function of δ.

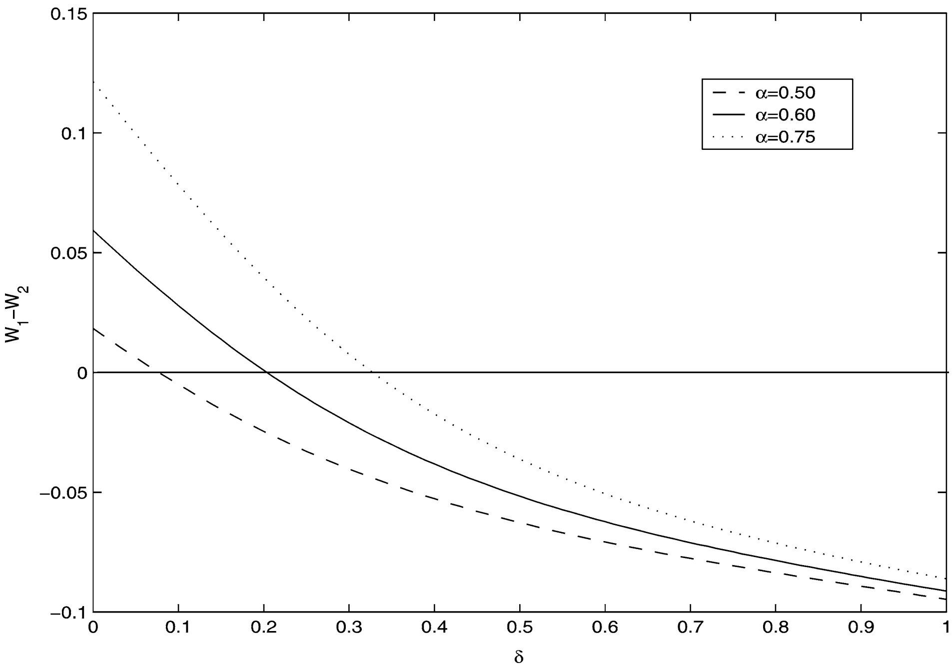

Fig. 2. $W_1 - W_2$ as a function of δ.

of finding a match relative to City 2. However, the decrease in the relative probability gap comes at a cost: relative nonunion wages fall in City 1 as δ increases.

Whether the probability of matching depends more on firms (high α) or on workers (low α) also dictates how the tradeoff between the probability of matching and nonunion wages takes place.[18] In particular, lowering the value of α flattens the curves in both graphs. This in turn reduces the region where threat-like effects ($W_1 - W_2 > 0$) exist.

4. Discussion

This paper has developed a theory of persistent nonunion wage differentials across cities due to queueing for union jobs. If the queue for union jobs is from the nonunion sector in the same city as the union, nonunion firms in that city are able to extract a portion of the workers expected gains from having union jobs in the future. On the other hand, if the queue is from the unemployed sector, firms must pay workers in the city with a union a premium to leave the queue. These nonunion wage differentials persist despite expected zero profits for firms and workers having expected wages which are equal across cities.

Our treatment of union wage and size may be of some concern in a general equilibrium model, where variables of interest are expected to be endogenous. However, we emphasize that our comparative statics analysis is not about the 'evolution' of the nonunion and union sectors. In this paper we are not interested in measuring the responses of the union sector to the nonunion sector. Rather, we are interested in what the nonunion labor market must look like in equilibrium given any union size or wage. No matter how a particular union size and wage came to be, the nonunion sector must behave in a particular way for firms to have zero expected profits and nonunion workers to be indifferent across locations.

A second strong assumption is the separability of the labor markets between City 1 and City 2. Without some separability of the labor markets, expected wages when old would be equal across cities implying that the probability of employment and the corresponding expected wage when young must also be the same across cities. While we believe that it is easier to obtain a union job in a particular locale when one lives in that locale, it is certainly the case that workers may apply for union jobs in other geographic locations by such methods as telephone, internet, and word-of-mouth. Extending the model such that workers can apply for union jobs across locations does not affect the qualitative results of the model as long as there is some advantage to being in the city with the union initially. This advantage can either be a moving cost associated with changing locations or through being more likely to have job contacts in the location where one is living. Both of these changes can be incorporated into the model but do not qualitatively affect the results. Consider the latter case where individuals in City 1 always have a higher probability of finding a union job than those initially in City 2. The transition probabilities into the union sector are

$$P_{u|e} = \frac{\delta_1 U}{\delta_1 x_1 + \delta_2 (N_1 - x_1) + (1 - \delta_1 - \delta_2) N_2},$$

[18] The empirical literature on matching functions has typically estimated α to be around 0.6. See Petrongolo and Pissarides [14] for a review.

$$P_{u|ne} = \frac{\delta_2 U}{\delta_1 x_1 + \delta_2(N_1 - x_1) + (1 - \delta_1 - \delta_2)N_2},$$
$$P_{u|city2} = \frac{(1 - \delta_1 - \delta_2)U}{\delta_1 x_1 + \delta_2(N_1 - x_1) + (1 - \delta_1 - \delta_2)N_2},$$

where $\min\{\delta_1, \delta_2\} \geqslant (1 - \delta_1 - \delta_2)$, $\delta_1 + \delta_2 \leqslant 1$, and $P_{u|city2}$ is the probability of transitioning into the union job if the worker is located in City 2.[19] Incorporating these changes in the transition rates then affects the worker's indifference condition between City 1 and City 2, but has no effect on the zero profit conditions of the firms. Allowing workers to transfer from City 2 to the union in City 1 will then only dampen the differences in labor market outcomes across locations but not change their signs.[20]

'Closer' can signify similarity of job description as well as geographic proximity. The two-city model translates directly into a model with two industries. City 1 would then be an industry where a union did exist with City 2 being an industry where no union exists. This ease with which the 'closer' nonunion worker queues can be attributed to such factors as lower information cost and speed of information delivery in learning about such positions, and the ability to more easily lobby to obtain the position once the worker queues. Therefore, union membership should favor home-grown workers to nonunion workers from 'farther away.' What we expect to see in the data is not complete labor market separation, but a higher percentage of 'closer' workers being accepted into the union than workers who are 'farther away.' In fact, the union set-up used in this paper is relevant for any situation in which one market serves as an informal queue to gain entry into another, more desirable market.

The transitions that occur across jobs then lead to ripple effects throughout the whole economy. Wage increases in one job lead to lower wages in jobs which transition into the job with the wage increase, and correspondingly higher wages in jobs which do not transition into the job with the wage increase. Hence, the general equilibrium effects work to undo wage increases in particular industries through the entry and exit of workers and firms into the industry. This is consistent with Neumark and Wachter [13] who find that industries with strong unions in particular locations have lower wages in the industry for nonunion workers, yet higher wages for other jobs in the city. The lower wages in the nonunion sector of an industry with a strong union is consistent with workers queueing for the union jobs by working in a nonunion job in the same industry. However, with

[19] Here, it makes no difference whether the worker was unemployed or employed in City 2 when calculating the transition rate into the City 1 union. Relaxing this assumption again leads to threat and spillover-like effects in City 2. For example, if it is easier to transfer into the City 1 union from the employed sector in City 2 than the unemployed sector in City 2, firms can take a cut of the expected future wage gains from the individual being employed when young. However, the degree of advantage should be higher in City 1 than in City 2 and the qualitative results then do not change.

[20] Another possible extension is to endogenize δ, allowing union firms to select where the queue forms. If nonunion firms and union firms compete with each other in the product market, union firms would face a tension on how many workers to hire from the nonunion queue. While hiring from the nonunion queue may mean more highly qualified workers (suggesting a high δ), union firms can raise the price of labor for nonunion firms by choosing a low value of δ. Allowing δ to be endogenous, however, would require an explicit modeling of the union's objective function.

workers queueing for a union job, there is a scarcity of workers for jobs outside of the union industry.

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Appendix A

Proofs are only sketched here. Full proofs are available upon request and can also be downloaded at http://www.econ.duke.edu/p̃sarcidi.

Proof of Proposition 1.
Available upon request.

Proof of Proposition 3.
We show that for $\delta > 0.5$, $W_1 < W_2$ using the zero profit conditions for firms in City 1 and City 2. Then, we show that $\mathrm{d}(W_1 - W_2)/\mathrm{d}U$ is negative as well for $\delta > 0.5$. Define

$$F_1 = q_1(1-\beta)\big[f(x_1) + P_D(W_u - W_o)\big] - K,$$
$$F_2 = q_2(1-\beta)f(x_2) - K,$$
$$F_3 = \beta P_1\big[f(x_1) + P_D(W_u - W_o)\big] + P_{u|ne}(W_u - W_o) - \beta P_2 f(x_2),$$

and use implicit function theorem

$$\begin{pmatrix} \frac{\partial J_1}{\partial U} \\ \frac{\partial J_2}{\partial U} \\ \frac{\partial N_1}{\partial U} \end{pmatrix} = -B^{-1} \begin{pmatrix} \frac{\partial F_1}{\partial U} \\ \frac{\partial F_2}{\partial U} \\ \frac{\partial F_3}{\partial U} \end{pmatrix},$$

where

$$B^{-1} = \frac{1}{\mathrm{Det}(B)} \begin{pmatrix} \frac{\partial F_3}{\partial N_1}\frac{\partial F_2}{\partial J_2} - \frac{\partial F_3}{\partial J_2}\frac{\partial F_2}{\partial N_1} & \frac{\partial F_3}{\partial J_2}\frac{\partial F_1}{\partial N_1} & -\frac{\partial F_2}{\partial J_2}\frac{\partial F_1}{\partial N_1} \\ \frac{\partial F_3}{\partial J_1}\frac{\partial F_2}{\partial N_1} & \frac{\partial F_3}{\partial N_1}\frac{\partial F_1}{\partial J_1} - \frac{\partial F_3}{\partial J_1}\frac{\partial F_1}{\partial N_1} & -\frac{\partial F_2}{\partial N_1}\frac{\partial F_1}{\partial J_1} \\ -\frac{\partial F_3}{\partial J_1}\frac{\partial F_2}{\partial J_2} & -\frac{\partial F_3}{\partial J_2}\frac{\partial F_1}{\partial J_1} & \frac{\partial F_2}{\partial J_2}\frac{\partial F_1}{\partial J_1} \end{pmatrix}$$

and $\mathrm{Det}(B)$ can be written as

$$\mathrm{Det}(B) = \frac{\partial F_2}{\partial J_2}\left[\frac{\partial F_1}{\partial J_2}\frac{\partial F_3^1}{\partial N_1} - \frac{\partial F_3}{\partial J_1}\frac{\partial F_1}{\partial N_1}\right] + \frac{\partial F_1}{\partial J_1}\left[\frac{\partial F_3^2}{\partial N_1}\frac{\partial F_2}{\partial J_2} - \frac{\partial F_3}{\partial J_2}\frac{\partial F_2}{\partial N_1}\right].$$

We next show that $\mathrm{Det}(B) < 0$ for $\delta > 0.5$. Having shown that the determinant is less than zero, we show that $\partial J_1/\partial U > 0$, $\partial N_1/\partial U > 0$, and $\partial J_2/\partial U < 0$ using simple algebra.

Having determined that in equilibrium, with an increase in U, both J_1 and N_1 increase, we prove that W_1 must decrease using proof by contradiction. If both J_1 and N_1 increase, then $f(x_1)$ must decrease. Now suppose that P_D decreases. Note that since P_D, $P_{u|e}$, and $P_{u|ne}$ are all related by a positive constant, a decrease in P_D is equivalent to decreases in $P_{u|e}$ and $P_{u|ne}$. We can see from the zero profit condition for City 1 that q_1 must then increase. From the worker indifference condition, $f(x_1)$ decreases, and since P_D, $P_{u|e}$, and $P_{u|ne}$ decrease, P_1 must increase. However, by definition, P_1 decreases if q_1 increases. Therefore, P_D must be increasing. Since $f(x_1)$ is decreasing and P_D is increasing, $\mathrm{d}W_1/\mathrm{d}U < 0$. Since both N_2 and J_2 are decreasing in U, x_2 unequivocally decreases, and W_2 increases. Therefore, $\mathrm{d}W_2/\mathrm{d}U > 0$. Therefore, $\mathrm{d}[W_1 - W_2]/\mathrm{d}U < 0$. □

Proof of Proposition 4. Let $\delta = 0$ and $\alpha = 1$. We can establish for this case that $W_1 - W_2 > 0$ using the zero profit conditions for City 1 and City 2.

We now establish that $\mathrm{d}[W_1 - W_2]/\mathrm{d}U$ may be positive as well.

Noting that the sign of the determinant of the Jacobian defined in proof of Proposition 3 is ambiguous, we show that if the determinant is positive at a particular equilibrium triplet, there must exist two other equilibria where the determinant is negative. We also show that an equilibrium where the determinant is positive is unstable in that the next firm entering City 1 earns positive profits given the response by N_1 to entry.

If the determinant is positive, we can show that an infinitesimal increase u leads to an increase in J_1, which leads to an increase in N_1, which leads to an increase in J_1, and so forth. The positive feedback loop explodes the number of workers and firms in the economy.

If the determinant is negative, with $\alpha = 1$ and $\delta = 0$, it is easy to show that an increase in U leads to a decrease in number of matches, which increases $f(x_i)$ as well as $P_{u|ne}$. Both terms lead W_1 to increase, making the gap between W_1 and W_2 larger. □

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