Heterogeneous Labor, Minimum Hiring Standards, and Job Vacancies in Public Employment

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Abstract
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Keywords
public employment, hiring, heterogeneous labor, monopsony, vacancies

Disciplines
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Heterogeneous Labor, Minimum Hiring Standards, and Job Vacancies in Public Employment

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I. Introduction

The existence of substantial, persistent, and widespread job vacancies or shortages among certain classes of urban government employees is well established, with attention recently being focused on shortages of policemen and registered nurses.\(^1\) Several authors have attempted to explain this phenomenon by postulating that local governments can be considered as monopsonists in the markets for job classes for which they are large employers.\(^2\) As is well known, a monopsony structure implies that job vacancies will be observed.

Although a government employer may be the only employer of a particular class of employees in an area (say firemen), it does not necessarily follow that the government agency possesses monopsony power, as current or potential employees can find employment in alternative occupations in the private sector. Moreover, a model is presented in this paper that indicates that the existence of persistent vacancy rates for a class of employees is compatible with there being a greater number of applicants than there are positions, at a wage rate that is predetermined either through a legislative process or collective bargaining. In particular, if applicants vary in quality, then under certain conditions a rational

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Research was partially supported by a grant from the Manpower Administration, U.S. Department of Labor. I am grateful to Richard Kihlstrom and a referee for their comments on an earlier version.
government employer will choose to employ fewer employees than his assumed predetermined authorized employment level. That is, the employer will choose an optimal equilibrium positive vacancy rate.

As might be expected a priori, the vacancy rate that results from our model is a function both of the "value" of the public service to the community and the cost of public employees. However, contrary to the implications of the textbook monopsony model, it is shown that increasing the wage rates of public employees may actually increase rather than decrease observed vacancy rates. Thus, on the theoretical level, it is not at all clear that increasing the wages of public employees (relative to those in the private sector) is the appropriate way to reduce urban government manpower shortages.

After developing the model in the next section, we apply it in an attempt to explain variations in vacancy rates across police departments for a sample of over 400 United States cities in 1967. Preliminary evidence on the wage-vacancy relationship is obtained, and it appears that empirically one can also not conclude that increasing the wages of public employees would help to reduce manpower shortages in urban governments.

II. A Model of Equilibrium Job Vacancies

We assume that either through a political process or by some other means a governmental agency is allocated an authorized employment level and, abstracting from the internal wage structure, informed of the fixed wage rate per employee that they can pay. At this exogenously determined wage, the agency is assumed to attract more potential applicants than it has authorized vacant positions. Suppose the quality level of applicants varies, and the recruitment division must accept or reject each applicant as he presents himself, rather than cumulating all applicants and then selecting the best. Given a stochastic distribution of applicants by quality, one approach that the decision makers can follow is to choose a set of minimum hiring standards or a minimum acceptable quality level, so as to maximize the expected net gain to society. Implicitly and rationally, this approach may create an expected positive number of vacancies.

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3 The analysis presented below draws heavily on the methodology used by Mortensen (1970) and several papers in the Phelps (1970) volume.

4 This type of approach seems to be quite similar to that which is often followed by government agencies. For example, consider the situation in which all applicants who achieve above a specified minimum score on an examination are placed on an "appointment list" with the order of appointments to be based upon test scores. A persistent positive queue of acceptable applicants can be thought of as negative "vacancies" in this context. Note also that an implication of this approach is that publicized minimum standards may discourage some applicants from applying; consequently, the observed number of applicants is not a good measure of the potential number of applicants that the agency faces at the specified wage rate.
More specifically, we consider for simplicity a single-period model in which labor turnover is ignored. We also ignore the possibility of altering the quality distribution of applicants either by recruiting expenditures or by training expenditures once an applicant is employed. Let $W$ and $E$ denote, respectively, the specified wage rate and authorized employment level given from the political process, and let $P$ denote the value per unit of the public service to society.

Applicants are assumed to be heterogeneous with $q_i$ (where $0 \leq q_i \leq 1$) being the service flow from the $i$th applicant. Although the quality of each applicant can be ascertained with certainty once he presents himself, the flow of applicants to the recruiting office is a random variable with distribution $f(q)$. Given this situation, suppose $q^*$ is designated as the minimum acceptable quality level. That is, all applicants exceeding this minimum hiring standard will be employed; all others will be rejected. Then the expected quality of an accepted applicant is given by $A(q^*)$, where

\[
A(q^*) = \frac{\int_{q^*}^{1} q f(q) \, dq}{\int_{q^*}^{1} f(q) \, dq} \quad \text{and} \quad A'(q^*) > 0. \tag{1}
\]

Let $M$ be the total number of applicants to the agency. This number is assumed to be greater than the number of available positions, assumed here to be the entire authorized employment level ($E$). The probability that any one of these applicants meets the minimum quality standard $q^*$ is then

\[
n(q^*) = \int_{q^*}^{1} f(q). \tag{2}
\]

The number of applicants who satisfy this standard, $X$, is thus a random variable distributed binomially with expectation $n(q^*)M$. Let $B(X, n, M)$ denote the relevant binomial probability density function.\(^5\) Then the number actually employed, $Y$, is a random variable such that

\[
y = \begin{cases} 
X, & \text{if } X \leq E, \\
E, & \text{if } X > E. 
\end{cases} \tag{3}
\]

The agency’s expected employment level, $N$, is therefore given by

\[
N = \sum_{0}^{E} XB[X, n(q^*), M] + E \left[ 1 - \sum_{0}^{E} B[X, n(q^*), M] \right]. \tag{4}
\]

An increase in the minimum acceptable quality level, $q^*$, obviously decreases the probability $n(q^*)$ that any applicant will meet the standard. Crucially one can show that a decrease in this probability leads to a

\(^5\) Where $B(X, n, M) = \binom{M}{X} n^X (1 - n)^{M - X}$. 
decrease in the expected employment level.\textsuperscript{6} Hence, increases in the minimum acceptable quality level cause expected employment to decrease:

\[ N'(q^*) < 0. \tag{5} \]

The expected value of the net gain to society from employing the particular class of public employees is given by

\[ G = PA(q^*)N(q^*) + VW[E - N(q^*)]. \tag{6} \]

The first term represents the expected value of the public service, the expected number of "quality units" of public employees \([A(q^*)N(q^*)]\) multiplied by the value per unit. The second term represents the value to society of funds that can be utilized elsewhere because all of the agency's authorized positions are not filled. This is equal to the expected number of vacant positions \((E - N)\) multiplied by the wage cost per man and the value to society of a dollar spent in alternative uses \((V)\). Note that equation (6) can be rewritten

\[ G = [PA(q^*) - WV]N(q^*) + WVE. \tag{6a} \]

With the equation rewritten in this manner, it is clear that the term in brackets represents the expected net value to society of each employee that the agency hires. Consequently, in order for any employees to be hired, the term in brackets must be positive for some value of \(q^*\).

If we assume that an interior solution exists, the first-order necessary condition to maximize equation (6a) requires that the minimum acceptable quality level be chosen to satisfy

\[ [PA(q^*) - WV]N'(q^*) + PA'(q^*)N(q^*) = 0. \tag{7} \]

The interpretation of this condition is straightforward. An increase in the minimum acceptable quality level increases the expected quality level, and hence the expected net value of the service flow per man of those applicants accepted. On the other hand, it results in a decrease in the expected number of acceptable applicants. The agency must choose the minimum quality level such that the net impact of these two effects is to maximize the expected value of the net gain to society.

Totally differentiating equation (7) and making use of the second-order necessary condition for equation (7) to have yielded a local maximum, we find that\textsuperscript{7}

\[ \frac{\partial q^*}{\partial W} > 0, \quad \frac{\partial q^*}{\partial P} < 0, \quad \frac{\partial q^*}{\partial V} > 0. \tag{8} \]

\textsuperscript{6} A formal proof of this proposition is available on request. I am indebted to Richard Kihlstrom for helping to construct the proof.

\textsuperscript{7} The second-order necessary condition is that \(B(q^*) = [PA(q^*) - WV]N''(q^*) + 2PA'(q^*)N'(q^*) + PA''(q^*)N(q) < 0.\) Furthermore, \(\frac{\partial q^*}{\partial W} = VN'(q^*)/B(q^*) > 0,\) \(\frac{\partial q^*}{\partial P} = -A(q^*)N'(q^*)/B(q^*) < 0,\) \(\frac{\partial q^*}{\partial V} = WN'(q^*)/B(q^*) > 0.\)
That is, an increase in the wage cost of public employees or the value of funds in alternative uses, *ceteris paribus*, leads to increases in the minimum acceptable quality level, while an increase in the value per unit of the public service leads to a decrease. The rationale for these effects should be obvious and need not be discussed here.

The minimum acceptable quality level is not directly observable. In practice it may consist of a vector of hiring standards such as educational requirements, physical and mental health characteristics, test scores, and residence requirements. Note, however, that the agency’s expected vacancy rate is given by

$$VR = 1 - \left(\frac{N}{E}\right).$$  \hspace{1cm} (9)

Differentiating equation (8) with respect to each parameter then yields directly \[since \ N'(q^*) < 0\]:

$$\frac{\partial VR}{\partial W} > 0, \quad \frac{\partial VR}{\partial P} < 0, \quad \frac{\partial VR}{\partial V} > 0. \hspace{1cm} (10)$$

An increase in the wage cost of public employees or the value of funds in alternative uses and a decrease in the value per unit of the public service all lead to an increase in the expected vacancy rate. Crucially, then, increasing the wages of public employees to reduce the number of vacancies would be a self-defeating policy.

If the government agency does have monopsony power in the market for its potential employees, this conclusion must, of course, be modified. In the context of our model, monopsony power reflects either the number of applicants to the agency increasing or the quality distribution of the applicants shifting upward in response to a *ceteris paribus* increase in the agency wage. While the net impact of these two effects may be to decrease the expected vacancy rate when the agency wage increases, a priori there is no reason to conclude that the net impact of these effects plus the previously discussed one would be negative. Hence, until empirical evidence is presented on the net relationship between public employees’ wages and vacancy rates, there should be no presumption that increasing the wages of public employees would prove to be an effective method of reducing the number of job vacancies in public sector agencies.

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8 Throughout, we continue to assume that the wage rate is predetermined and is not necessarily equal to that wage which a profit-maximizing monopsonist would choose. Thus it remains meaningful to speak of increasing the wage rate.

The quality distribution of applicants could shift, without the number of applicants changing, if the increase in high-quality applicants is offset by a decrease in the number of previously low-quality applicants. The latter group may withdraw from potential applicant status when they observe the higher minimum standards that accompany an increase in the wage rate.
III. Empirical Analysis

This section presents preliminary evidence on the public employee wage-vacancy relationship as we apply the model of the previous section in an attempt to explain variations in vacancy rates across police departments for a sample of over 400 United States cities in 1967.\(^9\) Table 1 presents the results of regressions in which two measures of the department vacancy rate were regressed on several alternative measures of the wage costs of police, a measure of the frequency of recruitment, and several sociodemographic variables designed to act as proxy variables for the values to the community of police services and of funds in alternative uses. The sociodemographic variables are included primarily as control variables. Since in most cases they would be expected to have similar impacts on the value of police protection and the value of other services (e.g., fire protection), we cannot a priori predict the signs that their coefficients should have.\(^10\) Given the crude nature of the data, the results presented here should also be considered only suggestive.

Equations (1)–(4) utilize as a dependent variable \(V1\), a dichotomous variable that takes on the value of unity if the police department is below authorized strength, and zero otherwise.\(^11\) Inasmuch as some vacancies are caused by disequilibrium phenomena and some are caused by positions being authorized but not funded, it is not surprising that the explanatory power of the estimated equations is quite low (with \(R^2\) less than .1 in all cases). Nevertheless, the calculated \(F\)-statistics indicate that statistically significant relationships exist between the dependent and independent variables. Furthermore, regardless of whether we use as the measure of wage costs the police patrolmen’s entrance salary \((W1)\), average annual earnings of police department employees \((W2)\), or the analogous variables adjusted for city price level differences \((W3\) and \(W4)\), we observe a significant positive relationship between the vacancy dummy variable

\(^9\) The sample consists of 419 cities with population greater than 25,000, for which police department vacancy data were reported in the 1967 Municipal Year Book. Over 75 percent of the cities in the sample reported that their police departments were below authorized strength, with the mean vacancy rate across all of the cities being over 5 percent.

\(^10\) The city crime index might appear to be a good proxy for the value of police services. However, this may be simultaneously determined with the police vacancy rate, and the accuracy of crime reporting varies widely across cities.

\(^11\) The customary disclaimers that: (a) the qualitative nature of the dependent variable implies that the disturbances will be heteroskedastic, and hence the estimates are not minimum-variance estimates; (b) the predicted values of the dependent variable may fall outside the \((0, 1)\) range; and (c) the disturbances are nonnormal, hence the significance tests should be considered only as heuristic tests, are all applicable here. In addition to the results present below, regressions in which all variables were in linear form were also estimated, and the results differ only marginally from those reported in the paper.
<table>
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<th>Dependent Variable</th>
<th>W1</th>
<th>W2</th>
<th>W3</th>
<th>W4</th>
<th>X1</th>
<th>X2</th>
<th>X3</th>
<th>X4</th>
<th>X5</th>
<th>X6</th>
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Note.—Where (all variables are in logarithm form except V1, V2, and X1), V1: equals one if police department is below authorized strength, zero otherwise; V2: police department vacancy rate; W1: police patrolmen annual entrance salary; W2: police department employees' average annual earnings; W3: police patrolmen annual entrance salary (in real terms); W4: police department employees' average annual earnings (in real terms); X1: frequency of recruitment (one if continuous, zero otherwise); X2: 1960 population density; X3: 1960 nonwhite proportion of the population; X4: 1960 median education level; X5: 1960 proportion of the population with less than 5 years education; X6: 1960 proportion of the population with family income less than $3,000; X7: 1960 proportion of owner-occupied dwellings; and X8: 1960 median value of owner-occupied dwellings (in real terms when used in conjunction with W3 and W4).
and police wage costs.\textsuperscript{12} \textit{Ceteris paribus}, the higher the wage, the greater the probability that the police department will have vacancies.

Equations (5)–(8) utilize $V2$, the actual police department vacancy rate, as the dependent variable.\textsuperscript{13} In contrast to the results above, here we observe either a negative relationship between the wage level and vacancy rate ($W1$ and $W3$) or an insignificant positive one ($W2$ and $W4$). Given the contradictory nature of the two sets of results, it is clear that one should not claim that the available evidence indicates that increasing police employees' wages would unambiguously reduce police department vacancy rates.\textsuperscript{14}

IV. Conclusion

This paper has presented an alternative explanation, based upon a stochastic quality distribution of applicants, for the existence of job vacancies or shortages among public employees. Contrary to the implication derived from the textbook monopsony model, increasing the wages of public employees, a priori, would not necessarily prove to be an effective means of reducing these shortages. Empirical estimation of the relationship between police wages and police department vacancies in 1967 for a sample of 419 United States cities lends support to this conclusion.

References


\textsuperscript{12} The money wage variables were adjusted for city price level differences using an estimated city price level variable, developed by the author, that is based upon the Bureau of Labor Statistics Indexes of Comparative Living Costs for 44 metropolitan and nonmetropolitan areas (U.S., Bureau of Labor Statistics, 1970). Details of the variable's construction are available from the author.

\textsuperscript{13} In addition, equations (5)–(8) were estimated for the subset of cities with positive vacancy rates to avoid potential biases due to the significant number of zero vacancy observations (Goldberger 1964, p. 252). The results, however, were virtually identical with those reported in the text. Equations (5)–(8) were also reestimated using a dependent variable which assumed that all police department vacancies occur among uniformed employees, i.e., an estimate of the vacancy rate among uniformed employees. Again the results were virtually identical with those reported.

\textsuperscript{14} For brevity, since they are not our central concern, we have omitted all discussion of the coefficients of the nonwage variables. In any case, most do not have unambiguous interpretations.


