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JOB VACANCY RATES IN THE FIRM: AN EMPIRICAL ANALYSIS

Harry J. Holzer

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ABSTRACT

In this paper I present some evidence on the magnitudes and determinants of job vacancy rates at the firm level. The data are from a survey of firms in 1980 and 1982, as well as from 1980 Census data on industry and local area characteristics.

The results show that overall job vacancy rates are low but there is substantial variation across firms, occupations, industries, and local areas. Unemployment rates, either local or aggregate, have negative effects on vacancy rates while average industry skill levels have positive effects, thus indicating the importance of the firm's demand for skills. Large and/or unionized firms have relatively low vacancy rates, which also account for the low vacancy rates of high-wage firms; and firms with high turnover and recent sales growth have higher vacancy rates. Thus, a variety of market conditions and firm characteristics influence vacancy rates at the firm level.

Harry J. Holzer
Department of Economics
Michigan State University
101 Marshall Hall
East Lansing, MI 48824

I. Introduction

Job vacancy rates play an increasingly important role in recent analyses of labor markets and unemployment. At the theoretical level, various models of the "job-matching" process analyze the flows of workers into and out of vacant jobs as the key to understanding aggregate unemployment dynamics.[1] At the empirical level, vacancy rates have been used in attempts to distinguish frictional or structural types of unemployment from the "deficient-demand" type.[2]

Despite this growing importance, there has been a notable lack of work on vacancy rates below the aggregate level. Most empirical analyses have used time-series data on actual vacancies (in many OECD countries) or on the "Help-Wanted Index" (in the U.S.). Even the few efforts involving vacancy data at the state or regional level (e.g., Medoff (1983), Abraham (1983)) have primarily involved time-series variation in these data rather than cross-sectional analysis.[3] Micro-level analysis of job vacancy rates - i.e., at the level of the firm - has been virtually nonexistent to date, given the general lack of available data at this level. This, of course, stands in sharp contrast to the very large body of micro-level empirical work on worker unemployment and job search in the last few decades.[4]

Yet the need for and potential usefulness of micro-level vacancy analysis is also quite clear. Aggregate data give us very little insight into the characteristics of jobs and/or firms that are associated with "structural" problems in hiring. Mismatches between skill requirements of jobs and skill levels of workers, wage and recruitment activities by firms, overall labor availability, as well as other factors should help to determine the extent to which high vacancy rates plague firms in the U.S. As aggregate labor markets

have tightened, and as shortages of particular kinds of skilled labor continue to be felt, it has become increasingly important to quantify the extent to which various structural and behavioral factors are associated with hiring difficulties for firms.[5] Indeed, a variety of alternative policy responses (such as targetted education and training, relocation assistance, immigration policy, etc.) clearly require better understanding of these factors before being implemented. But little strong evidence has appeared to date on any of these issues.

In this paper, I present some evidence on the magnitudes and determinants of job vacancy rates at the firm level. The source of the data is the Employment Opportunity Pilot Project (EOPP) Surveys of Firms in 1980 and 1982. Approximately 3400 firms in 28 sites were interviewed twice as part of this survey, which provides us with data on a variety of worker and firm characteristics in addition to job vacancy rates.[6]

After briefly reviewing various models of job vacancy determination, more detailed characteristics of the data, and estimation issues, I present summary statistics on job vacancy rates for 1980 and 1982. These two dates represent quite different points in the aggregate business cycle, and thus enable us to see how the business cycle affects vacancy rate formation. Summary data on vacancy rates by industry and by occupation are also presented (the latter are for 1980 only, since they are not available in the data for 1982).

I then present the results of various estimated equations for vacancy rates. A two-stage Tobit procedure is used for the estimation, so that we obtain separate estimates for the probabilities of firms having vacancies and for their conditional values, where they are nonzero.

A variety of firm, industry and local labor market characteristics are used as determinants of vacancy rates in these equations. Some equations are strictly "reduced-form" in nature, while others recognize the simultaneous relationship between job vacancies and firm choices of wage levels and thus use an instrumented firm-level wage variable. Overall vacancy rate equations for firms are estimated separately for 1980 and 1982.

The main findings of the empirical analysis can be summarized as follows:

1) While overall job vacancy rates appear to be quite low, there is substantial variation across firms in these rates. There is also substantial variation across occupations, industries, local areas and over the business cycle.

2) The skill requirements of jobs generally have significant positive effects on vacancy rates. In particular, higher average occupational compositions of industries are associated with higher vacancy rates. Regarding local labor supply, we find that unemployment rates are associated with lower vacancy rates.

3) Unionized and/or large firms have generally have lower vacancy rates than do other firms, though the effects vary with the business cycle and with the particular measure of vacancy rates used (i.e., probabilities of nonzero vacancies v. conditional means for firms with nonzero vacancies). Unionism and firm size also appear to account for the negative effects of firms' wage levels (as well as their recruiting activity and job applicants) on vacancy rates.

4) Firms with high turnover and recent sales/employment growth have higher vacancy rates than do other firms, which imply higher vacancy

frequencies. However, these characteristics do not appear to account for the effects of unionism and firm size noted above. The latter therefore appear to have effects on vacancy durations as well as vacancy frequencies.

II. Vacancy Rates in the Labor Market and the Firm

Models of job vacancies traditionally have focused on their joint determination with unemployment rates at the level of the overall labor market. Early work in this mode included papers by Lipsey (1960), Holt and David (1966), and Hansen (1970); more recent work in the "job matching" context by Pissarides (1985), Blanchard and Diamond (1989), and others (see Footnote 1) expands on this tradition.

Generally, these models posit that a "matching function" exists for the filling of vacant jobs with unemployed workers. These outflows from the stocks of vacancies (and unemployment) are compared with inflows from job turnover in the determination of vacancy levels over time:

$$1)\quad dV/dt = qE - f(U,V,Z) \qquad f_1,\ f_2,\ f_3 > 0$$

where E, U, and V represent employment, unemployment, and job vacancies respectively; q represents the turnover rate; f represents the matching function (often assumed to be Cobb-Douglas in the literature); and Z represents all variables which influence the matching technology. The Z would presumably include measures of "mismatch" between available jobs and workers (such as differences in education, occupations, industries, and geographic locations); measures of search effort by firms and workers; and any other characteristics of each that would enhance job matching probabilities.

In steady-state, inflows into vacancies equal outflows and a locus of unemployment and vacancy combinations is determined. For given values of q and Z, an inverse relationship between unemployment and vacancies exists in steady-state which is generally referred to as the "Beveridge Curve". Exogenous "cyclical" shifts in labor demand generate inversely-related changes in the values of U and V until a new steady-state is determined; while "structural" shifts are reflected in changes in the values of q and Z which shift the steady-state locus and generate positively-related changes in U and V.[7]

We can easily solve the steady-state version of Equation 1) for the level of vacancies as follows:

2) $V=g(U,Z,qE)$ $\qquad V_1<0,\ V_2>0,\ V_3>0$

We note that the vacancy rate (i.e., $v=V/V+E$) will reflect both the frequency of vacancy formation as well as duration of vacancy spells. Under steady-state conditions, the frequency of vacancy formation is determined only by the turnover rate, while in non-steady-state conditions this frequency would reflect changes in desired net employment as well. Vacancy durations will generally reflect the available pool of unemployed workers as well as the efficiency of the matching technology - i.e., U and Z.[8] Any characteristics or activities by workers and firms which enhance the matching process are likely to affect these durations.[9]

We also note that wage determination does not appear explicitly in this process. In some recent models, wages are only an outcome of the matching process that is determined by Nash bargaining between matched workers and firms; in other cases (e.g., Jackman et. al. (1984), Albrecht and Axell (1984)), wages are chosen by the firm in order to influence the expected

vacancy duration.[10] In the latter cases, wages are comparable to recruiting activity by the firm and might thus be included in the Z vector of variables.

While these models have generally been applied only at the level of the overall labor market, they can quite easily be adapted to the analysis of firm-level vacancy rates as well. In this case, Equation 2) would represent a firm with steady-state employment that has vacancies generated only by turnover, while desired net employment growth would also contribute to the frequency of vacancies in non-steady-state conditions.

Local unemployment would now be an exogenous determinant of vacancy durations, as would be relevant characteristics of the local labor force (e.g., skill levels, search effort, etc.). Characteristics of the firm or its industry that determine its skill requirements and/or its ability to generate job applicants, such as unionism or firm size, would also be exogenous variables affecting vacancy duration. Since these and other factors also help to determine a firm's wage premium (for a given level of skill) and its recruiting activity, their importance is this analysis is underscored. Determinants of vacancy frequencies, such as turnover or desired employment growth, would be relevant as well in an analysis of firm-level vacancies.

III. Data and Summary Results

The local market and industry variables used in the analysis below will include dummies as well as specific characteristics: unemployment rates and average education levels for the former, average occupational composition for the latter. In particular, we use an index of occupational composition for each 2-digit industry as the latter variable.[11] All industry and local market

characteristics are taken from the 1980 Census of Population and merged with the firm-level data by industry and local area.[12]

As noted above, the firm data themselves are from the EOPP Surveys of Firms in 1980 and 1982. Job vacancies that were "available for immediate occupancy" at the time of the survey were listed for the entire firm in 1982 and by occupation in 1980.[13] Vacancy rates are thus defined as the fraction of vacancies out of total jobs in the firm, where the latter is the sum of current employment and vacancies.

Several measures are included here for the relevant characteristics of the firm. These include fraction of the firm's work force unionized and firm size, which are likely to influence a firms's vacancy rate through a variety of mechanisms - e.g., its wage and recruiting activity, the numbers of job applicants it receives, its turnover rates or desired net employment growth, etc.

As for these latter variables, we measure job turnover as the fraction of employees who either quit or were discharged during a period prior to the survey - the last three months of 1979 in the 1980 equation, and the year 1981 in the 1982 equation. These were the only dates for which such data were available in the survey, and their use clearly requires the strong assumption that these measures reflect steady-state turnover.[14] We also have measures of real sales growth and employment growth at the firm between 1979 and 1981 in some equations for 1980 to measure desired net employment growth in the firm. If anything, the former is likely to be measured with less error than the latter.[15] However, neither seemed appropriate for the 1982 equation, given their timing and changing business cycle conditions in that year. An alternative measure for the determinants of vacancy frequency is the gross

hiring rate, thus encompassing both turnover and desired net growth. These measures also are available for the last three months of 1979 and the year 1981, and are used in various specifications of the 1980 and 1982 vacancy rate equations.

We also provide estimates of the effects of starting wages (as well as total hours of recruitment per recruiting period, and number of applicants) on vacancy rates in 1980 and 1982.[16] These variables are, however, only available for the "last worker hired" by the firm on or before August 1981. They also might be viewed as being endogenous with respect to the firm's vacancy rates. We therefore use instrumented versions of these variables based on specific firm-wide characteristics (e.g., industry, unionism, and firm size) in these equations. Various specifications for these instruments are provided, and the appropriateness of the exclusion restriction in each case are discussed.

Table 1 presents means and standard deviations (as well as sample sizes) for firm-level vacancy rates. The results appear for overall vacancy rates in 1980 and 1982, as well as for specific occupational groups in 1980. Vacancy rates here (and in all equations below) are defined as the log of (1 + the vacancy rate) of the firm. Both unweighted and weighted (by firm size) results are presented, since the latter represent means across jobs rather than firms.

The results show vacancy rates that are quite low relative to unemployment rates. In 1980, when aggregate unemployment averaged about 7.0%, the aggregate (weighted) vacancy rate is 1.5%. For 1982, when the aggregate economy was at the trough of a recession, vacancy rates are even lower.[17] These results are quite consistent with those of Abraham (1983), who notes that vacancy rate magnitudes are substantially lower than those of

Table 1

Vacancy Rates, 1980 and 1982: Means and Standard Deviations

	Unweighted		Weighted		
Vacancy Rates:	Mean	Std. D.	Mean	Std. D	N
1980, All workers	.016	.060	.015	.031	1940
1982, All workers	.012	.044	.008	.024	1940
1980, By Occupation					
Sales	.011	.052	.010	.041	1022
Laborers/Service	.012	.052	.011	.032	1434
Crafts	.016	.060	.016	.051	1229
Operations	.008	.042	.008	.021	1017
Clericals	.004	.026	.009	.022	1813
1980, By Industry					
Minimg	.006	.023	.012	.016	32
Construction	.020	.078	.007	.040	142
Durable Manufacturing	.016	.051	.006	.022	140
Non-Durable Manufacturing	.008	.032	.004	.015	115
TCU	.006	.018	.006	.013	73
Wholesale Trade	.016	.057	.011	.031	152
Retail Trade	.014	.054	.010	.033	657
FIR	.013	.067	.011	.018	130
Services	.020	.072	.016	.039	500

Table 1 (cont'd)

	Unweighted		Weighted		
	Mean	Std. D.	Mean	Std. D.	N
1982, By Industry					
Mining	.004	.010	.015	.017	32
Construction	.025	.078	.015	.051	142
Durable Manufacturing	.009	.027	.006	.020	140
Non-Durable Manufacturing	.004	.015	.004	.013	115
TCU	.009	.042	.005	.019	73
Wholesale Trade	.010	.033	.007	.020	152
Retail Trade	.012	.040	.007	.023	657
FIR	.013	.058	.006	.018	130
Services	.013	.046	.013	.026	500

NOTE: Vacancy Rates are measured as log(1+vacancy rate). Means are weighted by number of jobs (firm-wide or occupation-specific). The vacancy rate for all workers in 1980 does not include professional and managerial employees.

unemployment rates over the entire business cycle. The procyclical movement in these rates is, of course, consistent with the implications of virtually all models of matching and the "Beveridge Curve".

Despite the low mean vacancy rate, we note very substantial variation across firms in these rates. Coefficients of variation generally range from 2 to 4 when the sample is weighted. We also note quite substantial variation across occupational categories in mean vacancy rates, which is somewhat greater than that seen in previous work (e.g., Abraham (1987)).[18] In both weighted and unweighted samples, vacancy rates are highest among craft occupations and are lowest among operatives or clericals. The result for crafts suggests a possible role for skill requirements as a determinant of vacancy rate differentials across occupations.

Before moving on, we note that weighting by firm size tends to slightly lower mean vacancy rates in most cases and to substantially lower estimated variation across firms. Since the firms included in the survey do not represent a strictly random sample (see Footnote 6), we also note that sample weights are available in the data here. Their use along with size-weighting (which creates random samples of jobs <u>within</u> sites but not overall) produces similar results to those presented here.[19]

The means by industry also show substantial variation. In general, we find higher vacancy rates in the trade and service sector than in "traditional industries" such as manufacturing and utilities. Weighting by firm size again tends to reduce vacancy rates within most industries as the economy moves in to the recession of 1982.

Some further descriptive evidence on job vacancies appears in Table 2, where we present the frequencies on the number of vacancies reported by firm

size categories in each year. We also present the fraction of firms reporting at least some vacancies, the conditional mean number of vacancies and vacancy rates for such firms, and the mean rate for all firms in each size category in each year.

Several striking findings appear in Table 2. We note that the vast majority of firms, regardless of size, report no vacancies at all; and when they do, they report very few. The fraction reporting at least one vacancy rises with firm size, as does the conditional mean number of vacancies. But the rise in the latter number is far slower than that in average firm size across these categories. Hence, we find that conditional mean vacancy rates decline monotonically with firm size; and even unconditional means on this variable decline quite consistently with size.

What might account for these conflicting effects of firm size on job vacancies? Indivisibilities in individual vacancies, along with the relative rarity with which vacancies are observed at all firms, could easily generate the observed pattern. The more jobs that exist at a firm, the more likely that at least one of them is vacant; but when vacancies do occur at smaller firms, they will account for larger fractions of jobs there.

But there may also be more substantive reasons for the observed relationships. Larger firms are more likely to have personnel (or human resource) departments that list formal job definitions and vacancies than are smaller ones, thus diminishing ambiguity over the concept of a vacancy in the more structured institutional environments of the former.[20] On the other hand, the relatively high wages and large applicant flows received by these firms (Brown and Medoff, 1989; Holzer, Katz, and Krueger, 1991) should also mean

Table 2

Vacancy Frequencies and Rates
by Firm Size, 1980 and 1982

1980

Cross-Tabulations of Firms:

	Size →	1-5	6-10	11-20	21-40	41-60	61+
No. of Vacancies →	0	414	328	301	262	129	230
	1	19	21	14	19	2	33
	2	5	9	7	14	4	22
	3	3	2	4	6	3	10
	4	0	1	1	2	5	12
	5	1	2	2	4	2	10
	≥ 6	1	0	5	5	1	24
Fraction Reporting Vacancies > 0		.065	.096	.099	.160	.116	.326
Mean Number of Vacancies for Those with > 0		1.140	1.686	3.364	2.680	3.235	4.465
Mean Vacancy Rate, for Those with > 0		.338	.177	.162	.088	.069	.028
Mean Vacancy Rate, Overall		.022	.017	.016	.014	.008	.009

1982

Cross-Tabulations of Firms:

	Size →	1-5	6-10	11-20	21-40	41-60	61+
No. of Vacancies →	0	402	351	288	259	112	218
	1	20	26	31	39	17	42
	2	4	7	15	10	5	28
	3	0	3	1	4	5	15
	4	1	0	2	1	2	5
	5	0	0	0	2	0	2
	≥ 6	0	0	1	0	2	21
Fraction Reporting Vacancies > 0		.059	.093	.148	.178	.217	.341
Mean Number of Vacancies for Those with > 0		1.271	1.366	1.662	1.517	2.000	4.935
Mean Vacancy Rate, for Those > 0		.271	.151	.101	.051	.037	.021
Mean Vacancy Rate, Overall		.016	.014	.015	.009	.008	.007

shorter durations once vacancies are listed. Lower turnover rates may mean lower vacancy frequencies as well.

In any event, the rarity with which vacancies are reported and their conflicting relationships with firm size must both be kept in mind as the determinants of job vacancy rates more generally are estimated below.

IV. Estimates of Vacancy Equations

Given the inability of firms to have negative vacancies, and given the very large fraction of firms which have vacancy rates at the lower limit of zero, it is clear that estimated equations must be of the Tobit form. On the other hand, the data described in Table 2 clearly imply that firm size (and perhaps other variables as well) have very different effects on the probability of being above the lower limit and on the expected value of vacancy rates, conditional on being above the limit.

We therefore estimate these effects separately, using a two-stage Tobit procedure analyzed by Cragg (1971). This model is estimated as follows:

$$3)\quad P(v_i > 0) = \Phi\left(\sum_j \beta_{1j} X_{ij}\right)$$

$$4)\quad v_i \mid v_i > 0 = \sum_j \beta_{2j} X_{ij} + \epsilon_{2i}$$

where i denotes firm and j denotes explanatory variables.

The first equation above is estimated through a Probit model and the second one represents a truncated regression. When $\beta_{1j} = \beta_{2j}$ for all j, the model reduces to a standard Tobit.

Furthermore, the partial effect of any characteristic X_j on overall vacancy rates can be computed as follows:

$$5) \quad \frac{\partial v}{\partial X_j} = \frac{\partial (P(v > 0) * E(v|v > 0))}{\partial X_j} = \beta_{1j} * \phi(\Sigma_j \beta_{1j} X_j) * E(v|v > 0) + \beta_{2j} * P(v > 0)$$

where ϕ represents the normal density function. Probit coefficients are thus converted into partial derivatives before being used along with truncated regression coefficients to compute their joint effects on vacancy rates.

Quite clearly, the effects of any characteristic X_j on overall vacancy rates can occur through either or both of the above channels. All tables below thus present the β_{1j} and β_{2j} as well as their joint effects on vacancy rates for a variety of X_j.

Before proceeding, we must note that some difficulties were encountered in estimating certain specfications of the trucated regressions below. Some equations had difficulty converging, while others were plagued repeatedly by singularity in the data matrix. For this reason, there will be some asymmetries below in terms of which equations are presented between 1980 and 1982 and within each year. Nevertheless, the results presented below appear to be robust and will be described more completely below.

Proceeding now to the results, Table 3 presents estimated coefficients and their joint effects on vacancy rates for a variety of firm-specific characteristics. These include: fraction of employees belonging to unions and firm size; the turnover rate and recent sales growth rate (the latter only for 1980) of the firm; and the recent gross hiring rate. Means and standard deviations on these variables appear in Table A of the Appendix below.

Table 3

Vacancy Rate Equations:
Effects of Firm-Specific Characteristics

A. 1980 Results

	Probits				Truncated Regs.				Joint Effects			
	1	2	3	4	1	2	3	4	1	2	3	4
Constant	-1.900 (.091)	-2.054 (.096)	-1.971 (.116)	-2.065 (.097)	.487 (.022)	.387 (.019)	.430 (.024)	.456 (.026)	.087	-.024	.016	.022
Fraction Union	-.317 (.132)	-.247 (.134)	-.253 (.142)	-.298 (.133)	-.005 (.045)	.040 (.034)	.017 (.038)	.083 (.039)	-.009	-.002	-.004	.000
Firm Size	.281 (.027)	.275 (.027)	.273 (.028)	.277 (.027)	-.142 (.010)	-.103 (.007)	-.110 (.008)	-.126 (.010)	-.183	-.078	-.101	-.142
Turnover	-	2.268 (.335)	2.272 (.339)	-	-	.143 (.055)	.135 (.059)	-	-	.056	.056	-
Hiring Rate	-	-	-	1.721 (.277)	-	-	-	.226 (.055)	-	-	-	.067
Sales Growth	-	.280 (.175)	.293 (.178)	-	-	.047 (.032)	.059 (.033)	-	-	.001	.001	-
Industry Dummies	no	no	yes	yes	no	no	yes	yes	-	-	-	-
- Log L	737.1	713.9	711.4	718.4	481.9	469.04	481.9	375.9	-	-	-	-

Table 3 (cont'd)

B. 1982 Results

	Probits				Truncated Regs.				Joint Effects			
	1	2	3	4	1	2	3	4	1	2	3	4
Constant	-1.957 (.092)	-2.048 (.097)	-2.174 (.103)	-2.023 (.118)	.344 (.013)	.327 (.014)	.312 (.014)	.349 (.017)	-.087	-.123	-.166	-.096
Fraction Union	-.533 (.138)	-.467 (.139)	-.415 (.141)	-.437 (.148)	.010 (.024)	.040 (.023)	.045 (.023)	-.014 (.024)	-.011	-.006	-.004	-.011
Firm Size	.331 (.028)	.318 (.028)	.332 (.028)	.336 (.029)	-.093 (.005)	-.088 (.005)	-.097 (.005)	-.087 (.005)	.004	.007	-.007	.021
Turnover	-	-	.913 (.164)	-	-	-	.059 (.020)	-	-	-	.065	-
Hiring Rate		.727 (.230)	-	.654 (.233)	-	.020 (.035)	-	.009 (.034)	-	.035	-	.031
Industry Dummies	no	no	no	yes	no	no	no	yes	-	-	-	-
Log L	776.7	771.8	761.6	765.3	678.20	670.8	672.2	670.7	-	-	-	-

NOTE: Firm size, turnover, and hiring all appear in log form, while union is in percentage points. The dependent variable is defined as log(1+ vacancy rate), while sales growth is similarly defined. Sample size for this (and the following table) is 1941. All numbers appearing in parentheses are standard errors.

The gross hiring rate, which largely determines vacancy frequencies, is likely to reflect both turnover and sales growth (where the latter reflects desired net employment growth); and all of these variables could be affected by unionism or firm size (due to both their wage and nonwage effects). We therefore present several specifications of each equation, in which unionism and firm size either appear alone or jointly with hiring rates or their determinants. Firm size, turnover, and hiring rates all appear in log form, while vacancy and sales growth appear as the log of (1 + the rate). Estimates appear both with and without industry dummies, and they appear for 1980 in part A and 1982 for part B of the table.

The results of Table 3 show different effects of some characteristics on probabilities of nonzero vacancy rates and on their conditional values. For 1980, we find significant negative effects of unionism on vacancy rate probabilities but not on their conditional values. Consistent with what we observed in Table 2, we find very significant positive and negative effects of firm size on vacancy probabilities and conditional values respectively. The magnitudes of these effects are somewhat reduced but by no means eliminated when turnover and hiring measures are included, thus indicating that unionism and firm size influence vacancies through their durations as well as their frequencies. Whether these effects occur via the wage mechanism or some other is discussed below.

We also find significant positive effects of turnover and hiring rates on both vacancy probabilities and conditional values. Sales growth effects are also positive and marginally significant. The inclusion of 1-digit industry dummies has very little effect on any coefficient, thus indicating that these results are largely within-industry effects.

The joint partial effects reveal that unionism and firm size lower overall vacancy rates while turnover and hiring raise them. The magnitudes of these effects suggest that a one standard-deviation increase in unionism would lower vacancy rates by less than 10% of a standard-deviation (i.e., .0029 out of .031) at most. But a comparable change in firm size would lower vacancy rates by -.11 to -.32, either of which would constitute a change of several standard deviations in vacancy rates! The large negative effects of firm size on overall vacancy rates that we observed in Table 2 are thus confirmed here as well. Standard-deviation changes in turnover and hiring generate changes in vacancy rates of one-fourth or one-fifth of a standard deviation, and those in sales would generate even smaller effects.

Turning to the results in part B of Table 3 for 1982, we find a generally similar pattern of effects. Comparing them to 1980, we find larger negative effects of unionism, smaller negative effects of firm size (with larger positive effects on probabilities of having nonzero vacancies), and smaller positive effects of hiring/turnover during the trough of the recession in 1982. Indeed, the negative joint effect of firm size on overall vacancy rates largely disappears in that year.[21]

One possible interpretation of these results is that unionized firms face more cyclically sensitive demand and therefore have many fewer vancies than do other firms in a recession, while other vacancy differentials that are more associated with equilibrium conditions (such as turnover and perhaps firm size) become correspondingly less pronounced. It is also possible that the turnover and hiring measures are measured with greater error in 1982 than in 1980, since the assumption of steady-state turnover on which they are based is far more questionable during the deep recession year of 1982.

Before moving on, we also note that Appendix B contains regression results for specifications comparable to those of Table 3 but estimated using the Tobit form for the whole sample and OLS for those reporting nonzero vacancies. The Tobit results are quite comparable to the Probit results of Table 3, no doubt reflecting the large fraction of observations at the zero limit. But the separate analysis of the nonzero vacancy observations does appear quite reasonable in this light. The similarity between OLS and truncated regression results for the nonzero vacancy sample also suggest that the reported estimates are quite robust, despite the computational difficulties in generating them that were noted above.

Industry and Area Characteristics: Skills and Local Unemployment

In Table 4 we present estimates from vacancy rate equations that include the firm-specific characteristics described above as well as some particular characteristics of the firm's industry and local area. The industry characteristic used here is the weighted mean of average occupational earnings, weighted by occupational shares of each industry; this is used to proxy the demand for skilled labor in any firm. Supply of skilled labor to the firm is measured by fraction of the local labor force with college degrees. We also use local unemployment rates in each year to measure the effect of cyclical swings (or local demand shifts) on the firms' vacancy rates.

The results of Table 4 show that local unemployment rates have consistently negative effects on vacancy rates, though these are only significant for the probability of nonzero vacancies.[22]

The magnitude of the joint effect is not particularly large - a standard-deviation change in unemployment lowers vacancy rates by only about .002,

Table 4

Effects of Industry and Local Area Characteristics on Vacancy Rates

	1980	1982	1980	1982	1980	1982
Industry:						
Occupational Composition	-.215 (.443)	.343 (.433)	.165 (.101)	.105 (.060)	1.149	1.715
Local Area: Fraction with College	-.109 (.875)	.411 (.723)	.077 (.212)	.053 (.110)	-.018	.021
Local Area: Unemployment Rate	-7.269 (2.438)	-3.821 (1.992)	-.171 (.560)	-.031 (.025)	-.114	-.090
- Log L	709.3	769.0	490.9	681.2	-	-

NOTE: All equations include the firm-specific variables from column 2 in Table 3 as controls.

which is a very small fraction of a standard deviation change in vacancy rates. Clearly, demand and supply variations across firms within local areas are far more important than are those between areas.

We also find small and generally insignificant effects of the local supply of college graduates on vacancy rates. In contrast, the effect of the demand for skills in a firm's industry is quite striking - the effect of skills on the conditional vacancy rate is positive and significant at the .10 level. The joint effects indicate that a one standard-deviation change in industry skill level raises vacancy rates by about .10 in 1980 and .14 in 1982, or about one-third to one-half of a standard deviation in vacancy rates.

The larger effect of skill demand on vacancy rates during the recession may indicate a greater cyclicality of demand for less-skilled workers. Still, the presence of a fairly large effect of skills during either part of the business cycle suggests that skill demand also plays an important role in determining vacancies in equilibrium market conditions.

This might reflect the need to screen applicants for jobs with greater skill requirements more extensively, as well as the greater amount of time needed for recruiting qualified applicants for these positions.[23] Any imbalance or "mismatch" between demand and supply of these skills would be reflected in the latter factor.

Furthermore, a significant outward shift in the demand for skilled labor, as we have apparently experienced in the 1980's in U.S. labor markets, could significantly raise vacancy rates in firms and industries using large quantities of skilled labor. [24] It is thus at least possible that vacancy rates for particular occupations and industries during the late 1980's or 1990's could be substantially higher than those presented here for 1980 and

1982, and that some degree of "skill mismatch" might be represented in these rates.

Effects of Wage Premia

The negative effects of unionism and firm size on vacancy rates that were observed in Tables 2 and 3 above raise the question of exactly what mechanism is driving these results. Is it the relatively high wages at these firms that not only reduce vacancy frequencies (by reducing turnover and perhaps desired employment growth) but also vacancy durations (by enabling the firm to attract a larger quantity and quality of workers for any given vacancy)? Is it other nonwage characteristics of these firms (e.g., grievance procedures and security at unionized firms) that make it easier for them to attract qualified applicants and fill vacant jobs? Is it other differences in firm search, such as more extensive recruiting behavior?

While our ability to provide definitive answers to these questions is somewhat limited, some evidence on the issue appears in Table 5. Here we present results from vacancy rate equations which include a measure of the wage premium at the firm: the starting wage of the most recently hired employee, controlling for observable characteristics of the employee and job.

Since the wage offered to workers is likely to be quite endogenous with respect to vacancy rates (with high rates generating upward pressure on wages), we use the predicted rather than the actual log of starting wages as our independent variable here. Ordinary least squares equations were used to generate these wage predictions as functions of the worker's age, sex, education, experience, occupation, and year hired as well as the firm's fraction unionized, size, and industry. All personal characteristics are then used as controls in every vacancy rate equation, while different firm

characteristics are used to identify the vacancy equation in different specifications.

The results of Table 5 show that the effect of a firm's wage level on its vacancies depends very much on which characteristics of the firm are used to identify the vacancy equation. In particular, effects on vacancy probabilities are positive and those on conditional vacancy rates are negative, as are joint effects, so long as unionism and firm size are not controlled for. These results are stronger in the recession year of 1982 than in 1980, and they even rise with the inclusion of industry dummies as controls. The magnitudes are also quite striking - a standard-deviation change in predicted wages (equal to about .3) generates overall vacancy rate changes of about .45 to almost 1.4 - i.e., many standard deviations in vacancy rates.

But the inclusion of firm size in 1980 and of either firm size or unionism in 1982 dramatically reduces or even reverses the signs on these observed effects. Thus, unionism and firm size seem to fully account for the tendency of high-wage firms to have lower vacancy rates. On the other hand, the converse is not true - the presence of a wage term in these regressions does not dramatically reduce the coefficients on unionism and firm size, relative to what we observe in Table 3.

Furthermore, results were quite comparable to these when our measures of intensity of recruiting effort or applications per opening (described in Section III above) were used instead of the starting wage of the most recent worker.[25] Also, the inclusion of turnover, hiring rates, etc. as additional controls did not fundamentally change these results.

We therefore conclude that large and/or unionized firms clearly have lower vacancy rates, though the exact mechanism through which these effects

Table 5

Effects of Firm-level Wage Premia on Vacancy Rates

A. 1980 Results

	Probits			Truncated Regs.			Joint Effects		
	1	2	3	1	2	3	1	2	3
Wages	.609 (.333)	-.103 (.273)	.109 (.353)	-.386 (.286)	.092 (.068)	.168 (.076)	-1.536	.427	1.170
Fraction Union	-.041 (.193)	-	-.188 (.199)	-.344 (.193)	-	-.039 (.046)	-.036	-	-.040
Firm Size	-	.224 (.033)	.227 (.034)	-	-.146 (.011)	-.113 (.009)	-	-.230	-.135
Industry	no	no	no	no	no	no			
- Log L	591.76	568.6	568.1	280.2	383.5	373.6	-	-	-

B. 1982 Results

	Probits					Truncated Regs.					Joint Effects				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Wages	.401 (.240)	.894 (.361)	.849 (.320)	-.450 (.273)	.112 (.346)	-.591 (.206)	-.951 (.251)	-.144 (.144)	.058 (.028)	.089 (.036)	-3.077	-4.610	.269	-.260	.699
Fraction Union	-	-	-.422 (.201)	-	-.544 (.206)	-	-	-.147 (.111)	-	-.041 (.028)	-	-	-.023		-.015
Firm Size	-	-	-	.288 (.036)	.294 (.036)	-	-	-	-.090 (.005)	-.090 (.005)	-	-	-	-.024	-.018
Industry	no	yes	no	no	no	no	yes	no	no	no	-	-	-	-	-
- Log L	646.1	640.2	643.8	612.3	608.8	425.2	441.6	422.1	571.7	572.8	-	-	-	-	-

NOTE: The wage variable is a predicted value, based on the log of the starting wage of the last worker hired by the firm before or during 1981. Besides the determinants of wages that are reported in the table, other variables used to predict wages and included here as controls are age, sex, occupation, experience and year hired for the last worker. Sample size is 1533 for this table.

occur is unclear. High-wage firms or industries per se do not seem to generate the same effects. These results are consistent with those of Holzer et.al., who show that large firms (and, to a lesser extent, unionized ones) attract large applicant flows independently of their wage levels. Perhaps size affects the quality as well as quantity of applications, where the two are correlated but the former is unobserved; and it is possible that jobs in large firms are more attractive for other reasons besides their starting wages (such as security, benefits, promotion chances, etc.). Whatever the reason, we note that large and/or unionized firms have low vacancy rates for reasons that are not totally apparent here.

V. Conclusion

In this paper I present some evidence on the magnitudes and determinants of job vacancy rates at the firm level, using data from the 1980 and 1982 EOPP Surveys of Firms. I have estimated separate effects of firm, industry, and area characteristics on the probabilities of having nonzero vacancy rates and on the conditional vacancy rates for those with rates above zero. The joint effects of these characteristics on overall vacancy rates are also presented.

The results show that overall job vacancy rates are low but that there is substantial variation in these rates across firms, occupations, and industries. The average demand for skills in an industry, as measured by its occupational composition, has a strong positive effect on vacancy rates. This could have important implications for vacancy rates in the 1990's, as the demand for skills in our labor force appears to have shifted out in recent years. Local and aggregate unemployment rates also have negative effects on vacancy rates, as most models of the job matching process predict.

Among firm-specific factors, large and/or unionized firms have relatively low overall vacancy rates, though the results vary somewhat over the business cycle and with the particular version of the vacancy measure considered (i.e.,nonzero vacancy probabilities as opposed to the conditional means).

While there are many potential reasons for the effects of unionism and size on vacancy rates, we could not successfully sort out the mechanisms through which these effects occur. We explicitly consider the role of wage premia here. These had generally negative effects on vacancy rates, but these weakened substantially when firm size and (in some cases) unionism were controlled for. The results thus suggest that unionism and firm size can account for the effect of firms' wages on vacancies, though the converse does not appear to be true. Comparable results for recruiting behavior and applicant flows facing firms were also obtained (though not presented here).

Finally, we note that turnover rates, sales growth, and gross hiring activity all had positive effects on vacancy rates, presumably through their effects on vacancy frequency.

Overall, these results suggest that many different characteristics of firms and their labor or product markets influence their success in the matching process. While data availability clearly limits what can be further done in this area, it seems as though a great deal more can be learned about the job matching process and potential structural problems from this line of inquiry.

Appendix A

Means (S.D.'s) on Independent Variables

	1980	1982
Fraction Union	.109 (.287)	.107 (.281)
Firm Size	2.818 (1.400)	2.825 (1.332)
Turnover Rate	.057 (.098)	.200 (.213)
Hiring Rate	.087 (.124)	.158 (156)
Sales Growth	.016 (.225)	-
Occupational Index of Industries	9.529 (.084)	9.577 (.084)
Local Fraction of College Grads	.143 (.046)	.143 (.046)
Local Unemployment	.070 (.017)	.104 (.019)

NOTE: Turnover includes quits and discharges. The turnover and (gross) hiring rates for 1980 and 1982 are based on the last three months of 1979 and the year 1981 respectively. Firm size appears in logs. The occupational index (described in the text) and local characteristics are based on 1980 Census data. These means are unweighted.

Appendix B

Alternative Specifications for Equations with Firm-Specific Effects

	Tobits		OLS on Truncated Sample	
	1980	1982	1980	1982
Constant	-.365 (.033)	-.259 (.023)	.326 (.016)	.246 (.011)
Fraction Union	-.045 (.032)	-.059 (.023)	.014 (.019)	.005 (.013)
Firm Size	.032 (.006)	.030 (.005)	-.058 (.003)	-.044 (.002)
Turnover	.501 (.074)	-	.081 (.039)	-
Hiring Rate	-	.092 (.016)	-	-.009 (.021)
Sales Growth	.073 (.039)	-	.019 (.023)	-
Industry Dummies	yes	yes	yes	yes
- Log L	424.3	343.3	-	-
R^2	-	-	.570	.593

NOTE: See notes for Table 2.

ENDNOTES

1. See Pissarides (1985), Blanchard and Diamond (1989), Sattinger (1990), and Hosios (1990) for some recent examples.

2. Recent efforts in this regard include Abraham (1983) and Abraham and Katz (1986). Earlier efforts date back to Dow and Dicks-Mireaux (1958).

3. An exception is my earlier work (Holzer (1988,1989)) which presented cross-sectional analysis of vacancy and unemployment rates in local labor markets.

4. See Johnson and Layard (1986) for one survey of this literature.

5. Accounts of labor shortages in particular fields (e.g., nursing) and of skilled labor in general abound in the popular press - for example, see The New York Times, "Impending U.S. Jobs Disaster: Work Force Unqualified to Work", p. 1, September 25, 1989. Recent reports by The Hudson Institute (entitled Workforce 2000) and the Labor Department's Commission on Workforce Quality and Labor Market Efficiency (entitled Investing in People) also stress current and projected future shortages of skilled workers. Yet the evidence of these shortages remains quite sparse. See Levitan (1989) for a critical discussion of these issues.

6. The 1980 wave of the survey was administered to about 5300 firms, while the sample size of the followup was reduced to about 3400. About half of the 28 sites were SMSA's and the rest were county groups. They were heavily concentrated in the South and mid-West; see Holzer (1989) for a complete listing. Within each site, large and/or low-wage firms were oversampled.

7. Recent contributions to this literature have modified these relationships and specified the nature of these cyclical and structural shifts in a variety of ways. Thus, Pissarides models these shifts as multiplicative shocks to the value of output which directly affect the value of jobs and thus vacancies; while Blanchard and Diamond model the creation and destruction of productive jobs, in combinations that can be either cyclical or structural. The fundamental characteristics of the basic model are not substantially altered by these modifications.

8. Under the appropriate assumptions, the expected duration of a vacancy is the inverse of the probability that a vacancy will be filled in a given period (i.e., $V/f(U,V,Z)$), which in turn reflects the joint probabilities of applications being filed and offers being made and accepted.

9. See Jackman et. al. for an analysis of how "mismatch" measures, search effort, etc. affect vacancy durations over time.

10. Choices of wage offers by the firm would then be analogous to choices of reservation wages by searching workers.

11. The index is a weighted average of mean occupational wages where the weight on each is the fraction of employment in the industry accounted for by that occupation - i.e., $\sum_i s_{ij} * w_i$, where i denotes occupation and j denote industry, w denotes wage and s denote occupational shares of each industry.

12. Though the industry and local characteristics are themselves sample means drawn from survey data, the large samples on which published Census data are based (i.e., 1 in 6 for the 1980 Census of Population) tend to mitigate this concern. The labor force data are based on published county-level unemployment and education levels, since each local area is defined as a county group.

13. Vacancies were not gauged in the 1980 survey for the professional, technical, and managerial categories of employees. These categories are therefore also omitted from the number of employees in the firm when calculating vacancy rates. Since 1982 vacancies are gauged for all employees in the firm, vacancy rate calculations in that year are based on total firm size. This discrepancy between the two measures must therefore be kept in mind when interpreting the results.

14. Since the empirical evidence strongly suggests that quits are procyclical, and since the recession worsened between 1981 and 1982, turnover rates calculated for the latter year are likely to be downward biased. The mild recession during the spring and summer of 1980 (when the surveys were being administered) may create a similar problem for the 1980 data.

15. The real sales growth measures are based on a single retrospective question while the employment growth measures are based on questions for separate points in time. Measurement error is thus likely to be exacerbated in the latter (Freeman, 1984). On the other hand, given the longer time periods over which the questions are being asked, the problem of endogeneity with either measure should not be severe.

16. The recruiting period for these jobs was defined in the survey as the time between the firm's first efforts to fill a vacant job and the time when the employee first began working. Since some time may have elapsed between the time when the worker was hired and the time when he/she began to work, the measure of the recruiting period may contain some error. Furthermore, it was not used as an explicit measure of vacancy duration since it is so highly correlated with characteristics of the job in question. These unmeasured job characteristics are likely to be correlated with other characteristics of the firm that appear as independent variables, thereby producing seriously biased parameter estimates in vacancy duration equations.

17. Given the absence of data on professional and managerial workers from the 1980 rate, the comparison across years is somewhat problematic. If the omitted groups have higher vacancy rates than the included ones for 1980,

the variation in vacancies over the cycle would be increased; otherwise, it might be reduced. Since it is reasonable to assume that professional and managerial workers might have lower vacancy frequencies (due to lower turnover) but longer durations (due to more careful screening, etc.), the net effect on estimated vacancy rates is unclear.

18. Most of the estimates cited by Abraham (p. 216) do not disaggregate the blue-collar category into specific one-digit occupations. Yet the data in Table 1 suggest a great deal of variation between craft and operative vacancy rates. Abraham's data on 1-digit occupations within the white-collar category do suggest some fairly substantial variation across these categories in vacancy rates.

19. Since the focus of Holzer (1989) is on local labor markets, summary statistics are generally sample- and size-weighted there. Though certain occupation-specific rates reported there are higher than those contained here (e.g., vacancy rates for crafts and sales in the former are .020 and .025 respectively), the overall magnitudes and comparisons across occupations are very consistent with those presented here.

20. See Roper (1986) for a discussion of differences in firm's propensities to list vacancies with the Employment Service in Britain.

21. The disappearance of the firm size effect on overall vacancy rates for 1982 (though it remains for conditional vacancy rates) is fairly consistent with the results of Table 2, which show no real trend in vacancy rates for that year for firms with sizes of 20 or less. These constitute well over half of the sample. We also note that the fairly strong positive correlation between firm size and unionism (rho=.3) implies a weakening of the partial firm size effect as the unionism effect strengthens.

22. See Footnote 12 above.

23. See Barron et. al. (1985) for an analysis (using these data) of the time needed for recruiting and screening job applicants.

24. See Blackburn et. al. (1989) and Bound and Johnson (1989) for discussions of how demand for labor has shifted away from the less-skilled towards the more highly skilled in the 1980's.

25. More detail on estimated results using recruiting activity and application rates are available upon request from the author.

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